PICES-2025

BOOK OF ABSTRACTS

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KEYNOTE SPEAKER

What have we done and where should we go? -The role of PICES for the North Pacific marine science and human well-being

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PICES was founded as intergovernmental marine scientific organization in 1990. The founders of PICES opted against fisheries resource assessments because of the conflict among member states over the exploitation of fisheries resources. This pragmatic and wise decision not only enabled the establishment but also made PICES as a platform for pure scientific discussion, enhancing international science collaboration and expanding the human network. The 1990s was also the era when interdisciplinary marine scientific research began to flourish, thanks to the theory by Cushing and Kawasaki on the connection between climate and fishery production, Martin's iron hypothesis, JGOFS monitoring program, etc. Climate Change and Carrying Capacity Scientific Program (CCCC) was launched in 1995 as the first integrated Science Program in PICES, and various interdisciplinary expert groups such as Task Team on Conceptual/Theoretical and Modeling Studies (1995-2009), Advisory Panel on Iron Fertilization Experiment in the Subarctic Pacific Ocean (1998-2007), led marine sciences.

In face of increasing anthropogenic environment changes, PICES started the 2nd integrated Science Program FUTURE (Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems) in 2009. In addition to the challenges of natural science, FUTURE aimed to solve social issues based on an understanding of the status of the North Pacific and forecasting the future. To accelerate communication with society, Human Dimensions Committee was established in 2016. FUTURE and related expert groups have contributed to significantly raising PICES's standing as a preeminent scientific organization engaged in inter- and transdisciplinary marine sciences has been greatly enhanced by FUTURE and associated expert groups in the global academic arena.

The Earth is on the planetary boundary, which are thresholds that enable humanity to survive and thrive for future generations. It is estimated that several boundaries have been crossed the thresholds. Tremendous efforts of scientists have been made to prepare best scientific knowledge for decision making through such as IPCC, CBD, Global Plastic Treaty, etc. Under the critical condition, the United Nations has declared the years 2021-2030 as the UN Decade of Ocean Science for Sustainable Development. Without a doubt, PICES must play a role in these international science-society cooperative initiatives. But, how? We ought to stand on the uniqueness of the PICES as well as the past success and impediments experienced. I'll review PICES's previous scientific endeavors in the presentation and offer some suggestions for future activities regarding to 1) disciplinary and inter-/transdisciplinary science, 2) nurturing the next generation of scientists, and 3) the uniqueness of PICES as a scientific platform for international scientific cooperation.

SESSION 1: Science Board Symposium

Innovative Approaches and Applications to Foster Resilience in North Pacific Ecosystems

Oral Presentations

S01, AbstractID= 18891, (ECOP)

PICES-2023 Zhu-Peterson Early Career Scientist Award winner

From dreaming to doing: My journey with mentors

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This talk will present both my previous and on-going research within the PICES realm, focusing on the analysis of sinking particles and sediment samples collected using sediment traps and boxcore in the Ulleung Basin, located in the southwestern part of the East/Japan Sea (EJS). These data are being used to better understand the dynamics of carbon cycling and the efficiency of the biological carbon pump (BCP) in the EJS.

With deep appreciation for my collaborators, a wide range of tracers has been analyzed-ranging from basic biogeochemical properties to various organic and inorganic isotopes. These multidisciplinary efforts have significantly enriched the scope of the research. In addition to sharing my scientific findings, I will also highlight the invaluable role that mentors and senior colleagues have played throughout my research journey. Their guidance and support have not only shaped my scientific development but have also inspired me to pursue ambitious goals.

Through this talk, I hope to emphasize the critical importance of mentorship for early-career scientists and how such relationships can help turn dreams into reality in the world of research.

S01, AbstractID= 18892, (ECOP)

PICES-2024 Zhu-Peterson Early Career Scientist Award winner

Shifting the narrative of meaningful early-career engagement in global science-policy collaborations

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With the UN Decade of Ocean Science for Sustainable Development (2021-2030) reaching its midway point, early career ocean professionals (ECOPs) have emerged as a strong and influential force since 2019. The global, interdisciplinary, and cross-sectoral community they have nurtured is redefining the concept of 'meaningful engagement' in international scientific collaborations and knowledge-policy-society interfaces. Encouragingly, recognition of the value of involving early-career professionals in positions of trust within national and international organizations and initiatives (e.g., ICES, PICES, IPOS, APN), collaborative research projects, networks, and working groups is growing. Momentum remains strong, yet persistent structural, financial, and cultural barriers still hinder equitable participation, as evidenced by a comparative analysis of needs-assessment surveys across Asia, Africa, and Central America between 2022 and 2024. ECOP-led workshops, position papers, training sessions, policy briefs, and other forms of knowledge translation are offering co-developed guidelines and practical recommendations to support meaningful ECOP engagement across a wide range of academic and professional contexts.

This presentation will highlight the latest achievements, insights, and solutions co-developed by ECOPs and institutional partners and conveyed through publications, strategic communications, and interventions at high-level ocean conferences. Driven by a shared passion and purpose for social impact and measurable change, early-career professionals are mobilizing a shift in research cultures and engagement narratives that will benefit the long-term success of both individual researchers, their institutions, and science itself.

S01, Awardee, AbstractID=18566, (ECOP)

2025 FUTURE ECOP SEES Award Winner

Spatial transitions of coastal fishing infrastructure and socio-ecological systems in Hokkaidō, Japan

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This study explores the spatial transitions of coastal fishing infrastructure in Hokkaido, Japan, with the aim of understanding how local socio-ecological systems (SES) respond to regional environmental variability and socio-economic change. In particular, we focus on traditional fishing facilities—known locally as *ban'ya*—that historically functioned as seasonal operational bases for small-scale fisheries. Their spatial decline is hypothesized to reflect not only long-term structural transformations in coastal communities but also short-term variability in environmental and socio-economic conditions.

Our methodology combines GIS-based spatial analysis with local ecological knowledge gathered through field interviews and archival sources. Phase I involves mapping past and present locations of *ban'ya* using aerial imagery and historical data. Phase II analyzes changes in socio-economic indicators such as population trends, industrial shifts, and coastal land use. Preliminary results from the Shiretoko Peninsula suggest regionally distinct patterns of loss and persistence, shaped by both ecological exposures and community adaptability.

By extending this analysis to the entire coastline of Hokkaido, we aim to reveal how different forms of variability—such as sea surface temperature fluctuations or fisheries activity—interact with broader processes of change. We argue that the decline of *ban'ya* may serve as a sensitive indicator of coupled socio-ecological transformation in the North Pacific coastal regions. This presentation highlights the project's initial findings and reflects on the methodological potential of integrating spatial and qualitative approaches in SES research.

S01, Oral, AbstractID=18165, (ECOP)

Movement-informed projections of Bristol Bay red king crab predict seasonal shifts in distribution to inform spatial management decisions

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Understanding seasonal shifts in the spatial distribution of Bristol Bay red king crab (BB RKC) is essential to developing adaptive management strategies that promote sustainable harvest. Although fishery harvests suggest a substantial shift in the distribution of male crab between late spring (when fishery-independent bottom trawl surveys occur) and autumn-winter (during the directed fishery), the environmental drivers underlying this shift and the autumn-winter distribution are not well characterized. In this study, we fit an advection-diffusion model of mature male RKC seasonal movements to satellite tag data to estimate the habitat preferences of migrating crab. We then used estimated preference parameters and annually varying environmental data to project the distribution of the RKC stock from the late spring to the autumn from 2005-2023, and evaluated the similarities between these projected distributions and directed fishery catches through spatial overlap analysis. Our habitat preference model suggested that late spring to autumn RKC movements were explained by a preference for cooler temperature habitats in central Bristol Bay, with preference for shallow habitats at low tidal current velocities and deeper waters at higher velocities. We found that projections of seasonal BB RKC distributions estimated from the movement model could skillfully predict interannual variation in fishery catch per unit effort. Our results offer new insights into the environmental drivers of seasonal Bristol Bay RKC movements and demonstrate the utility of movement-integrated species distribution modeling for seasonal projection of animal distributions.

S01, Oral, AbstractID=18178

Near real-time monitoring from mobile oceanographic platforms for dynamic management of acoustically active taxa

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Many marine taxa are detectable by autonomous platforms capable of transmitting detection data to shore in near real-time. Making use of detections in management requires collaboration among scientists, policy-makers and managers. Here we present two new papers describing a decade of experience integrating glider detections into government-led dynamic management operations to protect whales from human activities. An informal network of oceanographers interested in whale conservation deployed gliders with near real-time acoustic detection and species classification capability along the migratory route of an endangered whale that uses both Canadian and US waters. Glider detections have been applied in six management contexts, including to trigger dynamic vessel speed restrictions and dynamic fishery area closures. We focus on a first-of-its-kind operation in Dynamic Shipping Zones (DSZs), where we collaborated with federal partners to design and implement a glider-triggered dynamic vessel speed restriction strategy. Across 580 glider survey days, 30 near real-time acoustic detections of endangered whales triggered 194 days of mandatory 10-knot vessel speed limits in three DSZs. We found a high degree of interannual and seasonal variation in whale acoustic occurrence and vessel slowdowns in the DSZs. Gliders were more effective than aerial whale surveillance at triggering slowdowns by a factor of 2–5 during fall and summer, but were less effective during spring when whales call less often. Our results show that gliders are effective monitoring platforms that can support dynamic ocean management goals. This technology is transportable, and long battery life means it can be used in most ocean regions.

S01, Oral, AbstractID=18242, (ECOP)

Development of a deep learning-driven framework to analyze fishing vessel activities using automatic identification system data

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The large volume of Automatic Identification System (AIS) data provides a valuable opportunity to monitor vessel behavior, thereby helping to address the spatial and temporal limitations of traditional catch data. This necessitates the extraction of meaningful information from AIS records. In this study, we develop a comprehensive framework that integrates deep learning techniques to analyze marine fishing activities using AIS data in conjunction with environmental variables. First, we employ a transformer-based model combined with a majority voting strategy to classify fishing vessels types. This approach effectively handles AIS sequences of varying lengths and achieves an accuracy exceeding 90%. We then apply the Temporal K-Means algorithm to capture the temporal patterns in AIS time-series data and identify fishing behavior. The inferred fishing hours are subsequently mapped onto spatial grids, enabling us to explore the relationship between fishing activity and environmental factors. Correlation analyses reveal distinct environmental preferences across vessel types, which shape their spatial distributions. We find that the spatial distribution of different vessel types reflects the distribution of their target species. Therefore, the observed relationships between fishing activity and environmental variables may also serve as proxies for the habitat preferences of the target fish species. Overall, the proposed framework provides a coherent and scalable pipeline for extracting meaningful insights from AIS data, enhancing our understanding of fishing dynamics, and offering valuable guidance for fisheries management and policy formulation.

S01, Oral, AbstractID=18276, (ECOP)

Effort in, assessment confidence out: Does survey effort matter to stock assessment outcomes

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Fishery-independent surveys provide information on fish stock biomass and composition (e.g., size, age, sex) and broader ecosystem dynamics that are utilized in stock assessments. These surveys are central to monitoring ecosystem change and informing sustainable fisheries management under climate-driven pressures such as ocean warming, acidification, and increasing variability in ocean conditions. However, surveys are subject to disruption by weather conditions, shifting institutional priorities, and resource constraints (e.g. increased operational costs, decreased funding)—factors that may compromise their reliability over time. The ramifications of these inconsistencies on stock assessments are frequently alluded to but infrequently quantified. Given the significant resources that support surveys, it is important to understand them so that we may more efficiently allocate survey effort. To address the knowledge gap, we conducted a case study evaluating the relationship between stock assessment uncertainty and survey effort, as well as the relative importance of survey data in stock assessments for a set of species monitored by the U.S. West Coast Groundfish Bottom Trawl Survey. Recognizing the usefulness of our workflow to others exploring survey design changes, we decided to turn our workflow into an open-source R package - {surveyresamplr}. This presentation will share the preliminary findings of our case study and provide an introduction to the functionality and applications of {surveyresamplr}. By creating not just a case study, but reproducible tools and workflows, this work contributes to more adaptive and resilient fisheries science in the face of climate variability and resource constraints—an essential step toward sustainable ecosystem management.

S01, Oral, AbstractID=18540

"Salmon are life" - Indigenous knowledge and ecosystem stewardship along the Kuskokwim River

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Indigenous and rural communities in the Kuskokwim River watershed in Western Alaska are experiencing unprecedented multi-year, multi-species salmon collapses, with negative impacts to people, cultures, and ecosystems. While communities within the Kuskokwim watershed are among those most impacted by salmon declines and climate change, these communities continue to be disproportionately underrepresented in fisheries decision-making processes that manage the marine stage of Kuskokwim salmon life cycles. As one step to build equity in federal fisheries management and resilience for salmon and salmon dependent communities, the Kuskokwim River Inter-Tribal Fish Commission, in collaboration with the University of Alaska Fairbanks Tamamta Program and Ocean Conservancy, hosted a series of in-person workshops and interviews with Indigenous Knowledge Holders and Elders from the Kuskokwim to document their Knowledge of Kuskokwim River salmon ecology and potential causes of salmon declines; traditional salmon stewardship principles; and recommendations for enhancing equity in salmon management. Results from this project emphasize that Indigenous Knowledge systems and traditional teachings can and should play a vital role in ecosystem based management and stewardship in Alaska fisheries management. Kuskokwim Knowledge Holders shared that "salmon are life," and emphasized "we must avoid wasting fish and polluting the environment" and attributed salmon declines in salmon size and abundance to "trawling (bycatch & habitat impacts), pollution, climate change, and former Kuskokwim commercial fisheries." This presentation will summarize this project's co-production process, results, and management recommendations for building resilient fisheries management systems that are more inclusive of communities, diverse knowledge and data, and holistic ecosystem considerations.

S01, Oral, AbstractID=18649

Tritium in the western North Pacific: Natural tendencies and new challenges

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Tritium (3H) is a low-energy beta-emitting radioisotope of natural (cosmogenic) and man-made (technogenic) origin, present in the environment mainly as part of water molecules. Its content in the Earth's atmosphere, on land and in the ocean has increased by orders of magnitude since the start of nuclear weapons testing in the second half of the 1940s. After their restriction by the 1963 Partial Nuclear Ban Treaty, tritium releases into the environment decreased but did not stop. The source of man-made tritium remains nuclear power plants, spent nuclear fuel reprocessing plants, regulated discharges, uncontrolled leaks and accidental emissions. A widely discussed source of tritium at the moment is the discharge into the Pacific Ocean of water accumulated after the accident at the Fukushima-1 nuclear power plant, which began in 2023. We collected samples and measured tritium concentrations in the northwestern Pacific Ocean and its marginal seas in 2012 and 2022–2024 during five research cruises. Observations showed that tritium content in surface ocean samples has decreased to the level of the early 1950s (about 0.3–0.5 TU). Elevated values of up to 1.0–2.5 TU are observed near the continent and islands and are associated with the influence of land waters, in which the tritium content is significantly higher. To assess the contribution of the discharge of waters accumulated at the Fukushima-1 NPP, we preliminarily modeled the propagation of water particles from the Fukushima coast into the ocean. Shipboard observations confirmed the capture of waters by the main stream of the Kuroshio Extension and mesoscale eddies in the area east of Japan with a maximum of up to 0.78 TU. At the same time, the tritium content in the southwestern part of the Sea of Okhotsk exceeded 1.0-1.5 TE, which is obviously due to the influence of the Amur River runoff. Thus, the impact of the discharge of Fukushima waters on the Pacific Ocean to the east of Japan can be considered insignificant. However, continued monitoring is necessary.

S01, Oral, AbstractID=18668, (ECOP)

Recreational fisheries as indicators of change: Species range shifts from NOAA's Marine Recreational Information Program paired with economic trends

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In response to global climate change, many marine fish species are shifting their distributions poleward and into deeper, cooler, and more oxygenated waters. Most studies examining these range and distribution shifts rely on fishery-independent surveys or fishery-dependent data from commercial fisheries. However, stock assessments in the United States also incorporate data from NOAA's Marine Recreational Information Program (MRIP), a long-term intercept survey that collects dockside and phone-based data to estimate recreational fishing effort and landings, with continuous coverage since 1981. In this study, we use MRIP data to quantify latitudinal and range shifts in four marine species: black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), and scup (*Stenotomus chrysops*). These species are either structure-associated and difficult to sample with traditional methods, underrepresented in standardized trawl surveys, or not targeted by U.S. commercial fisheries. Additionally, we evaluate changes in the economic contribution of marine recreational fishing by state over this period, using value-added estimates. Our results indicate that recreational fisheries data can effectively complement existing survey frameworks, particularly for species poorly captured by conventional methods. We also suggest that MRIP data can serve as an indicator of climate-driven species redistribution and associated economic impacts. Importantly, the methodology presented here is transferable to other regions that contain robust recreational survey programs. By linking climate change, ecosystem responses, and economic outcomes, this study highlights the importance of integrating diverse data streams into adaptive, ecosystem-based management. We recommend further investigation into the sensitivity of recreational and other datasets for detecting early signals of ecological change, which can support proactive and resilient fisheries governance.

SESSION 1 – Science Board Symposium

Innovative Approaches and Applications to Foster Resilience in North Pacific Ecosystems

Poster Presentations

S01, QR Poster, AbstractID=18203, PosterID: S01-P1, (ECOP)

Studies on the use of locally available renewable seaweed wastes from Cox's Bazar and Saint Martin as compost organic fertilizer resources

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This study evaluates the potential of *Hypnea* species, a red seaweed prevalent along the coasts of Cox's Bazar and Saint Martin, Bangladesh, as a sustainable source for organic compost fertilizer. *Hypnea*'s nutrient profile includes high levels of potassium (K), nitrogen (N), and phosphorus (P), alongside micronutrients such as iron (Fe), zinc (Zn), and manganese (Mn), as well as bioactive compounds like carrageenan, auxins, and cytokinins. These characteristics make it beneficial for enhancing soil health, promoting plant growth, and increasing crop yield. The composting process for *Hypnea* is efficient, marked by rapid biodegradation and active microbial involvement, resulting in nutrient-rich humus that enhances soil structure, moisture retention, and pH balance, while improving plant resistance to stressors like drought and salinity. A six-month field experiment conducted in the Khasia farming community of Sreemangal assessed three treatments: T1 (control with standard farming practices), T2 (25 g of seaweed-based compost per support tree), and T3 (50 g of seaweed-based compost per support tree). The highest yield was observed in T3, with an average of 2880 betel leaves plucked per day, significantly surpassing T1 and T2, which both recorded 2780 leaves. Analysis of variance (ANOVA) analysis confirmed the statistical significance of these results (F-statistic: 14822.79; p-value ≈ 8.84 × 10^-42). The findings underscore that applying 50 g of seaweed-based compost per tree significantly boosts betel leaf yield, demonstrating the practice's economic viability by reducing reliance on chemical fertilizers and cutting agricultural costs, aligning with sustainable development goals and the blue economy framework. Challenges such as salinity management, seasonal availability, and contamination prevention are noted, with recommendations for future research including optimization of composting techniques and long-term trials. This study advocates for integrating traditional knowledge with modern composting to foster sustainable, productive agricultural practices.

Keywords Betel leaf yield . Hypnea species . Khasia farming community . Organic compost fertilizer . Sustainable agriculture

S01, Poster, AbstractID=18363, PosterID: S01-P2, (ECOP)

Improving costal marine habitats in the northern Yellow Sea: The role of artificial reefs on macrobenthic communities and eco-exergy

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The deployment of artificial reefs can significantly enhance coastal ecosystems and restore biological resources, serving as a crucial method for the recovery of nearshore marine habitats and fisheries. Macrobenthos, which play a crucial role in marine ecosystems, are particularly sensitive to environmental variations. Understanding the community dynamics and thermodynamic indicators of macrobenthos in different reef habitats is therefore essential for assessing the ecological effects of artificial reef construction. This study, based on data from the northern coastal areas of the Yellow Sea, examines the differences in community structure and ecological integrity of macrobenthos across different types of artificial reef habits and natural habitats in the region. The results indicate that both seasonal changes and reef types significantly influence the composition of macrobenthic communities. While the construction of artificial reefs did not alter the dominant species of macrobenthos, it did change their relative abundance. Notably, artificial reef habitats showed significantly higher species richness, abundance, biodiversity, and eco-exergy of macrobenthic communities compared to natural habitats, with rock artificial reefs exhibiting the most pronounced differences. This study demonstrates that the construction of artificial reefs enhances the diversity and ecological integrity of macrobenthic communities in adjacent waters, providing crucial data for understanding how these communities respond to different types of artificial reefs and offering a comprehensive insight into the ecological benefit of artificial reef habitat construction.

S01, Poster, AbstractID=18447, PosterID: S01-P3, (ECOP)

The pelagic species trait database: An open data resource to support trait-based ocean research

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Trait-based frameworks are increasingly useful for predicting how ecological communities respond to ongoing global change. As species range shifts result in encounters between new predator and prey pairs, identifying prey 'guilds', based on a suite of shared traits, can simplify complex species interactions and assist with predicting food web dynamics. To promote advances in trait-based research in open-ocean systems, we present the Pelagic Species Trait Database, a comprehensive resource synthesizing functional traits of many pelagic fish and invertebrate species in a single, open-source repository. We used literature sources, online resources, and species images to collate traits for 521 pelagic species describing 1) habitat use and behavior, 2) morphology and morphometrics, 3) nutritional quality, and 4) population status information. Species in the database are primarily from the California Current system (CCS) and broader NE Pacific Ocean, but also include globally important pelagic species known to be consumed by top ocean predators from other ocean basins. We share examples of how the trait database is implemented to better understand the complex foraging dynamics of a highly migratory pelagic predator, albacore tuna. Consistent habitat, morphological, and nutritional quality traits explain taxonomically complex feeding patterns by albacore tuna and are useful for

predicting future distributions of highly preferred prey for albacore tuna. This database promotes trait-based approaches in marine ecosystems and for predator populations worldwide.

S01, QR-Poster, AbstractID=18546, PosterID: S01-P5, (ECOP)

Effects of oceanographic conditions and longer-term climate patterns on the catch and by-catch rates in Hawai‘i’s longline fisheries

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Oceanographic conditions can affect fisheries performance and bycatch patterns both directly through small scale fluctuations in properties that fish respond to and longer-term processes that influence water mass patterns. We use fisheries observer data on catch rates for more than 20 species caught in the Hawai‘i shallow-set and deep-set longline fisheries to identify how environmental variables drive the occurrence and catch rates of these species. We perform two broad sets of analyses: 1) modeling the associations between environmental variables and catch rates of each species using machine learning techniques, and 2) assessment of hypothesized mechanisms of longer-term (e.g., seasonal and interannual) oceanic drivers of catch rates of target species. Models for the shallow-set swordfish (a‘u kū) fishery indicated that catch rates were partitioned by the North Pacific Transition Zone for many species, while catch rates for many species in the deep-set bigeye tuna (‘ahi) fishery were partitioned by subsurface properties, namely temperature and dissolved oxygen. Further, larger scale atmosphere-ocean processes such as the Pacific Decadal Oscillation showed linkages to variability in swordfish catchability in the shallow-set fishery along the North Pacific Transition Zone. Interannual variability in catchability of bigeye tuna in the deep-set fishery appeared to be more closely associated with the North Pacific Gyre Oscillation (NPGO). The mechanisms linking the latter (bigeye catch to NPGO) remain uncertain, though we believe variability in subsurface dissolved oxygen may be playing a role. The collective goal of this work is to not only establish near-real-time connections between oceanographic conditions and catch rates for fisheries optimization, but also to identify patterns that may be useful for annual scale forecasting.

S01, Poster, AbstractID=18586, PosterID: S01-P6, (ECOP)

Larval dispersal networks between coral reefs in the Nansei Islands, Japan

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For effective conservation of patchy marine habitats such as coral reefs, it is important to understand the ecological networks among habitats via larval dispersal. In the Nansei Islands of Japan, unexpectedly high genetic connectivity has been reported between the southern and northern ends of the archipelago for reef-building corals. This geographically independent connectivity is thought to be driven by the Kuroshio Current's influence on larval transport. However, support from studies combining population genetics and physical oceanography is lacking. In this study, we conducted larval dispersal simulations and population genetic analyses across the Nansei Islands for *Acropora digitifera*, a major reef-building coral. The simulations showed that larvae from the southern tip of the archipelago (Sakishima Islands) were mostly transported by the Kuroshio Current, bypassing the intermediate islands (Okinawa Islands, etc.), and reaching the northern tip (Osumi Islands) with relatively high frequency. Genetic differentiation between sites was more strongly correlated with dispersal probability than with geographic distance. Kume Island, located adjacent to the Kuroshio Current, was identified as a key stepping stone using betweenness centrality. This study provides fundamental insights into larval dispersal along the Kuroshio Current, which are crucial for connectivity-based conservation of corals and potentially other marine organisms.

S01, Poster, AbstractID=18679, PosterID: S01-P7, (ECOP)

Evaluating the economic impact of the allowable-catch transfer system on fishers: A case study of set-net fisheries in Ishikawa prefecture

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In recent years, the releasing of Pacific bluefin tuna at sea has emerged as a critical issue in Japan. The main cause is the strict quota-based resource management system introduced in response to the species' sharp stock decline. Under the Total Allowable Catch (TAC) system—adopted based on international agreements such as those by the Western and Central Pacific Fisheries Commission (WCPFC)—catch limits are allocated to each prefecture and to certain licensed fisheries. However, since tuna migration is highly unpredictable, some areas may experience a sudden influx of fish, quickly exhausting their quotas. Once the quota is exceeded, further catch is prohibited, leading to wasteful releases. To address this issue, Japan introduced a quota transfer system that allows for the flexible redistribution of TAC across regions. Unlike many countries where such transfers involve monetary transactions, Japan and France have implemented a rare non-monetary system. This study evaluates the economic impact of this system using the case of Ishikawa Prefecture's set-net fisheries, where the system is actively used. Using data from tuna release logs, species-specific landings, and quota allocations, the study estimates counterfactual release losses had no transfer system existed. The results from 2019–2023 show significant economic benefits only in 2022 (approximately 74 million yen). One challenge identified is the over-acquisition of quotas by fishers to hedge against uncertainty, leading to underutilization. The study suggests that enhancing the speed and flexibility of quota transfers is key to realizing the intended benefits of the system.

S01, Poster, AbstractID=18716, PosterID: S01-P8, (ECOP)

High-resolution ecological habitat modeling for the US West Coast and its application for place-based resource management

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Making informed decisions about place-based management requires having access to current information about the state and trends of ocean change. However, delivering timely observations for the deep ocean (>200 m) at relevant spatial scales remains challenging. To address this, we developed a high resolution (600 m) benthic habitat model for the United States Exclusive Economic Zone of the West Coast using a top-down, high-resolution clustering approach. The model leverages multivariate environmental data—such as temperature, salinity, dissolved oxygen, particulate organic carbon flux, and benthic terrain—derived from regional oceanographic models and global bathymetry, to identify distinct habitat zones that reflect underlying physical drivers of benthic community composition and variability. To improve interpretability and alignment with existing management frameworks, model outputs were translated into descriptive categories using Coastal and Marine Ecological Classification Standard (CMECS) naming conventions. Our reproducible modeling workflow was used in a hands-on international workshop where participants generated benthic habitat maps for their regions of interest to support decision-making in contexts such as marine protected area (MPA) design, offshore wind development, and sampling designs for new ocean observing efforts to identify and fill information gaps. We are initiating biological validation efforts using species occurrence and community structure data to assess how well the modeled clusters reflect observed ecological patterns. This integrative modeling approach provides a scalable, transparent foundation for supporting ecosystem-based management in deep-sea environments, where in situ data remain sparse.

SESSION 2: BIO/FIS/HD/ POC/MONITOR/FUTURE Topic Session

Changing Ecosystem Structure Under Global Climate Change: Monitoring, Detecting, Modelling, and Socio-Ecological Impacts

Oral Presentations

S02, Invited, AbstractID=18297

Aquatic biodiversity monitoring: ANEMONE and ANEMONE Global

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To assess the current status and potential impacts of drastic and extreme environmental changes on marine ecosystems, long-term monitoring and an effective system to support it are essential. One such systems is the All-Nippon Environmental DNA Monitoring Network (ANEMONE), a nation-wide eDNA-based monitoring network for aquatic biodiversity, launched in Japan in 2019. ANEMONE comprises 77 regular monitoring sites located at coastal areas, rivers, lakes, where water is sampled on weekly, monthly or seasonal bases. Using the MiFish metabarcoding method, the network has so far detected over 1,000 fish species (as of March 2023). ANEMONE is characterized by its inclusivity and openness: it operates through a centralized system, emphasizes open data sharing, and promotes knowledge coproduction among diverse entities beyond academia. In the centralized framework, a hub handles preparation of sampling kits, logistics, laboratory analyses and data dissemination, while local nodes conduct water sampling and filtering following standardized protocols. All data and associated metadata are archived in the publicly accessible database “ANEMONE DB”. ANEMONE has now evolved into ANEMONE Global, an international initiative aimed at building a global eDNA-based biodiversity monitoring network. It promotes internationally standardized protocols, open-data sharing, and serves as a platform for collaborative research, knowledge exchange, and capacity building. This expanding network offers a practical and scalable tool for understanding aquatic biodiversity in both local and global contexts, enhancing not only data availability but also scientific and societal connections.

S02, Invited, AbstractID=18311

Long-term changes in marine heat waves around the Korean peninsula: Impacts on marine ecosystems, fisheries, and societies

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In this talk, I will begin by reviewing recent studies on marine heatwaves (MHWs) in the seas around the Korean Peninsula (KP). Subsequently, I will discuss long-term changes in the characteristics and properties of MHWs, along with their impacts on marine ecosystems, fisheries, and societies. Recent studies suggest that several distinct types of both ocean- and atmosphere-driven MHWs have been generated and dissipated around the KP through various mechanisms. These include, but are not limited to, wind relaxation, mixed layer shoaling, increased solar radiation, horizontal advection, and vertical mixing. A better understanding of the changes in MHW characteristics (such as the pattern of time-depth evolution of temperature anomaly) and their metrics (including cumulative and maximum intensity, frequency, and duration) is crucial. These changes are partly associated with known intraseasonal oscillations and climate variability. Such understanding is essential for our society to effectively manage and adapt to changes in marine ecosystems and fisheries, which are closely linked to the nutrient, carbon, and hydrological cycles of the nearby East Asian marginal seas. During this session, I will present several case studies that provide insights into the known and unknown connections between long-term changes in MHW properties around the KP and their effects on ecosystems, fisheries, and societies. This will emphasize the significance of long-term and continuous observations of key physical processes, such as MHWs, supporting better marine management and climate adaptation.

S02, Oral, AbstractID=18161, (ECOP)

Mind the gap - The need to integrate novel plankton methods alongside ongoing long-term monitoring

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This talk outlines current issues facing sustained long-term plankton monitoring, contrasting modern methods with traditional microscopy, and presents a set of recommendations to integrate these methods and maintaining established monitoring programmes. Changes in plankton have important implications for ecosystem services, including supporting fish stocks, carbon sequestration, nutrient cycling, and oxygen production. Standard long-term plankton monitoring relies on light microscopy to identify and count plankton taxa, with methods fully supported by international standards, providing high quality trusted data. Novel methods, including imaging and molecular, offer means of collecting select types of plankton data efficiently, filling targeted knowledge gaps left by standard monitoring and generating a more complete picture of plankton dynamics. Standard and novel monitoring methods present different advantages and costs, positioning their suitability to address different management needs. Standard plankton monitoring time-series are unique in providing the long-term temporal coverage, and thus statistical power, needed to detect and understand climate change impacts. When explored in parallel with standard monitoring, novel methods open doors to observing our seas from complementary perspectives, but further work is necessary before data from standard and novel methods can be integrated to address policy needs. Marine management priorities are shifting, and novel methods are increasingly proposed as possible alternatives to standard monitoring. However, for a long-term taxonomic perspective it is still essential to retain the specialist skills

and maintain standard monitoring time-series to inform policy assessments of important changes in pelagic biodiversity.

S02, Pre-RecordedOral, AbstractID=18173, (ECOP) (CANCELLED)

Long-term trophic dynamics and biodiversity trends in the Moroccan Mediterranean under fishing pressure

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An ecosystem model of the Moroccan Mediterranean Sea was developed using data from 2000 to 2019 to assess the combined effects of trophic interactions, fishing pressure, and environmental drivers on marine resources. The model is driven by fishing effort and mortality rates and compares predicted outputs with observed biomasses and catches. Model outputs closely align with observed trends for key species: sardine, anchovy, and deep-water rose shrimp showed marked declines, while common octopus, bluefin tuna, and blackspot seabream exhibited biomass increases. These contrasting patterns are expected to influence ecosystem structure through direct and indirect trophic interactions. In particular, increases in non-commercial species at lower trophic levels (e.g., benthic invertebrates) and species with high turnover rates (e.g., cephalopods, benthopelagic fish) suggest the occurrence of trophic cascades, potentially driven by predator and competitor release following the depletion of top predators and small pelagic fish. Ecological indicators reveal a dynamic trajectory over time: the mean trophic level of the community (mTLco, excluding primary producers and detritus), Kempton's biodiversity index (Q), and the Fishing-in-Balance (FIB) index all increased, while the mean trophic level of the catch (mTLc) and Shannon diversity index declined. Moreover, the rising demersal-to-pelagic biomass ratio indicates a relative shift in community composition, with demersal species gaining prominence as small pelagic fish become less abundant.

S02, Oral, AbstractID=18176, (ECOP)

Using the Continuous Plankton Recorder to detect and monitor *Alexandrium catenella* in the Bering Sea

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Warming seas introduce an increased risk of non-native and/or harmful microbes entering the arctic environment, such as food-borne micro-organisms that negatively impact human health directly or indirectly through access to marine food resources. In recent years the Arctic Ocean has seen significant warming trends and changes in circulation, which have been shown to accommodate potentially harmful toxic phytoplankton species and bacteria. By providing the coverage of both the North Pacific and now the boundary conditions between the Arctic, the CPR is ideally suited to tracking these changes. The CPR survey's extended sampling coverage through the Bering Sea and Arctic Ocean detected a summer bloom of *A. catenella* in 2021, a year where, to our knowledge, there were no other oceanographic sampling for the species in the region, and another mega bloom in July 2023. *A. catenella* is a toxin producer that can harm marine organisms and cause Paralytic Shellfish Poisoning (PSP) in humans. *Alexandrium* species are difficult to speciate by light microscopy and two toxic species grow in North American coastal waters, whilst East Atlantic seas contain a mix of toxic and non-toxic species. Molecular techniques have been applied to CPR samples, specifically DNA sequencing of partial Large Ribosomal Sub unit rDNA in CPR samples identified these cells as *A. catenella*. We show the CPR survey can be a useful platform to measure the distribution of harmful algae in a vulnerable but difficult to access environment.

S02, Oral, AbstractID=18176, (ECOP)

Copepod grazing and prokaryotic decomposition amplify the effect of diatom-dinoflagellate regime change on Biological Carbon Pump efficiency

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Copepod fecal pellets (FPs) are an important but highly variable component of the global Biological Carbon Pump (BCP). This study decoupled and quantified how copepod grazing and prokaryotic activities affect BCP efficiency under different phytoplankton dietary regimes. With a diet of diatoms, copepods FP production rates double, FP sinking rates triple, and FP decomposition rates are significantly lower relative to those with dinoflagellate diets. When diatoms are the primary producers, these biological activities synergistically enhance the efficiency of FP exports to the deep ocean. Opportunistic particle-attached (PA) prokaryotes were crucial to FP decomposition. Metagenomic analyses revealed that CAZymes and lysosomal enzyme abundances correlated with FP decomposition rates. These functional enzymes targeting phytoplankton- and copepod intestine-derived macromolecules from the PA prokaryotic communities were key to FP decomposition. Genomic properties of the Planctomycetota revealed that strong motile ability, detoxification systems and macromolecule degradation enzymes enabled the success of these opportunistic PA prokaryotes. Elevated temperatures amplified FP decomposition rates by enhancing enzyme abundances, and especially accelerated the decomposition of FPs composed of dinoflagellates. This reduced BCP efficiency, as rapidly recycled organic materials will remain in surface waters. Our findings highlight the synergistic biological activities amplifying the effects of phytoplankton composition changes on BCP efficiency. This underscores the importance of considering grazing regimes in combination with microbial dynamics in assessing ocean carbon cycling.

S02, Oral, AbstractID=18176, (ECOP)

Ocean freshening driven by warming threatens the Arctic hyperiid amphipod *Themisto libellula*

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Excessive atmospheric CO_2 has led to a rapid increase in temperatures worldwide, with the excess heat being absorbed by the ocean, thereby altering the hydrological cycle. This has resulted in a decrease in seawater salinity. In particular, the Arctic Ocean is projected to experience conspicuous changes in salinity due to changes in the hydrological cycle as well as sea ice melting. The Arctic amphipod, *Themisto libellula*, is widely distributed throughout the Arctic Ocean and plays an important role in the Arctic ecosystem. In this study, we investigated the impact of low salinity on *T. libellula* by analyzing its mortality and exoskeleton traits after 7 days of exposure to three different salinities (34, 29, and 24 psu). The results revealed that mortality reached 100% at 24 psu, highlighting the severe impact of low salinity on survival. We also observed two layers of exoskeleton: the exocuticle and the endocuticle. The thickness ratio of these two layers was not affected by salinity. Salinity did neither influence the elemental composition of the exocuticle and endocuticle. However, the Ca and P content on the exoskeleton surface was higher at 34 psu compared to 29 psu. In contrast, the N content was higher at 29 psu than at 34 psu. These results indicate that ocean freshening induced by warming threatens the survival of *T. libellula*, which could have cascading effects on Arctic marine ecosystems.

S02, Oral, AbstractID=18262, (ECOP)

Exploring public awareness of adaptation to changing marine environment under climate change

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Climate change-induced alterations in the marine environment pose significant risks to regional communities. Public engagement is essential in formulating effective responses, making it important to understand how people perceive and are aware of these changes. This study aims to examine public awareness of adaptation to marine environmental changes and identify the factors influencing such awareness. An online survey was conducted by Rakuten Insight Inc. in February 2025, targeting 2,000 respondents (Mean age = 53.13; SD = 11.652; 33.5% female, 66.6% male) across 39 coastal prefectures in Japan. Factor analysis identified four key factors with high reliability (KMO ≥ 0.950): Ocean Value (α = .922), Ocean Value Individual (α = .942), Responsibility (α = .911), and Influence (α = .975). The reliability of the outcome variable, Awareness of Adaptation, was acceptable (α = .721). Correlation analysis showed that Awareness of Adaptation was significantly related to all four factors (r = .200–.335, p < .001), indicating their relevance in shaping adaptive attitudes. Responsibility had particularly strong associations with Ocean Value Individual (r = .437), Influence (r = .347), and Ocean Value (r= .330), while Ocean Value Individual was also significantly linked with Influence (r = .302). These findings suggest that individuals who feel personally affected by marine environmental changes and who perceive a sense of responsibility are more likely to recognize the need for adaptation. Therefore, fostering emotional connection and personal responsibility may be key to promoting public support for marine climate adaptation strategies.

S02, Oral, AbstractID=18265

Development of a biogeochemical modeling approach to investigate present and potential future impacts of ocean acidification in Tokyo Bay, Japan

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Along with various concerns related to global warming, there is increasing concern in recent years that ocean acidification (OA) primarily caused by excessive anthropogenic CO_2 may adversely affect calcifying organisms. This study describes the development of a biogeochemical modeling approach to help evaluate and predict OA states in Tokyo Bay. The Coastal and Regional Ocean COmmunity model (CROCO) system version 1.3.1 (Jullien et al., 2022) was used to couple the Regional Ocean Modeling System (ROMS) (Shchepetkin and McWilliams, 2005) with the Pelagic Interactions Scheme for Carbon and Ecosystem Studies version 2 (PISCES-v2) model (Aumont et al., 2015) to simulate physical and biogeochemical processes in the highly eutrophic Tokyo Bay. The model grid spatial resolution was set to ~1 km with bathymetry derived from the ~500 m General Bathymetric Chart of the Oceans (GEBCO). Initial and boundary conditions for physical parameters were derived from the 3-hourly global HYCOM GOFS 3.1 Analysis dataset to simulate present day conditions, while biogeochemical initial and boundary conditions for the PISCES-v2 model were derived from various sources, such as the World Ocean Atlas, data collected during research cruises, and yearly monitoring by government institutions. Realistic atmospheric, tidal, and river input forcing was also added. To evaluate model performance, outputs were compared to time-series observations of various parameters within Tokyo Bay taken at the Kawasaki Artificial Island (KAI) monitoring station as well as from other monitoring programs. Future scenario cases are also being developed, with physical parameter boundary conditions derived from the Future Ocean Regional Prediction dataset (FORP; Nishikawa et al., 2021) as well as future prediction outputs for dissolved organic carbon from the MIROC-ESM model (Watanabe et al., 2011). Early versions of the model successfully reproduced general trends in observed physical parameters but failed to properly capture periods of relatively low pH levels and omega aragonite saturation states (Ω_{arag}) detected by continuous monitoring sensors, especially in near-bottom waters. Trends in DO were generally well-reproduced, except for the summer season in near-bottom waters. River nutrient inputs may be still greatly underestimated in the model setup and simulation of near-bottom processes requires closer consideration, and hence the details of the model setup continue to be improved. Overall, this study stresses the potential usefulness of having model setups capable of incorporating both regional and local factors affecting OA as helpful tools in the determination of necessary mitigation and adaptation measures.

S02, Oral, AbstractID=18271, (ECOP) (CANCELLED)

Northwestern Pacific sea bream fisheries under climatic and monsoonal oceanographic variability: Dominance of long-term climatic variabilities over short-term extremes

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The North-Western Pacific is crucial to global fisheries, sustaining a variety of commercial species and making a substantial contribution to seafood supplies. Climatic variability, especially long-term oscillations and seasonal monsoonal systems, significantly impacts oceanic conditions, thereby influencing fishing dynamics. This study examines the synergistic effects of climatic variabilities and monsoonal oceanography on the Sea Bream Fishery in the North-Western Pacific (Taiwan strait), utilizing fisheries data from2014 to 2022. Generalized Additive Models (GAM), cross-spectrum analysis, and wavelet coherence were utilized to evaluate the temporal impact of several environmental indices on the catch rates of six seabream species. Research indicates that the Pacific Decadal Oscillation (PDO) exerts the most significant and enduring impact, exceeding the influence of short-term climate variability. The PDO elicits both rapid and delayed species-specific reactions, resulting in significant variations in capture rates. Simultaneously, monsoonal variability was evaluated through machine learning techniques, uncovering specific seasonal oceanographic preferences. During the southwest monsoon, seabream shown a predilection for elevated sea surface and bottom temperatures, whereas the northeast monsoon correlated with increased salinity and chlorophyll levels. Significantly, catch rates consistently exceeded in the southern segment of the study region throughout both monsoonal periods. These observations highlight the necessity of integrating both long-term climatic variabilities and seasonal oceanographic dynamics into adaptive fisheries management systems. The findings provide essential direction for formulating sustainable fishing plans and robust policy interventions, in accordance with overarching global sustainable development objectives.

Keywords: Climate variability, cross spectrum, GAM, mean oceanography, North-Western Pacific, sea bream fishery, wavelet

S02, Oral, AbstractID=18278

Reshaping frontiers: Potential climate-induced adaptation or tropicalization of apex pelagic predators in the Indian and South Atlantic Oceans

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Examining the consequences of worldwide climate change on fisheries is essential as it directly impacts the well-being of marine ecosystems. This study aimed a comprehensive analysis on the potential responses of apex pelagic predators inhabiting in the Indian ocean (IO) and South Atlantic ocean (SAO) in response to changing climate. Significant shifts in the mean temperature of catch (MTC) were forecasted for all species inhabiting the IO and SAO under extreme climatic conditions (potential adaptation), but no changes were expected under normal conditions. All the species from both oceans exhibited a tendency to shift their distribution latitudinally (southward) in response to extreme conditions, while shifting longitudinally (wither east or westward) under normal conditions (potential tropicalization). In addition, SAO species were predicted to experience higher latitudinal and longitudinal displacements compared to those in the IO, in normal to extreme conditions. Present study suggests that, tropical Indian ocean species like bigeye, skipjack, yellowfin tuna, swordfish and marlins are less susceptible to climate change due to higher SST preferences, while temperate IO species like albacore and southern-bluefin tuna are more vulnerable compared to their counterparts in the SAO under changing climatic conditions. The study also suggests that SAO and IO species are likely to undergo topicalization, with adaptation to oceanography under extreme changing climate. The study's results can enhance comprehension of the potential consequences of climate change on marine species, provide guidance for conservation strategies, and assist in the development of adaptive management practices for sustainable fisheries.

Keywords: Adaptation, climate change, habitat displacement, Indian Ocean, mean temperature of catch, pelagic predators, south Atlantic Ocean, tropicalization

S02, Oral, AbstractID=18285

Future projection of jellyfish bloom potentials in Japan

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Outbreaks of moon jellyfish *Aurelia* spp. are frequently reported from many parts of the world's coastal areas, and can have severe effects on coastal ecosystems through their predation and human enterprises, such as fisheries and coastal power plant operation. Therefore, the prediction of their future bloom intensity under climate change scenarios is needed to better understand the effects on coastal ecosystems. In this study, we aimed to estimate the future bloom potentials of *Aurelia coerulea* in Japanese coastal areas and compared to those of the present situation based on numerical calculation. In the estimation, we calculated the growth rate of their polyps, which is a benthic stage and the growth is suggested to be the most important factor of their bloom, from seawater temperature and zooplankton abundance according to the bioenergetic model of Ikeda et al. (2017). In the calculation, we also assumed the polyps died under more than 5 days of the temperature higher than 30°C based on laboratory experiments in which we observed their mortality rate under the seawater temperature of 21–33°C. For the impact assessment of climate change, we utilized seawater temperature and zooplankton abundance data of regional ocean future projection dataset FORP (Future Ocean Regional Projection) under three climate situations (present: 1991–2018, future: 2086–2100 of RCP2.6 and RCP8.5 scenarios), which was developed to predict future changes in marine environment around Japan with high resolution (Nishikawa et al. 2021). In our simulation, semi-enclosed bays were estimated to have higher bloom potentials than open shores, which is consistent to the present situation of their bloom. In eastern Japan, the growth rate was projected to be higher in the future under RCP2.6 scenario due to more suitable environment (higher seawater temperature), while polyps would show high mortality under RCP8.5 scenario. In western Japan, where seawater temperature will be higher than eastern part in future, the bloom potential would be lower in the future because polyps was projected to show high mortality even under RCP2.6. Our study suggests that the effects of future climate change on jellyfish bloom potentials would show spatial variations.

S02, Oral, AbstractID=18294, (ECOP)

Heavy precipitation-induced Yangtze River runoff greatly regulates heterotrophic prokaryotes production and growth-limiting resources in the northern East China Sea

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Although heterotrophic prokaryotes (HP) play a crucial role in biogeochemical carbon cycles, microbial oceanographic studies associated with the heavy precipitation-induced large-scale freshwater runoff are understudied in the East China Sea (ECS), the largest continental shelf in the northwest Pacific. To elucidate the impact of Yangtze River Diluted Water (YRDW) on the HP production (HPP) and growth-limiting resources, a combination of comprehensive microbial oceanographic measurements with analysis of satellite images and optical properties of dissolved organic carbon (DOC) was conducted in the northern ECS. The multidisciplinary observations carried out seasonally for three consecutive years revealed that the HPP and phytoplankton primary production (PP) were consistently highest in summer due to the supply of excess DOC and nutrients via YRDW runoff, which is intriguing considering the enhanced HPP coupled with spring phytoplankton bloom in middle latitudes. However, the exceptionally great YRDW runoff induced by heavy rainfall resulted in the excessive supply of terrestrial-origin recalcitrant DOC and nutrients imbalance with high N:P ratio, which was responsible for the limited DOC bioavailability and phosphorus-limitation for the HPP. Accordingly, the enhanced HPP:PP ratio in summer suggested enhanced carbon flow via microbial loop, which ultimately affects the fishery structure and production by reducing energy efficiency in food web process. Our results demonstrating the dual impact of YRDW on regulating (i.e., either stimulating or suppressing HPP) the HPP provide new insights into the microbial responses to climate change-induced large-scale freshwater discharge.

S02, Oral, AbstractID=18299, (ECOP)

Positive loops of regenerated nutrients produced by bloom degradation as promoting another blooms

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This study aimed to investigate how much phytoplankton decomposition is mediated by bacteria during bloom decay, and how this process is related to seawater temperature and regional characteristics. Over time, a general increase in small-sized phytoplankton was observed. Flow cytometry results indicated a sharp increase in phytoplankton abundance until day 5, followed by a rapid decline. Decay rate analysis showed that in spring, offshore stations exhibited higher growth and lower mortality. In summer, despite higher seawater temperatures compared to the previous year, decay rates of picoeukaryotes and *Synechococcus* were not significantly affected.

Additionally, the aggregation of organic matter during decomposition was evaluated using perimeter particle size analysis. Over time, particle sizes increased, indicating the death and aggregation of biological material. These results suggest that the phytoplankton community gradually shifts toward smaller-sized species, which thrive under high-temperature conditions. Moreover, as organic matter aggregates into larger particles, the supply of organic matter to deeper layers and the amount of regenerated nutrients through remineralization are expected to increase.

S02, Oral, AbstractID=18299, (ECOP)

Lipidomic perspectives on post-bleaching mortality of *Acropora tenuis* exposed to thermal and cold stress

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Coral reef ecosystems support approximately 25% of all marine species, making them critical to marine biodiversity. Corals maintain a mutualistic relationship with dinoflagellates (zooxanthellae), which provide photosynthetically derived energy that allows corals to thrive even in oligotrophic environments. However, this symbiosis is sensitive to stressors, such as thermal anomalies and excessive light, leading to symbiont expulsion—i.e., coral bleaching. Bleaching events have intensified in recent years; in 2024, severe bleaching occurred across Okinawa due to elevated sea temperatures. Bleached corals often die from oxidative stress and energy depletion, reflected by increased oxidized lipids (Botana et al., 2022) and reduced neutral lipid reserves (Yamashiro et al., 2005). Post-bleaching mortality mechanisms likely differ by stress type; distinct physiological responses to heat and cold have been suggested (Higuchi et al., 2015). As coral habitats shift poleward with ocean warming, understanding cold stress impacts is essential for predicting future community distributions. To understand the mechanisms of coral bleaching and subsequent mortality, we conducted a 10-day incubation experiment on *Acropora tenuis* under a temperature gradient (15–32 °C) and 3 light levels (150, 400, 800 µmol photons m^{-2} s^{-1}). Both cold and heat stress induced bleaching and subsequent mortality. In addition to measuring respiration and photosynthesis rates, symbiont density, chlorophyll concentration and photosynthetic efficiency, we focused on lipid profiles including total lipid content and fatty acid composition. We will present lipid analysis results and assess energy balance during bleaching. Comparing cold and heat stress conditions, we discuss distinct mortality mechanisms in the coral holobiont.

S02, Oral, AbstractID=18308, (ECOP)

Effects of ocean acidification and freshening on the physiology, behavior, and shell integrity of the limpet *Cellana toreuma*

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Excessive anthropogenic carbon dioxide emissions induce global warming, driving climate change. In the Yellow Sea, warming intensifies monsoonal rainfall and river discharge, increasing freshwater input and thereby reducing salinity. This increased freshwater input accelerates ocean acidification by weakening the buffering capacity of seawater. In this study, we investigated the impact of ocean acidification and freshening on the limpet *Cellana toreuma*, a dominant species that inhabits the rocky intertidal shores. We hypothesized that low pH and salinity would negatively affect the biological responses of *C. toreuma.* To test this, we exposed limpets to four different treatments combining two pH (8.0 and 7.5) and two salinity (30 and 21 psu) levels for 31 days. No significant differences in survival, condition factor, and Ca content were observed. However, low salinity significantly decreased behavioral responses (righting and emergence). Low pH negatively affected shell integrity, increasing surface dissolution. Low pH also significantly increased the shell thickness ratio and Mg/Ca ratio in the M + 2 layer. These findings suggest that *C. toreuma* may compensate for behavioral impairments and weakened shell integrity by adjusting shell mineral composition.

S02, Oral, AbstractID=18346, (ECOP)

Environmental DNA method in open ocean revealed environment dependent distribution patterns of small pelagic fish

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Small pelagic fish are both a key part of the marine ecosystem and an important food resource for humans, but the investigation is difficult because they live in the huge and unpredictable open ocean. This research applied the recently developed eDNA method to detect small pelagic fish in the Kuroshio current system, known to be important spawning and recruitment ground for many species including small pelagic fish. We targeted four small pelagic fish species (*Sardinops melanostictus*, *Engraulis japonicus*, *Scomber japonicus*, and *Scomber australasicus*). To obtain the occurrence and density of the target fish, the eDNA method was performed on seawater samples collected from four cruises by research vessels Shinsei-Maru and Hakuho-Maru. 0 m water samples were collected by a bucket and all other water samples (up to 150~300m depth) were collected through Niskin bottles combined with Conductivity Temperature Depth (CTD) instrument. Water samples were filtered on board and the filters were frozen. Later, DNA extraction and PCR were performed to detect the target fish eDNA. During the water sampling, the environment information, temperature, salinity, chlorophyll-a concentration, oxygen concentration, was recorded by CTD instrument. With the target fish eDNA data and environmental data, Generalized additive models (GAMs) analyses were performed to show the relationships between the target fishes (their DNA, to be precise) distribution and above environmental factors. For *Scomber japonicus* and *Scomber australasicus*, we further examined the effects of prey fish. Temperature is found to be an important factor, especially for *Sardinops melanostictus* and *Engraulis japonicus*. On the other hand, *Scomber japonicus* and *Scomber australasicus* were more common where more *Engraulis japonicus* existed. This study provides knowledge of how physical environment and interspecies relationships influence the small pelagic fish in open ocean and supports using the eDNA method in answering similar questions.

S02, Oral, AbstractID=18347

Climate-induced seasonal shift in copepod density in shallow water estuaries

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Copepods play a crucial role in aquatic food webs by connecting primary producers to higher-level consumers. As an important abundant food source for fish larvae, copepod density directly impacts fish recruitment and, consequently, fishery productivity. Previous studies have revealed that copepod blooms usually occur in spring (March to May) and are strongly correlated with "wet years," characterized by increased freshwater discharge. To investigate the seasonal patterns of copepod density and quantify the impact of freshwater input, we deployed an in situ underwater plankton imaging system, the PlanktonScope system, at the Patuxent River mouth in Chesapeake Bay. We collected copepod density data from February 2023 to February 2024, utilizing the high-frequency data to observe a significant increase in copepod density after major freshwater discharge events. The peak in copepod density was observed in late winter to early spring (February and March) during the survey period. We also noticed distinct daily discharge peaks that were followed by corresponding increases in copepod density. To analyze these data, we employed a Distributed Lag Non-Linear Model (DLNM) and identified that moderate freshwater discharge (27.5 m3/s) had the most pronounced positive effect on copepod density, with a 17-day lag. When compared to historical copepod densities in Chesapeake Bay from 1984 to 2002, our findings suggest a clear seasonal shift. The peak in copepod densities has shifted 1-2 months earlier compared to two decades ago, indicating a transition from the traditional spring bloom to a winter bloom. This shift may be attributed to increased freshwater discharge in winter, which is linked to rising temperatures and precipitation associated with climate change. Such a seasonal shift in copepod phenology could potentially lead to a mismatch between copepod availability and fish larvae recruitment in spring, potentially reducing the production of economically important fish species in coastal waters.

S02, Oral, AbstractID=18356, (ECOP)

The essential role of large research vessels in marine ecosystem observations and ocean sustainability

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Our understanding of marine ecosystems and ability to manage them sustainably has come from multidisciplinary observations made repeatedly over long periods of time. These long-term ecosystem observations depend on the capabilities of large research vessels, which play an essential role in the collection of global ocean observations. Research vessels serve as large, stable platforms for collecting high volume samples from the surface to the seafloor. Additionally, they serve as mobile laboratories enabling the collection, preservation, processing, and analysis of unique samples and data. Given their capacity for, and repeated use in, collecting comprehensive marine ecosystem observations large research vessels provide insight into long-term regional ecosystem dynamics. They also act as platforms-of-opportunity for testing, refining, and comparing technologies, enabling innovation and the evolution of the observing system. High-quality observations from large research vessels serve as the backbone for many other components of the global ocean observing system through their use in calibrating autonomous sensors and predictive modeling. Large research vessels also function as mobile, experiential training and exploration platforms that facilitate discovery, education, and collaboration. An effective, modular marine ecosystem observing system will depend on large research vessels to sustain and augment existing observing programs and to deploy, service, and validate the growing array of autonomous platforms that contribute to it. Achieving this vision will likely require maintaining and upgrading ship-based infrastructure and personnel, integrating emerging technologies, leveraging the unique capabilities of large research vessels in conjunction with other platforms, strengthening collaborative partnerships, and building social capital for marine ecosystem observations.

S02, Oral, AbstractID=18358

Biogeochemical properties of shallow-water CO_2 seeps on Himeshima Island and Showa Iwojima Island, Japan

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Volcanic gases erupt from the seafloor in several regions around Japan. Volcanological and geochemical gas seep studies have mainly focused on coastal shallow-water areas that are relatively accessible and important to human society. Shallow-water CO2 seeps are thought to foreshadow future marine environments that may develop if CO2 emissions are not drastically reduced. Thus, CO2 seeps provide important insights for assessing and projectting the impacts of ocean acidification on marine ecosystems. This study is the first to investigate two shallow-water CO2 seeps near Japan from the perspective of ocean acidification. We observed biotic transitions and reduced biodiversity around these CO2 seeps, as well as high CO2 concentrations, low pH, and low calcium carbonate saturation—conditions expected to occur by the end of this century unless anthropogenic CO2 emissions are significantly reduced. These results suggest that, from a marine life conservation perspective, it is essential to mitigate ocean acidification through substantial reductions in anthropogenic CO2. Shallow-water CO2 seeps serve as natural experimental sites that illustrate ocean acidification and its effects on marine ecosystems. Given that the shallow-water CO2 seeps examined in this study are both located in geoparks, study tours and ecotourism field trips should utilize these sites to enhance awareness of the consequences of ocean acidification and climate change.

S02, Oral, AbstractID=18386 CANCELLED

Sources and sinks of N_2O in the subtropical Jiulong River Estuary, Southeast China

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Nitrous oxide (N_2O) is one of the most important greenhouse gases and contributes to the depletion of ozone in the stratosphere. Estuaries are areas of intensive biological production and associated N_2Oemissions through both denitrification and nitrification processes. The spatial and temporal variations of N_2O in the Jiulong River Estuary, a subtropical estuary, were explored to evaluate sources and sinks of N_2O in this area. The estuary was found to be a strong source of N_2O, its saturation in the surface water ranged from 113 to 2926% relative to the ambient atmospheric concentrations, showing great temporal and spatial variations and was influenced by multiple factors N_2O concentrations were at a high level in upper estuary but reduced to the lower parts of the estuary. Groundwater input could be another contributor to N_2O in the estuary. Almost all N_2O within the estuary was released into the atmosphere rather than being transported to the bay. The N_2O flux in the estuary (mean 597 μmol/m^2/d) was at the higher end of the range observed in estuaries worldwide due to the very high DIN loads in the Jiulong River Estuary. Our data indicate that the N_2O saturation in the estuary continues to increase, although the DIN inputs began to decline in 2011, which might be relate to the improved environmental conditions with increased oxygen concentrations. N_2O production pathways have changed from predominantly denitrification in the past toward significant production from nitrification in the present. Further investigation is needed to better understand the behavior of N_2O in the Jiulong River Estuar.

S02, Oral, AbstractID=18409, (ECOP)

Using Vessel Monitoring Systems data to characterize movement patterns of the Pacific Salmon ocean troll fishery in response to variable oceanographic conditions on the West Coast of the U.S.

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This study uses historical data on the spatial distribution of fishing vessels from 2007 – 2022 in Washington, Oregon, and California to develop models of spatial distribution and movement patterns of the Pacific Salmon Ocean Troll Fishery on the West Coast of the United States. This period is characterized by highly irregular oceanographic conditions, most notable of which was a severe marine heatwave (MHW) that persisted from 2013-2016. Previous studies have primarily investigated the biological impacts of this MHW, but less is known about the economic and social consequences among port communities. We analyze oceanographic variables, vessel monitoring systems data, and landings receipts to understand both the spatial redistribution of fishing effort and changes in fisher movement patterns (e.g., transiting, fishing, and searching) in response to environmental shocks (e.g., MHWs). We do this by evaluating changes in the location of salmon fishing effort in relation to port-level distribution of landings and revenue. This analysis integrates models from animal movement ecology, geography, and machine learning to better understand changes in fisher movement patterns over time.

Preliminary results indicate that during the MHW: 1) Landings were much lower than in previous years; 2) fishing locations shifted northward and farther from shore; 3) fishing trips were longer both in terms of distance from port and number of days at sea per trip; and 4) fishers spent more time searching for fish and less time actively fishing. Results from this study will be used to link the spatial distribution of fishing effort to port-level landings to assess community impacts and economic consequences of fleet responses to climate-induced changes and create a production and technical efficiency analysis which will examine the productivity of the commercial salmon fishery, particularly addressing increases in some measures of catch per unit effort amid low abundance in recent years.

S02, Oral, AbstractID=18420, (ECOP)

Modeling the future distribution of Yellowfin and Bigeye Tuna in the Pacific Ocean using sdmTMB and Habitat Suitability Index

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Yellowfin tuna (YFT) and Bigeye tuna (BET) are commercially important species in the Pacific Ocean, representing a significant portion of catches targeted by longline fisheries. Climate change may affect the spatial distribution and abundance of these species. Numerous studies have assessed the spatiotemporal distribution of YFT and BET under climate change using advanced modeling approaches, such as the sdmTMB package. Although these spatiotemporal models can accurately estimate abundance hotspots, certain limitations persist in their application. This study aims to use the sdmTMB package to simulate the abundance of YFT and BET under two climate scenarios: SSP1-2.6 and SSP5-8.5. In addition, habitat suitability index (HSI) analyses for both species are conducted using fishery data from the OFDC and environmental data from the GFDL-ESM4 model. The results indicate that the spatial distributions of BET and YFT are largely similar under SSP1-2.6 and SSP5-8.5, as estimated by sdmTMB packages. HSI results also show comparable spatial patterns under SSP1-2.6 for both species. However, compared to the historical period, the habitat of BET is projected to decrease in the central Pacific Ocean by 2100 under SSP5-8.5, while YFT is expected to exhibit a broader distribution under the same scenario. These findings suggest that the HSI approach may better capture spatial variation in tuna distribution under projected climate scenarios compared to sdmTMB modeling. Future studies should consider incorporating species-specific HSI indices to improve the estimation of tuna abundance. Additionally, reducing the weight of spatiotemporal effects in models may help emphasize the influence of environmental factors on tuna distribution under climate change.

S02, Oral, AbstractID=18426, (ECOP)

Stochastic assembly processes drive fish diversity patterns in the northwestern Pacific: Insights from environmental DNA

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The northwestern Pacific (NWP) is characterized by high biological and physical complexity, shaped by diverse ocean currents and climate zones. To elucidate fish biodiversity patterns and underlying ecological processes, we employed environmental DNA (eDNA) metabarcoding across five biogeographic regions in the NWP, integrating taxonomic, functional, and phylogenetic perspectives. Our results revealed that the fish alpha diversity was notably higher in the Kuroshio Extension (KE) and Transition Zone (TZ) compared to the North Equatorial Current (NEC). Alpha diversity was significantly influenced by environmental factors, including temperature, chlorophyll-a, and pH in NEC and NPSG; and by longitude, bathymetry, temperature, dissolved oxygen, and pH in KE and TZ, indicating region-specific drivers of alpha diversity. For beta diversity, species turnover rather than nestedness was the dominant contributor to taxonomic, functional, and phylogenetic diversity. The observed turnover patterns were primarily driven by environmental factors such as pH, chlorophyll-a, dissolved oxygen, net primary productivity, and latitude across the NEC, North Pacific Subtropical Gyre (NPSG), KE, TZ, and Kuroshio Current (KC). Furthermore, stochastic processes, particularly ecological drift and dispersal limitation, played a dominant role in shaping fish assemblages across most NWP regions. By integrating eDNA data with key oceanographic parameters, this study provides novel insights into community assembly mechanisms and biodiversity distribution in dynamic marine systems. Our findings contribute to the development of advanced marine ecosystem monitoring strategies and highlight the potential of molecular tools in supporting predictive ecological research and adaptive resource management.

S02, Oral, AbstractID=18451, (ECOP)

Spatial patterns of ecosystem function in Chinese coastal waters based on phytoplankton resource use efficiency

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Resource use efficiency (RUE) is a key metric in evaluating ecosystem function and resilience. In this study, we calculated phytoplankton-based RUE using chlorophyll-a data from 2022 to 2024 across the South China Sea, the Taiwan Strait, the Yellow Sea, and the Bohai Sea. RUE was consistently higher in the southern waters (South China Sea and Taiwan Strait) compared to the northern part (Yellow Sea and Bohai Sea), a pattern further supported by phytoplankton biomass data in 2022. At the large regional scale, RUE showed a significant positive correlation with species diversity. At a finer spatial scale, we evaluated RUE in two typical coastal ecosystems around Hainan Island: seagrass beds and coral reefs across three seasons of 2021. RUE was higher in seagrass beds than in coral reefs, and both exhibited substantially higher RUE than the open waters. However, unlike the large-scale trend, RUE in the seagrass beds was negatively correlated with species diversity. This divergence suggests that RUE may be shaped by habitat-specific factors such as structural complexity, nutrient availability, and community composition. To further examine long-term variability and environmental differences in RUE, we analyzed data from 2004 to 2023 across three typical coastal regions of China: Bohai Bay, the Pearl River Estuary, and the Yangtze River Estuary. RUE generally followed the order Bohai Bay > Pearl River Estuary > Yangtze River Estuary, with Bohai Bay also showing greater interannual variability. These findings underscore the importance of incorporating spatial heterogeneity into ecosystem assessments and developing region- and ecosystem-specific management strategies.

S02, Oral, AbstractID=18461

Recent 25 years of environmental change in the northwestern Pacific observed by satellite radiometers

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In the recent 25 years since around 2000, multi-wavelength visible-infrared satellite radiometers have been in operation, such as MODIS, VIIRS, SGLI and OLCI as well as microwave radiometers such as AMSR-E and AMSR2 which have been calibrated with high accuracy with maintaining the orbit of local time. Their timeseries confirm that the global average sea surface temperature (SST) has increased by +0.02°C/year, consistent with the well-known warming trend in global air temperature. The trend is not uniform, e.g., several times larger in the subarctic frontal area of the northwest Pacific and including variations due to several El Niño events and decadal scale changes. In this presentation, we will introduce the characteristics of environmental changes in North Pacific that have been prominent in recent years by using monthly timeseries including SST, solar irradiance (SWR) and chlorophyll a concentration (CHL) over the past 25 years generated using multiple satellite sensor data (provided by NASA OBPG and JAXA G-portal).

The monthly anomaly of global average SST (60°N~60°S average) reached the highest value in January 2024 and then has returned to the level of long-term trend of +0.02°C/year corresponding to the end of El Niño. On the other hand, SST anomaly in the North Pacific subarctic front region (e.g., 160°E-165°W, 35°N-45°N) reached more than +3°C in September-October 2024. Monthly anomaly of CHL decreased in negative correlation with SST (the gradient of primary regression was about -3%/°C in the area). CHL is generally sensitive to sensor calibration errors, but the multiple sensors show similar variations, supporting the reliability of the CHL changes.

The seasonal cycle of CHL is known to depend on seasonal changes of mixed layer, nutrient, and euphotic zone depths. The seasonal cycle of CHL in the Northwestern Pacific derived by the principal component analysis showed typical patterns with a single peak around September in north of 42°N, a single peak around February in south of 35°N, and two peaks around April and September between 35°N and 42°N. The spatial boundary of the pattern seemed to move northward by 1-2 degrees along latitudes especially after 2020. The meridional slopes of SST images also showed the frontal (large slope) zone has shifted northward by about 2 degrees in the period. It seems indicate that the marine environment related to CHL (i.e., phytoplankton) is changing with physical environment such as the increase of SST.

S02, Oral, AbstractID=18464, (ECOP)

Development of a high-sensitivity qPCR method of harmful *Dinophysis* spp. using synthetic oligonucleotides

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With the accelerating impact of climate change, Korean coastal waters are shifting toward subtropical conditions, increasing the likelihood of harmful algal bloom (HAB)-forming species. Early detection of HAB species is critical for effective monitoring and management. Among these, the *Dinophysis* genus, which produces Diarrhetic Shellfish Poison (DSP), is difficult to culture in laboratory conditions, posing challenges in developing accurate quantitative standards. To overcome this limitation, this study used artificially synthesized oligonucleotides as a substitute for *Dinophysis* DNA to construct a qPCR standard curve. Species-specific primers targeting the LSU rDNA region were designed, and the accuracy of the synthetic oligo-based standard curve was validated by comparison with actual *Dinophysis* DNA. A spike experiment was also conducted to accurately quantify cell densities in environmental samples. EvaGreen-based qPCR assays were tested to evaluate the sensitivity and specificity of the developed detection method. As a result, a reliable and high-sensitivity qPCR-based quantification platform was established for non-culturable *Dinophysis* spp. This approach enables effective analysis of environmental samples and demonstrates the potential for applying DNA sequence-based detection strategies for other non-culturable harmful microalgae. The method contributes to improving HAB monitoring efforts in response to the ecological changes driven by climate change.

S02, Oral, AbstractID=18482, (ECOP)

The past, present, and future of the Ocean Tracking Network supporting the global telemetry community

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The Ocean Tracking Network is a global aquatic research, data management, and partnership platform headquartered at Dalhousie University in Halifax, Nova Scotia, Canada. OTN's mission is to inform the stewardship and sustainable management of aquatic animals by providing knowledge on their movements, habitats, and survival in the face of changing global environments by providing acoustic telemetry and digital infrastructure to support aquatic animal tracking and monitoring. OTN is supporting many different projects in the Pacific but is well positioned to expand support for the animal tracking community, particularly in the western Pacific. There are three main nodes operating through OTNs database framework that connects researchers on a global scale, the Northeast Pacific node (NEP), the North Pacific Acoustic Cooperative Tracking node (NPACT), and the Pacific Islands Regional Acoustic Telemetry node (PIRAT). In this talk, we will provide an overview of the functions of OTN and the development as a 'network of networks' to better serve the animal and environmental community.

S02, Oral, AbstractID=18487

Chinese coastal ecosystem in the climate changing environment

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The Chinese coastal ecosystem, a vital zone of ecological and economic significance, faces escalating pressures under climate change and human activities. This study examines the ecological dynamics of China's coastal regions, emphasizing the interaction between climate-driven stressors and anthropogenic activities. Heat waves, ocean acidification, hypoxia and imbalance of nutrients have exacerbated ecological disasters, including harmful algal blooms (red tides), large-scale green algae (e.g., *Ulva prolifera*) bloom, and jellyfish blooms, which disrupt biodiversity, fisheries, and coastal livelihoods. Concurrently, the rapid expansion of aquaculture has strained ecological carrying capacity, with overexploitation of resources and nutrient pollution further degrading water quality and habitat integrity. We will evaluate the ecological capacity and healthy condition of key coastal zones, revealing declining resilience due to combination of climate impacts and unsustainable practices. Case studies highlight regions such as the Bohai Sea, Yellow Sea, and East China Sea, where eutrophication and hypoxia threaten marine ecosystems and aquaculture productivity. Mitigation strategies, including integrated coastal zone management, nutrient load reduction, and climate-adaptive aquaculture practices, are proposed to enhance sustainability. By synthesizing climatic, ecological, and socioeconomic data, this study underscores the urgency of balancing economic development with ecological preservation to safeguard China's coastal ecosystems in a warming world.

S02, Oral, AbstractID=18508

Potential habitat shifts of chum salmon at sea under contemporary climate

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Climate change is accelerating at unprecedented rates, with disproportionate impacts on marine ecosystems. We examined the distributional responses of a keystone species to recent climatic changes in the North Pacific from 1998 to 2022. We applied a multi-model ensemble approach to examine the spatial and temporal distribution patterns of potential habitats for chum salmon (*Oncorhynchus keta*) across their seasonal migratory grounds. Our results captured the spatial shifts of potential habitat in feeding and overwintering grounds over time, driven by increasing temperature, declining food condition, and increasing wind and marine heatwave intensities. During feeding migration, their potential habitat in the Bering Sea revealed reduction in the southern areas and expansion into the Arctic. Potential overwintering habitat patterns further captured an overall decline in the trailing edges of their distribution, accompanied by habitat shifts towards the central North Pacific. Marine heatwave events also coincided with sizable habitat loss. Such habitat displacements suggest the increasing exposure and vulnerability of chum salmon to climate and productivity changes throughout their marine life history. Hence, underlining repercussions on productivity and provision of ecosystem services, necessitating climate-adaptive measures to manage and conserve salmon resources.

S02, Oral, AbstractID=18522

A novel quantified UAV and AI-based remote sensing approach for jellyfish population monitoring

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The frequency of jellyfish blooms in marine ecosystems has been rising globally, attracting significant attention from the scientific community and the general public. Low-altitude remote sensing with Unmanned Aerial Vehicles (UAVs) offers a promising approach for rapid, large-scale, and automated image acquisition, making it an effective tool for jellyfish population monitoring. This study employed UAVs for extensive sea surface surveys, achieving quantitative monitoring of the spatial distribution of jellyfish and optimizing flight altitude through gradient experiments. We developed a "bell diameter measurement model" for estimating jellyfish bell diameters from aerial images and used the Mask R-CNN algorithm to identify and count jellyfish automatically. This method was tested in Qinglan Port, where we monitored *Acromitus flagellatus* populations from mid-April to mid-May 2021 and late May 2023. Our results show that the UAVs can monitor jellyfish with bell diameters of 5 cm or more, and the optimal flight height is 100–150 m. The bell diameter measurement model, defined as $L = 0.0103 \times H \times N + 0.1409$, showed no significant deviation from field measurements. Compared to visual identification by human experts, the automated method achieved high accuracy while reducing labor and time costs. Case analysis revealed that the abundance of A. *flagellatus* in Qinglan Port initially increased and then decreased from mid-April to mid-May 2021, displaying a distinct patchy distribution. This study introduces a novel, efficient, and cost-effective UAV-based method for quantitative monitoring of large jellyfish populations in surface waters, with broad applicability.

S02, Oral, AbstractID=18523, (ECOP)

Promoting joint satisfaction among stakeholders for managing Japanese fisheries using coupled bio-socioeconomic models

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Marine fisheries are complex systems integrating biological, social, economic, and political processes. Effective management thus requires a holistic approach drawing insights from multiple disciplines: beyond biological science, fisheries management must also account for social, economic, and political factors. While many studies have explored this integration qualitatively, we present a pioneering quantitative approach. For this purpose, we devise several coupled bio-socioeconomic models tailored to different Japanese fisheries in mainland Japan and Okinawa. On this basis, we define utility functions for different stakeholder groups and evaluate management strategies according to their impacts on stakeholder utilities. Using these integrated models, we determine joint stakeholder satisfaction (JSS) across a wide diversity of management strategies and identify those that maximize JSS. The resultant integrated-assessment tool supports decision making in complex marine fisheries systems by finding common ground among stakeholders and creating a shared understanding of goals and priorities. It also contributes to bridging the gap between scientists and fishing communities by transparently and quantitatively illustrating the outcomes of management decision from multiple perspectives. Our approach can thus enhance the potential for consensus and compromise formation among stakeholders concerning management decisions affecting livelihoods, community well-being, and cultural practices.

S02, Oral, AbstractID=18524, (ECOP)

Machine learning projections of top predator distribution shifts under climate change scenarios

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Top predator species, such as tuna and billfish, are ecologically and economically important in the Indian Ocean. In recent years, machine learning algorithms have become an important method for forecasting the distribution of top predators in different regions. XGBoost (eXtreme Gradient Boosting), a decision-tree-based ensemble learning method, has demonstrated high predictive performance in various ecological studies. In this study, we applied XGBoost to project the catch per unit effort (CPUE) and spatial distribution of top predators under future climate scenarios. Fishery data were obtained from the Indian Ocean Tuna Commission for the period 1980-2022, and environmental forecasters were derived from the IPCC AR6 scenario outputs of the Geophysical Fluid Dynamics Laboratory Earth System Model (GFDL-ESM4). Time series results indicated that projected CPUE for yellowfin tuna and bigeye tuna under SSP3-7.0 and SSP5-8.5 scenarios showed a significant decline beginning around 2014–2016, with a continuing downward trend through 2100. The spatial distribution of yellowfin tuna and bigeye tuna was mainly located around the central and western Indian Ocean. The projection spatial distribution revealed that areas with high CPUE (>80%) for yellowfin tuna and bigeye tuna are expected to shift westward as global warming increases. The top predators(including yellowfin tuna, bigeye tuna, albacore, skipjack, bluefin tuna, swordfish, and blue marlin) are high-trophic-level species, their abundance and spatial patterns are likely to experience similar shifts under different climate change scenarios, and try to explore the projected CPUE and spatial distribution of billfish under future climate scenarios and assess whether there is spatial overlap among these top predator species.

S02, Oral, AbstractID=18542, (ECOP)

Monitoring shifts in nearshore zooplankton community structure using high-throughput imaging tools

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Understanding how climate-driven stressors influence marine food webs is essential for protecting species and ecosystems critical to ecological and human well-being. In the Strait of Georgia (British Columbia), nearshore habitats are key foraging grounds for juvenile Pacific salmon and other forage fish. These habitats are increasingly affected by urbanization, warming, and other climate change driven effects, yet they remain understudied. This project used semi-automated imaging for rapid classification and quantification of zooplankton from preserved samples. This approach dramatically reduces processing time, enabling expansion of the spatial and temporal resolution required for effective ecological analyses. Using these techniques, we examined how physical oceanographic changes influence zooplankton biomass, size structure, and community composition across an on-to-offshore depth gradient in an important salmon migration corridor in the Strait of Georgia. Shallow nearshore sites were found to have distinct zooplankton dynamics compared to deeper sites. In particular, the shallowest site was characterized by an elevated ratio of meroplankton (part of life-cycle as plankton) to holoplankton (entire life-cycle as plankton) and frequent spikes in meroplankton abundance, likely driven by strong benthic-pelagic coupling and episodic larval recruitment. In contrast, in the deeper site total zooplankton biomass peaks were dominated by holoplankton and occur later in the season. Understanding shifts in the relative abundance of meroplankton and holoplankton provides insight into benthic-pelagic coupling and recruitment processes under climate change. These preliminary results suggest that shallow, nearshore systems are hotspots for early-season meroplankton pulses, potentially enhancing local prey availability for juvenile salmon but increasing sensitivity to environmental variability.

S02, Oral, AbstractID=18550, (ECOP)

Using exposure indices to examine how climate variability influences the spatial distribution and abundance of Portunid crabs in the Southern East China Sea

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Climate change impacts global fisheries, including the swimming crab (family: Portunidae), a vital fishery resource in the Southern East China Sea. This study conducts a climate exposure vulnerability assessment of three economically significant swimming crab species: *Charybdis feriatus*, *Portunus pelagicus*, and *Portunus sanguinolentus* from 2011 to 2022. Exposure indices (E) were derived as E=1− Suitability Index (SI), which modelled deviation from optimal ranges of five environmental variables: sea surface temperature, sea bottom temperature, sea surface salinity, sea surface heigh, and chlorophyll-a. Species-specific exposure scores were synthesized by weighting variable-specific exposures using Variable Importance in Projection. Pearson correlation was used to examine the relationship between exposure scores and the climate indices: Oceanic Niño Index (ONI), Western Pacific Oscillation (WPO), Pacific Decadal Oscillation (PDO), North Pacific Gyre Oscillation (NPGO), and North Pacific Oscillation (NPO). Time-lag were analysed to capture delayed effects. The results revealed seasonal and species-specific exposure patterns, predominantly found in mid-spring (April) to early-autumn (September). The seasonal exposure of *P. sanguinolentus* and *C. feriatus* correlated negatively with ONI ($r = -0.628$; $r = -0.625$), PDO ($r= -0.699$; $r = -0.681$) and NPO ($r= -0.629$; $r = -0.668$) during the spring and summer ($p<0.05$), while *P. pelagicus* has no correlation. Seasonal variations in exposure scores were analysed to determine the vulnerability of these species to climate-driven environmental changes. These findings highlight the need for adaptive fisheries management strategies, including seasonal fishing bans and real-time environmental monitoring, to mitigate climate change impacts on swimming crab populations in Southern East China Sea.

Keywords: Portunidae, Swimming crab, Exposure, Climate, Vulnerability

S02, Oral, AbstractID=18578, (ECOP)

Difficulties in identification of small centric diatoms

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Many diatoms, especially those found in marine environments, are small species, and their morphology can only be evaluated by SEM. The combination of LM and SEM techniques used to examine phytoplankton samples gave us a more accurate insight into the health of the marine ecosystem and an opportunity to identify several taxa new to the study area. During the study, a bloom of *Mediolabrus comicus* was reported for the first time in Russia. Seasonal and interannual dynamics of phytoplankton community in the study area were investigated as part of the research undertaken for the first author's Ph.D. thesis on *Thalassiosira* species. Sampling was conducted at stations in Paris Bay off the northwestern side of Russky Island between January 2016 and December 2018. Over the study period, the phytoplankton community contained a substantial number of centric diatoms that could be identified only to genus level with LM. To carry out a more detailed taxonomic analysis, each sample was divided into two subsamples of equal volume, which were then simultaneously examined with LM and SEM. That combined approach allowed us to add to the knowledge of the community composition in the study area and to find some species new to the region. Eleven species, namely *Thalassiosira allenii var. allenii, T. allenii var. striata, T. hispida, T. levanderi, T. lundiana, T. minicosmica, T. ordinaria, T. conferta, T. minima, T. oceanica, T. tealata,* were new records for Russia. Five species, namely *Thalassiosira allenii var. striata, T. favosa, T. hispida, T. levanderi u T. conferta*, were first records for the Sea of Japan. The phytoplankton community in the study area was dominated by *Thalassiosira aestivalis, T. allenii* var. *allenii, T. binata, T. lundiana, T. tenera, T. pseudonana*. During the current study, a bloom of *Mediolabrus comicus*, a small-celled diatom, was reported for the first time in Russia. In August 2017, the species dominated the phytoplankton community in Paris Bay at a water temperature of 22°C, with cell concentrations reaching up to $5.5x10^5$ cells/L. The work was conducted at the Primorsky Aquarium Shared Equipment Facility of the A. V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences (NSCMB FEB RAS).

S02, Oral, AbstractID=18593, (ECOP)

Species-specific ENSO responses of commercial fish in the northern South China Sea under climate warming scenarios

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The El Niño–Southern Oscillation (ENSO) is a key driver of environmental variability in marine ecosystems. To investigate how commercial fish species in the northern South China Sea respond to ENSO under future warming scenarios. Using environmental data from 10 ensemble members of the GFDL ESM2M model, coupled with the Dynamic Bioclimatic Envelope Model (DBEM), we projected species-specific changes in fish biomass. ENSO phases (El Niño, La Niña, and neutral) and Niño 3.4 index strength were used to evaluate abundance responses. Using univariate linear regressions, we quantified the strength and direction of ENSO's influence on each species' biomass. La Niña events showed the strongest and most consistent effects, significantly influencing 17 of 21 species, with 65% showing positive responses. When treated as a continuous variable, ENSO significantly affected 16 species, though response directions varied. Pelagic and predator species tended to increase with ENSO intensity, while benthic and reef species often decreased. ENS110 and ENS111 ensembles best captured these relationships. These patterns are likely driven by ENSO-induced changes in sea surface temperature, productivity, oxygen, and salinity, which influence habitat suitability and trophic interactions. The heterogeneous and species-specific nature of ENSO impacts under climate change, need to consider model uncertainty and species-level sensitivity in ecosystem and fisheries assessments.

S02, Oral, AbstractID=18602, (ECOP)

Climate change impacts on ecological connectivity of Marine Protected Areas in the Yangtze River estuary and adjacent waters

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Marine protected areas (MPAs) are essential for conserving marine biodiversity and managing fishery resources, with ecological connectivity playing a crucial role in their effectiveness. However, both MPAs and their connectivity are increasingly threatened by climate change, and our understanding of these impacts remains limited. This study evaluated the effects of climate change on ecological connectivity for three significant migratory fish species—*Coilia mystus*, *Harpadon nehereus*, and *Larimichthys crocea*—within the Yangtze River estuary and adjacent waters. Using resistance surfaces based on environmental gradients, we predicted suitable habitats, identified least-cost ecological corridors, and assessed key migration pinch points under current and future climate scenarios. Key findings include: 1) *C. mystus* is projected to face considerable reductions in habitat suitability and area, while *H. nehereus* may see increased habitat area but decreased suitability; L. crocea is expected to experience overall habitat expansion. 2) Future scenarios predict a decrease in electric current density for *C. mystus*, but an increase for *H. nehereus* and *L. crocea*. 3) Corridor resistance is expected to decrease for *H. nehereus* and *L. crocea*, particularly in the northern Yangtze River estuary, while *C. mystus* will experience increased resistance, posing greater migration challenges. 4) Pinch points will decrease for *L. crocea*, remain stable for *H. nehereus*, and increase for *C. mystus*. This study underscores the need to incorporate climate resilience and connectivity into MPA assessment and design, emphasizing species-specific dispersal capacities and future migration patterns.

S02, Oral, AbstractID=18620, (ECOP)

Genome-scale shifts in bacterial communities across diatom bloom phases

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While the association between algal blooms and bacterial dynamics is well known, the underlying mechanisms remain unclear. To elucidate this mechanism, functional bacterial studies are crucial but remain inadequate due to the lack of comprehensive data, unidentified taxonomic groups, complex ecological interactions, and incomplete genetic profiles. In this study, we reassemble metagenomic assembled genomes (MAGs) from metagenome data collected at every four-hour interval during a *Chaetoceros* sp. diatom bloom to perform species-specific genomic analyses of bacteria. A total of 582 high-quality MAGs were assembled from 132 time points, among which 48 belonged to the *Planktalea* genus, 27 to the *Paraglaciecola*, and 4 to the *Glaciecola* genus. Two different unidentified species belonging to *Planktotalea* genus were detected prior to the initiation and during the stationary phase of the bloom respectively, exhibiting distinguished genome sizes and gene counts. Within two species of *Paraciecola* genus showed little inter-species variation, whereas two species of *Glaciecola* genus displayed significant differences in coding density, gene counts, and genome size, identified specifically during the stationery and termination phases of the bloom, respectively. Moreover, genome size distribution is significantly related to cyanobacterial cell density, phosphate concentration, and pH. Our findings reveal that genomic differences correlated with bloom phases may play a crucial role in bacterial adaptation and survival, supported by streamline theory, which posits that genome size impacts metabolic regulation and energetic requirements.

S02, Oral, AbstractID=18683, (ECOP)

Long-term variability of spring phytoplankton bloom phenology in the Bering Sea in 1998–2024

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Long-term variability of spring phytoplankton bloom (SB) timing in the Bering Sea was estimated using ocean color remote sensing data from 1998–2024. Chlorophyll-a concentration (Chl-a, mg m^{-3}) was accessed using satellite data from the European Space Agency (ESA) Ocean Color Climate Change Initiative (OC CCI) database, version 6, with a spatial resolution of 4 × 4 km and a temporal resolution of 1 day. The data were regridded into spatial cells formed in the polar stereographic coordinate system with cell size of 25 × 25 km. Spatial interpolation of the data was performed to the inverse distance weighted (IDW) method with search radius 50 km (an agreement between predicted and original satellite data: $r = 0.92$, RMSE = 0.46 mg m^{-3}). Temporal interpolation with locally estimated scatterplot smoothing (LOESS) was additionally applied to data in order to fill in yet existing data gaps. The SB onset determined with the threshold approach (the median of the Chl-a time series before annual maximum).

The SB begins earliest (beginning of April) in the Bering Sea shelf and the continental slope, as well as along the eastern part of the Aleutian Islands. The SB occurs later in the central deep-water part and in the northern part of sea (beginning of May).

Positive trend of onset in the western Bering Sea (+2 days/year). Negative trend of onset in the oceanic domain and northern Bering Sea (up to −2 days/year). Nearly the entire sea area demonstrates a positive trend in bloom intensity, increasing at a rate of 0.005 mg/m³ per year.

S02, Oral, AbstractID=18717

Freshwater cyanotoxins in marine seafood: A One Health concern

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Freshwater cyanotoxins produced by harmful algal blooms (FHABs) are an emerging global threat to coastal ecosystems. These potent natural toxins—such as microcystins, cylindrospermopsin, and anatoxin-a—have been detected in marine shellfish, fish, seabirds, and mammals, raising significant concerns for food safety and ecological health. Yet despite their widespread presence and known impacts, these toxins are rarely monitored in marine environments. This gap in surveillance is particularly concerning for communities that rely on seafood for subsistence, cultural practices, and local economies. In the Salish Sea, a transboundary marine ecosystem spanning Washington State (USA) and British Columbia (Canada), seafood plays a central role in Indigenous lifeways. For the Coast Salish Peoples, who have stewarded and harvested these resources for thousands of years, access to safe seafood is critical to food sovereignty and public health. Between 2017 and 2025, our team documented over 200 detections of freshwater cyanotoxins in the Salish Sea food web—including in sediment, shellfish, fish, seabirds, crabs, snails, and marine fecal samples. These findings confirm that freshwater toxins are entering coastal waters and accumulating in marine species, yet remain largely absent from conventional marine toxin monitoring programs. To address this oversight, we apply a One Health framework—recognizing the interconnected health of people, animals, and ecosystems. Our research integrates freshwater and marine monitoring to assess the full extent of cyanotoxin exposure in marine environments. These efforts provide urgently needed data to support Indigenous-led policy, protect marine biodiversity, and ensure safe, sustainable seafood for all communities who depend on the ocean. By bridging disciplines and knowledge systems, this work underscores the importance of holistic, collaborative approaches to environmental health in a changing climate.

S02, Oral, AbstractID=18746, (ECOP)

Potential habitat distribution of yellow croaker (*Larimichthys polyactis*) in Korean waters: Past and future

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Yellow croaker (*Larimichthys polyactis*), commercially important in Korea and China, is a demersal species found mainly in the shallow Yellow and East China Seas. Given its demersal nature and its habitat in semi-enclosed seas, the species is vulnerable to climate change due to limited access to climate refugia. However, most habitat studies have focused on specific seasons or Chinese waters, with limited consideration of Korean waters and seasonal variation. Here, we projected seasonal habitat changes of yellow croaker in the 2050s under two climate scenarios (SSP1-2.6 and SSP5-8.5). In particular, a regional ocean climate model, which better captures local dynamics in narrow shelf regions like the Yellow and East China Seas, was used with four species distribution models driven by three environmental variables: bottom temperature, salinity, and depth. Results indicate that yellow croaker habitat was projected to contract year-round along the Korean coast in the Yellow and East China Seas, while expanding in the central Yellow Sea and across the East China Sea during summer and fall. These changes were driven by contrasting effects of bottom temperature and salinity: increasing temperatures raised the presence probability in the Yellow Sea but reduced it in the East China Sea, whereas decreasing salinity showed the spatially opposite pattern. Our findings suggest that the future habitat of yellow croaker may shift offshore, reducing availability along the Korean coast. These spatial shifts may adversely affect Korean yellow croaker fisheries by increasing operational costs due to longer travel distances to fishing grounds.

S02, Oral, AbstractID=18784

Ocean Networks Canada's ocean monitoring programs as a change detection array in the North Pacific

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Over the past 19 years, Ocean Networks Canada (ONC) has developed extensive ocean monitoring infrastructure in the North Pacific. Its foundational projects—the VENUS observatory in the Salish Sea and the NEPTUNE observatory in the northeastern Pacific Ocean—have grown into a broad network that now includes moorings, vessel-based sensors, coastal observatories, oceanographic radar stations, earthquake early warning systems, and buoy profilers. Recent expansions include the West Coast Distributed Biological Observatory pilot project and the community-driven Community Fishers program.

As a UN Ocean Decade Implementing Partner and in line with the decade goals, ONC emphasizes co-production of knowledge, which brings together Indigenous knowledge systems and science, working with community and research partners to bridge data gaps, aligning research with societal needs, and prioritizing knowledge mobilization. By training community scientists to conduct monitoring and establishing consistent sampling sites, ONC is increasing data volume and geographic coverage along Canada's coastline.

From large-scale infrastructure to community-led initiatives, ONC's network serves as a change detection system, capturing environmental and climatological signals to inform models and anticipate future impacts across multiple spatio-temporal scales. This summary highlights ONC's expanding programs and new data products, showcasing environmental phenomena captured, and contributions to the broader research community.

S02, Oral, AbstractID=18171, (ECOP)

Response of fish biodiversity to climate change in the Northwest Pacific Ocean

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Species composition and biodiversity changes under climate change have received much attention, while phylogenetic and functional diversity and community restructure of fish communities have received less attention. Based on contemporary (2000-2014) and future (2040-2050, 2090-2100) environmental data, the species distribution model was constructed to predict the habitat distribution of 47 fish species in the Northwest Pacific Ocean. The study found that cold-water species would be more sensitive to climate change and warm-water species would be more likely to benefit in the future. The functional traits of fish communities were closely related to the environment in both time and space, showing a north-south spatial gradient distribution. The shorter-lived and earlier maturity fish dominated the southern community, while longer-lived and later maturity species dominated the northern community. In the future, longer span fish will move to higher latitudes (off the coast of Hokkaido and the Sea of Okhotsk), while larger fish will decline in the Yellow Sea and East China Sea. By calculating β-diversity to explore the process and mechanism of community species composition change, species loss (nestedness) in fish communities is the main process of species composition change by 2040-2050; The contribution of species replacement (turnover) would increase over time and will dominate changes in community species composition in the future.

SESSION 02: BIO/FIS/HD/ POC/MONITOR/FUTURE

Topic Session

Changing Ecosystem Structure Under Global Climate Change: Monitoring, Detecting, Modelling, and Socio-Ecological Impacts

Poster Presentations

S02, Poster, AbstractID=18162, PosterID: S02-P1

Frontal eddies in the northwestern Japan Sea: Lagrangian analysis and ship observations

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Using the eddy-detection algorithm and altimetry-based Lagrangian maps, we have found two (three) domains in the northwestern Japan Sea with increased occurrence frequency of anticyclones (cyclones), where mesoscale frontal eddies regularly form, circulate and decay. The distributions of eddies over the values of nonlinearity parameter, lifetime, radius, swirl and other parameters have been calculated in 1993 – 2022 and analyzed. A few sampled eddies have been studied in detail with the focus on the thermohaline properties, vertical structure and genesis. Using the particle-tracking method, the content of waters of subtropical and subarctic origin in the surface cores of these eddies has been estimated. It has been found that cyclonic eddies are associated with a dome-like lifting of isolines which can be traced down to the bottom, but they did not transport water over a long distance. Anticyclonic eddies contained low-salinity water in the cores. Extremely low saline water was observed in the eddies northwest of the Subpolar Front. The frontal eddies had warm and high-salinity upper cores formed by modified subtropical water and contained secondary cores of low-salinity water in intermediate depth. By trapping and transporting low-salinity water, the studied eddies contribute to distribution of such water in the Japan Sea.

The work was supported by the Russian Science Foundation (grant no. 23-17-00068).

S02, Poster, AbstractID=18175, PosterID: S02-P2

Assessing the state of marine biodiversity in the Northeast Atlantic

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The Northeast Atlantic has been exposed to a wide range of direct human pressures, such as fishing, shipping, coastal development, pollution, and non-indigenous species (NIS) introductions, in addition to anthropogenically-driven global climate change. Nonetheless, this regional sea supports a high diversity of species and habitats, whose functioning provides a variety of ecosystem services. As part of the 2023 OSPAR Quality Status Report, here,for the first time, we use a semi-quantitative approach to evaluate holistically the state of Northeast Atlantic marine biodiversity across marine food webs, from plankton to top predators, via fish, pelagic and benthic habitats, including xeno-biodiversity. Our analysis reveals widespread degradation in marine ecosystems and biodiversity, which is likely the result of cumulative effects of multiple human activities, such as overexploitation, the introduction of NIS, and climate change. Bright spots are also revealed, such as recent signs of recovery in some fish communities and recovery in harbour and grey seal populations in some regions. The status of many indicators, however, could not be assessed due to gaps in data, unclear pressure-state relationships, and the non-linear influence of some pressures on biodiversity indicators. Lessons learned will drive progress towards a better integrated assessment of wide-scale marine ecosystems.

S02, Poster, AbstractID=18234, PosterID: S02-P3, (ECOP)

Seasonal dynamics of phytoplankton in Chernyshev Cove (Peter the Great Bay, the Sea of Japan)

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Long-term studies on phytoplankton in the coastal waters off Vladivostok have been conducted mainly in Amur Bay, with little attention being paid to algal communities in Ussuri Bay. The data provided in this paper shed light on phytoplankton community structure and abundance in Chernyshev Cove, a small bay within Ussuri Bay, and will be used as a basis for prediction of water quality changes in the study area. From January to December 2020, phytoplankton exhibited summer and winter peaks due to an increase in diatom abundance. During the summer, one peak was observed in June (t_{water}=15°C; S=33‰), and the other occurred in August (t_{water} =19,5°C; S=31‰), with *Skeletonema dohrnii* dominating the community in both months ($4{,}2x10^5$ cells/L and $1{,}5x10^6$ cells/L, respectively). The winter peak of phytoplankton abundance ($1{,}0x10^6$ cells/L) was dominated by *Thalassiosira nordenskioeldii* (t_{water}=-1,8°C; S=31,8‰). The absence of an autumn peak can probably be ascribed to the impact from typhoons Maysak and Haishen, which occurred in autumn 2020. They caused a significant storm surge in the study area, resulting in a large amount of debris being washed into the coastal waters and the stirring up of the bottom sediments, accompanied by an increase in the turbidity and a decrease in the photosynthetic capacity of the algal cells.

The work was conducted at the Primorsky Aquarium Shared Equipment Facility of the A. V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences (NSCMB FEB RAS).

S02, Poster, AbstractID=18277, PosterID: S02-P4, (ECOP)

Parameter identification and optimization of an ocean biogeochemical model for sub-seasonal to seasonal prediction

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Subseasonal-to-seasonal (S2S) prediction of ocean biogeochemistry remains a major challenge, primarily due to the scarcity of observational data needed to generate realistic biogeochemical initial conditions and to constrain ecological and physiological parameters. Additionally, existing model parameterizations are inadequate to represent the spatial and temporal variability of these parameters. Over the past decade, significant progress has been made in autonomous ocean observing systems—most notably through the expansion of the Biogeochemical Argo (BGC-Argo) float network—providing unprecedented opportunities to improve S2S biogeochemical forecasts with potential benefits for fisheries and aquaculture management.

In this study, we leverage BGC-Argo data to constrain both state variables and parameters of an ocean biogeochemical model in a vertical one-dimensional configuration. We assimilate three BGC-Argo-measurable variables: chlorophyll-a, nitrate, and suspended particles. Through sensitivity analysis, we identify a subset of parameters that most strongly influence these variables on S2S timescales. We present results from a test case using time series from a single float and examine how optimized parameter values vary with season and forecast lead time. Furthermore, we explore the transferability of these optimized parameters by applying them to other floats and fixed-point time series such as those from Ocean Station Papa.

S02, Poster, AbstractID=18307, PosterID: S02-P5

A novel Indicator of anthropogenic infuence on the fluctuability and stability of phytoplankton community composition

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In natural environments, marine community composition typically remains stable over time, but anthropogenic disturbances—such as increased nutrient input—can alter its structure. Diatoms and dinoflagellates, dominant phytoplankton groups in coastal waters, are often used to characterize these changes. This study introduces the *Areal Phytoplankton Community Composition Index (APCI)*, a novel metric based on the area of a scatter plot of dinoflagellate abundance (y-axis) versus diatom abundance (x-axis) over 1-, 2-, or 3-year time windows. The APCI quantifies community fluctuability within a given period, while temporal changes between consecutive APCIs reflect compositional stability. We hypothesize that shifts in APCI trends signal environmental disturbances. To test this, we applied the APCI to a 28-year monthly dataset of diatom and dinoflagellate abundances from four stations in Tolo Harbour and Channel, Hong Kong. We calculated APCIs for 1-year (APCI-1y), 2-year (APCI-2y), and 3-year (APCI-3y) windows, finding that longer windows (e.g., APCI-3y) exhibited greater fluctuability (larger areas) but higher stability (smaller temporal changes between adjacent APCIs) compared to shorter windows (APCI-1y). Temporal APCI trends correlated significantly with declining dissolved inorganic nitrogen and phosphate concentrations, reflecting improved water quality following Hong Kong's 1998 sewage diversion initiative. These results demonstrate the APCI's utility as an ecological indicator, effectively capturing phytoplankton community responses to environmental changes. The method offers a practical tool for assessing disturbance impacts in aquatic ecosystems, particularly in nutrient-affected coastal waters.

S02, Poster, AbstractID=18338, PosterID: S02-P6, (ECOP)

Potentially toxic phytoplankton species in the coastal waters off the eastern part of Russkiy Island (Peter the Great Bay, the Sea of Japan)

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Species of nuisance and toxic marine and estuarine algae may cause human illness (if contaminated seafood is ingested) and severely affect marine ecosystems. From January to December 2019, nine species of potentially toxic algae, namely *Pseudo-nitzschia delicatissima* (at cell concentrations up to $1{,}7 \times 10^5$ cells/L), *P. pungens* ($12{,}0 \times 10^4$ cells/L), *P. caliantha* ($14{,}0 \times 10^4$ cells/L), *P. seriata* ($14{,}0 \times 10^4$ cells/L), *Dinophysis acuta* ($2{,}5 \times 10^4$ cells/L), *D. norvegica* ($3{,}5 \times 10^2$ cells/L), *Prorocentrum micans* ($4{,}6 \times 10^3$ cells/L), *P. minimum* ($8{,}6 \times 10^4$ cells/L) and *Fibrocapsa japonica* ($1{,}2 \times 10^3$ cells/L), were found in Paris Bay, a small bay within Peter the Great Bay. Though a warm-water species, *F. japonica* was recorded at a water temperature of 1°C and salinity of 34,1‰. The absence of a distinct seasonality in occurrence may suggest that the species is highly tolerant to different environmental conditions. During the study, the reported species of harmful algae were present in concentrations below maximum levels set by European Regulation for aquatic life. The occurrence of potentially toxic phytoplankton in Paris Bay highlights the importance of year-round monitoring for assessing the health of the marine ecosystem and informing the public about harmful algal blooms and their impacts.

The work was conducted at the Primorsky Aquarium Shared Equipment Facility of the A. V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences (NSCMB FEB RAS).

S02, Poster, AbstractID=18376, PosterID: S02-P7, (ECOP)

Food availability drives contrasting responses of fauna diel vertical migration in the northwestern Pacific

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Diel Vertical Migration (DVM) is a circadian phenomenon in which marine organisms ascend to surface waters at night to forage and descend to the mesopelagic zone at dawn to evade visual predators. This behavior is crucial for balancing energy acquisition with predation avoidance, while simultaneously facilitating the transport of carbon and nutrients to the deep ocean. Although DVM is generally triggered by local solar variations, the biomass involved in this migratory process and the role of food availability remain inadequately investigated.

It is commonly assumed that migrant biomass increases with primary production. However, analysis of decade-long acoustic data from moorings on both sides of the Kuroshio Extension in the Northwestern Pacific reveals contrasting responses of DVM to food availability: (1) in oligotrophic subtropical regions, DVM intensifies with elevated chlorophyll-a levels, whereas (2) in relatively productive mixed and subpolar zones, DVM peaks under low-food conditions. Additionally, we observed a positive relationship between daytime temperature (at residence of ~400-500 m) and DVM biomass in the north of the Kuroshio Extension, suggesting that warmer habitats may enhance metabolic rates and stimulate more animals to graze upward in this region. No such relationship was found in the southern region.

These findings indicate that under global warming, as the ocean is more stratified, changes in productivity could significantly affect DVM patterns. The decreased (increased) productivity in the Kuroshio (Oyashio) region will both lead to a decline in DVM biomass, further influencing the carbon export to the deep ocean.

S02, Poster, AbstractID=18398, PosterID: S02-P8

Monitoring ocean acidification for ecosystem assessment and management

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The global ocean absorbs 25% of the human emitted carbon dioxide from the atmosphere. While this vital service helps mitigate additional atmospheric warming, it comes at a significant ecological and economic cost to marine ecosystems. Once absorbed, the dissolved carbon dioxide undergoes a series of chemical reactions that reduce seawater pH through a process known as ocean acidification. As a key component of climate change, ocean acidification is a global phenomenon with notable impacts in the northeastern Pacific, especially around Alaska. The northern Gulf of Alaska, Bering Sea, and Chukchi Sea are naturally cold and carbon rich. These conditions make them especially susceptible to further decreases in pH, pushing marine carbonate chemistry toward thresholds where sensitive species may have negative effects. Ocean acidification acts as a co-stressor to an already vulnerable marine food web, systems that support multi-billion-dollar fisheries and are integral to economies and cultures. Therefore, understanding and addressing ocean acidification is essential for accurate assessments of future ecosystem structure and socio-ecological impacts. We present a synthesis of monitoring efforts and available products that track ocean acidification in Alaska's large marine ecosystems. This includes tools and services designed to support North Pacific communities in making informed decisions. We will also identify key knowledge and technology gaps that must be addressed to translate scientific understanding into actionable information for decision makers. The UN Ocean Decade has identified ocean acidification as a global environmental threat and requires coordinated regional and global responses. Our goals include work to strengthen collaboration across the North Pacific, elevate ongoing efforts, and form new partnerships that align science with societal needs.

S02, Poster, AbstractID=18405, PosterID: S02-P9, (ECOP)

Opposite latitudinal biodiversity gradient in the open ocean generated by transition zones: Insights from fish distribution in the Northwest Pacific

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Marine species diversity is influenced by environmental factors such as water temperature, latitude, and seafloor depth. While the classic latitudinal diversity gradient (LDG) predicts that species richness declines from the equator toward the poles, marine fish communities often deviate from this pattern. Mid-latitude regions with active ocean fronts and current convergence zones, such as the Kuroshio–Oyashio transition zone in the Northwestern Pacific, form biodiversity hotspots. These areas support complex ecosystems where warm- and cold-water species coexist, but their dynamic water mass structure makes it difficult to observe fine-scale ecosystem structure corresponding to the water mass structure by traditional conventional sampling methods. We applied environmental DNA (eDNA) metabarcoding to 989 seawater samples collected at 176 stations during 17 research cruises from 2018 to 2023 using the research vessels, Shinsei Maru and Hakuho Maru. Sampling covered coastal to offshore habitats, from surface to 200 m depth. MiFish primers were used for species detection. Cluster analysis revealed six major communities with distinct distributions. NMDS and PERMANOVA indicated significant differences of fish communities between the clusters driven by temperature, depth, salinity, chlorophyll-a, and vertical temperature gradient. GAM showed that richness generally decreased among these gradients but exhibited local peaks at ~16 °C, ~23 °C, and ~4000 m depth, highlighting patterns that deviate from the classic LDG. The model explained 65.7% of variance, highlighting the importance of environmental drivers in shaping fish diversity and informing future conservation efforts in this climate-sensitive region.

S02, Poster, AbstractID=18410, PosterID: S02-P10

Harmful impacts of climate change on the ecophysiological traits of ciguatera-causing dinoflagellates

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Rising seawater temperatures due to climate change can affect the physiological characteristics of microalgae, and the mucilage they produce may influence marine ecosystems. This study examined the influence of temperature on the growth, mucilage production, and toxicity of the mucilage-forming, toxic benthic dinoflagellate *Gambierdiscus jejuensis* GCJJ1 under various temperature conditions.

The results showed that growth rate, total organic carbon (TOC) concentration, and toxicity were all affected by temperature variation. Cell growth peaked at 26 °C with a maximum growth rate of 0.08 d^{-1}. TOC change was also greatest at this temperature, with a value of 0.10 mg L^{-1} d^{-1}. Toxicity, assessed via *Artemia* bioassay, was strongest at 26 °C, where the LC_{50} was 14.50 ppm, indicating a substantial increase compared to lower temperatures. In contrast, mucilage area continued to increase with rising temperature, reaching its highest value of 16.82 ± 3.83 μm² at 29 °C. These results suggest that although both growth and toxicity slightly declined at the highest temperature, mucilage production per cell remained elevated.

These findings suggest that rising seawater temperatures may promote the proliferation and ecological impact of harmful benthic dinoflagellates by enhancing both biomass and toxic potential. Understanding the temperature-driven responses of *G. jejuensis* provides valuable insight into how climate change could influence future bloom dynamics and toxin events, offering a basis for risk assessment and ecosystem management.

S02, Poster, AbstractID=18413, PosterID: S02-P11, (ECOP)

Phytoplankton community response to climate stress in an advanced ocean-biogeochemical model

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Climate forcing impacts the marine environment through various physical and biogeochemical processes, including changes in temperature and nutrient availability. Phytoplankton respond to these changes in a type-specific manner, as each type exhibits distinct preferences for temperature and nutrient conditions. Consequently, climate stressors can reshape phytoplankton community composition. While previous studies have examined these changes using statistical approaches (e.g., species distribution models), mechanistic models have been applied more infrequently, withholding insights into the physical mechanisms and leaving key uncertainties unresolved. To address this, we develop a modeling framework using an advanced coupled ocean–biogeochemical model (MITgcm–Darwin), in which biogeochemical processes for 310 types of phytoplankton are numerically resolved. In this model, 310 types are configured by different combinations of key traits: 14 size classes, 10 temperature preferences, and 8 ecological functions. We are analyzing the outputs of this simulation to understand how phytoplankton community composition responds to climate forcing, with a particular focus on marine heatwaves as well as the mechanisms driving these changes.

S02, Poster, AbstractID=18490, PosterID: S02-P12

Long-term drivers of spring bloom dynamics in the northern Gulf of Alaska and impacts on planktonic community structure

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The northern Gulf of Alaska (NGA) is characterized by a mosaic of processes underlying a biologically complex and productive marine ecosystem. Here, we analyze a 25-year (1996–2020) high-resolution hindcast from a coupled physical-biogeochemical model to identify the dominant mechanisms controlling interannual spring bloom dynamics in NGA and its impacts on planktonic community structure. Using an empirical orthogonal function (EOF) decomposition combining abiotic and biotic variables, we find that both light intensity and nitrate availability are important drivers of phytoplankton variability during spring, while zooplankton fluctuations result from a combination of carry-over effects and bottom-up controls. A more unexpected finding is that the cumulative biomass of large copepods and euphausiids has a significantly stronger dependence on phytoplankton community structure (i.e., relative diatom abundance) than on nitrate availability. Since these organisms play a key role transferring energy to many ecologically, economically, and culturally important species, our work provides a robust baseline to assess the effects of long-term climate change and extreme events on the broader NGA ecosystem, as well as the services and resources it provides.

S02, Poster, AbstractID=18534, PosterID: S02-P13, (ECOP)

Long-term sea level rise rates in the southwestern East Sea (Japan Sea) from 1993 to 2023: Focusing on thermosteric and halosteric effects

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The southwestern East Sea (Japan Sea) exhibits a significantly higher sea level rise rate (5.21 ± 1.00 mm/year) than the global average (3.25 ± 0.37 mm/year), potentially threatening the stability of regional ecosystems. While thermosteric effects are recognized as major contributors to sea level rise of the southwestern East Sea, the relative contribution of thermosteric and halosteric effects near Ulleung Island have never been quantitatively assessed yet. This study based on gridded (L4) and along-track (L3) satellite altimetry data from Copernicus Climate Change Service (CMEMS), hourly tide gauge records from the Korea Hydrographic and Oceanographic Agency (KHOA), and bimonthly hydrographic station data provided by the Korea Oceanographic Data Center (KODC) to estimate the long-term sea level rise rate and evaluate the thermosteric and halosteric contribution. The long-term sea level rise rates and standard errors were calculated by linear regression based on annually averaged time series over the entire study period. Long-term sea level rise rates near Ulleung Island were estimated at 4.47 ± 2.62 mm/year based on L4 data and 5.21 ± 1.00 mm/year from L3 data. Notably higher seasonal trends were observed in summer (5.28 ± 1.17 mm/year, L4) and fall (5.72 ± 1.69 mm/year, L3). Tide gauge observations indicated an even higher rise rate of 6.26 ± 0.97 mm/year. The estimated steric contribution (2.70 ± 0.76 mm/year) accounted for 60.4 % (L4), 51.82 % (L3) and 47.9 % (KHOA). According to the depth-resolved thermosteric and halosteric effects analysis, both sea level rise due to ocean warming and sea level decline due to salinification were observed simultaneously at depths between 50 and 200 m. These findings offer an understanding of how sea level rise, driven by temperature and salinity changes and regional marine conditions. By combining multiple observational platforms and long-term data products, this study contributes to regional ecosystem monitoring and supports international efforts toward integrated marine research for the UN Ocean Decade, particularly in the Asian Marginal Seas.

S02, Poster, AbstractID=18535, PosterID: S02-P14, (ECOP)

Habitat distribution patterns and overlap characteristics between tunas and sharks in the western and central Pacific Ocean

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Tunas are important top predators in the Pacific Ocean targeted by longline fisheries, while sharks are frequently caught as bycatch. Both sharks and tunas share similar trophic niches, making it essential to understand their habitat distribution and overlap for effective ecosystem-based fisheries management. Fishery data from the Western and Central Pacific Fisheries Commission were used to calculate catch per unit effort (CPUE) and visualize spatial overlap patterns. Overlap frequency and overlap rate were used to identify high co-occurrence zones, with values closer to 1 indicating greater overlap. Results show that blue sharks, shortfin mako sharks, and hammerhead sharks are the most frequently bycaught species during the harvesting of albacore, bigeye, and yellowfin tunas, with the hammerhead being a species of particular conservation concern. High CPUE overlap areas were mainly found between 140°W–150°W and 20°N–10°S. The CPUE overlap rates between blue sharks and yellowfin, albacore, and bigeye tunas were 0.51, 0.63, and 0.66, respectively; shortfin mako sharks had a consistent overlap rate of 0.60 with yellowfin, albacore, and bigeye tunas. Hammerhead sharks showed a uniformly high overlap rate of 0.95 with all three tuna species. These patterns likely reflect species-specific CPUE distributions. Blue and shortfin mako sharks have broader distributions, leading to lower overlap, while hammerheads concentrate within tuna hotspots, resulting in higher overlap. Such overlap suggests possible interspecific competition and ecological niche displacement. Future studies will integrate the species distribution overlap centroid index and environmental variables to examine spatial overlap dynamics in relation to habitat distribution.

S02, Poster, AbstractID=18583, PosterID: S02-P15

A numerical study on the larval dispersal and potential connectivity of coral reefs around the coast of Hainan Island

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In recent decades, the coral reefs around the coast of Hainan Island have undergone persistent degradation. The connectivity between coral reef regions is crucial for the natural resilience of coral reefs. A three-dimensional ocean hydrodynamic model was employed to simulate the hydrodynamic conditions and a Lagrangian particle tracking method was used to investigate coral larval dispersal pathways. Influenced by the current, coral larvae along the eastern coast of Hainan Island primarily disperse southward. With the current turning northward at mid-May, the larvae are carried and disperse northward. In contrast, coral larvae released from the western coral reefs mainly disperse northward and finally reach the coast of Guangxi. Coral reef connectivity is stronger in the eastern Hainan Island than that in the western Hainan Island. In addition, there is a limited connectivity between the eastern and western coral reefs of Hainan Island. The results is benefit for the coral reef protection around Hainan Island.

S02, Poster, AbstractID=18584, PosterID: S02-P16, (ECOP)

Carbon dynamics in a eutrophic estuary: Riverine organic matter overrides nutrient-induced sinks

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Estuaries are dynamic transition zones where riverine inputs of organic matter (OM) and nutrients regulate carbon cycling through competing effects on production and remineralization. Yet the relative control exerted by these inputs on CO_2 fluxes remains a critical uncertainty in predicting whether estuaries function as net carbon sources or sinks. To resolve this, we applied an observationally constrained coupled physical-biogeochemical model to the eutrophic Pearl River Estuary (PRE) during summer, when peak river inputs drive the most active carbon cycling. Results show that although the high-salinity plume region ($S > 25$) acts as a CO_2 sink due to nutrient-stimulated production, the broader estuarine system ($S < 30$) remains a net CO_2 source (~75 mmol C m^{-2} day^{-1}), dominated by outgassing in low-salinity waters ($S < 10$) where riverine OM remineralization prevails. We further demonstrate that riverine OM loading exerts disproportionate control: doubling OM raises CO_2 outgassing by 41% via enhanced remineralization, while halving it reduces emissions by 20%. In contrast, equivalent increases in nutrient loads cause only a marginal reduction in outgassing because nutrient-stimulated phytoplankton uptake is largely offset by concomitant OM degradation. Crucially, CO_2 outgassing was found to scale linearly with the riverine OM C/N ratio, revealing a stoichiometric mismatch. Here, nutrient release (N and P) during degradation of riverine OM (typically higher than the Redfield ratio) was insufficient to support proportional new production (which follows the Redfield ratio), resulting in net CO_2 release. These results highlight that managing terrestrial OM inputs, rather than nutrients alone, is critical for mitigating estuarine CO_2 emissions.

S02, Poster, AbstractID=18622, PosterID: S02-P17, (ECOP)

Trophic shifts driven gelatinous zooplanktons modify the energy pathways within planktonic communities

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Gelatinous zooplankton profoundly leverage ecosystem structures by exerting substantial pressure on trophic pathways. The East Sea is experiencing one of the fastest oceanic changes globally, marked by a rapid warming phase occurring at a 2-fold higher than the global mean of sea surface temperature. This accelerated warming has resulted in substantial ecosystem degradation, threatening a key productive marine area and altering ecological dynamics. In this study, we investigate the impact of gelatinous zooplankton prevalence on the planktonic community structures with a focus on *Salpa fusiformis Cuvier, 1804*. High-resolution data were collected from 29 stations in the East Sea, Korea, during July-August 2019, including species-level identification of 59 taxa. Utilizing the proxy of carbon ratios based on their biological traits, we access food-web restructuring and paths diagrams. Our results demonstrate that gelatinous zooplankton dominance may trigger to fluctuate energy transfer links within ecosystems. Notably, high *Salpa* regions (12 stations; >95% confidence interval) showed a reduction in energy density (-0.48%, $p<0.05$) compared to the carbon lipid-rich dominated system (i.e., copepods and decapods). Alterations in energy flow at basal trophic levels simplify ecosystem structure by shifting from multichannel networks to linear pathways, potentially affecting ecosystem resilience in response to environmental change. We highlight gelatinous zooplankton as effective indicators for monitoring rapid ecosystem responses to oceanic changes. Future research aims to quantify the spatiotemporal variation of gelatinous zooplankton driven by hydroclimatic forcing and its influence on energy transfer across dynamic marine environments.

S02, Poster, AbstractID=18626, PosterID: S02-P18, (ECOP)

Transcriptomic analysis of intraspecific differentiated survival strategies of the dinoflagellate *Heterocapsa triquetra*

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Heterocapsa triquetra is a bloom-forming dinoflagellate that thrives across a wide range of water temperatures, forming blooms in both cold and warm seasons at the same geographic locations worldwide (Paek et al., 2011). To elucidate the mechanisms underlying temperature adaptation in dinoflagellates, we compared the physiological traits of two strains isolated from different seasons. We observed significant differences ($p < 0.05$) in growth rates and cell volumes between the two strains, which varied with temperature. To investigate the molecular basis of these physiological divergences, we conducted a transcriptomic analysis. Differential gene expression analysis indicated that, at 25°C, the winter strain exhibited distinct upregulation of genes associated with cell structure and biogenesis. In contrast, under thermal stress, both strains showed pronounced differential expression of genes related to nutrient metabolism and cell cycle pathways. These results suggest that the winter strain copes with heat stress primarily by enhancing structural stability, whereas the summer strain relies more on active cell proliferation. These findings provide valuable insights into the temperature adaptation strategies of H. triquetra and enhance our understanding of how dinoflagellate populations persist across diverse environments.

S02, Poster, AbstractID=18645, PosterID: S02-P19, (ECOP) (CANCELLED)

Understanding and predicting the combined impacts of climate change and internal variability on North Pacific ecosystems: Toward innovative approaches for resilience

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The resilience of North Pacific marine ecosystems is increasingly threatened by the compounding effects of anthropogenic climate change and natural modes of climate variability, including the El Niño–Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO). While long-term warming trends are reshaping species distributions, productivity, and biogeochemical cycles, episodic extremes associated with internal variability—such as marine heatwaves, deoxygenation events, and shifts in circulation—can exacerbate ecological stress and disrupt ecosystem services vital to coastal communities. Understanding the interplay between forced climate trends and internal variability is essential for improving predictive capabilities and informing adaptive management strategies.

This study synthesizes recent advances in high-resolution climate modeling, machine learning–based ecological forecasting, and integrated observing systems to characterize the combined impacts of climate change and climate modes on North Pacific ecosystems. We demonstrate how ensemble simulations and artificial intelligence approaches can help disentangle the relative contributions of external forcing and internal variability to observed and projected ecological changes. Case studies illustrate how predictive models of ENSO-related ocean anomalies can be linked with biological indicators to anticipate shifts in fisheries productivity and habitat suitability months in advance.

We further highlight co-production frameworks that engage scientists, policymakers, and local stakeholders to translate forecasts into actionable strategies for ecosystem resilience. By integrating innovative tools with participatory approaches, this work underscores the potential to enhance adaptive capacity and support sustainable development in the North Pacific under a changing climate.

S02, Poster, AbstractID=18646, PosterID: S02-P20, (ECOP)

Variations on the distribution and abundance of apex predators in response to Indian Ocean Dipole events in the Indian Ocean

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The Indian Ocean is a crucial fishing ground for Taiwan's longline fishery. It contains both high-value and bycatch apex predators. Previous research shows that their abundance and distribution are sensitive to climatic variability, particularly the Indian Ocean Dipole (IOD). At present, the most effective method for forecasting the IOD is the convolutional neural network (CNN). Therefore, this study aims to apply a CNN model to identify optimal environmental factors for apex predators and analyze the influence of the IOD on environmental factors, as well as its relationship with the abundance and distribution of apex predators. Based on IOD effects and fishing activity, the study area is divided into four subregions (northwest, southwest, northeast, and southeast Indian Ocean) to examine the correlation between environmental factors and apex predator abundance in each region. The spatial distribution showed that billfishes, yellowfin tuna, and silky sharks were mostly concentrated in the northwest Indian Ocean, while other shark species were broadly distributed throughout the Indian Ocean. Pearson correlation analysis of the four subregions revealed that in the northwest Indian Ocean, mackerel shark catch rates were positively correlated with SST (r =0.707). In this region, the distribution of yellowfin tuna and black marlin overlapped and showed similar patterns in catch rate, with a significant increase in 2012 and declined in 2013 during the positive IOD event. In the future, we will use a Generalized Additive Model to compare which model has the best explanation, and figure out how IOD-induced environmental effects affect apex predator abundance.

S02, Poster, AbstractID=18655, PosterID: S02-P21

Seasonal variations of marine toxicity in relation to environmental factors and phytoplankton communities in Korean coastal waters

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This study investigated seasonal patterns of marine toxicity in Korean coastal waters from spring 2024 to winter 2025 using Microtox bioassays (EC50), along with measurements of seawater temperature, salinity, pH, DO, nutrient levels, phytoplankton communities, and documented harmful algal blooms (HABs).

In spring, elevated seawater temperatures coincided with increased occurrences of *Pseudonitzschia* spp., potential producers of domoic acid, leading to lower EC50 values and suggesting higher toxicity. This pattern also aligned with reports of paralytic shellfish poisoning (PSP) and local blooms. During summer, EC50 was inversely related to temperature, indicating that rising temperatures might contribute to greater toxicity. In autumn, reduced EC50 values were often observed in some southern coastal areas, where toxicity appeared linked not only to temperature but also to benthic dinoflagellates and recurring *Pseudonitzschia*, implying complex ecological interactions that could influence toxin dynamics. By contrast, winter generally showed higher EC50 values across sites, indicating minimal toxicity during this period.

Overall, these findings suggest seasonal shifts in environmental conditions and phytoplankton structures may jointly affect marine toxicity. Continued monitoring and further studies are needed to better understand these interactions and their implications for coastal ecosystem health.

S02, Poster, AbstractID=18662, PosterID: S02-P22

Winter ocean–atmosphere heat flux variability in the Barents and Bering Seas

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The Barents and Bering Seas are highly productive regions where phytoplankton blooms sustain the marine food web. These blooms depend on specific physical conditions, including the formation of a seasonal pycnocline, which is influenced by heat exchange between the sea surface and the atmosphere during the cold season. This study analyzes the spatiotemporal variability of total heat flux (HB) in both seas from 1979–2023 (Barents Sea) and 1979–2022 (Bering Sea) using ERA5 reanalysis data (0.25° hourly). The HB is calculated as the sum of shortwave and longwave radiation, sensible heat, and latent heat, processed via daily averaging and a 30-day moving average. In the Barents Sea, the spatial distribution of heat flux aligns with Atlantic water inflow, showing maxima along the Nordkapp and West Novaya Zemlya Currents and a local minimum over the Central Bank due to dense cold water formation. In the Bering Sea, heat flux peaks along the Kamchatka-Koryak shelf (−3000 to −4000 MJ/m²) and minimizes near St. Lawrence Island (−500 to −1000 MJ/m²). Unlike the Barents Sea, the Bering Sea lacks a consistent ice cover trend, preventing a similar linear increase in heat transfer. These findings highlight contrasting responses to climate change, with the Barents Sea experiencing amplified heat loss due to ice retreat, while the Bering Sea shows regional variability without a clear ice-driven trend.

S02, Poster, AbstractID=18665, PosterID: S02-P23, (ECOP)

Quantifying the controls on biological carbon pump efficiency: Temperature and planktonic food web structure in the oligotrophic South China Sea

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The biological carbon pump (BCP), which transfers organic carbon from the upper ocean to depth via particle export, is a critical but poorly constrained component of the global carbon cycle. While biogeochemical models are widely used to study BCP efficiency, their estimation and future projections remain highly uncertain. This uncertainty arises partially from inadequate representations of temperature-dependent processes (growth, respiration, and remineralization) and planktonic community dynamics. Here we quantify how these underrepresented mechanisms control BCP efficiency and its climate sensitivity. Using the oligotrophic South China Sea as a testbed, we implement one-dimensional ecosystem models with varying complexity at the long-term time series monitoring station (SEATS). We evaluate how model-estimated BCP efficiency is affected by the parameterization of temperature-dependent functions and planktonic food web structure (e.g., number of planktonic groups and their interactions). We further assess the relative importance of these processes in modulating future BCP projections under climate change scenarios. The results will provide critical guidance for improving global biogeochemical models' capacity to predict both current and future ocean carbon sequestration under changing climatic conditions.

S02, Poster, AbstractID=18680, PosterID: S02-P24

New record of the iravadiid gastropod *Wakauraia sakaguchii* (Kuroda & Habe, 1954) from Korean salt marshes

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The unrecorded species of Iravadiidae (Mollusca: Gastropoda: Littorinimorpha), *Wakauraia sakaguchii* (Kuroda & Habe, 1954), was discovered in the Korean estuarine salt marshes of the Eastern Yellow Sea. The genus *Wakauraia* Kuroda & Habe, 1954 is a group of small, elongately conic, solid-shelled gastropods characterized by a distinctively reddish brown periostracum and an angulated anterior aperture. Currently, only two species have been reported globally from Japan and Australia, typically inhabiting estuarine environments such as under rocks and logs, or within damp or submerged leaf litter in river mouths and mangrove forests. We collected several specimens from Korean salt marshes, and their morphological descriptions are provided below. The analysis of shell morphology allows us to identify the examined specimens as *W. sakaguchii*. This species has not been previously recorded in Korea waters. The present species has an elongately conical shell measuring 4.3–6.5 mm in height and 2.1–3.1 mm in width. The shell is solid, with low spiral ribs and a dark reddish brown periostracum. The umbilicus is closed. The aperture is truncated, with a slightly sinuate anterior apertural lip. These external characters collectively indicate that the present species should be assigned to the genus *Wakauraia*. In addition, its lower shell height and nearly vertical columellar lip, compared to its congener *W. fukudai* Golding, 2014, suggest that the present species is *W. sakaguchii*. This report expands the known distribution of *Wakauraia* gastropods and provides supplementary biogeographic information for *W. sakaguchii*, a species listed in the Red Data Book of Seashore Benthos as threatened in Japanese tidal flats.

S02, Poster, AbstractID=18712, PosterID: S02-P25

Disentangling climate forcing effects on pelagic marine ecosystem dynamics using Bayesian causal inference

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Understanding the extent to which interannual variability in marine ecosystems is driven by climate forcing is essential for both ecological theory and effective management in a rapidly changing ocean. In this study, we evaluate the relative influence of climate variability on pelagic ecosystem dynamics using a high-resolution, multi-decadal dataset that integrates climate, hydrological, and zooplankton records.

We employ a Bayesian structural causal modeling framework to quantify the effects of temperature regimes on three key ecological processes: (i) the timing of seasonal zooplankton development (SZD); (ii) the strength of predator–prey interactions between jellyfish and copepods under varying climate conditions; and (iii) the emergence of compensatory dynamics (i.e., negative covariance) among competing species. Our models reveal that the relationship between climate variability and SZD is non-stationary, shifting over time and across ecological scales.

We further identify the temporal scales at which anthropogenic and climatic drivers affect SZD and segment the climate time series into statistically significant and non-significant phases. Notably, a persistent warm-phase regime is linked to an increased likelihood of jellyfish blooms, which in turn alters plankton community dynamics.

Our results demonstrate that both predator–prey interactions and compensatory mechanisms are regulated by threshold responses to climate forcing, potentially driving synchronized shifts at population and community levels. These results underscore the dominant role of climate forcing over ecological interactions under certain conditions and suggest that climate thresholds may offer predictive value for anticipating interannual changes in pelagic ecosystem structure and function.

S02, Poster, AbstractID=18783, PosterID: S02-P26

Integrating video annotations for multiscale marine biodiversity monitoring using Ocean Networks Canada's Coastal Community Observatories

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Presented by Lucianne M. Marshall on behalf of Sofia Jimenez

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Ocean Networks Canada's Coastal Community Observatories are an innovative technology that enables a better understanding of local marine regions by providing a comprehensive picture of the ecosystem. They collect continuous measurements of temperature, salinity, CO_2, O_2, and chlorophyll, alongside video and acoustic data. Each observatory is designed and customized in consultation with local leaders and provides a localized system for year-round continuous, real-time ocean monitoring.

These high-quality data are freely available and accessible through the Oceans 3.0 data management system, which includes SeaTube - a custom designed tool for video data. Recent software development enabled the integration of Coastal Community Observatory video archiving with an expanded set of tools, including a video annotation feature. SeaTube allows users to label specific events in the footage using a structured format that includes timestamps, taxonomic labels integrated with WoRMS, and optional comments. Annotations can also incorporate attributes that describe key traits, such as behaviours (e.g. predation, camouflage, or schooling) or physical characteristics (e.g. life stage or sex). Multiple individuals can contribute to the online video annotation database, highlighting events relevant to diverse research topics and utilizing the long-term video time series collected by the coastal observatories. This collaborative potential is further enhanced by the SeaTube Search tool, which enables users to explore and build upon existing annotations created by others, expanding access to shared knowledge.

These observations can be examined alongside environmental data continuously collected by the observatories, contributing to a holistic view of local ecosystem dynamics. To illustrate this potential, this case study showcases the new annotation feature using China Creek Coastal Community Observatory data, supported by a training workshop tailored for non-scientific audiences. By engaging citizen scientists, the platform's application extends beyond the scientific community, blending the data with existing knowledge from local communities while supporting informed decision-making within their territories.

S02, Poster, AbstractID=18795, PosterID: S02-P27

Influence of the river runoff from volcanic catchments of the Kamchatka Peninsula to the environment of the adjacent Pacific Ocean

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Field observations on different rivers and three cruises on both sides of Kamchatka Peninsula were made from 2022 to 2025, together with satellite data on chlorophyll a concentration, are analyzed to show the hydro-ecological features of different catchments and receiving basins. Unlike other volcanic regions of the world, the catchments of Eastern Kamchatka are characterized by a long spring-summer flood as a result of snowmelt, therefore, the seasonal effect of dilution of Pacific coastal waters is noticeable at depths up to 500 m and at distances of more than 150 km from the coastline. Together with the increasing runoff of the volcanic rivers of Eastern Kamchatka, concentrations of nutrient are systematically increasing due to accumulation of nutrients in the snow and groundwater discharge. As a result, phytoplankton blooms from May to July with the spring-summer stratification of the Pacific coastal waters occurs. The second stage of blooming of phytoplankton, during which the development of harmful dinoflagellates is often, and sometimes large-scale "red tides" occur in September-October. This occurs because snowmelt in the highlands of the catchment areas can continue to the September supplying additional nutrients to the coastal Pacific Ocean. Thus, the most intense phytoplankton blooms should be expected in the adjacent part of the Pacific Ocean in years with both a large amount of snow in the previous winter and sufficiently high air temperatures in summer for intensive snowmelt in the highlands and the establishment of stratification of Coastal Pacific waters.

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S02, QRPoster, AbstractID=18897, PosterID: S02-P28

Extraction, characterization, and cytotoxicity assessment of collagen from the tomato jellyfish (*Crambione mastigophora*)

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Jellyfish (Phylum Cnidaria) often form dense aggregations and blooms in marine ecosystems, posing significant challenges to sectors such as fisheries and tourism. Nevertheless, jellyfish represent an underexplored source of marine collagen with considerable biotechnological potential. *Crambione mastigophora*, commonly known as the tomato jellyfish due to its reddish-brown umbrella, has not previously been investigated for collagen extraction or characterization. This study aimed to extract crude collagen from different body regions of *C. mastigophora* using an ultrasound acid-assisted extraction method. The proximate composition was analyzed, and the extracted collagen was characterized using Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Sodium Dodecyl Sulfate–Polyacrylamide Gel Electrophoresis (SDS-PAGE). Cytotoxicity was also evaluated against 3T3 mouse embryonic fibroblast cells using the MTT assay. Several specimens were collected and processed in the laboratory. The oral arm yielded the highest collagen content (4.34 ± 1.74%), followed by the whole body (3.33 ± 0.27%) and the bell (2.73 ± 0.60%), with no significant difference ($p < 0.05$). Proximate analysis revealed that the bell had the highest moisture (98.12 ± 0.17%) and ash (58.06 ± 5.25%) content, while the oral arm exhibited the highest protein concentration (73.39 ± 1.99%) and the lowest ash (15.82 ± 1.00%) and lipid content (0.41 ± 0.09%). FTIR spectra showed five characteristic collagen peaks (Amide A, B, I, II, and III), confirming structural integrity. SEM imaging demonstrated intact fibrils and fibers, and SDS-PAGE revealed similarities to Type I, II, and III collagen. Cytotoxicity testing confirmed that all extracts were non-toxic up to 500 µg/mL. In summary, this study successfully extracted and characterized collagen from *C. mastigophora*, with the oral arm identified as the most promising source. The findings highlight its potential for future biomedical, cosmetic, and pharmaceutical applications.

SESSION 3: POC/FUTURE Topic Session

Interactions of Variability and Change in the North Pacific

Oral Presentations

S03, Invited, AbstractID=18774

Quantifying temporal beta diversity across marine assemblages experiencing variable trajectories of community change

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Across global ecosystems elevated levels of biodiversity loss, climate impacts, and anthropogenic stressors drive continued investigations into how communities across the globe are changing. Beta diversity is the change in community composition measured in a spatial or temporal context within an ecological system, and temporal beta diversity is the change in community composition over time in a repeatedly observed study area. The comparison of paired observations in time is a valuable indicator of shifts in community members within an ecological assemblage. Here we assess and quantify these shifts across 15 demersal marine fish assemblages to visualize and compare trends and trajectories of community change over time. To test area-specific variation in community dynamics over the study period we employed a community trajectory analysis (CTA), a multivariate geometric approach that characterizes and compares temporal shifts in community composition. We observed that all assemblages within the analysis changed over time, however, a negative relationship between overall directionality and average interannual change emerged. The more directional communities shifted in small, incremental time steps resulting in a significant deviation in community structure over time. Identifying trends and baselines of temporal beta diversity is a critical step in connecting compositional changes to ecological processes, and this study also highlights the utility of temporal beta diversity to resource managers as an indicator of shifting community dynamics and persistence in community structure over time.

S03, Oral, AbstractID=18290, (ECOP)

Interannual to decadal variability of the ocean heat content in the western North Pacific and its nonstationary relationship with major climate modes

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Understanding the long-term variability of upper-ocean heat content (OHC) in the western North Pacific (NP) is essential, as it plays a crucial role in regional climate and ocean-atmosphere interactions. This study investigated the relationship between OHC variability in the western NP and major climate modes, including the Pacific Decadal Oscillation (PDO) and North Pacific Gyre Oscillation (NPGO) from 1964 to 2020. During 1964–2008, the OHC variability in the western NP is associated with two independent modes: 1) a meridional shift of both the Kuroshio Extension (KE) and subarctic frontal zone (SAFZ), linked with the PDO with a 6-month lag, and 2) changes in the strength of the KE, linked with the NPGO with a 3-year lag, which were documented in previous studies. For the latter period (1993–2020), a dominant mode emerges that captures coherent changes in both latitude and intensity of the KE, which is strongly correlated with the PDO and NPGO at comparable three-year lags but in opposite phases. This weakening is likely due to a non-stationary relationship between two climate modes after the 1990s, which may have impacted the KE, causing a meridional shift and changes in its strength to become synchronously linked rather than behaving as independent modes. It is possible that the PDO and NPGO no longer modulate OHC variability separately but instead interact through a combined mechanism after the 1990s. The previously noted correlations with the PDO and NPGO may not hold consistently due to the non-stationarity of the climate mode indices, highlighting the need to reassess the validity and limitations of these Pacific climate mode indices under the assumption of their stationarity.

S03, Oral, AbstractID=18325, (ECOP)

Monthly to sub-annual variability of sea surface temperature and thermal fronts in the Kuroshio meander system

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This study examines the monthly to sub-annual variability of Sea Surface Temperature (SST) and thermal fronts in the Kuroshio meander system over the recent decade (2014–2024), focusing on the region between 30°N–50°N and 130°E–165°E. Using high-resolution satellite-derived SST data, we assess recent trends and fluctuations in thermal front behavior. A distinct warming trend is observed, consistent with global ocean warming, along with marked monthly, seasonal, and annual SST variations. Seasonal cycles show peak SSTs in late boreal summer (June–August) and minima in winter (December–March). A major finding is the persistent Kuroshio meander that began in July 2017. Since then, SST front gradient magnitudes weaken from July to September, indicating reduced frontal intensity during mid-summer. In contrast, fronts strengthen from December to April, peaking as the Kuroshio bends southward. This forms a repeating July-to-June cycle in frontal intensity. We also observe a consistent northward and westward shift in the upstream Kuroshio path during the meandering phase, affecting thermal front development and mesoscale dynamics. This study employs statistical and trend analyses to characterize spatial and temporal SST patterns. Thermal fronts serve as indicators of oceanic productivity and dynamic activity. Overall, the findings highlight how recent Kuroshio meandering has altered SST front behavior, with implications for climate monitoring, oceanography, and fisheries resource management in the Northwest Pacific.

S03, Oral, AbstractID=18325, (ECOP)

Drivers of historical multi-decadal compound change for the northern California Current System

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Seasonal upwelling in the northern California Current system (nCCS) drives high productivity, supporting diverse fisheries; however, it is also prone to persistent ocean acidification and hypoxia, whose occurrence has changed over time. On the continental shelf, intensive rates of subsurface and benthic respiration increase over the summer upwelling season, often generating hypoxia or anoxia. Corrosive (Ω_{Ar}<1) waters coincidently expand encompassing most of the shelf by late summer. Over the past 30 years, the extent to which these conditions have co-occurred has changed, becoming more severe over time. To examine the drivers of this historical compound change, we use LiveOcean, an existing local forecast system to realistically simulate the historical ocean conditions from 1993 to 2022. Using observations, we analyze the spatiotemporal patterns and simulated trends and show that the model is skillful at reproducing the variability of biogeochemical properties as well as the long-term compound change over this period. Upwelling can change in multiple ways, so we utilize several metrics including CUTI and BEUTI to quantify how changes in upwelling have influenced the compound changes. Our results indicate the mixed layer depth shoaled historically, while the nutrients at that depth remain unchanged. This suggests a shift in nutrients supplying the upwelled water, which has implications for compound change that will be discussed alongside mechanisms for this change. Coastal modification of the upwelling signal appears to amplify rates of deoxygenation and acidification in this system, highlighting that it is an important process to be both observed and included in future ecosystem projections.

S03, Oral, AbstractID=18517

Linking circulation change to decadal–multidecadal ocean heat content anomalies in the central North Pacific via budget-based decomposition

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The Pacific decadal oscillation (PDO), defined as a leading EOF mode of monthly sea surface temperature anomalies in the North Pacific, has been widely used to discuss the impact of climate variability on various variables, including ecosystem and fishery resources. However, recent marine heatwaves in the eastern North Pacific caused a fundamental change to the leading EOF, suggesting doubts about whether the PDO would continue to be as useful an indicator as it has been. Therefore, to reconstruct existing knowledge of climate variability impacts, it is essential to deepen our understanding of the mechanisms underlying the PDO. As a result of numerous studies to date, a consensus is forming that the PDO is not a single physical mode but caused by a combination of different physical processes. At decadal to longer timescales, the influence of circulation changes is suggested to be non-negligible. However, it is still not well understood how important the variation of circulation is for the temperature variation around the center of action of the PDO in the central to eastern Pacific. We focused on the monthly heat content anomaly of the surface layer in this region and examined the heat budget using a long-term ocean state estimation dataset that was derived from an ocean data synthesis system (ESTOC) applying a four-dimensional variational data assimilation method based on a “strong constraint” and thus dynamically self-consistent. Budget based decomposition of the heat content anomalies clearly shows that the heat transport anomalies associated with geostrophic current anomalies cannot be ignored to reproduce the multi-decadal variation. We will show the associated circulation change and discuss its role on the heat content variability.

S03, Oral, AbstractID=18521, (ECOP)

Spatially heterogeneous ecosystem responses to marine heatwaves in the Northeast Subarctic Pacific

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Marine heatwaves (MHWs) have increased in frequency, intensity, and duration across the northeast subarctic Pacific Ocean (NESAP) in recent years, yet their spatially heterogeneous ecosystem impacts remain poorly understood. Using satellite-derived estimates of chlorophyll-a concentrations and primary productivity spanning a quarter century (1998-2023), we found differential MHW responses in shelf-break and oceanic regions of the NESAp i. Shelf-break waters, influenced by seasonal upwelling, experienced significant productivity declines during MHWs. In contrast, offshore waters, characterized by iron-limited with excess macro-nutrients, showed weaker MHW responses. Our spatially-resolved analysis suggests varying sensitivities to MHWs across the region in relation to underlying patterns of nutrient limitation associated with enhanced mixed layer stratification. The differential response of MHWs has critical implications for predicting ecosystem impacts under projected ocean warming scenarios.

S03, Oral, AbstractID=18606, (ECOP)

Spectral clustering-based identification of shifting and emerging EKWC pathways

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To objectively characterize the circulation patterns of the East Korea Warm Current (EKWC) in the East/Japan Sea (EJS), we applied a spectral clustering algorithm to a 30-year record of daily sea surface height (SSH) reanalysis data. This unsupervised classification revealed three robust current pathways, consistent with earlier manually derived categorizations based on Lagrangian trajectory analyses. The close correspondence supports spectral clustering as a powerful tool for identifying circulation patterns in the EJS.

In recent years, a clear shift has emerged, with a northward EKWC route becoming increasingly dominant over the historically common alternatives along the Japanese coast or southward near Korea. To capture variations within this northern branch, we performed an additional clustering considering waviness and path length. This revealed two distinct types: straight paths (SPs) and large meanders (LMs). Notably, the frequency of SPs has risen markedly in the past decade, while LMs have declined.

Autoregressive time series analysis indicates that enhanced SP frequency in spring tends to persist into autumn. Furthermore, increased SP occurrence is closely associated with preceding winter conditions, including stronger meridional SSH gradients and negative surface wind stress curl anomalies. These findings suggest that a negative phase of the Arctic Oscillation (AO) during winter may promote the emergence of SP-dominated circulation in the following spring. This shift implies reduced mixing between colder, fresher northern waters and warmer, saltier southern waters, reinforcing SP dominance and potentially weakening the regional overturning circulation through a sustained meridional SSH gradient.

S03, Oral, AbstractID=18732

Impacts of the 2025 Los Angeles urban wildfire on the Californian coastal ecosystem

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The catastrophic 2025 Los Angeles fires illustrate the emerging complexity of wildfire impacts on the whole Earth system, including the Ocean. Wildfires have the potential to cause both ecosystem fertilization from wildfire-derived nutrients and pose severe environmental risks through urban-derived wildfire toxicants. The complexity is further illustrated as this event unfolded in a dynamic coastal ocean where ecosystem health is already balanced by multiple drivers, including La Niña climate conditions, seasonal upwelling, and the concurrent emergence of a severe toxic algal bloom.

Leveraging long-term monitoring baselines and collaborations with multiple survey agencies, we established a comprehensive sampling program to capture and analyze ash and coastal water during and after the LA urban wildfires, to assess the event's distinct impacts on air quality and ocean biogeochemistry. Models can then use this information to map the dispersal of toxic inputs through the air and water. We will then trace contaminant bioaccumulation within the marine food web starting with experiments on the microbial loop, in particular to assess the potential of selective stimulation of key toxic phytoplankton species.

Understanding the effects of contaminants derived from urban wildfire on coastal ecosystem health and water quality is critical for informing coastal management and for predicting future wildfires impact.

S03, Oral, AbstractID=18769, (ECOP)

Inherent non-stationarity in the dominant patterns and regional impacts of North Pacific climate variability

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Observed changes in climate indices and their impacts in the North Pacific have raised questions regarding the stability of patterns of basin-scale variability. Establishing the range of internal variability inherent to these patterns (e.g., the Pacific Decadal Oscillation [PDO] and North Pacific Gyre Oscillation [NPGO]) is necessary for assessing the significance of recent and future changes. We evaluate non-stationarity (i.e., changes through time) in the dominant patterns and regional impacts of North Pacific variability. Using a ten-member ensemble of pre-industrial control (>700 years) and historical simulations from CMIP6 models, we characterize the expressions of the PDO and NPGO and their associated atmospheric forcing patterns (i.e., the Aleutian Low [AL] and North Pacific Oscillation [NPO]).We quantify: (1) the reproducibility of each mode within the multi-model ensemble, (2) the stationarity of the leading patterns of variability at multi-decadal timescales, and (3) the consistency of ecosystem- and fisheries-relevant impacts across timescales in Large Marine Ecosystems (LMEs). We find the spatial expression of the PDO is generally stable, though its strength varies, contrasting with the NPGO which exhibits larger spatial variations in pattern but more consistent relative importance. For the indices of both, correlations with LME-scale variables are most robust at long timescales. Occasional decorrelation at decadal timescales should be expected even when consistently significant at longer timescales, given the noise either in pattern or relative importance. However, recent changes in correlations and expressions of each pattern have not yet exceeded the internal range of variability of each.

SESSION 03: POC/FUTURE Topic Session

Interactions of Variability and Change in the North Pacific

Poster Presentations

S03, Poster, AbstractID=18259, PosterID: S03-P1, (ECOP)

Decrease in oxygen concentration in the intermediate layer in the northwest Pacific Ocean

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This study investigates decadal trends (2014–2023) in dissolved oxygen and nutrient dynamics (Si, P) within the Northwest Pacific's intermediate layers, focusing on the Kuril region—a critical gateway for oxygen-rich waters from the Sea of Okhotsk. Using data from 10 expeditions, we applied non-parametric statistics (Mann-Kendall test, Spearman's correlation) and visualization tools (ODV, Python) to assess hydrochemical variability. Results reveal significant deoxygenation (–0.06 mL/L/yr at 500–1000 m, $p<0.05$), driven by reduced ventilation from the Sea of Okhotsk due to declining ice cover and weakened slope convection under climate warming. Silicon concentrations increased (+1.78–2.17 μM/yr), reflecting stratification-driven nutrient trapping, while phosphorus trends remained insignificant. Spatially, a secondary Kuril transect (60 nautical miles offshore) showed no oxygen decline on average. The Kamchatka transect, representing the subarctic gyre's terminus, mirrored deoxygenation (–0.05 mL/L/yr), confirming regional ecosystem vulnerability. These shifts could threaten marine biodiversity and fisheries, as oxygen depletion alters habitat suitability and nutrient imbalances may disrupt primary production. Our findings emphasize the need for adaptive monitoring frameworks to track nonlinear ecosystem responses. Integrating hydrochemical data with climate models could improve predictions of biogeochemical cycles.

S03, Poster, AbstractID=18393, PosterID: S03-P2

Impact of the marine heatwave in the Oyashio region in 2022/23 on dissolved oxygen and subduction

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The authors examined the impact of the 2022/23 marine heatwave on dissolved oxygen (DO) by analyzing observations from a vessel and biogeochemical Argo floats. DO anomalies from the climatology above a depth of 200 m were negatively correlated with the temperature anomalies at the same depth, while the opposite was true for larger depths. In the density coordinate, DO and temperature anomalies exhibited a strong negative correlation when the potential density (σ_θ) was less than ~27.0 kg m^{-3}. We concluded that a dynamical process, whereby the intrusion of the Kuroshio water pushed down the density surfaces, caused oxygenation. Meanwhile, isopycnal mixing tended to mitigate the increase of DO concentration since DO concentration was smaller in the south than in the north on an isopycnal surface of σ_θ<27.0 kg m^{-3}. This relationship enabled us to estimate four-dimensional distribution of the DO anomaly in the pressure coordinates from temperature and salinity of an ocean reanalysis. The authors also examined interannual variations of subduction rate in this region using the eddy-resolving ocean reanalysis. Despite the warming of the upper ocean, annual subduction rate showed an increasing trend since 2004 due to enhancement of eddy activity. The subduction rate in 2022 was on a high level. This suggests that vertical exchange of water mass and materials became more active during the anomalous warming.

S03, Poster, AbstractID=18545, PosterID: S03-P3, (ECOP)

Interannual assessment of the dynamics of the Bering Sea water in the Chukchi Sea

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The waters flowing into the Arctic Ocean through the Bering Strait affect the thermohaline structure of the nearby Arctic seas, including the Chukchi. The work is devoted to an interannual assessment of the flows of water, heat and salt passing through the Chukchi Sea at a latitude of 68°33° N, as well as an analysis of the dynamics of waters in the selected region. The data were the deep-sea monthly average values of current velocities, water temperature, and salinity of the GLORYS12V1 (Copernicus) reanalysis for the period 1993-2020. The average long-term values of water consumption, heat and salt fluxes in the latitudinal section are 1.34 Sv, 15.78 TW, and 44.42 Mt/s, respectively. Most of them pass in the direction of the Chukchi Sea from the Pacific Ocean: and only a small part of the flows go in the opposite direction. In the temporal variability of fluxes, a distinct trend is observed. This trend is most pronounced along both the western and eastern coastlines, which can be attributed to the presence of two main streams. Based on linear trend coefficient estimates, all fluxes through the Chukchi Sea—directed from the Arctic Ocean into the Pacific—exhibit intensification. Moreover, these trends are statistically significant, with the exception of the northward heat flux, which also demonstrates significance.

S03, Poster, AbstractID=18549, PosterID: S03-P4, (ECOP)

Climate variability of volume, heat and salt fluxes through the Bering Strait

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The ongoing changes to the global climate system cause the increasing inflow of waters from the Pacific to the Arctic Ocean through the Bering Strait. The current study assesses temporal and spatial variability of volume, heat, and salt fluxes through a cross-section in the Bering Strait over the span of ~30 years as well as dependence of these fluxes on wind forcing conditions. CMEMS GLORYS12V1, WIND GLO, and ERA5 reanalysis data with monthly and daily temporal resolution were used in the study. The study covers a period from January 1993 to December 2020 and from October to December 2023. It was found that over the study period prevailing direction of the fluxes was into the Arctic Ocean; volume flux was calculated to be 1.42 Sv, heat flux was 16.95 TW and salt flux was equal to 47.07 t/s. Warmer and less salty surface waters flow to the north, colder and saltier bottom waters flow to the south. ЬIOverall, no significant trends in the studied fluxes were found, but smaller regions with significant trend coefficients with opposite signs along the studied section were observed. An increase in flux values in the direction of the Pacific Ocean was identified, as well as an increase in the average water temperature and a decrease in the average salinity along the section. Correlation of calculated fluxes with the meridional component of wind speed was found to be larger than correlation with zonal component; correlation with the meridional component increased to the east of the section.

S03, Poster, AbstractID=18733, PosterID: S03-P5

From simulation to projection: The North Pacific SST variability in CMIP6

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Global sea surface temperatures (SST) have been rising rapidly in response to global warming, with certain regions of the North Pacific warming at rates two to three times higher than the global average. However, research on SST variability, beyond the magnitude of this warming, remains limited. This study analyzes CMIP6 models' data to investigate the simulation of past characteristics and future changes in seasonal and interannual SST variability. The analysis was conducted using 31 CMIP6 models and included the historical, SSP2-4.5, and SSP5-8.5 scenarios.

In the northwestern Pacific, the amplitude of seasonal variability is pronounced in the mid-latitudes, particularly in the Kuroshio Extension region. Climate models tend to underestimate variability in the mid-latitudes and overestimate it in the low latitudes of the Pacific. Projections indicate that the amplitude of seasonal variability in the North Pacific will increase in the future, with a greater increase under SSP5-8.5 scenarios. Interannual variability tends to decrease under 2-4.5 scenarios but increases under 5-8.5 scenarios.

These results suggest that future SST variability distributions will differ depending on carbon dioxide emissions and region, with the Kuroshio Extension showing particularly large differences, both seasonally and among models, compared to other regions.

SESSION 4: BIO/FIS/MONITOR Topic Session

Responses of Small Pelagic Fish Communities to Recent Climate Regime Shifts and Climate Extremes

Oral Presentations

S04, Invited, AbstractID=18324

Unconventional sea surface temperature regime around Japan in the 2000s–mid-2010s and beyond: Potential influences on major fisheries resources

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Changes in oceanographic conditions due to climate change, particularly sea surface temperatures (SSTs), have systematically affected many marine fisheries resources around Japan. The Pacific Decadal Oscillation (PDO) index is considered one of the most important climate indices for describing basin-scale SST variations in the North Pacific, which are closely related to decadal variations in fisheries resources. Time series of the PDO index has been used to conventionally classify decadal conditions of ocean and fisheries resources around Japan as either warming or cooling regimes. It is now clear that for the 2000s to the mid-2010s, mostly during the "global surface warming slowdown," the SST regime around Japan was unconventional: despite the PDO index being in a negative phase, which normally corresponds to a warming regime around Japan, SSTs exhibited decadal cooling in some waters and seasons. SSTs in the western part of the North Pacific subtropical gyre gradually decreased, particularly in autumn–spring, whereas SSTs in the western subarctic gyre and the Sea of Okhotsk increased. Moreover, around Japan, some major marine fisheries resources, including small pelagic fishes, showed decadal increases or decreases beginning in the mid-2000s, and appeared to respond to the unconventional SST changes in their early life stages. I hypothesize that the decadal-scale variability in SSTs and associated variations in fisheries resources were driven mainly by mid-latitude Eurasian cooling, a phenomenon that has been suggested to be linked to Arctic sea-ice reduction. In this presentation, I also discuss the oceanographic conditions that have emerged since the mid-2010s, focusing on climate extremes and signs of nonstationarity.

S04, Pre-RecordedInvited, AbstractID=18441, (ECOP) CANCELLED

Recruitment, ecology, and management of coastal pelagic fish in the California Current

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The last century has seen multiple phases of small pelagic fish stock dynamics in the California Current Ecosystem. Fisheries management has adapted to this dynamism through frequent monitoring, annual and seasonal allocation adjustments, and harvest advice that is responsive to environmental observations. We provide an overview of efforts to understand stock responses to changing ocean conditions and to provide management tools that aim to be nimble, responsive, and possibly anticipate future conditions. We discuss the holistic, interdisciplinary approach taken for a case study on coastal pelagic species (CPS) along the US West Coast by two research programs: Future Seas and the Changing Ecosystems and Fisheries Initiative. This work began with building a conceptual model of CPS recruitment success, followed by data-driven analyses and simulation modeling of biomass dynamics, leading to evaluation of potential environment-recruitment linkages for tactical decision support. We discuss evidence of four main drivers for Pacific sardine (*Sardinops sagax*) and northern anchovy (*Engraulis mordax*) recruitment: 1) spawner condition, 2) oceanographic effects on spawning and larval development, 3) early life stage foraging habitat, and 4) predation. We then present efforts to model near- (less than ten years) and long-term (end-of-century) responses of Pacific sardine to environmental variation and climate change. We conclude by identifying the hurdles and leverage points for the next generation of climate-ready management of small pelagic fishes in the California Current.

S04, Oral, AbstractID=18181

Diet and prey fields and predatory and competitive interactions in early-stage pelagic fishes in the Chukchi Sea

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The Pacific Arctic is in transition. In recent years, the region has experienced unprecedented increases in temperature and decreases in sea ice, leading to considerable shifts in system phenology, species interactions, and ecosystem interactions. Understanding spatial distribution and available prey fields for the main pelagic fish species in this region is important to monitor the persistence, health, and competitive dynamics of these important fishes and implications related to potential transformation of Arctic food webs An Integrated Ecosystem Research Program launched by the North Pacific Research Board conducted a series of pelagic fish surveys in 2017 and 2019. Substantial numbers of Arctic cod (*Boreogadus saida*), Arctic sand lance (*Ammodytes hexapterus*) and juvenile walleye pollock (*Gadus chalcogrammus*) were collected in a survey that extended across the entire eastern shelf of the Chukchi Sea. This presentation will characterize the physical oceanographic environment in this region, the spatial distribution and relative abundance of these fishes, and their diet and stomach fullness indices across latitudinal gradients and from nearshore to offshore environments. Analyses provide insight to potential competitive dynamics among these species and further insight into important prey fields that sustain populations of pelagic fishes in the Pacific Arctic.

S04, Oral, AbstractID=18371, (ECOP)

Possible phenotypic responses to geographical range expansion of tropical small pelagic fish in the Northwest Pacific

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The Bali sardinella *(Sardinella lemuru)* is one of the most abundant sardine species in the tropical western Pacific. In recent years, however, it has been observed to expand its distribution into the temperate waters off Japan. This study examines the life-history traits of *S. lemuru* populations in both tropical and temperate waters of the western Pacific, using otolith microstructure and reproductive trait analyses. Results revealed contrasting life-history traits: the tropical population exhibits faster early life growth (0.5 – 1.3 mm d^{-1}), smaller size (~17 cm SL), younger (smaller) age (size)-at-maturity (< 1 year), longer spawning duration (6 – 9 mos.), lower fecundity (mean: 20,858), and smaller to medium-sized eggs (mean: 303 μm). In contrast, the temperate population displays slower early life growth (0.25 – 0.6 mm d^{-1}), larger size (~23 cm SL), older (bigger) age (size) -at-maturity, higher fecundity (mean: 50,971) and bigger eggs (mean: 533 μm). The computed Fulton's condition factor (K > 1.0) indicates that both populations are in good condition. However, temperate sardines have relatively higher K (1.7), reflecting differences in resource availability and competition. A comparison of egg quality suggests differing energy allocation strategies, with temperate sardines investing more in growth, while tropical sardines allocate more energy to reproduction.

The findings are consistent with the Temperature-Size Rule (TSR) and further demonstrate that *S. lemuru* exhibits phenotypic plasticity, occupying varying position on the *r/K* continuum. Although the populations in these regions share a genetic degree of similarity, phenotypic differences can appear due to adaptations to local environmental conditions. The expansion in the distribution range of *S. lemuru* provides valuable insights into how populations respond to environmental changes, highlighting potential adaptation and survival strategies in the context of climate change.

S04, Oral, AbstractID=18455, (ECOP)

Where and how do pacific saury *Cololabis saira* migrate and grow after hatching?

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Pacific saury, *Cololabis saira* is widely distributed in the North Pacific, from subtropical to subarctic regions. Pacific saury is known to make large-scale ontogenetic and seasonal, migration. In recent years, the catch of this species has been declining, and their offshore distribution shift is considered to be a possible cause of the decline. However, it is still unclear what mechanism is causing the offshore distribution. Given the observed changes in its distribution and resource levels and the current concerns over climate change, we investigated the growth and migration of Pacific saury. We examined the daily rings in the otolith to estimate age and growth rates. Otoliths are primarily composed of calcium carbonate, which are metabolically inert hence preserve environmental conditions experienced in the past by the fish. In particular, high-resolution otolith oxygen stable isotope ratio analysis with a microgram-scale calcite auto-measurement line (MICAL3c) has made it possible to conduct detailed investigations. We used individuals collected in the North Pacific during June and July 2022 from 10 stations and extracted left otolith for the otolith daily increment analysis and right one for the oxygen stable isotope analysis. We conducted otolith daily increment analysis for 106 samples. We selected 39 samples for oxygen stable isotope analysis. Every 20 to 50 days of the otolith daily rings were used to measure the otolith oxygen stable isotope ratio. First, we divided the samples into three longitudinal ranges and calculated the average growth rates. As a result, the eastern group showed a tendency for lower growth rates compared to the other groups. To eliminate the effect of faster growth of early stages, we standardized the measured daily increment width regarding each daily age. Then, we applied cluster analysis on the standardized daily increment width. As a result, the samples were divided into 5 groups. Among the 5 groups, the group with a positive growth anomaly showed an increasing trend in oxygen stable isotope ratio. Since there is a negative correlation between the oxygen stable isotope ratio and experienced water temperature, it was suggested that this group experienced a decrease in water temperature with growth, indicating a northward migration. From the perspective of the zoo plankton community, it has been considered that northward migration can provide advantages in terms of feeding frequency and nutrition. Combined with the fact that longitudinal comparison revealed slower growth rate of individuals caught most offshore, it is suggested that changes in the migratory routes of Pacific saury may be negatively impacting growth, especially when considered the recent trend of offshore distribution. Our finding will contribute to evaluated Pacific saruy responses regarding their large-scale migration and growth under future climate change.

S04, Oral, AbstractID=18459

Recent expansion of tropical small pelagic fish in Japanese coastal waters: Case studies of *Encrasicholina punctifer* and *Sardinella aurita*

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Recent climate change, including marine heatwaves and changes in the Kuroshio Current path, have led to notable alterations in the composition and distribution of small pelagic fish communities in Japanese coastal waters. This study presents two case examples of tropical-origin species—*Encrasicholina punctifer* and *Sardinella aurita*—whose occurrences have increased significantly in recent years.

In 2022, *E. punctifer* was widely detected in juvenile anchovy fisheries from Kanagawa to Mie Prefecture, with peak catch rates exceeding 30% in some areas. Its appearance coincided with a northward shift of the Kuroshio and elevated sea surface temperatures, suggesting a strong link between oceanographic anomalies and species dispersal.

Similarly, *S. aurita* has shown rapid expansion since its first record in Mie Prefecture in 2009. By 2022, catch volumes in Ise and Mikawa Bays reached hundreds of tons monthly, and eggs and larvae were observed in multiple bays, indicating local spawning. The species has now been recorded as far north as Miyagi Prefecture, surpassing previous distribution limits.

These findings highlight the dynamic responses of small pelagic fish communities to recent climate extremes and underscore the importance of continuous monitoring and species-level identification in juvenile fish surveys. Understanding these shifts is critical for ecosystem-based fisheries management and for anticipating future changes in forage fish availability under ongoing climate variability.

S04, Oral, AbstractID=18536

Changing spawning phenology of European sardine, *Sardina pilchardus*, off the northern limit of the Canary upwelling ecosystem: Relationship with recruitment strength

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Ocean warming is causing changes in many fish species, particularly in the phenology of vital processes. This study analysed the environmental effects on the spawning phenology of the European sardine off the western and southern coasts of the Iberian Peninsula. The temporal and spatial variability of the onset, duration, and end of spawning was investigated, along with its relationship to adult nutritional condition, average sea surface temperature, and satellite-derived chlorophyll concentration as an indicator of food availability. To achieve this, time series analyses were conducted using sardine biological data collected over several decades (1950–2024) during research surveys carried out by IPMA and from samples collected from commercial fisheries. Finally, the variability in recruitment strength was related to changes in sardine reproductive phenology. Sardine spawning seasonality varied significantly over time and this change was related to environmental conditions, particularly the average temperature during the spawning season, which reached higher values in recent years, especially on the southern coast of Portugal. The results of this study aims to contribute to a better understanding of the temporal variability in sardine abundance, supporting improved management advice for this important fishery resource.

S04, Oral, AbstractID=18612, (ECOP)

Gear-specific CPUE decline and distributional shift of *Mene maculata* as early indicators of ecosystem change in the Taiwan Strait

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Rapid ocean warming in coastal ecosystems demands the identification of biological signals that can indicate emerging ecological tipping points. *Mene maculata* (moonfish), a key forage species contributing approximately 98% of Taiwan's purse-seine catch, is ecologically significant and sensitive to environmental variability. Using 2013–2023 fishery-dependent data, we analyzed gear-specific catch-per-unit-effort (CPUE) and spatial distribution patterns across Taiwanese purse seines, trawl nets, and gill nets in the southwestern Taiwan Strait. Purse-seine CPUE peaked at ~2,600 kgh^{-1} in 2016 before declining steeply to below 1,000 kgh^{-1} by 2019–2023, suggesting reduced stock accessibility or availability. In contrast, trawl and gill net CPUE remained consistently lower (1–8 and 0.5–2.5 kgh^{-1}, respectively), revealing marked gear-dependent catchability and selectivity. Spatially, the catch-weighted centroid of *M. maculata* shifted approximately 60–70 km southeast over the study period, indicating a redistribution of habitat likely driven by rising sea temperatures or altered productivity regimes. These concurrent declines in CPUE and spatial displacement are consistent with early-warning characteristics of ecological thresholds and may signal the onset of a regional regime shift. Our findings demonstrate that stratifying CPUE by gear type enhances sensitivity in detecting biological responses to climate stressors. This approach provides a practical and scalable early-warning framework for identifying shifts in fish population dynamics. By leveraging routine fishery-dependent indicators, such as CPUE and spatial metrics, fisheries managers can anticipate regime changes and implement adaptive, climate-resilient management strategies in response to evolving ecosystem conditions.

S04, Oral, AbstractID=18648, (ECOP)

Integrating fishery-dependent and independent data to model sardine distribution under environmental variability in Portuguese waters

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Small pelagic fish (SPF), such as the European sardine (*Sardina pilchardus*), are highly responsive to environmental fluctuations and fishing pressure, posing challenges for ecosystem-based management. This study presents an innovative joint hierarchical spatio-temporal species distribution model integrating fishery-independent (FID) and fishery-dependent (FDD) data to estimate sardine distribution along the Portuguese shelf, within the northern Canary Upwelling System. By addressing limitations of each data source - particularly preferential sampling in FDD - and combining their complementary strengths, we achieve improved spatial and temporal prediction resolution.

A key novelty lies in modelling the effects of environmental variables with time-lagged covariates, revealing delayed responses of sardine presence and biomass to changes in sea surface temperature, chlorophyll-a concentration, and ocean current dynamics. The model also includes vessel-specific catchability effects, enabling differentiation in fishing efficiency across purse-seine vessels, significantly improving interpretation of FDD. Spatial autocorrelation is addressed using the Barrier model, accounting for complex coastal geography.

Results indicate refined identification of sardine hotspots, extended environmental effect windows, and detection of ecological patterns not captured by FID alone. These outcomes support more accurate and ecologically meaningful predictions, crucial for adaptive fisheries management under accelerating climate variability.

By integrating high-resolution data and advanced statistical techniques, this study supports the development of resilient, data-driven approaches to marine ecosystem assessment - aligned with the PICES 2025 focus on climate-resilient, cross-disciplinary science. Moreover, this methodology can be used to characterize environmental effects on SPF distribution across the range of this and other species, as planned within the PICES-ICES WG53 framework.

S04, Oral, AbstractID=18669, (ECOP)

Understanding the origin and migration route of Japanese sardine collected off California in 2022 using daily increments and stable isotopes in otoliths

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Unexpectedly, a recent genomic study reported that Japanese sardine, *Sardinops melanosticta*, whose habitat was thought to be limited to the western and northwestern North Pacific, were found in the California Current Large Marine Ecosystem in 2022. However, at what life stage they started migrating and which pathways they used to move across the North Pacific Ocean are yet to be elucidated. To address these questions, we analyzed otolith microstructure to determine growth patterns, oxygen stable isotope [$\delta^{18}O$] to track temperature and salinity trajectories, and carbon stable isotope [$\delta^{13}C$] to retrace changes in metabolic rates over individual fish lifespan. Otoliths from age-2 fish that were genetically identified as Japanese sardine and caught in 2022 were used for the analyses. Additionally, otoliths of age-2 Pacific sardine, *Sardinops sagax,* collected during the same 2022 survey were also analyzed for comparison. The Japanese sardine otoliths generally showed greater daily increment widths and lower $\delta^{13}C$ during the first 100 days from hatch compared to Pacific sardine, suggesting faster early growth under higher metabolic rates. These differences were consistent with results from a previous study that compared growth and metabolic rates among year-classes from both species. Likewise, our preliminary results provide some support to the possibility that the Japanese sardine originated from the western North Pacific. However, the ranges of otolith $\delta^{18}O$ during the first 150-days post hatch showed overlaps between the species, hence their natal origin cannot be determined solely from $\delta^{18}O$. Nevertheless, by comparing otolith $\delta^{18}O$ composition with model-predicted isoscapes, the temporal evolution of potential distribution of the Japanese sardine was predicted. During their first winter, when $\delta^{18}O$ ranged from 1.1‰ to 1.3‰, the potential distribution was north of 40N. This indicates that survival of Japanese sardine in cool and likely offshore waters during winter may be a key factor controlling their potential migration to the eastern Pacific. Further analyses using complementary methods are needed to confirm the origin and migration routes.

S04, Oral, AbstractID=18705

A literature review of studies relating environmental conditions to Japanese sardine (*Sardinops melanosticta*) in the North Pacific Ocean

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Japanese sardine (*Sardinops melanosticta*) are a commercially important small pelagic fish generally found in the western North Pacific Ocean. Typical of small pelagic species, the Japanese sardine has experienced “boom and bust” cycles with rapid population expansion followed by periods of low stock productivity. These cycles are thought to be related to environmental effects on recruitment and mortality. Recently, the species has been expanding its distribution into international waters of the western North Pacific and even crossing the Pacific as evidenced by recent (2022 and 2023) captures on the west coast of North America. This expansion has been of great interest to members of the North Pacific Fisheries Commission who capture this species in both domestic and international waters. Here we present the results of a literature mapping and review exercise that attempts to synthesize some of the major impacts of the environment on Japanese sardine. The synthesis will be useful in understanding the potential variability in the distribution and abundance of the stock in the context of future climate conditions and extremes. There are applications of this work to the North Pacific Fisheries Commissions efforts to include ecosystem information into management, as well as in identifying future research needs and stock assessment considerations for this species.

S04, Pre-Recorded-Oral, AbstractID=18766, (ECOP)

Preliminary projection of distribution shift for Pacific saury in the Northwestern Pacific Ocean under climate change

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Pacific saury (*Cololabis saira*) is an economically and ecologically important pelagic species in the Northwestern Pacific Ocean. The spatial distribution of Pacific saury has been showing signs of shifting northeastward over the last decade, which potentially impacts its stock assessment and management due to the change of fish availability. By employing a spatio-temporal model, sdmTMB, we assessed the potential shift in the distribution pattern for Pacific saury under two future climate scenarios (SSP245 and SSP585). The sdmTMB model was developed based on the catch per unit effort (CPUE) data of stick-held dip net fisheries collected by China during 2013 to 2022 and environmental variables including sea surface temperature (SST) and mixed layer depth (MLD), as well as spatial and spatio-temporal random field components. The center of gravity (COG) movements manifested conspicuous annual fluctuations during 2013-2022. The inclusion of spatio-temporal random fields contributed to a northward shift of 0.14° and the latitudinal displacement of 0.03° under SSP245 and SSP585. The projected maps of the fitted models indicated potential shift in the distribution of Pacific saury. Future stock assessment and fishery management for Pacific saury should consider the spatial dynamics under changing environments.

SESSION 4: BIO/FIS/MONITOR Topic Session

Responses of Small Pelagic Fish Communities to Recent Climate Regime Shifts and Climate Extremes

Poster Presentations

S04, Poster, AbstractID=18628, PosterID: S04-P1

ENSO-driven synchronous variations in fishery dynamics and habitat distribution of *Scomberomorus* spp. off Taiwan

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The genus *Scomberomorus* comprises at least 18 species worldwide, five of which are commonly found off Taiwan. These species are economically significant among the catches from Taiwan's nearshore and coastal fisheries. However, their catches have exhibited a declining trend in recent years. This study focuses on the three most abundant species (*S. commerson*, *S. niphonius*, and *S. guttatus*), integrating high-resolution fishery data and satellite-derived environmental data from 2011 to 2019.To explore species–environment relationships, we developed generalized additive models (GAMs) and habitat suitability index (HSI) models using remote sensing variables as predictors. The GAM results reveal that each species exhibits distinct environmental preferences, with the models explaining 11.2% to 18.3% of the deviance in catch rates. Potential habitat variations during the main fishing seasons indicate that under La Niña conditions, suitable habitats expand southward for all three species, whereas during El Niño events, habitat ranges generally contract northward. Simultaneously, the variation in catch rates revealed that *S. commerson* recorded 8.00 kg/hour during La Niña years and declined to 6.56 kg/hour during El Niño periods. *S. niphonius* showed a similar pattern, decreasing from 3.46 to 2.09 kg/hour, while *S. guttatus* decreased from 2.05 to 1.31 kg/hour. This combined GAM–HSI approach highlights how shifts in climate regimes play a critical role in shaping habitat overlap and potential interspecific interactions.

S04, Poster, AbstractID=18697, PosterID: S04-P2, (ECOP)

Seasonal influence of extreme climate events and SST variability on pelagic fisheries vulnerability in the Bay of Bengal

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The study highlights the vulnerability of the eastern coast to tropical cyclones and the unique characteristics of the Bay of Bengal region. Seasonality, driven by global climatic events and geography, significantly affects the marine ecosystem. Furthermore, it underscores the effects of extreme climate events on marine pelagic fisheries and advocates for a state-based approach to raise awareness among government institutions and fishing communities. Findings reveal a significant negative relationship between Sea Surface Temperature (SST) and fish-catch (coefficient = -0.09, $p<0.01$), indicating that rising SST adversely affects pelagic fish populations. Moreover, increased frequency of extreme events (-0.12 to -2.06, $p<0.05$ to $p<0.01$) and disturbances (-0.149 to -0.679, $p<0.05$) exhibits detrimental impacts across various models. Notably, seasonal variations play a crucial role, with quarters 1, 3, and 4 demonstrating positive associations (0.186 to 0.604, $p<0.1$ to $p<0.05$) with fish-catch, signifying potentially favourable conditions during specific seasons. State-specific analysis highlights diverse impacts, wherein West Bengal experiences substantial negative effects from extreme events (-2.056, $p<0.01$), emphasizing regional disparities. These findings underscore the need for regionalized mitigation strategies and sustainable fishing practices to ensure the future of the Bay of Bengal's marine ecosystem.

Disclaimer:
This abstract is based on the research article titled "Seasonal Impacts of Extreme Climate Events and Sea Surface Temperature Indicators on the Vulnerability of Marine Pelagic Fisheries in the Bay of Bengal" by M. Makwana and U. Patnaik, published in Marine Environmental Research. All rights and interpretations remain with the authors. Please cite appropriately when referencing this work.

SESSION 5: HD/POC/MONITOR/FUTURE Topic Session

Climate Extremes and Coastal Impacts in the Pacific

Oral Presentations

S05, Invited, AbstractID=18286

Intense marine heatwaves off Japan induced by the persistent Kuroshio large meander and the recent extreme northward-meandering Kuroshio Extension

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Since the summer of 2017, the Kuroshio has taken a Large Meander path off the southern coast of Japan, and this state has persisted for seven years and nine months. Due to the influence of the Kuroshio branch current associated with this meander, sea surface temperature (SST) in coastal regions have become abnormally high, with satellite observations detecting SST anomalies of about +3 °C. Regional atmospheric model experiments indicate that this coastal warming in summer increases water vapor, resulting in surface warming through local greenhouse effect and significantly enhanced precipitation along the Japanese coast. Since 2023, the Kuroshio Extension (KE), which typically flows eastward near 36°N, has developed an extreme northward meander, reaching as far as 40°N in the winter of 2024. Satellite data revealed that SST off the eastern coast of Japan increased by up to +4.9 °C from April 2023 to August 2024, with persistent marine heatwave conditions almost every day. Hydrographic surveys in May 2024 further showed that thick warm–salty subtropical water had replaced cold–fresh subarctic water off the eastern coast of Japan, with temperatures 10 °C warmer at depths of 50–400 dbar compared to past decades. These recent path anomalies of the Kuroshio and KE have triggered intense marine heatwaves around Japan, underscoring their potential impacts on atmospheric conditions, marine ecosystems, and coastal biological communities.

S05, Invited, AbstractID=18319, (ECOP)

Recent marine heatwaves in the East China Sea: Mechanisms and future risk under climate change

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In recent years, the East China Sea (ECS) has experienced unprecedented marine heatwaves (MHWs), raising concerns about their increasing frequency and duration under climate change. In 2022, a record-breaking MHW persisted for 62 days—six times longer than the climatological average. This event was associated with a shallow, salinity-stratified mixed layer induced by heavy freshwater discharge from Yangtze–Huaihe River floods in June, which preconditioned the upper ocean for warming. Concurrently, a stationary Rossby wave, sustained by mid-latitude vorticity forcing and thermal anomalies in Pakistan, anchored an anomalous anticyclone over the ECS, prolonging the MHW until Typhoon Hinnamnor disrupted the system in early September. In contrast, the 2023 MHW started unusually late, from August 12 to October 13, and was initially driven by enhanced shortwave radiation and ocean dynamics. In its later phase, weakened northerlies allowed warm, moist southerlies to dominate, reducing the air-sea humidity gradient and increasing downward latent heat fluxes. CMIP6 model projections suggest that such delayed and prolonged MHWs may become more common due to weakened air-sea heat exchange under global warming. These findings underscore the complex interplay of local hydrological events, atmospheric circulation, and global climate variability in shaping MHWs, emphasizing the need for improved monitoring and preparedness in the ECS region.

S05, Oral, AbstractID=18216

The seasonal blue carbon prediction system "SINTEX-F2bio": Preliminary results

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The SINTEX-F2 seasonal climate prediction system has demonstrated high performance in predicting El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). We activated the European biogeochemical (BGC) model, PISCES (with a horizontal resolution of 0.5°), on the SINTEX-F2 system (referred to here as "SINTEX-F2bio") to predict how BGC variables (e.g., chlorophyll, carbon, alkalinity, oxygen, nitrate, etc) respond to ENSO and IOD. Here, we present preliminary results based on re-forecast experiments from 1998 to 2024 with ten ensemble members. We found that the model accurately captured the chlorophyll subsurface maximum in the tropics and predicted the interannual variations of surface chlorophyll in the western tropical Pacific and south of Japan. Additionally, it accurately predicted the regression maps of marine BGC variables onto Niño 3.4.

S05, Oral, AbstractID=18219

Subsurface marine heatwaves on the Pacific coast of Canada

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Marine heatwaves (MHWs) at the surface of the ocean are readily observed by satellites. Subsurface heatwaves are much more difficult to observe and to characterize statistically. In the study, we derive marine heatwave statistics based on the 34-year record of moored subsurface temperature observations at a mooring in 100 m of water off the west coast of Vancouver Island, Canada. We show that the magnitude of heatwaves at 35 m depth exceed those at the surface and that large subsurface MHWs are not necessarily coincident with surface ones. To account for this counterintuitive finding, we examine the relationship between the timing of subsurface MHWs and the timing of fall storms. Potential links with El Niño events are also investigated.

S05, Oral, AbstractID=18291

A new dynamic regime in the Kuroshio/Kuroshio extension and the North Pacific climate system after 2018

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During the four decades following the 1976/77 climate regime shift, the Kuroshio Extension (KE) in the North Pacific subtropical gyre has been observed to oscillate between a stable and an unstable dynamic state on quasi-decadal timescales. This oscillation was facilitated by a delayed negative feedback loop that involved wind-forced interior ocean adjustment, its alteration to the KE dynamic state, and KE's feedback to the atmospheric stormtracks and wind stress field. This feedback loop has ceased to operate after 2018 and a new dynamic regime, in which the Kuroshio south of Japan settles in a persistent large meander (LM) path and the stabilized KE jet migrates poleward, has emerged. This study identifies three processes responsible for this new Kuroshio/KE dynamic regime: (1) an external forcing field where wind forcing over the southern subtropical gyre intensifies and that over the northern gyre weakens, (2) nonlinear reinforcement between the Kuroshio LM and poleward-migrated KE jet, and (3) a change in the stormtracks/wind stress responses to the KE's new stable dynamic state. The establishment of the new dynamic regime plays a critical role in generating the upper ocean warming (or marine heatwaves) prevalent in recent years along the 35°–45°N band of the western North Pacific. An upper ocean temperature budget analysis reveals that the cumulative warming in this band is caused primarily by lateral advection of the migrating KE jet. The net surface heat flux forcing works to damp the advection-induced temperature anomalies.

S05, Oral, AbstractID=18340, (ECOP)

Unraveling the coupled dynamics of marine and terrestrial heatwaves with typhoons during summer 2018

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Anthropogenic climate change has increased the frequency and intensity of extreme events such as marine heatwaves (MHWs), terrestrial heatwaves (THWs), and typhoons. When these events coincide, their combined impacts can exacerbate environmental consequences, resulting in compound extreme events. This study investigates the interactions among intense MHWs in the off the east coast of Korea, record-setting THWs across the Korean Peninsula, and a sequence of four typhoons during July–August 2018, using in-situ observations from the East Sea Real-time Ocean Buoy (ESROB) and reanalysis datasets. Typhoon Prapiroon (July 4) induced coastal downwelling in the western East Sea, setting the stage for the simultaneous development of MHWs and THWs under an upper-tropospheric high-pressure system that enhanced solar radiation, suppressed surface winds, and limited ocean–atmosphere heat exchange—thereby prolonging both heatwaves. Subsequent typhoons—Jongdari (July 29) and Leepi (August 15)—further intensified the MHW through coastal downwelling, despite a weakening of the anticyclonic atmospheric circulation at 500–200 hPa level. Notably, Typhoon Soulik (August 24) exhibited an abnormal intensification after crossing the Korean Peninsula, likely influenced by the pre-existing MHW anomaly. Meanwhile, the spatial pattern of THWs was shaped by mountainous landmass in the eastern part of the Korean Peninsula and typhoon-induced easterly winds, underscoring the complex coupling between atmospheric and oceanic extremes. Collectively, these events led to a doubling of ocean heat content in the upper 100 m and a marked increase in surface and subsurface temperatures off the east coast of Korea. As compound extreme events become more frequent under ongoing climate change, these findings emphasize the urgent need for sustained in situ observations to improve climate model performance and to enhance forecasts of future extreme events and their impacts on marine and atmospheric systems.

S05, Oral, AbstractID=18349

Surface and subsurface dynamics of Northeast Pacific marine heatwaves

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In recent decades, the Northeast Pacific Ocean has experienced very intense and long-lasting warm conditions known as marine heatwaves (MHWs) and has emerged as a hotspot for ocean extremes. Such events include the 2014-2016 MHW, colloquially known as 'the Blob", which persisted for about two years and caused devastating ecological impacts. Local drivers of MHWs in this region, including surface atmospheric forcing and advective convergence, are modulated by the influence of climate modes of variability, like the El Niño Southern Oscillation (ENSO) and Pacific Decadal Variability (PDV). In particular, PDV appears to play a critical role in the development and evolution of these events. Apart from their surface expressions, Northeast Pacific MHWs also exhibit intense subsurface signals which are particularly relevant for biological impacts. While some studies have examined statistical links between surface and subsurface MHWs in this region, a more comprehensive mechanistic understanding of their connection is still missing. In this presentation, we will discuss the dynamics associated with the onset, evolution and decay of Northeast Pacific MHWs and will examine the processes involved in the downward propagation of surface anomalies and their possible oceanic implications.

S05, Oral, AbstractID=18395, (ECOP)

Source water masses as a driver of ecosystem structure in the northern California Current

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The California Current System (CCS) represents a confluence of different water masses originating in the subarctic, subtropical, and tropical eastern Pacific. Throughout the region, variations in the relative influence of subarctic and tropical source waters have been shown to influence the structure and function of the ecosystem at different trophic levels. In this talk, I will present results from an optimum multiparameter analysis (OMP) applied to Newport Hydrographic Line physical and biogeochemical data to quantify the relative contributions of different source water masses and their spatial and interannual variability. Special attention will be given to years marked by extreme events in the northeastern Pacific. These results demonstrate that variations in the relative contributions of northern and southern source water masses are strongly related to zooplankton species composition in the northern CCS.

S05, Oral, AbstractID=18417, (ECOP)

Changes in phytoplankton composition driven by TC-induced mixing

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Tropical cyclones (TCs) are one of the most extreme events in the Northwest Pacific that induce strong mixing, leading to significant physical and biogeochemical changes in the ocean. Typically, mixing facilitates nutrient upwelling from deeper layers and lowers sea surface temperature (SST), triggering phytoplankton bloom after TCs passage. In particular, understanding how different phytoplankton species respond is essential for understanding biogeochemical community responses to TCs. However, there is still a lack of detailed understanding regarding species-specific responses and diversity change. In this study, we use a regional ocean biogeochemical model for the Northwest Pacific to examine how phytoplankton composition shifts following TCs passage. We find that phytoplankton vertical mixing dominates immediately after TC passage, followed by biologically driven changes due to nutrient enrichment. In the open ocean, nutrient-favored species such as picoeukaryotes and coccolithophores increase in biomass and contribute to prolonged blooms, accompanied by increased diversity. In contrast, coastal regions show shorter-lived blooms and a decline in diversity, as dominant species such as diatoms become further enriched. These contrasting patterns are shaped by background conditions and species-specific vertical profiles. Our results highlight the importance of considering both physical and biological processes to understand TC-induced ecosystem changes and suggest that phytoplankton composition is sensitive to strong mixing.

S05, Oral, AbstractID=18488

Surface marine heatwave prediction skill in the Canadian Seasonal to Inter-annual Prediction System (CanSIPS)

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Environment and Climate Change Canada operationally produces seasonal forecasts of sea surface temperature out to 12 months with the Canadian Seasonal to Interannual Prediction System (CanSIPS), which is based on two coupled atmosphere-ocean-land models and currently includes 20 ensemble members from each model (40 total). We show that over large areas of the global ocean and across a range of lead times, CanSIPS monthly marine heatwave predictions outperform the North American Multimodel Ensemble (NMME, to which CanSIPS contributes) as a whole. Strong predictive skill in the eastern equatorial Pacific at 6.5-month lead reflects skill in ENSO representation. Additionally, compared to an earlier version (CanSIPSv2.1), CanSIPSv3 exhibits improved skill in the western equatorial Pacific. We discuss skill and reliability for monthly and daily forecasts as well as the impact of parametric forecast calibration in Canadian Pacific waters.

S05, Oral, AbstractID=18494

Exploration and practice of applying DeepSeek to marine disaster prevention and control along China's coast

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As an innovative enterprise in China's artificial intelligence field, DeepSeek has developed the large language model DeepSeek-R1, which demonstrates remarkable performance in natural language processing and data analysis with its advantages of high efficiency, low cost, and high transparency. The coastal areas of China have long been threatened by disasters such as storm surges, tsunamis, ocean waves, and red tides. The DeepSeek technology provides new ideas for marine disaster prevention and control. In terms of disaster monitoring and forecasting, by integrating multi-source heterogeneous data from marine observation stations, satellite remote sensing, buoys, etc., and relying on the powerful analysis capabilities of DeepSeek-R1, it can capture the early signs of disasters and construct high-precision forecasting models. When it comes to risk assessment and the formulation of prevention strategies, DeepSeek-R1 can comprehensively consider the characteristics of marine disasters and the socioeconomic factors of coastal areas, achieve quantitative risk assessment, and generate personalized prevention and control plans. In terms of emergency response and post-disaster recovery, DeepSeek-R1 can quickly generate dynamic rescue plans according to real-time disaster situations and resource conditions, and automatically create systematic recovery plans.

S05, Oral, AbstractID=18500

Long-term changes in marine environment at a coastal station in Japan over 47 years

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Physical environmental parameters such as water temperature, air temperature, and wind velocity have been recorded at a coastal station in the northeastern region of Japan over 47 years (from 1977 to present). The station is located in a small bay, Otsuchi Bay (around 39.3 °N), facing the Kuroshio–Oyashio transition zone in the western North Pacific. Summer water temperature was particularly high in 2000, 2010, 2012, 2013, 2023 and 2024: monthly means for August and/or September were greater than 22°C (at a depth of 1 m). Winter water temperature was particularly high in 1990, 1995, 2007, 2016, 2017, 2021, 2024, and 2025: monthly means for February and/or March were greater than 7°C. In particular, those in summer 2023 and winter 2024 were record-breaking high. These recent records were strongly affected by the anomalous northward meander of the Kuroshio Extension that began in the spring season of 2023, and they were linked to the recent intense marine heatwave over the western North Pacific. A more careful look shows that the coastal water temperature is affected not only by the northward elongation of the Kuroshio Extension, but also by its path shift in the east-west direction. Air temperature in 2023-2025 also shows the same high trend as water temperature. However, prior to the recent anomalous northward shift of the Kuroshio Extension, interannual variations in water and air temperatures do not necessarily coincide. In winter and early spring, strong westerly winds blow down from mountains to the sea and they occasionally trigger massive wildfires around this area. It may be noted that cold, very strong wind blew in February 2025 when a massive wildfire occurred in a nearby area (Ofunato city). This implies that the massive wildfire might have been induced by the high water temperature, because it can strengthen the cold wind blowing down from the mountains. However, this simultaneous occurrence of high water temperature and strong wind in February 2025 may have been coincidental, because there is no high correlation between them over the 47 years. It should be noted that none of the data (water and air temperatures and wind speed) showed a clear linear trend over several decades prior to 2016 when the recent marine heatwave occurred in this area.

S05, Oral, AbstractID=18516

Evolving patterns of the Kuroshio large meander 2017–2024: Characteristics and environmental impacts

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The Kuroshio large meander, which began in 2017, has continued for over seven years (showing the sign of its ending, as I am writing this abstract). This meander is the longest known Kuroshio large meander event on record, and has had a significant impact on the marine ecological environment and weather. In this study, the characteristics defining this meander were examined using observations and the JCOPE2M reanalysis data. Based on the EOF analysis applied to the sea surface height in the JCOPE2M reanalysis, the large meander since 2017 can be classified into three main patterns. The first is the typical Kuroshio large meander pattern that appeared from 2017 to 2018, which appeared in the 2004-2005 events and others. Next is a pattern observed after around 2019, in which a cold-water eddy that created the meander shifted westward. Off the coast of Tokai, the S-shaped curve of the Kuroshio Current becomes more pronounced, causing the current to flow toward the Tokai coastline. This leads to strong marine heat waves along the Tokai Coast. A similar pattern also appeared during the large meander event of 1975-1980, which lasted for a long period. The third pattern, observed from 2023 to 2024, is accompanied by an extreme northward extension of the Kuroshio Extension. This northward movement is known to have a serious impact on the weather and fisheries. It is suggested that the shifts in the Kuroshio large meander pattern is influenced by the northward shift in Pacific winds.

S05, Oral, AbstractID=18609

Generation processes of extreme surface waves off the Sanriku coast of Japan in the western North Pacific

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Coastal area of Sanriku, Japan is composed of many small bays with a size of several kilometers, characteristic of a rias coastline. Previous studies indicated that surface waves observed in these bays are strongly influenced by swells propagating from the offshore region in the direction in which the mouth of each bay opens. Therefore, it is presumed that high wave events in Sanriku coastal area are caused mainly by strong winds blowing toward the bay in the offshore region, where typhoons and developed extratropical cyclones have passed through frequently. However, the characteristics and causes of extreme wave events with significant wave height whose exceeding probability is less than 1% have not been quantitatively clarified. This study aims to elucidate the factors causing seasonal and interannual variations of extreme waves that propagate to the Sanriku coast. Statistical analysis of wave observation data from NOWPHAS and wave hindcast data from the WAM model revealed that the extreme waves were attributed to wind waves generated and developed by strong winds caused by typhoons and extratropical cyclones that passed through the offshore region within 1,000 km of the Sanriku coast. The significant wave heights of extreme waves demonstrated a long-term upward trend showing a significant positive correlation with the offshore wind speeds. It suggests that the occurrence frequency of strong low-pressure systems, such as typhoons and bomb cyclones, passing near the Sanriku coast has been increasing over a long period.

S05, Oral, AbstractID=18625

Learning a Laplace Neural Operator (LNO) for subseasonal marine heatwave prediction

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This study investigates the application of a Laplace Neural Operator (LNO) for predicting marine heatwaves (MHWs), leveraging its ability to learn the governing equation of surface ocean heat conservation. The forecasting framework is designed to incorporate initial vertical stratification and the time-evolving surface atmospheric forcing—including heat fluxes and wind fields—to predict daily ocean temperature up to six months in advance. A case study of a coastal MHW event in the Yellow Sea is used to assess model performance and to determine the optimal number of temporal periods and vertical modes for accurate representation. Results show that prediction skill improves substantially with increased training data volume and diversity, highlighting the importance of capturing a wide range of atmospheric and oceanic conditions. These findings demonstrate the potential of neural operator-based models as effective tools for forecasting extreme sea surface temperature on subseasonal-to-seasonal timescales, particularly in dynamically complex coastal regions.

S05, Oral, AbstractID=18658, (ECOP)

Estimation and validation of the short- and long-wave radiation using GOCI-2 data

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Short- and Long-wave radiation account for approximately 70% of the total heat flux, making them the dominant components. Satellite data are essential for estimating radiation over broad oceanic and coastal regions, where buoy and ground-based observations are spatially limited. In Korea, the AMI sensor onboard the GK2A satellite provides shortwave and longwave radiation products along with cloud-related parameters (e.g., cloud fraction). These products are derived using a multiband regression algorithm. Although GOCI 2 is primarily an ocean color sensor, it features 13 spectral bands and offers a higher spatial resolution (250 m) compared to that of AMI (500–1,000 m), making it 4 to 16 times finer. In this study, we apply the regression-based algorithm used for AMI to GOCI 2 imagery to estimate both shortwave and longwave radiation. Cloud conditions are determined based on the assumption that reflectance values in specific bands are higher under cloudy skies, and this information is incorporated into the radiation estimation process. Shortwave radiation estimates will be validated using observational data from 65 ASOS stations operated by the Korea Meteorological Administration (KMA), while longwave radiation will be compared against observations from two KMA ground sites. Further comparisons with AMI-derived products are also planned.

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S05, Oral, AbstractID=18686

Exceptional heat and basin-scale connections in the Kuroshio-Oyashio region in the early 2020s

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This study investigates recent extreme conditions in the North Pacific, which began in the late 2010s and have intensified significantly by 2024, focusing on the Kuroshio-Oyashio region. The anomalies appear to have originated in the western North Pacific, linked to changes in the Kuroshio and Oyashio currents, while those in the eastern North Pacific began to develop in a separate and distinct region. Sea surface temperature anomalies in the Kuroshio-Oyashio region have reached record-breaking levels, with deviations up to 6°C above the 1990–2019 average. Subsurface temperatures have also increased notably, accounting for 15.8 % and 11.8 % in the western and eastern North Pacific (27.6% combined) of the global ocean heat content increase in the 0–300 m layer between 2020-2024 and 2010s. Extreme marine heat waves occurred in coastal water near Japan in 2023-2024, resulting in the largest area-day fraction of extreme MHWs among world basins. In the 2020s, Kuroshio water anomalously intruded northward to approximately 42°N along Japan's coast, forming a loop-like pattern with a southward return flow, while the Kuroshio Extension, over a wider zonal extent, also shifted northward by about 1.3° in latitude. These oceanic anomalies are likely influenced by wind changes, with Sverdrup theory suggesting weakened subtropical gyres and a northward shift of the subtropical-subpolar gyre boundary. Further research is needed to fully understand, monitor, and predict these changes and their impacts on regional ecosystems. This study, published online in the *Journal of Oceanography* in June 2025, can be accessed via the following shared link: https://rdcu.be/etVPC.

S05, Oral, AbstractID=18703, (ECOP)

Modeling the response of the ocean carbon cycle to marine heatwaves in the eastern North Pacific

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From winter 2013 to 2015, the Subarctic eastern North Pacific experienced sea surface temperatures approximately 2.5°C warmer than usual, causing major ecosystem disruptions. This region is also a significant sink of atmospheric CO2 due to its active air-sea CO_2 transfer. However, much less is understood about the response of the ocean carbon cycle to the heatwave condition. Current Earth System Models exhibit significant uncertainty in the air-sea CO_2 fluxes in this region. Limited observational data in this region led to inconsistencies among datasets in estimating air-sea CO_2 flux changes. Furthermore, mooring observations have shown surface ocean pCO_2 at Ocean Station P was lower than typical years despite the elevated sea surface temperature. Here, we developed a regional ocean carbon cycle model that successfully reproduces the observed ocean pCO_2 variability from the mooring. Using this model, we investigated underlying mechanisms of the carbon cycle response to the 2014–2015 marine heatwave. Our results show that reduction of surface ocean DIC was the primary cause of the reduced ocean pCO_2. The warming-induced increase in pCO_2 is offset by an even larger decrease caused by reductions in dissolved inorganic carbon (DIC). Furthermore, the DIC decrease was caused by reduced meridional transport of DIC-rich waters from the north caused by the weakened westerly winds and associated Ekman transport. These findings indicate that changes in wind-driven circulation played a critical role in modulating air-sea CO_2 fluxes during marine heatwaves, highlighting the importance of resolving physical-biogeochemical interactions for understanding climate impacts on the ocean carbon cycle.

S05, Oral, AbstractID=18743, (ECOP)

Impacts of North Atlantic SST forcing on the Kuroshio Extension and its implications for recent unprecedented ocean warming in the Northern Pacific

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Recent unprecedented ocean warming has produced coherent sea surface temperature (SST) anomalies across the Northern Hemisphere extratropics. Despite extensive research on inter-basin interactions, the causal mechanisms linking North Pacific and North Atlantic variability remain poorly understood. In this study, we show that internal SST variability in the North Atlantic region accounts for 16% of internal SST variability in the Kuroshio Extension in climate model simulations, while no significant reverse influence is detected. Specifically, positive SST anomalies in the Gulf Stream region lead to a Northern Annular Mode (NAM)-like atmospheric circulation pattern that weakens the Aleutian Low over the North Pacific. The resulting northward shift of the Kuroshio Extension enhances northward warm water transport and induces positive SST anomalies in the North Pacific. Also, Coupled Model Intercomparison Project Phase 6 climate models with higher oceanic horizontal resolution capture this SST-NAM coupling better than coarser-resolution climate models. These findings identify North Atlantic variability as one of the drivers of Northern Hemisphere mid-latitude climate, with implications for understanding and predicting the unprecedented SST warming observed in the North Pacific in recent years.

S05, Oral, AbstractID=18768

Statistics of marine heatwave parameters in the Sea of Okhotsk

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Marine heatwaves (MHWs) are events of warm sea water conditions relative to some climate temperature level which last for substantial time. Several well-known MHWs occurred in the North Pacific over past few decades, the most monstrous and famous of which being 'The Blob' in 2013–2016. Many publications report increase in MHW frequency, duration, and intensity across the World Ocean, including the North Pacific. However, information on the MHWs in the Sea of Okhotsk is still virtually absent. The aim of this study is to calculate mean statistics of MHWs parameters in the Sea of Okhotsk, as well as their linear trends. We use NOAA OI SST V2 dataset (1995–2024, 0.25° resolution, daily data). MHWs are identified by running 90-percentile threshold method. The results show more MHW events in the coastal areas than in the central part of the sea, though mean duration of MHWs follow opposite pattern: the most prolonged MHWs occurred in the central part. The heatwaves are usually stronger in the western (multiyear mean amplitude up to 0.7 °C) comparing to the eastern part of the sea (mean amplitude of about 0.4–0.5 °C). Statistically significant trends of MHW mean amplitude (about 0.2 °C per decade) are observed mostly in the coastal areas, though MHWs tend to last longer (about 1–2 days per decade) in the offshore regions. All trends are more pronounced for summer than for other seasons. The strongest (amplitude of more than 5 °C) and largest MHW (total area of more than 1.75×10^6 km^2) occurred in July 2022.

SESSION 05: HD/POC/MONITOR/FUTURE Topic Session

Climate Extremes and Coastal Impacts in the Pacific

Poster Presentations

S05, Poster, AbstractID=18261, PosterID: S05-P1, (ECOP)

Efficient biological shelf pump enhances organic carbon export in the Southern Sea of Okhotsk

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The Southern Sea of Okhotsk exhibits high primary productivity and a unique topography characterized by a deep basin nearshore. Elevated spring surface chlorophyll-*a* concentrations above this topography suggest an efficient biological shelf pump, yet no quantitative assessment has ever been conducted. We analyzed the total biogenic silica (BSi), particulate organic carbon (POC), lithogenic material, and calcium carbonate ($CaCO_3$) in the samples from a sediment trap moored at 550 m on the Kuril Basin slope and the shelf sediments. Temperature (50 m) and sea ice concentration were obtained from a moored sensor and satellite data, respectively. To divide the total sediment flux into the "in situ flux" (i.e., freshly produced phytoplankton and ice algae) and the "external flux" (i.e., other particles excluding in situ source), we used the shelf sediment data for calculation. The external fluxes increased during the development of sea ice and the initial influence of the East Sakhalin Current (ESC). The in situ fluxes increased in April (in ESC-influenced waters after sea ice retreat) and June (in warm waters). The in situ POC and $CaCO_3$ fluxes accounted for ~60% of the integrated values, while in situ BSi was comparable to external BSi over the 7-month sampling period. The in situ fluxes exhibited clear seasonality with low values in winter and high in spring. In April, elevated POC flux coincided with increased BSi and $CaCO_3$. $CaCO_3$ was the dominant carbon ballast. Overall, the Southern Sea of Okhotsk acts as an effective carbon pump compared to global deep-sea sites.

S05, Poster, AbstractID=18387, PosterID: S05-P2

Identification and delineation of key control areas for storm surge disasters in Zhoushan City based on loss perspective

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Typhoon storm surge disasters, characterized by wide distribution, high occurrence frequency, intense impact, and significant human and economic losses, pose a common management challenge for coastal countries worldwide. The conventional approach to defense and control is to manage zoning based on the overlay of storm surge disaster risk and vulnerability of the affected areas. Although this approach effectively identifies high-risk areas, regions with lower economic value may not receive adequate attention despite their high risk, leading to insufficient disaster preparedness. This study proposes a method for identifying and delineating key control areas for storm surge disasters based on a loss perspective. This method utilizes the ADCIRC model to simulate the inundation area under a 100-year return period scenario in Zhoushan City, Zhejiang Province. It calculates the affected population, direct economic losses, and indirect economic losses for each standard statistical unit and employs K-means clustering analysis to determine the classification characteristic values of the three loss indicators. Geographic spatial techniques are then used to identify key control areas. The results show that the classification characteristic values for the affected population, direct economic losses, and indirect economic losses in Zhoushan City are 102 people/km2, 374.4 thousand yuan/km2, and 92.6 thousand yuan/km2, respectively. The proportion of key control areas delineated based on these values to the inundation area is 32.8%. The findings of this study facilitate the adoption of more scientific and rational disaster prevention strategies by local authorities, considering both disaster losses and cost-benefit analysis comprehensively.

S05, Poster, AbstractID=18431, PosterID: S05-P3, (ECOP)

Sea ice-derived iron fuels the spring phytoplankton bloom in the southern Sea of Okhotsk and the Coastal Oyashio region

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The Sea of Okhotsk is a marginal sea in the northwestern rim of the North Pacific and represents the southernmost extent of seasonal sea ice in the Northern Hemisphere. The southern Sea of Okhotsk and the adjacent Coastal Oyashio region are high primary production areas where a large spring phytoplankton bloom is observed following the retreat of sea ice. One of the suggested factors contributing to the significant blooms is the enhanced iron supply associated with sea ice melt. However, the supply of iron by sea ice has not been quantitatively evaluated, and there is no direct evidence of the impact of the sea ice-derived iron on phytoplankton growth. In this study, we examined the distribution and supply processes of iron and macronutrients based on shipboard observations during the spring phytoplankton bloom immediately after sea ice retreat in the southern Sea of Okhotsk in April and the Coastal Oyashio region in March. We also quantitatively evaluated the impact of sea ice melting on changes in the concentration of iron and macronutrients in surface water. Furthermore, we conducted bottle incubation experiments to estimate the effect of sea ice presence on phytoplankton growth. Our results revealed that the melting sea ice stimulates phytoplankton growth, particularly leading to an increase in large-sized phytoplankton.

S05, Poster, AbstractID=18596, PosterID: S05-P4

Determinant factors of massive spring bloom event of Oyashio region: Roles of Coastal Oyashio water intrusion and mesoscale eddy

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The offshore area of east Hokkaido, Japan is characterized by the occupation of Oyashio water and the subsequent occurrence of massive bloom events every spring. So far, earlier studies pointed out that the importance of nutrient supply by winter convection and light availability due to surface stratification in determining the timing and magnitude of the spring bloom events, but quantitative evaluation of their effects has not been addressed, yet. In this study, we examined the determinant factors of interannual variability of spring bloom events in this area based on hindcast experiments of an ice-ocean coupled NPZD-Fe model (Fiechter et al., 2009). Our numerical model well simulates seasonal to interannual variability of observed spring bloom events in the Oyashio region, including the pronounced massive spring bloom event in 1997. The diagnostic analysis indicates that the large uptake rate of phytoplankton in 1997 is associated with dissolved Fe availability, which can be explained by the lateral advection of Coastal Oyashio water from the Sea of Okhotsk. On the other hand, our model fails to simulate the ring-shaped structure of high chlorophyll-*a* concentration, which is likely to be related to the existence of subtropical mesoscale eddy. In this presentation, we discuss the role of subtropical mesoscale eddy in regulating nutrient supply and biological productivity in spring.

S05, Poster, AbstractID=18666, PosterID: S05-P5, (ECOP)

Typhoon-induced nitrous oxide consumption in coastal open waters and its climate implications

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The mechanisms coupling typhoons with nitrous oxide (N_2O), a potent greenhouse gas, have gained increasing significance under global climate change. This study investigates the N_2O biogeochemical responses to Typhoon Yagi in the western Guangdong coastal waters (WGCW) through integrated analyses of nitrogen isotopes (δ^{15}Nbulk-N_2O), oxygen isotopes (δ^{18}O-N_2O), intramolecular ^{15}N site preference (SP), and ancillary biogeochemical parameters. Based on the data, SP values showed a pronounced decrease immediately post-typhoon, followed by progressive enrichment of SP, δ^{15}Nbulk-N_2O, and δ^{18}O-N_2O during time-series sampling. These phenomena indicate that typhoon disturbance altered the dominant nitrogen cycling processes from nitrification to denitrification with intensive N_2O reduction/consumption, likely driven by the combined effects of particulate matter inputs and subsequent degradation. Additionally, despite a substantial atmospheric N_2O influx into the marine environment across the air-sea interface, calculated using a two-layer model, N_2O concentrations remained stable in the WGCW post-typhoon. This stability was accompanied by the concurrent decoupling of δ^{18}O vs. δ^{15}Nα, δ^{18}O vs. δ^{15}Nbulk, and δ^{18}O vs. SP correlations, providing evidence supporting high N_2O reduction/consumption rates during denitrification which maintained stable N_2O concentrations after the typhoon. These findings suggest a negative feedback mechanism between open-water typhoon events and global warming, where enhanced denitrification due to typhoons may partially mitigate atmospheric N_2O accumulation

S05, Poster, AbstractID=18674, PosterID: S05-P6, (ECOP)

Tidal regulation mechanism of frontal convergence/divergence in the Changjiang River plume

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Fronts play a critical role in the physical and biogeochemical processes of the ocean, particularly in estuarine and coastal regions, where dynamic processes are often closely associated with high-frequency phytoplankton blooms. In strong-tidally estuaries, the horizontal convergence and divergence in frontal regions are significantly modulated by tidal forcing. While numerous studies have revealed the relationship between horizontal divergence/convergence in frontal zones and tidal cycles, the underlying driving mechanisms remain insufficiently explored. This study employs a high-resolution hydrodynamic model based on a Regional Ocean Modeling System to investigate the seasonal, spring-neap, and flood-ebb tidal cycle characteristics of horizontal divergence/convergence in the Changjiang River plume frontal region. Furthermore, the divergence/convergence tendency equation is utilized to diagnose its driving mechanisms and contributing factors.

The results indicate that horizontal divergence/convergence in the frontal region exhibits a consistent periodic pattern, with divergence during high tides and convergence during low tides. The study area is divided into a northern and a southern region by the mega estuarine constructions. The southern region contains numerous islands, while no islands are present in the northern region. The pressure gradient term (*PRG*) consistently acts as the dominant controlling factor under all temporal scenarios and in both the northern and southern regions. In the northern region, during spring tides, the vertical viscosity term (*VVISC*) acts to counterbalance the *PRG* in winter, spring, and autumn. In summer, however, the PRG is relatively weak, and consequently, viscous effects are not significantly induced. During neap tides, the dominant factors vary with season. In winter, both *PRG* and *VVISC* are important, likely due to background northward flows driven by prevailing northerly winds. In spring, the Coriolis term (*COR*) becomes increasingly influential due to enhanced vorticity resulting from intensified Coriolis effects and increased instability with the offshore spreading. In summer, the plume water is relatively stable, rendering the *COR* negligible. In autumn, wind field variations lead to the retreat of the plume water, and the influence of the *COR* diminishes accordingly. In the southern region, during spring tides, all four seasons are jointly dominated by the *PRG*, *VVISC*, the change of divergence/convergence itself (*DVC*), and the vertical deformation (*VDF*). During neap tides, the winter season shows a similar pattern to that of spring tides, whereas in spring, summer, and autumn, the *VVISC* is no longer a major contributor. This seasonal difference is likely attributed to the presence of numerous islands in the southern region, which induce stronger vertical deformation and divergence/convergence. The *PRG* can be further divided into barotropic (*BRT*) and baroclinic (*BRC*) components. The *BRC* correlates positively with the *PRG* (the coefficient of determination exceeds 95%), while the *BRT* correlates negatively with the *PRG* (the coefficient of determination exceeds 90%).

SESSION 6: FIS Topic Session

Incorporation of Climate and Ecosystem Impacts in Stock Assessment Advice: Discussion of Current Approaches and Challenges, and Charting a Path Forward

Oral Presentations

S06, Oral, AbstractID=18391, (ECOP) CANCELLED

Forecasting climate-driven habitat shifts of threadfin bream (*Nemipterus* spp) in the South China Sea using ensemble species distribution modeling

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Climate change is reshaping environment conditions, leading to shifts in species distributions and challenging the resilience of marine ecosystems and fisheries sustainability. This study utilizes survey data (2018-2020) and environmental predictors to model the current and future suitable habitats of threadfin bream (*Nemipterus* spp.) in the South China Sea. We applied an ensemble species distribution modeling approach using the Biomod2 platform in R, integrating multiple algorithms (CTA, GAM, MARS, FDA, GBM, and RF). The ensemble model achieved robust predictive accuracy (TSS = 0.73; ROC = 0.94), outperforming individual models. Maximum chlorophyll concentration emerged as the most influential factor (67.07 %). Future projections under five SSP-RCP climate scenarios, future projections indicate that suitable habitat will be primarily concentrated in the northern South China Sea coastal waters, particularly along the coastal waters of Guangdong Province and the southwestern waters of Hainan Province. Notably, they reveal a substantial contraction of suitable habitat in the southern South China Sea and a notable northward shift in habitat centroid. The findings highlight critical implications for climate-adaptive fishery management and biodiversity conservation in a warming ocean.

S06, Oral, AbstractID=18402, (ECOP)

Coupling bioenergetics and population dynamics models to simulate population dynamics of Japanese chub mackerel: Early life history analysis and future applications

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Widely distributing in temperate zones in the waters around Japan, the Pacific chub mackerel (*Scomber japonicus*) is one of key small pelagic fishes that consist important parts in the marine ecosystem by connecting lower and higher trophic levels. However, small pelagic fishes including chub mackerel are known to largely fluctuate their population responding to basin scale environmental change "Regime shift". In the western North Pacific, Kuroshio large meander locally generates larger temperature anomaly than "Regime shift". But its impact on marine resources is still unclear. In addition, marine microplastic debris reveal high concentrations in the western North Pacific. To investigate the mechanism and effect of these new emerging phenomena, we developed a bioenergetics and population dynamics coupled model for chub mackerel, in which the whole life history was closed and the energy budget for spawning was also incorporated. Hence, the model can be applied to investigate influences of temperature and plankton on growth and population. Individual growth was simulated from the bioenergetics model and mortality in the population dynamics model depends on fish body size (or both body size and growth), the coefficient of which is hard to observe in the ocean. Therefore, the body size dependency parameter was tuned to minimize the residual between simulated recruitment per spawners (RPS) and a virtual population analysis (VPA) derived RPS. The tuned model generated biomass of chub mackerel which tendency is similar with the observation. We conducted a series of sensitivity analyses to analyze the main environmental factors controlling the growth of early life stages and population dynamics in the model. Our model revealed higher sensitivity of prey availability for formation of stronger year classes. We extended the application of our model to understanding the effect of Kuroshio large meander in stock fluctuation. Our results revealed that the juvenile which entered the north water of the Kuroshio extension can successfully grow and contribute to the stock. Besides, our model can be applied to some other research. For example, it was also used to understand the process of bioaccumulation of microplastics in fishes.

S06, Oral, AbstractID=18418

Problems of the Pacific cod stock assessment in the western Bering Sea in relation to temporal warming

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The Pacific cod, *Gadus macrocephalus,* is a very important demersal fish species in Russian bottom fisheries. Primarily it is harvested in the western Bering Sea (WBS) from 170° E further to the East in Russian waters. Warming of bottom temperatures after 2014 is suspected in unusual distribution of biomass of cod in such a way that its sum in WBS could not be reproduced in the models of biomass dynamics and statistical catch at age (SCAA) models assuming independence and stationarity of biological parameters of the WBS stock. Therefore, we tested the performance of SCAA models with inclusion of the catch and age data from the Eastern Bering Sea (EBS) published by the North Pacific Fishery Management Council (NPFMC). We also tuned the recommended by NPFMC SS3 model 24.1 after inclusion of catch, age, and length data from Russia. None of the attempts decreased the mean absolute scaled error (MASE), but retrospective bias for 10 years decreased in SCAA model for WBS+EBS data to -0.002 for spawning biomass, while it was 0.13 for WBS data only. Unfortunately, MASE was higher than 1 in all cases. It indicates that the average model forecast became worse than a random walk. Probably joining the data from WBS and EBS was not a good idea to imitate one superpopulation of cod, though recruitment and survey index components of negative log-likelihood decreased and correlation between survey index input and output increased from 0.769 to 0.782 in SS3 model 24.1 after inclusion of data from Russia.

S06, Oral, AbstractID=18474, (ECOP)

A spatial-temporal stock assessment of the Korean chub mackerel (*Scomber japonicus*) with environmental conditions being incorporated

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In most previous stock assessments in Korea, the entire fishing area has been treated as a homogeneous unit, and only temporal variability in fish population dynamics was typically considered due to a lack of data. However, this unit comprises multiple subregions, each with distinct environmental conditions, which can lead to differences in the distribution and abundance of the same species. To address this issue, we have been collecting data on catch-per-unit-effort, fishery yields, other information, and abiotic variables by area as well as time, and been conducting a stock assessment of the chub mackerel (*Scomber japonicus*) in Korean waters. The chub mackerel spawns in the southern coastal waters between March and June, migrates northward during summer for feeding and growth, and returns south after November to overwinter and spawn. During this migration, Individuals in early life stages may be particularly sensitive to ocean conditions. Therefore, we hypothesized that the environmental conditions during the stage would have been reflected in fish recruit strength, and tried to analyze their relationship with recruits. As a preliminary result, we observed a weak correlation in annual variability between the density of amphipods, one of the major zooplankton groups, and the recruit strength of the chub mackerel. In this context, linking stock assessment with environmental drivers allows for adaptive management of fisheries in response to climate change. Furthermore, if spatial biological and environmental data are available about other species, this approach would be applied to them as well.

S06, Oral, AbstractID=18642, (ECOP)

Forecasting Japanese butterfish catches in Taiwan using Pacific climate oscillation indices: Implications for sustainable fisheries management

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The Japanese butterfish (Psenopsis anomala) is a commercially significant demersal fish species that is commonly found in the coastal waters of Taiwan. It is particularly prevalent in the Western Pacific, particularly in the vicinity of Japan, the Taiwan Strait, and the East China Sea. Butterfish fisheries, along with other coastal fisheries in Taiwan, have become a source of concern due to the evolving global climate. Despite its commercial importance, fluctuations in its catch rates have posed challenges to effective fisheries management. Thus, this study investigates the influence of Pacific climate oscillations on butterfish catch rate using bottom trawl fishery and climatic oscillation data. Using generalized additive models (GAM), we evaluated the lagged effects of various oscillation indices across regions, identifying Tropical Nino index (TNI) most significant predictors with 2 years lag in the northeast, and 3 years lag in the southwest. Our findings demonstrate strong regional and temporal variability in the climatic influence on butterfish availability, highlighting the need for region-specific management strategies. By identifying key predictive indices, it supports the development of early-warning system for catch variability. The outcomes of this study offer a foundation for forecasting future catch fluctuations and incorporating climate-based considerations into adaptive fisheries management in Taiwan and globally.

Keywords: Butterfish (*Psenopsis anomala*), Climate oscillations, Catch per unit effort (CPUE), Generalized Additive Models (GAM), Fisheries management, Taiwan coastal waters.

S06, Pre-Recorded-Oral, AbstractID=18692, (ECOP)

Evaluating the impact of age data on flatfish stock assessment and management under varying environmental conditions

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Age composition data for flatfish stock assessments are often limited over time and space, which presents uncertainty for stock assessment and thus management. Also, the impact of environmental conditions on flatfish life history is not often well understood, adding additional uncertainty. This study evaluates the impacts of biased age data in combination with incorrect stock assessment assumptions on flatfish stock assessment and management under time-varying life histories. To do this, scenarios with time-varying life histories and stock assessment assumptions and with and without bias and gaps in age data were simulated for a flatfish stock (in this case, Petrale Sole in BC). A closed-loop simulation framework with an age-structured operating model and stock assessment model was used. Preliminary results suggest that when a change in life history was not accounted for in the stock assessment model, age data had a larger impact. This study highlights the importance of evaluating the effect of composition data on stock assessments in order for sampling effort to be applied so that is has the most impact. This framework can be used to answer other questions regarding uncertainties in stock assessment.

S06, Oral, AbstractID=18695, (ECOP)

Rockfish road trip: Spatial variation in growth and maturity of black rockfish (*Sebastes melanops*) in the California Current and Gulf of Alaska

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Life history traits of marine fish influence the productivity of fish populations and inform the models that are used to estimate stock status. Although fisheries stock assessment models are limited in their spatial extent (e.g., regional or state-based), the lack of fine-scale information often requires an assumption that life history traits do not vary through time or space. Phenotypic plasticity (i.e., the expression of different characteristics in different environments), however, is common in marine species, which tend to grow faster and mature later at higher latitudes.

Although there are six separate stock assessments for black rockfish, three in Alaska and one for each of the states along the US West Coast, we do not yet have region-specific growth and maturity estimates. In collaboration with angling groups, state, and federal agencies, we estimated the growth and maturity of black rockfish (*Sebastes melanops*), an economically and ecologically valuable species, within the Gulf of Alaska and California Current. Accurately characterizing spatial variation in life history traits is imperative as stock assessments are highly sensitive to initial model parameterization. These models are also used to identify sustainable harvest practices, with the potential to have considerable impacts on coastal communities relying on this resource. To evaluate spatial differences, we estimated length – and maturity – at age using a logistic regression in each region and fit region-specific von Bertalanffy growth curves. We compared these curves using 95% confidence intervals. Results from this work can provide spatially-explicit estimates of growth and maturity for use in future stock assessments.

SESSION 6: FIS Topic Session

Incorporation of Climate and Ecosystem Impacts in Stock Assessment Advice: Discussion of Current Approaches and Challenges, and Charting a Path Forward

Poster Presentations

S06, Poster, AbstractID=18452, PosterID: S06-P1, (ECOP)

Modeling the population dynamics of Pacific saury considering migration

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The Pacific saury (*Cololabis saira*) is a commercially important small pelagic species distributed widely across the North Pacific, from the northern subtropical to the southern subarctic regions. In winter, it stays in the southern part of its range. From spring to summer, it migrates northward for feeding. In autumn and winter, it moves southward again and starts spawning during this migration. This species is currently managed by the North Pacific Fisheries Commission (NPFC), and its stock assessments are conducted using a Bayesian State-Space Production Model (BSSPM), which is non-spatial and does not account for migratory behavior. These assessments have indicated that the stock level has been low in recent years. In this study, we first constructed hypothetical stock dynamics for Pacific saury, based on the assumption that sea surface temperature (SST) significantly influences its migratory behavior. Using the constructed dynamics model, we generated synthetic catch-per-unit-effort (CPUE) data. We then attempted to reconstruct the original spatio-temporal stock distribution using the simulated CPUE and SST data. The reconstruction was successful, demonstrating the potential to estimate spatiotemporal changes in Pacific saury distribution based on CPUE and SST, given appropriate assumptions and sufficient data availability. Although further development is needed, our study framework would potentially contribute to (1) improving stock assessment and fisheries management under recent changes in the marine environment, (2) evaluating spatio-temporal management measures such as seasonal and area closures through Management Strategy Evaluation (MSE), and (3) integrating biological information revealed by otolith analysis and other techniques into population models.

S06, Poster, AbstractID=18638, PosterID: S06-P2, (ECOP)

Application of recurrent neural networks for model-free time series analysis in fisheries stock assessment

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Surplus production models (SPMs) have long been widely applied in fisheries stock assessments, with the use of a Pella-Tomlinson model being one of the most common approaches. However, these models rely on predefined functional forms for the surplus production, which may introduce biases if the actual stock dynamics deviate from these assumptions. To address this problem, this study explores the application of Recurrent Neural Networks (RNNs) to develop a model-free surplus production approach (SPM-RNN) and compares its performance to the conventional Pella-Tomlinson SPM (SPM-PT) through simulation experiments. We simulated CPUE and catch data under different surplus production scenarios, including a Pella-Tomlinson type model and two additional surplus production functions, flat-top and reduced-production. When the true surplus production function matched the assumptions of SPM-PT, both models performed similarly. However, when the assumption of SPM-PT was incorrect, SPM-PT resulted in biased estimates. In contrast, SPM-RNN provided more accurate estimates and future predictions without relying on predefined functional forms. Despite concerns regarding the interpretability of neural networks, SPM-RNN retains the core structure of SPM, ensuring comparability with conventional models. These findings suggest that SPM-RNN can serve as a robust and practical alternative, particularly in cases where traditional model assumptions may not be held.

SESSION 7: BIO/MONITOR Topic Session

The Impact of Oceanographic Processes on Ecosystems Supporting Fisheries Production in Boundary Current Regions

Oral Presentations

S07, Invited, AbstractID=18212, (ECOP)

Submesoscale eddy induced nitrate upwelling and effect on biological production in the upstream Kuroshio current

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While the Kuroshio, a western boundary current in the North Pacific, transports a large amount of nutrients in dark subsurface layers, it remains elusive whether and how these subsurface nutrients are supplied to continental shelves along southern coast of Japan. Recent observations revealed that the upstream Kuroshio flowing through rough topography forms a large-scale turbulence hotspot that may supply nutrients to sunlit surface layers. However, the Kuroshio-Island interaction in this region may also induce eddies and nutrient upwelling which have neither been observed directly nor quantified. Here, through high-resolution in-situ observations, we show submesoscale ~10 km nitrate structures along isopycnals, suggestive of eddy-induced upwelling. High-resolution simulations reproduce these features generated by submesoscale cyclonic eddy-induced nitrate upwelling at O(10) mmol N m^{-2} day^{-1}, accounting ~ 9% of net primary production in the area 400 km downstream during non-stratified season. Ecosystem model results suggest that rapid small zooplankton grazing could suppress the small phytoplankton increase, leaving a large fraction of supplied nitrate remain unused while it is carried by cyclonic eddies. These rather complex responses of lower trophic level ecosystem associated with submesoscale eddies in the upstream Kuroshio may partly explain how the Kuroshio sustains high biodiversity and biological production.

S07, Invited, AbstractID=18529

Spawning responses of anchovy and sardine to environmental factors in different ecosystems: Comparative approaches from international collaboration projects

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Out-of-phase population oscillations between anchovy *Engraulis* spp. and sardine *Sardinops*/*Sardinella* spp. have been observed in various regions worldwide. The patterns of such species alternations have responded to climate variability at a multidecadal scale. Various hypotheses have been proposed to explain biological processes linking climate variability to population dynamics of small pelagic fish. However, biological mechanisms behind the species alternations have been under debate. In this talk, first, I will review hypotheses of biological mechanisms behind the species alternations in the Kuroshio Current system, based on our previous studies on responses of spawning and larval growth rate to environmental factors. Then, I will introduce two international collaboration projects on comparative approaches to biological processes of species alternations between the Humbold and Kuroshio Current systems (upwelling vs boundary current regions) and between the southeastern Brazilian Bight and the Kuroshio Current system (boundary current regions), on behalf of collaborators mainly from Instituto del Mar del Perú (Perú), Universidade de São Paulo (Brazil), and Japan Fisheries Research and Education Agency, Hokkaido University, and University of Tokyo (Japan). We extracted species-specific spawning responses of anchovy and sardine to multiple environmental factors, based on data sets of egg surveys in the respective regions. Overall, anchovy and sardine exhibited contrasting responses to physical factors in the respective regions, and responses to biological factors indicated differential energy allocation strategies for reproduction between the species and between the regions. This review is anticipated to provide materials for discussion on oceanographic processes influencing fisheries production in boundary current systems.

S07, Oral, AbstractID=18198, (ECOP)

Larval fishes encounter favorable prey availability?
Testing Match-Mismatch hypothesis in major feeding grounds around the Kuroshio

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Small pelagic fishes demonstrated dramatically interannual fluctuations in their fishery stock. It has been long believed that their recruitment success is determined by growth and survival in early life stages under prey availability. The widely accepted hypotheses emphasize that larval fishes encountering favorable prey availability promote their growth and survival. In the present study, we evaluate the match-mismatch hypothesis whether the spatial and temporal appearance of foraging fish larvae is synchronized with high standing stocks of mesozooplankton in major feeding grounds for mackerel, jack mackerel anchovy and sardine. Their major feeding grounds were classified into three regions, the inside (IKB), mouth (MKB) and outside of Kagoshima Bay (OKB), based on water temperature, salinity and chlorophyll *a* concentration averaged in the sampling layer. Mesozooplankton standing stocks and productivity were higher in the IKB than in the MKB and OKB, due to the contribution of predominant copepods represented by cyclopoids and copepod nauplii. Larval abundances in the IKB and MKB were higher than those in OKB, where more contributions were found for copepods as favorable prey for the larval stages. The spatial and temporal abundance of foraging fish larvae demonstrated significant positive correlations to mesozooplankton standing stocks. These findings suggest that appearance of foraging fish larvae is synchronized with sufficient prey availability, supporting match-mismatch hypothesis in their major nursery grounds around the Kuroshio.

S07, Oral, AbstractID=18199, (ECOP)

Comparisons of fatty acid contents between zooplankton and fish larvae in the Kuroshio and neighboring waters

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The Kuroshio and its neighboring waters have been known as nursery grounds for early life stages of various fishes, despite poor food availability under oligotrophic conditions. Recent findings suggest that zooplankton standing stocks are not always low and provide suitable prey availability for larval fishes. However, there is limited information on nutritional evaluation of zooplankton as the larval prey. Here, we investigated fatty acid contents of zooplankton and larval fishes in the Kuroshio for evaluating match or mismatch of nutritional requirements of early life stages of fishes to their prey availability. Long-chain PUFA (LC-PUFA) contents represented by arachidonic (ARA), eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) were comparable between the Kuroshio and its neighboring waters. These LC-PUFA contents exhibited significantly positive correlations to relative abundance of Eucalanidae copepods and molluscans determined with metabarcoding analysis. These contents were also positively correlated with the haptophyte biomarker fatty acid contents. Beaked sandfish larvae showed higher contents of LC-PUFA than those for Anguilliformes leptocephali. Omnivorous crustaceans (Calanidae and Eucalanidae copepods) exhibited higher contents of LC-PUFA compared with non-crustaceans (Pteropoda and Chaetognatha). Multivariate analysis demonstrated that fatty acids compositions of omnivorous crustaceans were synchronized with those of beaked sandfish larvae. These findings suggest that omnivorous crustaceans in the Kuroshio accumulate LC-PUFA and provide suitable prey for nutritional requirements in early growth of planktivorous fish larvae.

S07, Oral, AbstractID=18246, (ECOP)

Growth and feeding requirements of Japanese sardine *Sardinops melanostictus* larvae in the northern Satsunan area, southern Japan

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Japanese sardine *Sardinops melanostictus* exhibits long-term fluctuations in stock abundance over several decades. During the high-stock period in the 1980s, a large spawning ground was present in the northern Satsunan area, southern Japan. However, this spawning ground disappeared during the low-stock period in the 1990s. Since 2015, we have conducted monitoring surveys targeting larvae of small pelagic fishes in this area, and detected the occurrence of Japanese sardine larvae for the first time in March 2023.This study aims to understand the process of spawning and nursery ground formation of Japanese sardine during the stock-increasing phase. We investigated the occurrence of Japanese sardine eggs and larvae, their growth, and feeding requirements in the northern Satsunan area. Eggs and larvae were collected using a twin NORPAC net and an ORI net, respectively, at eight stations in the mouth of Kagoshima Bay and adjacent waters from 2023 to 2025. After estimating the density (individuals per 1,000 ㎥) of eggs and larvae at each station, we examined the growth and food requirements of larvae. Eggs and larvae were mainly found in the coastal area on March in each year. The highest densities were recorded as 2,476.2 eggs in March 2024 and 355.3 larvae in March 2025. In 2024, the mortality rate was 11.3%. The weight-specific growth coefficient and daily ration were calculated to be 0.24 d^{-1} and 85.0% of body dry weight, respectively, both of which were higher than chub mackerel *Scomber japonicus* larvae (0.11 d^{-1} and 43.1%) in the study area.

S07, Oral, AbstractID=18252

The impact of summer Yangtze River runoff fluctuations on estuarine fronts dynamics and zooplankton communities from 2016 to 2023

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Estuarine fronts, which arise from the convergence of distinct water masses, exhibit considerable spatial and temporal variability and play a crucial role in shaping ecological dynamics within estuarine ecosystems. Despite their importance, due to limited data, there's inefficiency understanding on how biological communities, particularly zooplankton, respond to these dynamic environmental features. The Yangtze River Estuary (YRE), a transitional zone between the Yangtze River and the East China Sea, is an ideal place in which to study the response of zooplankton communities to estuarine fronts, as freshwater discharge, offshore waters, and the Taiwan Warm Current converge here and form sediment and plume fronts in summer. We investigate zooplankton communities and environmental variables including temperature, salinity, turbidity, and Chlorophyll a (Chl a) in the YRE during summer from 2016 to 2023, and examine the differences in spatial distribution of estuarine fronts and zooplankton community and the dominant environmental factors controlling zooplankton variation in different runoff years. Our findings found that the sediment fronts appeared around 122.5°E except in drought years (2022 and 2023); the plume fronts extended to 123.5°E and beyond during wet years (2016,

2020 and 2021), while shrank within 123°E in drought years. The zooplankton communities were classified into low-salinity, moderate-salinity, and highsalinity groups spatially in most years, but the low-salinity group had not been detected in the extreme drought year 2022. During flood years, low-salinity nearshore species such as *Oithona brevicornis*, *Centropages dorsispinatus* and Cladocera exhibited a notable increase in dominance, while the drought favored euryhaline species like *Microsetella rosea*. Furthermore, the turbidity, salinity and temperature all played significant roles in zooplankton spatial variation in wet years, while only salinity played as an important factor in drought years. These results implied the prominent sediment fronts and extended plume fronts in wet years shaped the zooplankton spatial variation collectively; in contrast, sediment fronts disappeared during drought years, and the plume fronts played a crucial role in shaping the zooplankton spatial variation. Besides, the extremely low runoff in 2022 has been shown to lead to obvious changes in zooplankton communities, which might affect fisheries stocks and require concern.

S07, Oral, AbstractID=18254, (ECOP)

Assessing the impact of oceanographic field variability on the spatial distribution of chub mackerel in the northwestern Pacific fishing grounds

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This work analyzes the dependence of chub mackerel (*Scomber japonicus*) catch distribution by the Russian fleet on oceanographic conditions in the northwest Pacific in 2020, 2021 and 2022. Frontal zones play a key role in shaping the distribution of commercial fish aggregations. Their effect is assessed through gradients of temperature, salinity, density, and Lagrangian indicators. The main oceanographic parameters were obtained from the GLORYS12V1 reanalysis, while Lagrangian characteristics were calculated through numerical solving of advection equations in the AVISO velocity field. Frontal zones were algorithmically identified using a probability distribution function. To evaluate which oceanographic parameter most significantly affects the formation of favorable conditions for hydrobionts, distances from fishing locations to the nearest frontal zone were calculated and analyzed. It was established that fishing grounds avoid significant distances from frontal zones, with temperature and density gradients having the strongest influence on the distribution of fish aggregations. The ability to understand fish behavioral responses to oceanographic conditions facilitates the creation of fishing forecasts: in this study not only Eulerian, but also Lagrangian approach is used, which could help improve the accuracy of fisheries forecasts.

S07, Oral, AbstractID=18275

Spatial assessment of the impact of Kuroshio branch intrusion on the spring phytoplankton bloom in Kagoshima Bay using GCOM-C SGLI

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Kagoshima Bay, a semi-enclosed embayment influenced by the Kuroshio branch current, plays a significant role in coastal material cycling and ecosystem dynamics. However, the extent to which Kuroshio intrusions contribute to phytoplankton bloom development and transport remains unclear. Using satellite data from the Second Generation Global Imager (SGLI) and ferry-based sea surface temperature (SST) measurements, we investigated how the Kuroshio intrusion affects the spatial distribution and temporal dynamics of phytoplankton. SGLI-derived chlorophyll-a (Chl-a) concentrations indicated that phytoplankton biomass continued to accumulate in the bay before being gradually transported offshore. Ferry-based SST data showed abrupt temperature increases (>1°C/day), which occurred multiple times annually and served as indicators of Kuroshio intrusions. Spatial correlation analysis revealed that 45.4% of the bay, especially the eastern region, exhibited significant positive correlation with conditions at the bay mouth. Partial correlation analysis demonstrated strong correlations at lag –5 days and +5 days, suggesting a 5-day periodicity in phytoplankton dynamics. These findings suggest that the Kuroshio intrusions allow phytoplankton blooms to persist and expand within the bay before being exported offshore. Such transport may enhance lower trophic-level productivity in adjacent Kuroshio waters.

S07, Oral, AbstractID=18279

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

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Bloom formation by the colony-forming diatom, *Thalassiosira diporocyclus*, was investigated inside and outside Kagoshima Bay in the Satsunan area near the Kuroshio Current at the western edge of the North Pacific Subtropical Gyre. In this bay, the intrusion of warm water originating from the Osumi Branch Current, a branch of the Kuroshio Current, causes the upwelling of nutrient-rich bottom water and phytoplankton blooms at the bay mouth. At this location, *T. diporocyclus* was found to be dominant among the diatom community in the surface layer between February and April. Conversely, its density at a depth of 50 m was higher inside the bay than at the bay mouth in January, which suggests that the *T. diporocyclus* population in the bay is transported to the bay mouth. Daily fixed-point observations showed that blooming started in the subsurface layer and then spread throughout the water column, suggesting that the diatom population would have been supplied to the subsurface layer. *T. diporocyclus* was also distributed in the Osumi Branch Current outside Kagoshima Bay. From this current, cells would be transported to the Kuroshio Current, as the two water masses meet. A survey of the literature revealed the detection of high abundances of *T. diporocyclus* in coastal areas near the western boundary currents and the Kuroshio Current. These areas are highly productive due to the inflow and upwelling of nutrient-rich subsurface waters. *T. diporocyclus* plays an important role as a primary producer in the wide areas influenced by western boundary currents and their branch currents.

S07, Oral, AbstractID=18367, (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

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Previous studies have demonstrated that typhoon passages can affect marine organisms. However, fewer studies examining how small to medium-sized fish respond after typhoons. Therefore, this study conducted sampling using commercial trawl nets in the southwestern waters of Taiwan in August 2023 (before Typhoon Saola) and September 2023 (after Typhoon Haikui) to investigate whether hydrological changes associated with typhoons affect fish composition and feeding habits. Our results showed that there was no significant change in chlorophyll-a concentrations, but sea surface temperature exhibited a declining trend a week after typhoon. Biologically, 19 families 31 species 483 fish were collected before typhoon, 3 families 7 species of cephalopods, 4 families 3 species of shrimps, 1 family 1 species of crab and other benthic organisms. The catch composition was dominated by fish.12 families 15 species 586 fish were collected after typhoon, 3 families 3 species of cephalopods, 1 family 1 species of shrimp, 1 family 2 species of crabs and other benthic organisms. The catch composition shifted to being dominated by cephalopods because the passage of the typhoon caused a decline in sea surface temperature. The body size of fish was generally higher after typhoon. Among co-occurrence species before and after typhoon, only *Pseudorhombus dupliciocellatus* exhibited a decrease before typhoon. Preliminary gut content analysis of fish showed that the main prey items of co-occurrence species remained consistent before and after typhoon, except for *Upeneus japonicus,* feeding variations may relate to body length. The study showed that catch composition changes after typhoon and fish body size generally increase, typhoon can affect marine organisms.

S07, Oral, AbstractID=18476, (ECOP)

Ecological impact of aplanochytrid protists as a source of DHA for copepods in the marine environment

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Polyunsaturated fatty acids are essential nutrients for many organisms, and docosahexaenoic acid (DHA) plays a vital physiological role in animals. Since animals such as marine fish cannot synthesize DHA, they must acquire it through trophic transfer. Labyrinthuleans, stramenopile protists distributed in global marine environments, are known for their high DHA content. Among them, *Aplanochytrium* spp. have been reported to feed on diatoms, which are abundant primary producers in the ocean. In this study, we estimated the ecological impact of aplanochytrids in the Oyashio region based on their biomass. Our results showed that aplanochytrids possess a carbon biomass equivalent to several percent of the total meso- and microzooplankton. Diatoms and dinoflagellates have been considered the dominant sources of DHA. However, meta-18S-based analyses of trophic interactions have reported that aplanochytrids, despite rarely detected in seawater, are grazed by multiple calanoid copepod species at frequencies comparable to those of algae. When accounting for the characteristically high DHA content of labyrinthuleans, our estimations suggest that aplanochytrids may be an equally or more important source of DHA as algae within the calanoid gut. These results suggest that aplanochytrids produce DHA by grazing on diatoms and directly transfer DHA to calanoid copepods, bypassing microzooplankton intermediaries. Based on our estimation that labyrinthuleans contribute the most to DHA transfer to calanoids, which are among the most heavily consumed prey in zooplankton food webs, we concluded that the labyrinthuleans may be a major source of DHA not only for zooplankton, but also for higher trophic levels, including fish.

S07, Oral, AbstractID=18551

Oceanographic influences on zooplankton dynamics with implications to fisheries in the northern Gulf of Mexico

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Oceanographic processes consist of primary mechanisms for driving dynamics of marine organism in the ocean. A key feature in the northern Gulf of Mexico is the spatial configuration and intrusion of the Loop Current. As it passes through the Strait of Florida eventually merging into the Gulf Stream and flowing northeastward off the North American coast. While the importance of zooplankton in fueling marine ecosystems and fisheries production has been well recognized, existing knowledge on the connections between zooplankton and the Loop Current associated mesoscale features in the northern Gulf of Mexico remains insufficient, which impede our understanding of how variations in ecosystem drivers and zooplankton may influence the dynamics of fish stocks. Such information is critically needed to assess the mechanistic ecosystem impacts on fisheries production. This talk will overview our recent efforts using observations and modeling to study zooplankton dynamics in terms of mesoscale processes, discuss bottlenecks and possible solutions to explicitly consider zooplankton dynamics in better assessment of ecosystem functions and fisheries resources in a changing ocean.

S07, Oral, AbstractID=18560

Distribution of marine organisms associated with physical and biogeochemical environments observed off the Pacific coast of Tohoku, Japan

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The area off the Pacific coast of Tohoku, Japan, is known to be a highly productive zone as well as an important fishing ground and has complicated structures in physical and biogeochemical properties because of the confluence of the Kuroshio, Oyashio, and Tsugaru Warm Currents. To understand the mechanisms of the high productivity as a consequence of oceanic processes for ecosystem, it is essential to measure environmental properties and the distribution of marine organisms simultaneously at high spatial and/or temporal resolutions and investigate their relationships in detail. Field surveys were carried out off the Pacific coast of Tohoku, Japan, during the research cruise WK2305C in May 2023 with R/V *Wakataka-maru*. High-resolution cross sections of environmental properties (temperature, salinity, fluorescence, turbidity, and oxygen concentration) were collected by using the tow-yo profiler BioUCTD (JFE Advantech). Concurrently with the cross-section surveys, acoustic backscattering strength was measured as a proxy of biomass of fish, micronekton, and/or large zooplankton by using a hull-mounted scientific echosounder KFC-3000 (KAIJO) with a transducer of 38 kHz. The observed temperature and salinity revealed that the Tsugaru Warm Current water was distributed along the coast, and the Oyashio and Kuroshio waters were located off the northern and southern coast of the survey area, respectively. Patches with intense backscatter, which most likely represent dense fish schools, were detected in the vicinities of the horizontal and vertical boundaries between the different water masses. The discussion about the influence of ocean environments including biogeochemical properties on the aquatic organisms will be presented in this talk.

S07, Oral, AbstractID=18587

Impacts of the Kuroshio nutrient stream on the high productivity in the Kuroshio-Oyashio interfrontal zone

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The Kuroshio-Oyashio interfrontal zone (KOIZ), transition area between the subtorpical and subarctic gyres in the western boundary of the North Pacific, is known as one of the most productive fishing grounds. Recent studies revealed that the Kuroshio transports considerable amount of nutrients to the downstream regions as is the case in the the Gulf Stream. It suggests significant impacts of nutrient transport along the Kuroshio on the high productivity in KOIZ, though supplies from the nutrient-rich subarctic region have been focused in most previous studies. In order to elucidate quantitatively the nutrient supply along the Kuroshio to KOIZ, we analyzed budgets of isopycnal transport of nitrate in the region which covers KOIZ, using vertical profiles of temperature, salinity, nitrate and current velocity observed at 200 stations enclosing the target region in spring 1998. Budget of nitrate transport integrated from the sea surface to the 27.5 sigma-theta isopycnal in the enclosed region was found to be not balanced but in excess of imports, which was comprised of water transported along the Kuroshio and that along the Oyashio at the same rate. The Kuroshio water accounted for a larger rate in the nitrate excess on the lighter isopycnal shallower than the nitracline, where new production averaged in the whole of the target region was estimated to correspond to a few hundred $mgCm^{-2}d^{-1}$, simply assuming that all the nitrate excess was consumed by phytoplankton. It suggests that the isopycnal transport of nutrients along the Kuroshio contributes significantly to the new production in KOIZ.

S07, Oral, AbstractID=18590, (ECOP)

Behavioral responses of skipjack tuna to river-influenced water in the East China Sea

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Freshwater discharge from continental rivers strengthens upper layer stratification and inhibits vertical oxygen supply, inducing lower dissolved oxygen (DO) in bottom waters in the presence of oxygen consumption by marine species and bacteria. While oceanic fish behavioral responses to temperature are well-studied, fewer studies examine salinity effects. Skipjack tuna (*Katsuwonus pelamis*) migrates to Japanese coastal waters via the Kuroshio Current near the East China Sea (ECS), where water properties change drastically due to freshwater discharge from Yangtze River. We investigated skipjack tuna migration patterns focusing on Yangtze River freshwater discharge using behavioral data from Japan's Nansei Islands collected through archival tag surveys by the Japan Fisheries Research and Education Agency and satellite/in-situ data (2012-2016). Among 18 individuals, only 5 experienced river-influenced water, exhibiting seasonally different patterns between summer (2 individuals) and spring (3 individuals). In spring, skipjack tuna avoided migrating inshore side across the oceanic temperature/salinity front (18.1°C, 32.8 psu) formed by the freshwater discharge, whereas summer showed weaker fronts with less saline water. Summer individuals returned offshore when salinity reached 31.3 psu in upper layers and DO dropped to 3.5 mL/L in lower layers. Furthermore, energy intake estimates from body temperature indicated increased feeding under lower salinity conditions, suggesting nutrient-rich river-influenced water provides favorable feeding environments. By considering the fact that few individuals entered the ECS, river-influence water would have not only positive but negative effects including low-temperature, low-salinity and low-DO. These findings suggest that freshwater discharge influences oceanic fish migration patterns and feeding behavior.

SESSION 7: BIO/MONITOR Topic Session

The Impact of Oceanographic Processes on Ecosystems Supporting Fisheries Production in Boundary Current Regions

Poster Presentations

S07, Poster, AbstractID=18169, PosterID: S07-P1

Phytoplankton growth is stimulated by mixing of coastal waters advected to the Kuroshio

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The Kuroshio and its neighboring waters have been known as nursery grounds for early life stages of small pelagic fishes and support their high fishery production, despite poor prey availability under oligotrophic conditions. Recent findings demonstrated that phyto- and zooplankton standing stocks are not low in the Kuroshio since biological productivity was stimulated with various mechanisms of nutrients supply, such as coastal waters advected to the Kuroshio. Nonetheless, the mechanisms on how phytoplankton growth in the Kuroshio is enhanced by the advected coastal waters remain unclear. Here, we conducted onboard experiments on how phytoplankton growth is variable to the extent of mixing between the Kuroshio and advected coastal waters. Coastal waters advected to the Kuroshio were represented by higher chlorophyll *a* concentrations under lower nutrients than the Kuroshio waters, whereas no substantial difference was found for microzooplankton biomass between the two water masses. Phytoplankton standing stocks increased by the end of the incubations due to the growth of micro- and nano-sized phytoplankton. Phytoplankton growth rates were not dependent on the mixing ratio and higher for micro- and nano-sized groups than pico-sized groups. Phytoplankton growth rates were variable with the conditions at the beginning of the incubations, increased with nutrients concentrations and microzooplankton biomass but decreased with chlorophyll *a*. These findings suggest that phytoplankton growth is stimulated with mixing of coastal waters advected to the Kuroshio and associated with contents of nutrients (resource), phytoplankton (competitor) and microzooplankton (nutrient regenerator).

S07, Poster, AbstractID=18201, PosterID: S07-P2, (ECOP)

Geographical variations in zooplankton standing stocks, productivity and taxonomic composition to mixing of coastal waters into the Kuroshio

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The Kuroshio and its adjacent waters are recognized as important as nursery grounds for early life stages of small pelagic fishes, despite low prey availability under oligotrophic conditions. This phenomenon, referred as the "Kuroshio Paradox", suggests that the early survival and growth of these fishes may be supported by biological productivity stimulated by oceanographic conditions unique to the Kuroshio. Previous numerical experiments have indicated that zooplankton standing stocks in the Kuroshio can be increased by coastal zooplankton community advected to the region. However, empirical evidence from oceanographic observations and sample analyses remains limited. In this study, we investigated how zooplankton standing stocks are influenced by the mixing of coastal waters into the Kuroshio, based on in situ oceanographic observations. Less saline waters were more pronounced on the continental shelf and diminished toward the pelagic sites, indicating salinity as an indicator of coastal waters. Zooplankton standing stocks and production rates were consistently higher in less saline waters, regardless of seasons or locations, whereas protein synthetase activity showed no clear relationship with salinity. Multivariate analyses revealed that four copepod families were predominant zooplankton taxa, and spatial variations in zooplankton standing stocks were particularly associated with the abundance of Paracalanidae. These results suggest that spatial patterns in zooplankton standing stocks can be explained by averaged salinity in the sampling layer, which reflects the presence of coastal copepods advected into the Kuroshio.

S07, Poster, AbstractID=18205, PosterID: S07-P3, (ECOP)

Impacts of ocean warming on sex ratio of yellow striped butterfish *Labracoglossa argentiventris* around the Izu Islands, Japan

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Marine ecosystems are experiencing warming events in various regions of the world. Thus, many fish species and populations are now being impacted by the warmer temperature conditions. Previous studies have reported temperature-dependent sex determination (TSD) in various fish species. Such temperature impacts could be a significant concern in stock assessment and fisheries management. However, few studies have demonstrated TSD in wild fish populations in the long term. Yellow striped butterfish *Labracoglossa argentiventris* is an important fishery species around the Izu Islands, Japan. In the present study, we examined impacts of ocean warming on sex ratio of yellow striped butterfish, based on a long-term monitoring for their sex ratio and temperature around the Izu Islands from 1987 to 2024. The mean temperature in the spawning season significantly increased, and the sex ratio (ratio of female to all) significantly decreased, after 2018. A generalized linear model showed that the sex ratio was negatively related to the mean temperature in the spawning season 3 years ago. Therefore, the recent trend of higher temperature would influence the sex ratio of yellow striped butterfish by affecting the critical period for their sex determination, skewing the sex ratio toward the male-dominant condition. The present study is a unique example of demonstrating the TSD in the wild pelagic marine fish in the long term. Monitoring surveys for reproductive traits would be essential to assessing the impacts of ocean warming and improving the stock assessment and fisheries management of the fish stocks under the climate variability.

S07, Poster, AbstractID=18244, PosterID: S07-P4, (ECOP)

Reconstruction in gelatinous zooplankton by climate change and environmental stressors in Daya Bay, China

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Ecological regime shifts involve abrupt and persistent changes in ecosystem structure and function, yet contemporary evidence of such shifts remains limited. Gelatinous zooplankton (GZ), key components of marine food webs and biogeochemical cycles, are highly adaptable to environmental changes. Under climate change, their dominance in planktonic ecosystems is projected to increase, driving shifts in community structure and energy flow. Nevertheless, the long-term trends of GZ populations, their dynamic drivers, and cascading ecosystem effects remain poorly understood. Using three decades of monitoring data (1994-2022), we documented a tipping point in GZ community in Daya Bay. Temporally, the regime shift occurred in 2008, after which GZ exhibited decreased species diversity but increased relative abundance, with taxonomic reorganization from Thaliacea-dominated to Appendicularians-dominated communities. Spatially, GZ communities showed significant functional trait divergence between human-impacted areas and minimally disturbed regions. Seasonal analyses identified winter as the most sensitive period, exhibiting the strongest abundance declines and clearest anthropogenic signals.By integrating climatic, anthropogenic, hydrographic, and biological drivers, we developed a piecewise structural equation model for GZ dynamics. Results demonstrated that marine fisheries production was the predominant driver of abundance variation, with distinct taxa exhibiting differential environmental responses. This study provides species-level evidence of spatiotemporal regime shifts in bay ecosystems and quantifies their significant impacts on ecosystem services.

S07, Poster, AbstractID=18245, PosterID: S07-P5, (ECOP)

Spatio-temporal patterns of holoplanktonic mollusc assemblages and indicator species of hydrodynamic conditions in the northwestern South China Sea

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Holoplanktonic molluscs are a group of overlooked but ecologically important zooplankton in marine ecosystems that play a crucial role in the marine food web and carbon cycle, serving as key prey for commercially important fish species and influencing fisheries productivity. However, changes in the marine environment can lead to an increase in the abundance of pelagic molluscs, causing ecological disasters. To understand the environmental factors that structure holoplanktonic mollusc assemblages, their diversity and abundance were analyzed in the northwestern South China Sea (NWSCS). A total of 39 holoplanktonic molluscs were identified, including 24 pteropod and 15 heteropod species. Significant seasonal and regional differences were observed in species diversity and abundance. Species richness was higher in offshore waters than in nearshore waters during summer and winter, whereas species abundance was significantly higher in summer than in winter. High species abundance was mainly concentrated in waters influenced by cyclonic eddies and coastal upwelling during summer. Temperature, salinity and chlorophyll a are important factors for structuring holoplanktonic mollusc assemblages. *Creseis acicula* was an effective indicator species in nearshore waters in both seasons, whereas *Limacina bulimoides* and *Heliconoides inflatus* were the best indicators in offshore waters in summer and winter, respectively. These findings provide a baseline for understanding the distribution of holoplanktonic molluscs in the marginal sea of the northwestern Pacific Ocean, offering insights for hydrodynamic influences on zooplankton distribution and ecosystem-based fisheries management in the NWSCS.

S07, Poster, AbstractID=18248, PosterID: S07-P6, (ECOP)

Feeding and reproductive ecology of skinnycheek lanternfish *Benthosema pterotum* in Kagoshima Bay, southern Japan

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In the world's oceans, mesopelagic fish stocks are enormous, amounting to one billion tons. The skinnycheek lanternfish *Benthosema pterotum* is widely distributed in coastal areas of the Indian Ocean and western Pacific Ocean. Although the species is dominant in Kagoshima Bay, southern Japan, findings on their life history characteristics has been limited. In the present study, we examined feeding and reproductive ecology of *B. pterotum* in Kagoshima Bay. The samples were collected by a trawl net in the center of Kagoshima Bay from July 2023 to April 2025. The trawl net was towed horizontally along two layers (approximately 140 m and 10–20 m in depth during daytime and night time, respectively) at an approximate speed of 2 knots. The species performed diel vertical migration and exhibited feeding activity in the surface layer from 19:00 to 03:00. The daily ration of food was estimated as 5.21% of body wet mass, which was higher than those of other myctophid fishes (*Diaphus garmani*: 2.74%, *Diaphus chrysorhynchus*: 2.66%). The feeding pressure on daily mesozooplankton production was estimated to be 34.5%. Based on the histological examination of gonads, the spawning occurred throughout the year and primary spawning period was between July and September.

S07, Poster, AbstractID=18300, PosterID: S07-P7, (ECOP)

Zooplankton biomass variability from ADCP backscattering strength data at the East China Sea stations

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As a main trophic link between primary producers and larger predators, zooplankton plays an important role in ocean ecosystems and material cycles. In addition, it contributes to the transport of carbon and nitrogen to the deep sea via the production of fecal pellets and active transport by diel vertical migration (DVM). Early studies about the zooplankton biomass mainly relied on the ship-based net sampling methods, which provide ground truth data but have spatial and temporal limitation. Acoustic backscattering strength data obtained from acoustic Doppler current profilers (ADCPs) have higher temporal and vertical resolution over a long duration. As one of the largest marginal seas in the western North Pacific, bounded by China, Korea, and Japan, the East China Sea (ECS) is a highly productive ocean area in the world, with plenty of zooplankton resources. A number of zooplankton studies have been done in this area; however, the long-term zooplankton biomass variabilities and the DVM characteristics still lack investigation. In this study, an RDI 307.2 KHz ADCP was deployed to obtain acoustic backscatter intensity for estimating zooplankton biomass as well as the current data. And the field observation zooplankton biomass data were also collected by a Norpac net with a mesh size of 100 μm. Based on these two datasets, we are able to retrieve the vertical and temporal variations of zooplankton biomass and show the structure of daily DVM. Our study focuses on the zooplankton biomass retrieval and examines the effects of periodic and episodic physical and biological events on zooplankton dynamics.

S07, Poster, AbstractID=18366, PosterID: S07-P8, (ECOP)

Environmental and biological factors influence on small and medium fish feeding ecology in the southwestern waters of Taiwan, Western Pacific Ocean

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This study conducted biological sampling in the Taiwan Banks area off southwestern Taiwan using a small bottom trawl and plankton net aboard R/V New Ocean Researcher 3 in July and September 2023. By analyzing marine organism composition and fish stomach contents, we investigated the spatiotemporal relationships between the feeding habits of small- and medium-sized fishes and environmental factors. Results showed temporal and spatial variations in hydrography and plankton communities. A total of 58 teleost species (30 families) and various benthic organisms were recorded. Fish abundance and size varied over time, while species composition differed spatially. Based on %PSIRI > 60%, fishes were categorized into piscivores, zooplanktivores, benthivores, and omnivores, with benthivores being dominant. Larger fishes consumed larger prey, with slight dietary shifts. Prey composition varied spatiotemporally for piscivores and zooplanktivores, but not for others. Environmental and prey factors influenced fish feeding differently: piscivores were prey-driven, benthivores environment-driven, and zooplanktivores affected by both.

S07, Poster, AbstractID=18412, PosterID: S07-P9, (ECOP)

Epifaunal assemblage and food web structures of the floating *Sargassum* in the Satsunan area: Spatiotemporal change during the drifting process

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Floating *Sargassum* provide essential habitats and feeding grounds for various small epifauna and fishes, serving one of the important ecosystem functions. Understanding the function requires a comprehensive analysis of the assemblage structure and energy pathways within the ecosystem, which can drastically vary during the drifting process. Despite their importance, very limited studies have focused on these dynamics in the drifting process. This study investigated the transitions in epifaunal assemblage structure of floating *Sargassum* drifting to the Satsunan area and examined the feeding habits of epifauna through metabarcoding analysis of gut contents. The results showed distinct spatiotemporal patterns: *Lepas* barnacles and harpacticoids were dominant in the East China Sea, upstream area, while *Sunamphitoe* and *Allorchestes* amphipods increased and become dominant as the *Sargassum* drifted towards the Satsunan area. Their feeding habits were categorized in to three groups: *Sargassum*-grazer such as *Sunamphitoe* or *Allorchestes*, particle-feeders such as *Lepas* and omnivores (herbivory + carnivory) such as *Idotea* or Portunidae. The food web was primarily based on two resources: floating *Sargassum* itself and external microalgae including phytoplankton. The *Sargassum*-grazer and omnivores increased during the drifting process probably due to large amount of *Sargassum* biomass. In contrast, the particle feeders—comprising the majority of sessile organisms like *Lepas*—declined during the drifting, likely due to a difficulty of reproduction during drifting. In summary, epifaunal assemblages and food web structure drastically changed during drifting process to Satunan area, driven by increases in *Sargassum*-grazers and omnivores, and a decline in particle-feeders reliant on external food sources.

S07, Poster, AbstractID=18425, PosterID: S07-P10, (ECOP)

How do fish larvae avoid dietary overlapping in the Kuroshio and its neighboring waters?

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It has been well known that small pelagic fishes demonstrated large stock fluctuations with species alternations. Such fluctuations have long believed to be driven by recruitment success from early life stages through spatiotemporal match or mismatch between their appearance and suitable prey availability. Despite many fish species spending such vulnerable life stages and resulting in high fishery production in the Kuroshio under poor prey availability, there is limited information on how they avoid dietary overlapping to support early survival and growth. In the present study, we investigated interspecific competition to prey sources among fish larvae abundantly appearing in the Kuroshio (KW) and coastal waters (CW) based on metabarcoding analysis of their gut content DNA. In both regions, calanoids were the most abundant and frequently appearing prey, and non-crustaceans represented by appendicularians and molluscs were supplementary prey. Multivariate analysis on diet composition revealed no clear segregation among fish species in either KW or CW due to their dependence on preferred prey like calanoids. Dietary overlapping was more pronounced for fish larvae more dependent on calanoids but declined for those preferred non-crustaceans. These findings suggest that competition for dietary sources is avoided by utilizing non-crustacean prey which has been overlooked.

S07, Poster, AbstractID=18493, PosterID: S07-P11, (ECOP)

High-resolution SWOT altimetry observations of the island mass effect in the Kuroshio Current

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The Island Mass Effect (IME), in which ocean currents interact with island and seamount topography to drive upwelling and stimulate biological production, plays a key role in supporting fisheries in oligotrophic waters. IMEs are increasingly recognized as ecologically significant hotspots where fine-scale physical processes, including turbulent mixing, frontal instabilities, and topographic flow disruption, enhance lower trophic level productivity and may contribute to fish recruitment and localized fisheries yield. In the Tokara Strait, a dynamic region where the Kuroshio Current flows over a chain of islands and seamounts, we used SWOT satellite altimetry in combination with MODIS sea surface temperature and chlorophyll-a data to examine the physical expression and biological signature of the IME. SWOT, the first satellite altimeter capable of delivering two-dimensional swath measurements of sea surface height at unprecedented spatial resolution (two 50 km swaths on either side of the nadir, with a native resolution of 250 m), provides a transformative capability for detecting submesoscale features and frontal structures previously unresolved by conventional altimetry. SWOT observations reveal intensified surface flow gradients and submesoscale activity downstream of topographic features, coinciding with SST cooling and elevated chlorophyll concentrations indicative of enhanced upwelling and biological response. This study provides one of the first demonstrations of how next-generation satellite observations can resolve fine-scale current-topography interactions that trigger localized phytoplankton blooms, offering a mechanistic pathway by which submesoscale physical processes may enhance biological productivity and influence fisheries productivity in western boundary current systems.

S07, QR-Poster, AbstractID=18576, PosterID: S07-P12, (ECOP)

What does 100 billion gallons of freshwater do to an estuary?

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The Mississippi River is the world's fourth largest river system, and many regions of the lower watershed are subject to freshwater diversions when the river flow is high. These diversions can redirect massive amounts of freshwater into brackish ecosystems that are not typically accustomed to these introductions and potentially impact estuarine fish populations. We use diversions via Louisiana's Bonnet Carré Spillway (BCS) as multiple well-observed case studies into the effects a large freshwater diversion can have on estuarine ecosystems, like the Lake Pontchartrain estuary. River flow varies annually and thus does not consistently necessitate spillway activities, but in years when the BCS is opened, the diversions vary in magnitude, duration, and water characteristics, implying uncertain effects on the present biota. Few formal, long-term studies of diversions' effect on estuarine fish have occurred, leaving room to better understand these phenomena. We hypothesize that BCS diversions cause a chain reaction that leads to increased productivity in the ecosystem and ultimately supports increasing finfish populations as a result. Our analyses explored linked environmental variables during and after BCS openings and compared them to the same conditions in years without openings. To more generally define fish response over longer timescales and potentially extract a lagging response by fish to BCS events, we explored annual variation of fish abundance in Lake Pontchartrain. Our results found the strongest seasonal ecosystem relationships immediately after the opening and diminishing strength of the relationships with increased trophic level. BCS effects on nutrient concentrations and plankton abundance appear positive, while most fish species do not show increases or decreases in relative abundance that differ from non-BCS years. BCS openings have clear effects on Lake Pontchartrain ecosystems; however, many finfish species show minimal effects from BCS diversions, likely due to their mobility and tolerance of changing water quality and the attenuation of BCS effects through trophic and energy pathways. These results contradict many anecdotal descriptions of how spillway events impact estuarine ecosystems, but the multiple sources of data used in our analyses do not exhaustively represent conditions observed in similar systems worldwide. In addition, our study views this system at a much larger scale than most observations have in the past. The fisheries in the area observe these spillway openings at a far more specific and localized scale than our research, which can cause differences in inferences. Our findings are the result of coalescing many different data sets and analyzing over a decade of observations, which creates the potential for smoothing over the final details that could be more obvious to a more hands-on researcher. However, our results imply that diversions of massive volumes of freshwater into a brackish system may not be as detrimental to the aquatic fauna as once was thought.

S07, Poster, AbstractID=18763 (o->p), PosterID: S07-P13

Recent changes in oceanographic conditions in the Northwestern Pacific and their potential impacts on the migration and reproduction of sardine, mackerel and saury

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The impacts of recent changes in oceanographic conditions on the feeding migration and reproduction of sardine (*Sardinops melanostictus*), mackerel (*Scomber japonicus*) and saury (*Cololabis saira*) in the Northwestern Pacific ware analyzed. The materials of TINRO complex pelagic surveys in 2004-2024 from the "Marine Biology" and "Oceanography" databases, fisheries information and gridded SST, water temperature on 50 and 100 m and currents from the NEAR-GOOS project were used. An assessment of various parameters reflecting climate change and multi-scale variability has been completed. The main factors causing changes in the spatial distribution and reproductive success of these species have been identified. Now these changes are most clearly manifested in the longer feeding periods of these species in subarctic waters. Key dynamic structures (branches and meanders of Kuroshio, Oyashio, Subarctic currents and mesoscale eddies) and related oceanographic fronts have effect on the migration patterns of the fisheries species in many respects. Recent 11 years to the east of 154°E transformed subtropical water spread farther north than usual. This situation was favorable for more intense northward migrations of sardine, mackerel and saury. However, the total area of the western cyclonic subarctic gyre waters has decreased. Extremely warm conditions offshore from Hokkaido and the relatively strong northeastward "third" Kuroshio branch or Isoguchi Jet played the negative role for saury fishing fleets of Russia. Fishing aggregations of saury were formed in the more distant areas from the coast. The dynamics of the environmental features indicate an intensification of variability (with a general increase in dispersion), accelerated warming, and an increase in the frequency of extreme events over the past 15 years. Such rapid and significant changes can have an adverse effect on these species.

SESSION 8: FUTURE/S-CCME/AP-ECOP Topic Session

How Can Ecosystem-Scale Information be Used to Improve Our Understanding of Climate Change Impacts, and Support Management and Conservation in the North Pacific?

Oral Presentations

S08, Invited, AbstractID=18532

Investigating the impacts of climate and fishing on fish populations and ecosystems in China's shelf seas using multiple models.

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The China's shelf seas, including the East China Sea, the Yellow Sea, and the Bohai Sea, are highly productive and support abundant fishery resources. However, many fish populations have declined severely with early maturation and miniaturization in size, and ecosystem functions have changed significantly due to multiple stressors, such as rising sea temperatures and overfishing. These changes pose significant challenges to the sustainable use of fishery resources and the conservation of biodiversity in China's seas.

A quantitative assessment of the effects of climate change and human activities on fish populations is fundamental to the implementation of ecosystem-based fisheries management. The impacts of climate change and fishing pressure vary greatly across different biological processes, including spawning, growth, early recruitment, species distribution and population dynamics. These changes also affect fish communities and entire ecosystems. Large fluctuations and high complexity in fish populations are caused by climate variability across multiple temporal and spatial scales. Furthermore, different fishing strategies (e.g. trawling and gillnetting) directly impact the dynamics of target species, amplifying the magnitude and complexity of climate-driven population changes.

To address these challenges, we have developed various models focusing on different processes, from early recruitment to the ecosystem level. These include a larval transport model, a species distribution model (SDM), an individual-based eco-genetic model (FIE model), and an ecosystem model (OSMOS). These models are used to investigate the effects of climate and fishing on fish populations and ecosystems at various scales. Our results provide mechanistic insights into population dynamics from multiple perspectives and propose region-specific fishing and management strategies for China's seas. This study offers a novel framework for climate-adaptive fisheries management and ecosystem-based approaches.

Key words: larvae transport model, specie, distribution model, ecological model, climate change, fishing induced evolution

S08, Invited, AbstractID=18788, (ECOP)

Climate change risks to marine ecosystems and fisheries: FishMIP insights for the North Pacific

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Climate change impacts on marine fisheries resources are changing the distribution and productivity of marine organisms around the globe. Knowledge and model projections to estimate fish biomass gains and losses are crucial for informing climate-resilient fisheries management and adaptation planning. The Fisheries and Marine Ecosystem Model Intercomparison Project (FishMIP) is a growing global network with currently over 150 marine ecosystem modelers, working in collaboration to understand and project changes under different climate and fishing scenarios. Now in its second decade, FishMIP developed a new simulation framework, FishMIP 2.0, to contribute to the third Inter-Sectoral Impact Model Intercomparison project (ISIMIP3). As a programme of the United Nations Ocean Decade, key objectives of FishMIP 2.0 include provision of accessible data tools for a wide range of stakeholders and for capacity building towards robust regional-scale ecosystem model ensembles. Highlighting our data tools for decision-makers and the general public, we focus on what our most recent projections to 2100 show for the North Pacific for exploitable fish biomass under low and high emissions scenarios, and their associated uncertainties. We show how our tools, directed at modelers, help address large uncertainties at regional scales by supporting the development and implementation of regional scale ecosystem model ensembles, including for the North Pacific. Our current and future internationally coordinated simulations integrate both climate and fishing drivers to 1) quantify model skill for detecting past ecosystem and fisheries changes and 2) assess future sustainability pathways under integrated climate and fisheries scenarios.

S08, Oral, AbstractID=18193, (ECOP)

Contrasting patterns and regulations of spawning behaviors under different management regimes of striped bass in the HRE ecosystem

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Spawning behaviors plasticity is critical for a population to buffer external perturbation. Reproductive resilience in marine fishes increases with increased diversity and decreased variability in spatiotemporal spawning behaviors. Using the ichthyoplankton data collected in the Hudson River Biological Monitoring Program (HRBMP), we evaluated the spawning behaviors diversity and variability of striped bass (*Morone saxatilis*) in the Hudson River estuary (HRE) ecosystem. From 1974 to 2014, the fisheries management in the HRE were divided into three different regimes based on the fisheries mortality: no management (1974-1984), strict management (1985-1995) and loose management (1995-2014). Our results showed that when fisheries management get involved, the spawning temporal diversity (STD), spawning temporal variability (STV) and spawning spatial variability (SSV) increased while spawning spatial diversity (SSD) showed no significant difference. Furthermore, these spawning behaviors indices were regulated by different driving factors (water temperature versus egg abundance) in different management regimes. During the regime 1and 2, they were mainly driven by abundance and temperature, separately. While during the regime 3, both of temperature and abundance were important. Our study demonstrates that fish spawning behaviors are influenced by both population dynamics and environmental factors and the regulation mechanism is not consistent under different management strategies.

S08, Oral, AbstractID=18315, (ECOP)

Risk and resilience: Assessing multi-species climate vulnerability in the Gulf of Alaska

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Understanding how economically and ecologically important species respond to changing climates is a critical first step in developing adaptive management strategies. Recently, marine heatwaves and other climate-induced changes have had considerable impacts on marine ecosystems and resource-dependent communities in the Gulf of Alaska (GOA). These impacts are expected to continue and intensify in the future, increasing the need for rapid evaluations of population- and community-level climate vulnerability in the region. Here, we applied semi-quantitative methods and an expert-opinion approach to conduct a trait-based climate vulnerability assessment for 60 economically-, recreationally-, and culturally-important marine species in the GOA. We define vulnerability as a function of biological sensitivity to their environment (e.g., a species' ability to move to new habitats or shift their diet) and exposure to changing conditions (e.g., temperature shifts, ocean acidification). We conducted comprehensive literature reviews to synthesize stock-specific responses to environmental characteristics and used regional ocean modeling system (ROMS) outputs to identify spatiotemporal variation in environmental conditions. We then used ROMS projections (to 2100) and species distribution maps to evaluate species' exposure to stressors as well as the inherent biological sensitivity of species to that same stressor. Here, we present our multi-stock vulnerability matrix for the region and evaluate sensitivity, exposure, and vulnerability across species, taxonomic groups, and the community. Results from this work inform past, present, and future resilience to climate change, which can be used to guide fishing portfolios, identify monitoring and research needs, and mitigate socioeconomic risks for resource-dependent communities in the GOA.

S08, Oral, AbstractID=18337, (ECOP)

Bridges and barriers to dynamic ocean management: Insights from scientific, fishing, and shipping vessel communities

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Dynamic ocean management (DOM) accounts for the shifting nature of the ocean and its users based on real-time biological, environmental, social or economic data. Unlike the use of static or time/area closures to prevent negative species interactions, DOM can support spatially and temporally flexible management strategies that offer more resilience in the face of changing ocean conditions, extensive species distributions, and fishing practices. DOM provides promising pathways for marine species conservation, yet previous DOM programs have had different levels of success depending on user engagement. Given the multi-dimensional challenges associated with this approach, a thorough understanding of factors that contribute to DOM's successes (bridges) and shortcomings (barriers) is required. Here, we document the bridges and barriers according to multiple perspectives, by utilizing a systematic review of scholarly literature (i.e., scientists and managers), combined with a quantitative survey distributed to user groups (i.e., fishing captains and crew, vessel owners and operators). From the scientific community, a majority of research papers attributed DOM's success to data availability (63%). However, survey respondents primarily attributed the approach's success to implementation considerations (76%). Both the scientific community and survey respondents attributed the biggest barriers to social factors (51% and 64%, respectively). Common themes in the literature were poor program implementation and cost, while misalignment among interest-holders was commonly cited by survey respondents. Identifying the needs and perspectives among interest-holders as they relate to DOM will be a pivotal step towards improving the overall efficacy and impact of adaptive approaches.

S08, Oral, AbstractID=18379, (ECOP)

Mechanism and evolution of regional endothermy in fishes

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The role of genetic and environmental regulation in biological development and evolution is a central topic in the fields of ecology and genetics. In marine ecosystems, temperature, as a critical ecological factor in climate change, significantly regulates the migration and distribution patterns of marine fish and profoundly influences the evolutionary potential of species. In-depth exploration of the endothermic tissues in fish and their genetic mechanisms for adapting to temperature changes is of great importance for understanding fish evolution, developmental regulation, and promoting species conservation efforts. This report summarizes the phylogenetic relationships and structural characteristics of endothermic tissues in regionally endothermic fish, elucidates the heat production methods and their mechanisms in these fish from molecular biological and physiological perspectives, and discusses the potential driving factors in the evolution of endothermy. It holds significant value for gaining a deeper understanding of the adaptive response processes and mechanisms of fish under climate change, as well as further advancing the knowledge of the convergent evolution of thermoregulation mechanisms in vertebrates.

S08, Oral, AbstractID=18381

Diel vertical movement patterns of blue sharks in the Northwest Pacific Ocean revealed by satellite tags

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Diel vertical movements (DVM) are a prevalent behavior observed across various marine taxa; however, the environmental factors influencing these behaviors in large pelagic sharks remain inadequately understood. This research involved the deployment of satellite tags on adult blue sharks (Prionace glauca) in the Northwest Pacific Ocean, successfully tracking 12 individuals (10 females and 2 males) over a cumulative total of 809 tracking days. The observed sharks displayed three distinct migratory patterns: northward movements towards the Kuroshio Extension (KE), residency near the Ogasawara Islands in the Philippine Sea, and southward migrations along the North Equatorial Current (NEC). Analysis of vertical movement patterns revealed three primary diel behaviors: (i) regular normal DVM (nDVM), characterized by a dawn descent and dusk ascent, with 5-40% of daytime spent below 200 meters; (ii) deep depth-oriented behavior, where more than 40% of daytime was spent below 200 meters; and (iii) surface-oriented behavior, with over 90% of both day and night spent above 200 meters. These behaviors exhibited distinct geographic distributions, with nDVM being more prevalent in colder, productive regions (NEC, KE, Ogasawara), while deep depth-oriented behavior was more common in warmer, oligotrophic waters that featured deeper chlorophyll a maxima. Surface-oriented behavior was generally associated with cold, productive waters. High-resolution archival data and Generalized Linear Mixed Model (GLMM) analyses indicated that the use of shallower depths during the daytime significantly increased with decreasing temperatures at 100 meters and with rising chlorophyll a maximum concentrations, which were often found at shallower depths in these areas. In summary, this study illustrates that the DVM patterns of blue sharks are significantly influenced by regional oceanographic characteristics, particularly vertical temperature profiles and primary productivity, thereby providing critical insights for the conservation and sustainable management of blue sharks in the Northwest Pacific.

S08, Oral, AbstractID=18397, (ECOP)

Identifying mesoscale fronts and their effects on fisheries under climate change

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Mesoscale fronts are highly energetic ocean processes that strongly influence local biogeochemical processes and have significant impacts on fisheries. Satellite-based front detection algorithms are fundamental tools for identifying the spatiotemporal patterns of frontal activity and investigating their impacts on marine ecosystems. This study developed an improved front detection algorithm that effectively addresses common issues such as undetected coastal fronts, discontinuities, and repeated detections of fronts, as validated by comprehensive assessments. Using this method, we generated an open-access, global, daily mesoscale front dataset spanning the past 40 years and found that persistent frontal occurrence and intensity have increased rapidly in subtropical regions (particularly around boundary currents and upwelling systems) and polar regions, while remaining stable or slightly declining in tropical regions. These trends may be attributed to changes in boundary currents, upwelling intensity, and sea ice retreat, respectively. By incorporating a mesoscale frontal index into a fish habitat model, we demonstrated that mesoscale fronts, rather than submesoscale features, play a significant role in determining the distribution of Pacific saury. Further analysis revealed that variations in front-related suitable habitat areas closely explain the fluctuations in saury abundance, particularly the sharp decline after 2010. The eastward shift of suitable habitat driven by mesoscale frontal changes may have contributed to reduced catch in Japanese waters by altering the saury' southern migration route. This study provides a valuable methodology for evaluating the ecological impacts of mesoscale fronts under climate change and offers new insights into physical-biological interactions shaping fish habitat variability in the ocean.

S08, Oral, AbstractID=18439

Significance of water properties for prediction of the Pacific saury occurrence in Russian catches

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The Pacific saury, *Cololabis saira,* was an important fish species in Russian fisheries. Its maximum catch by Russia exceeded 119 thousand tons in 2007, but then it decreased to 0 in 2022. Earlier, for 2004–2018, we used the absolute values and gradients of speed of passive particles, and Lagrangian indicators for encounter probability prediction in Random Forest (RF). Area Under the receiver operating characteristic Curve (AUC) reached 0.85 in it. This time, for a wider period of 1994–2021, we included new features to predict saury occurrence in RF: water temperature (wT) and salinity (Sal) at horizons #0, 1, 12, 17, 22, 25, 28 from the Global Ocean Physics Reanalysis (GLORYS12V1), Divergence (Div), Okubo–Weiss parameter (OW), Rotor (Rot), Sea Surface Height (SSH) in addition to Lagrangian indicators: Lyapunov exponent and particle path length. The new RF had higher AUC (0.97). The out-of-bag misclassification error rate was low (4.9%). The most significant loss of accuracy of classification (LAC) was observed during permutations of OW and Div. Coordinates, SSH, ordinal day in the year and distance to the shore formed the second block. The third block had a lower median LACs than the second block. It included Rot, and Lagrangian indicators. The fourth block started with wT at 0 horizon. It had lower LAC than 3 other mentioned blocks, but higher than wT and Sal at deeper horizons. All new features had LAC significantly higher than their permuted variants. Majority of spatial-temporal trends for high probability of saury occurrence became negative after 2015.

S08, Oral, AbstractID=18442, (ECOP)

The changing catch: Seasonal migrations and climate sensitivity of mahimahi in Hawai‘i’s fisheries

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Despite their major contribution to pelagic fisheries catch, mahimahi *(Coryphaena sp.)* are considered a “non-target” fishery species by industrial-scale fleets such as the Hawai‘i Longline Fishery, and thus have not been the focus of stock assessments or catch rate studies in the central North Pacific Ocean. However, mahimahi have long been an important food fish in Hawai‘i, acting as a stable source of catch for local troll fisheries and holding strong cultural ties to ancient fishing practices. To better understand spatial, temporal, and environmental trends in mahimahi catch rates around Hawai‘i, we explore patterns in the Hawai‘i commercial troll fishery alongside those of the North Pacific-wide shallow- and deep-set longline fisheries coupled with environmental conditions. The shallow-set longline fishery largely operates north of Hawai‘i around the North Pacific Transition Zone (summer), while the deep-set longline fishery spans much of the region to the south and north of Hawai‘i at different times of year. Within the troll fishery, we find that mahimahi catch rates show a strong spatial gradient, with higher CPUE occurring windward of the Main Hawaiian Islands. We identify a significant bimodal seasonal pattern in mahimahi CPUE and size during the spring and fall months, with fall CPUE increasing over the last three decades. We observe this bimodal seasonality to be present across all three fisheries, with slight shifts in the timing of seasonal CPUE peaks suggesting that mahimahi undergo annual meridional migrations across the central North Pacific Ocean, intersecting Hawai‘i as they move north and again as they move back south. The seasonal timing and catch rates of mahimahi are sensitive to temperature and chlorophyll concentration, properties expected to vary in response to climate-driven oceanographic changes. Our findings underscore the importance of recognizing mahimahi as a seasonally dynamic species that warrants greater attention in regional fisheries research and management. We highlight the urgent need to better understand mahimahi movements and catch rate patterns in the face of climate-driven oceanographic changes that may alter its availability to Hawai‘i’s fishing communities.

S08, Oral, AbstractID=18470, (ECOP)

Dynamic response of *Thichiurus japonicus* early growth to climate change and its management approach

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Largehead hairtail (*Trichiurus japonicus*), a commercially important fish in the China Seas, plays a pivotal role in the food webs during the juvenile stage as both predator and prey; concurrently, its early life stage represents the most critical period in its life history. Notably, the early growth of largehead hairtail is highly sensitive to environmental changes, thus serving as a key ecological indicator for assessing the impacts of climate change. However, the specific influence of climate-driven environmental fluctuations on early growth of this species remains unclear. In this study, we investigated the temporal-scale impacts of environmental changes on early growth of largehead hairtail. Our study revealed that there were pronounced interannual variations in the early growth of the population, which were significantly associated with environmental fluctuations. Notably, sea surface temperature was the dominant environmental driver, with warming exerting a significant negative effect on early growth, and increased mixed layer depth also negatively influenced growth. Furthermore, optimal environmental conditions in May triggered a phenological shift of the early growth peak from April to May post 2019. Early growth is a critical determinant for the successful stock recruitment, therefore, to achieve the sustainable development of fishery resources, it is recommended to implement Ecosystem-Based Fisheries Management (EBFM) measures, such as designating thermal refuge zones for early life stages. This study provides scientific basis for evaluating the impacts of climate change on early growth and offers theoretical support for designing adaptive management strategies for this species.

S08, Oral, AbstractID=18481, (ECOP)

Disentangling the roles of climate and fishing in the Newfoundland and Labrador cod collapse

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The Newfoundland & Labrador Shelf and the Grand Banks are one of the most historically productive fishing grounds in the world, supporting key groundfish species such as Atlantic Cod (Gadus morhua). In the early 1990s, the ecosystem experienced a dramatic collapse of capelin and groundfish such as cod. Despite decades of moratoria and management efforts, cod biomass has not returned to historical levels. Growing evidence suggests that climate variability and long-term oceanographic change have fundamentally altered ecosystem structure, function, and productivity. Here, we investigate the ecological mechanisms limiting cod recovery by developing a novel EcoState framework that integrates ecosystem structural states with species-specific physiological responses to climate drivers. Using long-term trawl survey data, Ecopath models, and environmental time series, we calibrated models to recreate collapses and the observed ecosystem response We identified the ecological and climate factors that hindered cod recovery. Our findings aim to inform adaptive, ecosystem-based management strategies for fisheries in dynamic ecosystems under climate change, with broader implications for global fisheries sustainability.

S08, Oral, AbstractID=18495, (ECOP)

Size-specific winter distribution changes of large yellow croaker (*Larimichthys crocea*) in the East China Sea

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The large yellow croaker (*Larimichthys crocea*), historically a vital commercial species in the East China Sea, has experienced severe declines due to overfishing. Current protective measures during overwintering habitat remain insufficient, and both juveniles and adults continue to be heavily targeted. Previous surveys revealed size-specific overwintering habitat preferences, with small individuals occupying coastal waters and larger individuals favoring offshore regions. However, due to the stock enhancement programs (SEP) and climate changes, the distribution patterns of large and small individuals may be altered.

This study used maximum entropy method (MaxEnt) and generalized linear model (GLM) from the Biomod2 package, as well as three bias corrected environments from the sixth phase of the Coupled Model Intercomparison Project (CMIP6) climate models and historical (1971–1982) and current (2005–2024) occurrence data, to create an ensemble species distribution model. The ensemble model was also used to project potential shifts in overwintering habitats due to the environmental change by switching the historical and current environments.

Results showed that historically, temperature and chlorophyll significantly influenced the distribution of large individuals. The projection by switching to the current environments indicated minimal shifts in habitat suitability, with slight northward hotspot centroid movements (33.3 km). On the contrary, temperature emerged as a dominant factor for current occurrence data, yet actual centroid shifts were notably larger (119.8 km northwestward), suggesting factors such as prey availability might potentially drive distribution toward colder regions.

For small individuals, historical analyses identified chlorophyll as key factors, potentially linked to copepod prey availability, followed by depth. Historically, suitable habitats were formed not only along the Fujian-Zhejiang coast but also near southern Korea and Jeju Island, partially overlapping with hotspot of large individuals, indicating there was no geographical isolation although there were size-specific distribution preferences. Current environmental analyses indicated the increased influences of depth and salinity, reflecting preferences for shallow and low-salinity coastal areas. Centroid shifts were substantial (178.3 km southwestward), reducing overlap with large fish.

In conclusion, current small individuals show altered habitat preferences possibly due to the influence of SEP, whereas large individuals exhibit distributional shifts possibly driven by prey

availability. This study highlights climate change and stocking impacts, informing targeted habitat management for the *L. crocea*.

S08, Oral, AbstractID=18499, (ECOP)

Projecting the poleward habitat expansion of whale sharks (*Rhincodon typus*) in the West Pacific and the East Indian Ocean in response to climate change

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Climate change is fundamentally reshaping the distribution of highly migratory marine megafauna, including the endangered whale shark (Rhincodon typus). Using high-performing species distribution models (SDMs) developed with H2O AutoML and CMIP6-based climate projections, we examined both historical (2004–2023) and future (2050s–2090s) habitat suitability across the Western Pacific and Eastern Indian Ocean. Presence records from OBIS, GBIF, and verified sightings in Korean waters were combined with environmental drivers including SST and chlorophyll-a. SHAP analyses revealed region-specific influences of environmental variables, with SST dominating habitat suitability in newly emerging northern habitats, while productivity (Chl-a) remained critical in traditional aggregation sites like the Philippines and Ningaloo Reef. Model projections indicate significant habitat contraction in equatorial waters and concurrent poleward expansions, with suitable habitats extending beyond 47°N under current conditions and up to nearly 50°N by the 2090s under high-emission scenarios. Notably, Korean waters, historically outside the known aggregation range are projected to become seasonally suitable habitats, suggesting emerging ecological roles in the Northwestern Pacific. This work demonstrates how ecosystem-scale modelling can inform adaptive, region-specific conservation strategies for transboundary species. The whale shark's wide-ranging movements across multiple jurisdictions underscore the need for coordinated international monitoring, data sharing, and climate-resilient management approaches. Our results contribute to the broader dialogue on integrating climate-impact science into ecosystem-based decision making across the North Pacific.

S08, Oral, AbstractID=18510

Promise or peril in a warming ocean? An emergent migratory pathway leads North Pacific loggerhead sea turtles *(Caretta caretta)* into the Northern California Current System

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In recent decades, the eastern North Pacific Ocean (ENP) has experienced significant climate-induced variability, characterized by rising sea surface temperatures (SSTs), a northward expansion of the North Pacific Transition Zone (NPTZ), and increasingly frequent marine heatwave events. The juvenile North Pacific loggerhead sea turtle (*Caretta caretta*), a highly mobile and environmentally sensitive species, has emerged as a sentinel of change within the region. Despite an extensive satellite tracking data set (n=307 individuals) spanning almost three decades (1997-2025), no loggerheads have been observed entering the colder, nutrient-rich waters of the northern California Current System (CCS). However, telemetry data have shown that loggerheads have gradually shifted northward as the NPTZ becomes more oligotrophic. In 2024, four out of 28 individuals deviated from previously documented migratory routes and entered the northern CCS. To explore the physical mechanisms that enabled these novel movements, we integrated monthly and daily SST and surface current conditions experienced by these individuals and compared them to historical records within the region. In September and October 2024, four turtles reached 45°N latitude, where they encountered the eastward-flowing North Pacific Current (NPC). Together with a northward-shifted 18°C isotherm, which the species commonly tracks, these conditions provided a transient migratory corridor into the northern CCS. While three of these individuals benefited from enhanced forage habitat in the CCS, one likely suffered cold-stunning upon entry into suboptimal waters. The remaining turtles from 2024 did not reach the NPC and moved southward within the subtropical gyre. Our study presents the first observed evidence of juvenile North Pacific loggerhead sea turtles entering the northern CCS through a previously undocumented migratory route, aided by a warming ocean and the northward shift in loggerhead habitat. These findings expand upon the conceptual framework of the 'thermal corridor hypothesis', by which sea turtles opportunistically exploit anomalously warm conditions to access forage habitats, and highlight the role of additional environmental

drivers such as advective current systems in facilitating such movements. As climate variability continues to restructure the oceanographic conditions within the region, such pathways may become increasingly common, with significant implications for conservation planning and fisheries management.

S08, Oral, AbstractID=18579, (ECOP)

Life history traits and bioenergetic trade-offs of key commercial species in the East China Sea under climate change

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Climate change is a critical driver of marine ecosystem dynamics, influencing fish populations through alterations in life history strategies and physiology, ultimately affecting marine organisms, population and trophic web structure. Traditional fisheries ecosystem models often overlook climate-mediated effects. On the contrary, the individual-based marine ecosystem model Osmose (Object-oriented Simulator of Marine Ecosystems) can fill up this gap by incorporating a bioenergetic module that explicitly represents the metabolic responses to environmental variables such as temperature (SST) and dissolved oxygen (DO). In this study, we developed Bioen-Osmose-ECS, a multi-species model for the East China Sea—a region with high climatic variability and essential habitats for commercial fish species. The model incorporates 16 fish species, categorized into three functional groups (pelagic, demersal, and invertebrates). This model allows to quantify climate-driven impacts in fished ecosystems under climate change scenarios using three Shared Socioeconomic Pathway (SSP) scenarios (SSP1-2.6, SSP2-4.5, SSP5-8.5). We explore climate change scenarios outputs using population-level ecological indicators, measures of change in energy allocation strategies and in thermal performance across ontogenetic stages. We anticipate divergent growth, maturation and reproduction patterns among functional groups under different SSP scenarios, which will impact population dynamics and reveal future winners and losers in the warming East China Sea. Using Bioen-Osmose-ECS to identify the climate-vulnerable species, we can draw more attention to these species and better inform ecosystem-based fisheries management (EBFM) strategies for the East China Sea.

S08, Pre-Recorded-Oral, AbstractID=18718, (ECOP)

Forging the trident: Modelling open subarctic Pacific ecosystems in three currencies

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The open subarctic Pacific Ocean extends over nearly six million km^2, from Asia to North America and from 45ºN to the Aleutian Islands. It provides the primary feeding ground for Pacific salmon (*Oncorhynchus* spp.). The pelagic phase of their life cycles is crucial to the growth and survival of these species, which are ecologically, economically, and culturally vital to North Pacific countries. This paper details the use of novel Ecopath with Ecosim models balanced in three currencies (biomass, t/km^2; energy, J/m^2; and iron, mg Fe/m^2) to investigate open subarctic Pacific ecosystem structure and dynamics and the importance of pelagic feeding, competition, and predation in salmon life cycles. Firstly, existing models of the eastern and western subarctic Pacific ecosystems (i.e. PICES areas ESA and WSA) were newly parameterized with improved data and fitted to time series to provide platforms for static network analysis and dynamic simulations. Secondly, biomass was converted to energy and diet compositions rescaled using published biomass energy content estimates (kJ/g), yielding energy-balanced models accounting for differences in energy content among salmon prey and their impacts on predator-prey interactions. Thirdly, published iron content estimates (kg/t) were employed, using the same method, to yield iron-balanced models designed to investigate ecological iron cycling and its contribution to meeting the iron demands of primary and ecosystem productivity, including salmon. Finally, ongoing developments include thermal niche parameterization permitting simulation of marine heatwave and climate change impacts and habitat capacity maps facilitating spatially explicit simulations of pelagic ecosystem dynamics.

SESSION 8: FUTURE/S-CCME/AP-ECOP Topic Session

How Can Ecosystem-Scale Information be Used to Improve Our Understanding of Climate Change Impacts, and Support Management and Conservation in the North Pacific?

Poster Presentations

S08, Poster, AbstractID=18440, PosterID: S08-P1

Species distribution modeling: the importance of zero caches in fishery for the chub mackerel (*Scomber japonicus*)

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Catches of the chub mackerel, *Scomber japonicus*, by Russian fleet for the last 10 years sharply increased to a maximum of 98,812 mt in 2018 but then declined to 7,233 mt in 2024. Different Species Distribution Models (SDMs) showed very poor performances in the Russian studies, when SDMs were tuned using pseudo absence information. The Area Under the receiver operating characteristic Curve (AUC) was 0.69, on average, growing up to 0.75 during the period of high catches in 2020. Replacement of pseudo absence places with real absence of chub mackerel in catches during midwater trawl surveys in Russian national waters and in High Seas increased AUC of SDM up to 0.99 for the period when accurate information on each commercial operation was available (between February 2021 and May 2023). Misclassification error rate of occurrence and absence probability were very low, of 4.2% and 4.1%, respectively. The most important predictor was water temperature at ~1.5 m depth from the Global Ocean Physics Reanalysis (GLORYS12V1) followed by the Sea surface temperature and salinity. Lagrangian indicators: Lyapunov exponent and particle path length had lower effect on the accuracy loss than predictors related to productivity, such as Net primary production of biomass expressed as the amount of carbon per unit volume, Mass concentration of chlorophyll *a*, Mole concentration of silicate, Mole concentration of nitrate, Mole concentration of phosphate, but appeared higher than other speed based predictors, such as vertical component of velocity, Divergence, Okubo–Weiss parameter, and Rotor. Nevertheless, all predictors were statistically significant. We need an external validation of our SDM to test its performance in areas where chub mackerel catches are high, and where Russian fleet operates occasionally. This step is impossible without merging Russian data with data on chub mackerel catch by China and Japan. That is where PICES is a good place for collaboration.

S08, Poster, AbstractID=18567, PosterID: S08-P2

Abundance indices of the chub mackerel (*Scomber japonicus*) in the EEZ of the Russian Federation

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Presented by Igor Chernienko on behalf of Vladimir Kulik

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Chub mackerel is one of the most significant fisheries species in the northwest Pacific Ocean (FAO statistical area 61). Chub mackerel is a transboundary species and is caught by Japan, Russia and China. Until recently, Russia has not conducted specialized chub mackerel fishing in the NWPO. Russian fisheries resumed fishing in 2015. In recent years, there has been a consistent decline in Russian catches. If in 2018 the Russian catch was 98812 tons, then in 2024 it was 7200 tons. In all areas of habitat, chub mackerel are characterized by long migrations, allowing each population to develop a vast range in different seasons of the year, using favorable habitats (primarily food areas), which determines the transboundary status. Temperature is the most important factor affecting the CPUE. Specific catches also depend on production factors, such as the type of vessels, the period of stay in the fishery, etc. These factors were used to model the spatio-temporal distribution of chub mackerel catches in the Russian EEZ. A generalized additive mixed-effects model (GAMM) with Gaussian Markov random fields (GMRF) was used with the sdmTMB package. This method takes into account spatiotemporal autocorrelation and allows assessing the influence of unaccounted environmental factors. The model also included the day of the year, engine power and sea surface temperature. Standardization of chub mackerel abundance indices in Russian waters (catch ton per vessel-day) was performed. It was shown that the standardized catch per effort decreased from 44.11 ton per vessel-day in 2016 to 19.67 11 ton per vessel-day in 2024.

SESSION 9: MEQ/TCODE Topic Session

Marine Plastic and Microplastic Pollution in the North Pacific

Oral Presentations

S09, Invited, AbstractID=18492

Long-term changes in the of large and small microplastic in western North Pacific

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This study presents an extensive long-term empirical dataset on floating marine plastic debris collected around Japan from 1949 to 2020. This covers the early stages of plastic pollution up to the present day. The abundance of large plastic debris (>450 μm) can be divided into three phases: 1) a period of increase (0–10^4 pieces/km^2) from the 1950s to the 1970s; 2) a stagnation period, with high abundance (10^4–10^5 pieces/km^2), from the 1980s to the early 2010s; and 3) a period of re-increase (>10^5 pieces/km^2), from the mid-2010s to the present. The shift from film to fragmented plastic in the 1980s, coupled with the continuous downsizing may have caused the expansion of the polluted offshore area, resulting in the stagnation period by enhancing the removal process through aggregation with phytoplankton. While the continuous size reduction may have facilitated the removal of plastic debris from the surface layer, causing the stagnation period to last 35 years, the recent increase in microplastics suggests that plastic discharge is outpacing its removal possibly due to the global increase in plastic use and climate change, which lower the primary productivity. The abundance of small microplastics (10–300 μm) estimated from the analysis of salp (gelatinous zooplankton) gut contents also increased between 1951 and 2020. However, the pattern of increase differed from that of larger plastic debris collected by a plankton net. This suggests that the dynamics of small microplastics are much more complicated.

S09, Oral, AbstractID=18159

Seafloor litter pollution in Japan and South Korea detected by a citizen science initiative

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Identifying the composition and source of marine debris, quantifying it and improving scientific data collection represent fundamental steps in improving the development of solutions on a global scale to tackle marine pollution. To this aim, citizen science initiatives represent time-efficient, cost-effective and valuable tools. This study assesses and characterises marine seafloor litter collected in Japan and South Korea by volunteer scuba divers through Dive Against Debris®, a worldwide citizen-science program carried out by PADI Aware Foundation. From 2011 to 2024, 663 dives were carried out in Japan and South Korea, collecting data on quantity, typology and distribution of benthic litter. The average litter density was 54.83 items/100 m^2, and plastics represented 60% of the total abundance, followed by metal at 22% and cloth/textile at 9%. Single Use Plastics constituted 17%, whereas lost fishing gear accounted for 26% of the total litter. The top ten marine litter items identified in the dataset contributed to 61% of the total litter abundance, with plastic fragments as the most abundant items (22%), followed by fishing sinkers/lures/hooks (11%) and fishing lines (6%). The data obtained by citizen science initiatives are essential for guiding the development of policies and legislation aimed at reducing the flux of debris into the ocean. At the same time, they represent powerful tools to increase civic awareness.

S09, Oral, AbstractID=18177, (ECOP)

The necessity of power analysis to effectively monitor microplastics contamination in fish

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Microplastics, known to be pervasive throughout the world's oceans, are a diverse group of contaminants with a broad range of effects in marine environments which we are only just beginning to understand. Relatively little is known about interactions between microplastics and fish, necessitating monitoring programs to understand these relationships as well as how trends of microplastic contamination in fish may change over time, across regions, and between species. The majority of current monitoring efforts consist of small sample sizes but do not include analysis of statistical power, leaving knowledge gaps regarding how much change in microplastic contamination of fish we are able to accurately detect. We conducted power analysis on 27 fish species examined for microplastic ingestion in the North Pacific, the Arctic, the Atlantic, and the Great Lakes in Southern Canada to establish sample sizes required to detect annual changes in microplastic contamination ranging from a 5% change to a 50% change at increasing intervals of 5%. Results thus far reveal there is no "one size fits all" sample size that can be applied as standard across species or regions to effectively monitor trends in microplastic contamination of fish, nor is it possible to attain suitable sample sizes for monitoring by scientific sampling alone. To truly understand trends in microplastic contamination of fish, sample size must be targeted to the species and location of interest, partnerships with fisheries should be used to obtain adequate sample sizes without increasing pressure on populations through additional sampling, and power analysis must become standard practice in monitoring programs.

S09, Oral, AbstractID=18180

Plastic pollution monitoring in coastal environments in northern and western Canada

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Understanding plastic pollution patterns in the environment across large scales is an important part of understanding the transmission, effects and fate of this pollution under real world conditions. Both the Arctic and the North Pacific region are large geographic regions where coordinated monitoring recommendations have been developed by regional expert groups. We present both litter and microplastics data from the Canadian Arctic and the North Pacific that has been collected by Canadian teams that aim to 1) focus on priority monitoring compartments (e.g. water, shorelines, birds), and 2) target data poor zones within these regions. We examine spatial patterns within the larger global context of available data, including the polymer and source sectors that are most associated with the plastics that are found within the datasets. This data will also be discussed in relation to how it will

S09, Oral, AbstractID=18382, (ECOP)

The crucial role of rainfall in microplastic transfer from terrestrial to marine environments

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Although rainfall can play a significant role in transporting microplastics to the sea, its impact has been overlooked in the measurement and modeling of microplastic input through waterways. This study aimed to quantify and characterize microplastics entering a coastal bay via streams, with a particular focus on the influence of rainfall-induced stormwater runoff discharge. To achieve this objective, we investigated the emission characteristics of microplastics into Masan Bay via the Samhochoen, an urban creek discharging into the bay, during two rainfall events using time-weighted sampling. The event mean concentrations (EMCs) microplastics ranged from 29.9 to 44.7 n/L. The abundance of microplastics generally peaked in the early stage of runoff and varied according to rainfall intensity during each rainfall event. Polypropylene and polyethylene were found as major polymers accounting for around 60% of total microplastics. Fragments were the dominant shape, and the most common size class was less than 200 μm. The total microplastic load emitted from an urban stream during a rainfall event was estimated to be between 3.75×10^{8} and 3.62×10^{10} particles. The load of microplastics was heavily affected by the total rainfall depth, and most microplastics were transported in the early stage of runoff. In our previous study, the annual microplastic load from creeks, based solely dry weather data, was estimated at 328 billion particles. This represented 22% of the total microplastic input into Masan Bay, while wastewater treatment plant (WWTP) effluent and atmospheric deposition accounted for 32% and 46%, respectively. However, in present study based on rainfall-event data, the annual load via creeks increased approximately 14-fold to 4.72 trillion particles. This led to a substantial increase in the contribution of creeks to 81% of the total microplastic input, whereas atmospheric deposition and WWTP effluent contributed only 11% and 8%, respectively. These findings suggest that rainfall-driven stormwater runoff discharge is a major contributor to microplastic transport from land to sea. Therefore, rainfall-induced runoff should be considered a critical factor when monitoring or modeling microplastic input through riverine pathways.

S09, Oral, AbstractID=18433

Dancing with the eddies: Microplastics in the northwestern Pacific Ocean

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Despite growing concern over marine microplastic pollution, the mechanistic understanding of how physical oceanographic dynamics govern their three-dimensional distribution in the ocean remains critically limited. Here, we show that mesoscale eddies, including anticyclonic (warm) and cyclonic (cold) eddies, affect the abundance and characteristics of seawater microplastics in the Northwestern Pacific Ocean. Warm eddies tend to trap larger quantities of microplastics, with their influence extending to depths of 600 m. Sea level anomalies (SLA) emerged as the dominant driver of this phenomenon. Higher positive SLA values are associated with greater diversity in microplastic characteristics. However, seawater microplastics ultimately sink into the deeper layers of the ocean regardless of eddy type. Therefore, our study reveals the close relationship between the three-dimensional distribution of microplastics and mesoscale eddies, enhancing our understanding of the fate and transport dynamics of oceanic microplastics.

S09, Oral, AbstractID=18446

Vertical flux of microplastics in the deep Sea within the Kuroshio Extension Recirculation Gyre

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The Kuroshio Extension recirculation gyre in the western North Pacific is an accumulation site of plastic litter transported by the Kuroshio Current. A sediment trap was moored at a depth of 4900 m at Station KEO within the Kuroshio Extension recirculation gyre, and the vertical flux of microplastics in sinking particles of size <1 mm was observed. Forty-one sediment-trap samples collected from July 1, 2014, to October 2, 2016, were analyzed with a micro-Fourier transform infrared spectrometer and microplastics were detected in all samples. Seventeen polymer types were identified, and 90% of the microplastics were less than 100 μm in size. Microplastic sinking was driven by the action of the biological pump, which was in turn driven by seasonal variations in solar radiation and increased surface primary production typical of the spring season. Microplastic mass flux varied from 4.5×10^{-3} to 0.38 mg m^{-2} day^{-1} during the sampling period, with a mean and standard deviation of 0.054 ± 0.075 mg m^{-2} day^{-1}. Extrapolating the annual microplastic mass flux at Station KEO to the entire Kuroshio Extension recirculation gyre, it is estimated that 0.028 million metric tons of microplastics are transported annually to 4900 m depth in this area.

S09, Oral, AbstractID=18465, (ECOP)

Fragmentation of nano- and microplastics from conventional and biodegradable plastics by photooxidation in water

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The production mechanisms of secondary nanoplastic (NP) and microplastic (MP), and changes in the surface properties during the weathering process have been actively studied in recent years. However, compared to parent plastics, information on these fragmented particles remains relatively scarce, particularly regarding particle quantification. This study investigated the changes in surface characteristics of five conventional thermoplastics and biodegradable plastic after photooxidation in water, as well as quantified the generated NPs and MPs and calculated their generation rates. The photooxidation was carried out using a xenon-arc lamp with a daylight filter to simulate natural sunlight (acceleration factor = 5.5). The weathering under the same conditions enabled a direct comparison between plastics.

PA showed the earliest surface cracking, followed by PET, PP and PS, while HDPE did not exhibit any surface cracks even after 176 days of photooxidation. PLA showed fine surface pits after 132 days and swelling after 300 days. The carbonyl index (CI) of HDPE and PET showed gradually increase with increasing exposure duration. Conversely, the CI of PP, PS, and PA initially increased, but then tends to decrease or fluctuate. This fluctuation is likely due to the exposure of unoxidized inner layers after the degradation of weathered surface. The fragmentation rates (particles/cm^2) of NPs and MPs by photooxidation within five years and subsequent mechanical abrasion (MA) were calculated using a quadratic function. Under photooxidation alone, the order was PET > PS > HDPE > PA > PLA, and with additional MA, PET > PS > PP > PA > PLA.

These fragmentation rates provide valuable data for developing plastic pollution management. For instance, fragmentation potential can be considered when selecting materials for outdoor plastic structures, and can also contribute to determining optimal removal intervals for plastic litter exposed in outdoor environments. Moreover, these data can be used as essential parameters for developing plastic weathering or fragmentation models.

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Microplastic contamination across trophic levels: Insights from benthic ecosystems and large marine animals

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Microplastics (MPs; <5 mm) are ubiquitous pollutants in the ocean and nearby coastal waters, posing increasing ecological risks to marine organisms. However, comprehensive assessments across trophic levels remain limited. In this study, we investigated MP bioaccumulation and trophic transfer in benthic ecosystems, as well as large marine animals including cetaceans and sea turtles. First, we assessed MP contamination in a hydrothermal vent ecosystem (Indian Ocean) and a tidal flat ecosystem (Yellow Sea) which have contrasting food web structures. Our results revealed bioaccumulation and trophic transfer of MPs from lower to higher trophic level invertebrates in both ecosystems. Second, we conducted necropsies of 5 species of large marine animals stranded along the Korean coast to determine the extent of MP contamination in top predators. MPs were detected in all large marine animals examined. We categorized cetaceans based on their feeding types and compared their MP ingestion. Filter-feeding cetaceans showed higher MP burdens than pelagic and benthic predators. In benthic feeding finless porpoises, a significant correlation between MP ingestion and BPA levels in blubber suggests that MPs may serve as chemical vectors. Surprisingly, MPs found in the lung tissues had a higher proportion of polymers with greater hazard index scores than those in stomach contents, implying a greater risk from airborne sources. Ultimately, this research contributes to the goals of the UN Ocean Decade by providing scientific evidence to improve understanding of MP pollution in marine ecosystems.

S09, Oral, AbstractID=18515

The reliability of methods and environmental implications of test materials in microplastic and nanoplastic study

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Currently, microplastics and nanoplastics (MNPs) have become a global issue and hot topic in environmental research. To be frank, there are still a series of questions to be answered, and more research is highly needed in this field. However, we should be cautious of the reliability of methods used in field investigation and the environmental implications of materials used in the tests of MNP studies. For example, the reliability of methods includes an adequate amount of samples, replicates, and identification of polymer composition as well as QC/QA process in field investigations. Simulated experiments are usually conducted in the laboratory, and pristine spherical polystyrene beads are widely used as the test materials. Microbeads can only stand for one of the primary MNPs but not all of the environmental MNPs. To make the study have environmental implications, the researchers need to consider environmentally relevant MNPs under environmental conditions.

S09, Oral, AbstractID=18588 CANCELLED

Uptake, elimination, and effects of micro- and nanoplastics in vertebrates

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Micro and nanoplastics (MNPs) as emerging contaminants have become a global environmental issue due to their small size and high bioavailability. However, there are still knowledge gaps regarding the processes of microplastic uptake and elimination by aquatic organisms. Herein we investigated the short-term and long-term uptake, elimination and effects of exposure to MNPs on the freshwater snail, *Biomphalaria glabrata* and brine shrimp, *Artemia parthenogenetica*. We found fast uptake in short-term and long-term in *B. glabrata* and irregular fragments were more easily ingested and egested compared to spheres. The mean size of the fragments in *B. glabrata* tissues after 48-h exposure was significantly larger than that of the standard sample, suggesting that aggregation in the gut may occur. Floating faeces containing microbeads were observed in the long-term exposure which could alter the fate, behavior and bioavailability of egested microbeads. Moreover, when exposed to a low food level, a U shape trend was observed for the three measured effects (survival rate, body length, and instar) in the brine shrimp. Significant interactions between food level and exposure concentration were found for all three measured effects. Our results demonstrate the long-term risks posed by MNPs especially when zooplankton have low levels of food intake.

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Zoop to poop and sediment scoops: Microparticles in the gray whale food web in the North Pacific

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Mysid shrimp are an important prey item in many marine food webs, including those containing predators such as salmonids and Pacific gray whales. Gray whales are ecosystem engineers requiring up to 75 million zooplankton, including mysid shrimp (*Holmesimysis sculpta*), daily. Gray whales, recently found to have reduced overall size compared to historic measurements, and mysid shrimp are subject to multiple stressors including climate change and pollution. Field measurements from *H.sculpta* and gray whale scat indicate consumption of up to 21 million microparticles (primarily microfibers) from prey and potential additional microplastic sources due to their benthic feeding behavior. Sediment was recently collected from gray whale foraging grounds for microplastic analysis and will highlight mysids' susceptibility to microplastic pollution. After a 14-day exposure to a weathered treated blend of cotton, spandex, and polyester, laboratory mysids, *Americamysis bahia* showed hypoactivity as a response to a stimulus. Field-collected *H. sculpta* were shown to 48h ingest similarly weathered polyester after just 48 hours of exposure. Future research will investigate longer exposures, textiles from across manufacturing stages (from greige (untreated) to fully chemically treated), and climate conditions. *A. bahia* and *H. sculpta* will be exposed to estuarine acidification or increased ocean temperatures, respectively, with treated or untreated weathered microfibers. Analyses of behavior, growth, reactive oxygen species, and caloric value will explore physiological responses to these stressors. Changes in the quantity and quality of these prey items due to climate change and microplastics may have substantial individual and population-level impacts on this North Pacific food web.

S09, Oral, AbstractID=18608

It's time for science-based recommendations to be used to inform action on plastic chemicals in the global treaty

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The unparalleled rise in global plastic production has resulted in widespread pollution and exposure of wildlife to thousands of hazardous chemicals, including marine organisms. Many of the chemicals used across the plastics life cycle meet criteria for persistence, bioaccumulation, mobility, and toxicity, characteristics that are used globally to designate chemicals of concern. The majority remain unregulated under existing multilateral environmental agreements, warranting further action. In response, the United Nations Environment Assembly (UNEA) has mandated the development of an international legally binding instrument to end plastic pollution, for which negotiations began in 2022 and continue with the next meeting set for August 2025 in Geneva. Although current treaty negotiations have begun addressing a short list of plastic chemicals and also touch on microplastics, significant gaps remain. These gaps include a comprehensive perspective on the diversity of plastic chemicals and their related mixture effects, insufficient regulatory mechanisms, lack of transparency and industrial accountability, and reliance on ineffective recycling strategies that reintroduce toxic substances into the environment. While regulatory gaps persist, the presence of harmful chemicals in plastics contributes to major environmental burdens, with a high impact to marine ecosystems. We therefore recommend six critical components for the treaty to effectively reduce the impacts of plastic chemicals: (1) reduction and simplification of polymers and chemicals, (2) safer and sustainable design of plastic chemicals, (3) incentives for change, (4) holistic (full-life-cycle, from extraction to reuse) approaches for alternatives, (5) just and equitable interventions, (6) centering human rights. Regulations of groups of harmful chemicals in plastics (e.g. all bisphenols) should replace individual chemical approaches (e.g. bisphenol A) to prevent regrettable substitutions. Lastly, binding, global obligations, rather than fragmented or voluntary measures, are vital for chemical safety, circularity, and accountability across the plastics life cycle. A strong, effective treaty is a critical opportunity to achieve a safer, more sustainable future for planetary health.

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Ocean acidification drives divergence in microbial assembly and function on macroplastics in contrasting marine environments

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The long-term persistence of macroplastic debris has introduced novel microbial habitats in marine ecosystems. To assess how ocean acidification (OA) influences plastisphere development, we deployed identical plastic substrates (bottles and nets) in two contrasting sites in Taiwan: a naturally acidified shallow water hydrothermal vent and a temperate, non-acidified coastal bay. Microbial biofilms were sampled at 1 hour, Day 8, and Day 16, and analyzed using full-length 16S rRNA gene sequencing via Oxford Nanopore technology. Results showed distinct taxonomic and functional profiles between sites. The acidified vent site was enriched with sulfur-oxidizing and nitrate-reducing microbes, while the neutral-pH coastal site favoured aerobic heterotrophs. Co-occurrence network analysis revealed higher microbial connectivity and niche specialization under acidified conditions. Sloan neutral model fitting indicated deterministic assembly under OA, shifting to stochasticity in the coastal bay. Functional predictions confirmed prolonged sulfur-driven metabolism in the vent and rapid carbon degradation in the bay. This study demonstrates that ocean acidification significantly alters microbial colonization, community assembly, and functional potential on marine plastics.

Keywords; Plastisphere, Ocean acidification, Shallowater hydrothermal vent, Microbiome.

S09, Oral, AbstractID=18624

Considerations for reducing human exposure to microplastics from consumption of fish

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As global plastic waste production continues to rise significantly in the coming decades, microplastics (MPs) remain one of the most challenging pollutants in environmental contamination worldwide. MPs are widely distributed in the ocean and can be ingested by fish. Despite fish being a major source of aquatic protein for humans, no study has yet addressed how to reduce the risk of human exposure to MPs when consuming fish. This study investigated 1,075 fish from 37 species across representative fishing areas, analyzing MP presence in various tissues, including gills, intestines, and muscles, to assess fish food safety comprehensively. MPs (particles > 20 μm in size) were detected in 36.28% of gills and 39.63% of guts, but were not found in muscle tissues. Fish from upper layers had higher MP abundances and smaller average sizes compared to those from deeper waters. A significant negative correlation was observed between the MP abundance in fish and their length and weight. The global per capita MP consumption from captured fish, including all tissues and muscles, is approximately 5.60×10^4 items/year. To minimize MP exposure, humans should prioritize consuming only fish muscle and selecting fish from deeper waters and larger sizes whenever possible. Optimizing fish consumption patterns could reduce human exposure to MPs and associated health risks.

S09, Oral, AbstractID=18696

Sources of marine debris in Hawai‘i

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Floating plastic marine debris from the North Pacific Garbage Patch significantly impacts the Hawaiian Islands, with an estimated 80% originating from derelict fishing gear. Much of this material is unfamiliar locally, indicating distant sources. To support targeted international mitigation strategies, the Center for Marine Debris Research analyzed 90 metric tons of debris collected across the Hawaiian Archipelago between 2019 and 2024. Over 13,300 individual samples so far have been sorted, weighed, photographed, and forensically characterized by gear type, morphology, and polymer composition using ATR-FTIR and, occasionally, DSC.

Source attribution used a weight-of-evidence approach involving expert interviews, gear markings, polymer types, catalog comparisons, marine debris guides, and Google Street View imagery from ports across the Pacific. The most dominant and high-certainty source was identified as small-mesh, thin-twine, high-density polyethylene netting from nearshore Asian trawl fisheries. Twisted and braided lines were also prevalent, though their sources were often uncertain. Additional identified sources included drifting fish aggregating devices from tropical tuna purse seine fisheries, and Asian-origin gillnets, eel traps, and oyster spacers.

A 2024 focused analysis on fishing floats confirmed trawl floats, particularly black ones common in Asian ports, as the most frequent. Longline, gillnet, purse seine, and aquaculture floats were also found. Rigid plastic crates, trays, jugs, and buckets—frequently labeled in Asian languages—likely originate from seafood supply chains and may fragment into microplastics impacting Hawaiian shores.

These findings underscore the urgent need for international cooperation to prevent fishing gear loss, support ongoing removal efforts, and reduce future marine debris inputs.

S09, Oral, AbstractID=18700, (ECOP)

Hawai‘i’s ALDFG Bounty Program: Harnessing partnerships to prevent, monitor, and remove marine debris for recycling

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Abandoned, lost, and discarded fishing gear (ALDFG) makes up over 80% of plastic marine debris found in Hawai‘i. These floating masses of nets and lines damage coral reef habitat, entangle endangered species, create navigational hazards, and damage vessels and active fishing gear. At-sea removal of ALDFG by vessels of opportunity helps protect nearshore environments and reduces entanglement hazards to protected species and important ecosystems, while shoreline removal prevents future damage if the debris is resuspended.

Our ALDFG Bounty Project works with 150 vessels in the Hawaii-based longline fleet, along with local commercial fishers, who are paid $1 per dry pound for ALDFG removed at-sea and on the O’ahu shoreline. The longline vessels operate within the North Pacific Garbage Patch, which is hundreds of kilometers northeast of the Hawaiian Islands but the main immediate source of marine debris in Hawai‘i. Fishers remove the ALDFG and bring it back to O‘ahu, where the Center for Marine Debris Research receives and transports it to a warehouse for drying, weighing, and analyzing. The debris is analyzed, firstly, to identify sources and transport pathways in order to inform targeted prevention strategies, and secondly, to chemically identify polymer types for future recycling opportunities.

To date, the project has removed 66 metric tons of plastic debris. The most common type of ALDFG removed through this program is a conglomerate, a tangled mass of nets, lines, and other fishing gear or debris primarily composed of trawl nets. A particularly impactful type of debris we receive are Fish Aggregating Devices (dFADs), originating from the tropical tuna purse seine fishery. Their long-tail structure creates a high entanglement risk and causes significant ecological damage. As part of this project we are monitoring tuna commission conservation measures to reduce plastic usage and entangling nets in dFADs. The bounty payments offset the cost of removal and further incentivize Hawai‘i fishers to remove the debris at sea and along shorelines. Prior to this effort, financial compensation for in-water removal of ALDFG did not exist in Hawai‘i. Through this project, we are working towards several UN Ocean Decade goals including understanding and beating marine pollution, protecting and restoring ecosystems, developing a resilient and equitable ocean economy, and increasing community resilience to ocean risks.

S09, Oral, AbstractID=18715, (ECOP)

Overlapping patterns of microplastics, seabirds, and zooplankton in the North Pacific

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The Arctic and subarctic North Pacific is experiencing rapid ecological change due to climate variability, oceanographic shifts, and increasing anthropogenic stressors. Among these stressors, marine microplastic pollution is increasingly known to infiltrate marine food webs and impact upper trophic-level species, including seabirds. While the presence and impacts of marine microplastics are relatively well-known in other marine ecosystems where plastic surveys and colony diet studies are emphasized, the distribution and abundance of microplastics in North Pacific waters is poorly characterized, particularly in Arctic waters. In recent years, however, plastics have been entrained and enumerated in systematic North Pacific zooplankton surveys conducted by the Continuous Plankton Recorder Survey (CPR), which coordinates survey transects within the Gulf of Alaska, Bering Sea, and Chukchi Sea. Using these data, we examined the spatial and temporal overlap between plastics and mesozooplankton recorded in CPR surveys with at-sea seabird data from the North Pacific Pelagic Seabird Database (NPPSD). While CPR surveys offer limited spatial coverage, they do reveal consistent hotspots of microplastics concentration in four regions: three small ($<200km^2$) Bering Sea regions near the western Aleutians, Nunivak Island, and Cape Hope; and the broad marginal boundaries of the North Pacific Subtropical gyre in the Gulf of Alaska (GoA). The smaller hotspots may be shaped by proximity to currents, coastal human communities, and ice-driven depositional dynamics, whereas the GoA pattern is likely structured by mesoscale eddy activity. To explore biological overlap, we applied spatiotemporal species distribution models and dynamic factor analysis to seabird and zooplankton data, identifying co-located communities along the CPR survey routes. For key zooplankton and seabird species, we quantified microplastic exposure as the product of species-specific density and plastic concentration across CPR transects and within the identified hotspots. We then estimated species-specific ingestion risks by combining exposure values with suggested ingestion rates from literature studies. This integrative approach helps identify the species and regions at greatest exposure risk to microplastics within an ecosystem that has not previously been characterized for these risks, thereby contributing an ecosystem-scale perspective on plastics exposure in North Pacific food webs.

S09, Oral, AbstractID=18731, (ECOP)

Estimating the social cost of plastic pollution

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Plastic pollution, now found in every ecosystem and human community around the globe, harms wildlife, ecosystems, and communities. Worldwide, stakeholders are working to mitigate the undesirable consequences of plastic pollution. However, these negative externalities—public costs not fully reflected in the market price of plastic products—are often overlooked, leading to underestimation of the benefits of plastic management strategies. The concept of social cost addresses this underestimation by incorporating both the public and private costs of production. Currently, no framework exists for quantifying the social cost of plastic pollution. Here, we present a model framework for estimating the social costs, which can be flexibly applied to different plastic types, geographies, and damages of interest. We then provide a case study in California to showcase how this framework can be applied, which estimates the social cost of a unit of single use consumer plastic produced in LA county. Finally, we discuss knowledge gaps and research needs to improve our estimates of the social cost of plastic pollution.

SESSION 9: MEQ/TCODE Topic Session

Marine Plastic and Microplastic Pollution in the North Pacific

Poster Presentations

S09, Poster, AbstractID=18577, PosterID: S09-P1, (ECOP)

Quantifying microplastic loads from stormwater runoff using pyrolyzer-GC/MS: A case study from a coastal urban creek in South Korea

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Microplastics (MP) are increasingly recognized as widespread environmental pollutants that pose serious threats to both the environment and human health. Stormwater runoff is thought to serve as a key transport pathway, carrying substantial amounts of MPs accumulated on urban surface—such as roads, rooftops, soils, and within drainage systems—into nearby aquatic ecosystems and, eventually, marine environments. However, information on rainfall-driven MP remains limited.

This study investigated the emission characteristics and loading of MPs transported into aquatic environments via urban stormwater runoff during a rainfall event with a total rainfall depth of 14 mm, at a coastal urban creek (Samhocheon) connected to Masan Bay, South Korea. Particular focus was placed on stormwater sampling using time-weighted methods, and quantifying mass-based MP loads through pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) following organic matter removal and density separation. The baseline MP concentration in creek water prior to the rainfall was 6.13 μg/L. MP concentrations increased sharply at the initial stage of the runoff, reaching the maximum concentration approximately 1.5 hours after runoff began, and then gradually decreased as the rainfall intensity decreased. The event mean concentration (EMC) of MPs was 11.93 μg/L. Polypropylene, polyethylene, and polyvinyl chloride were identified as the dominant polymer types, accounting for around 60-80 % of total MPs. The contribution of tire wear particles (TWPs) calculated using styrene-butadiene rubber (SBR) as a proxy, ranged from 20 to 68% of the total MP load. The total MP (> 20um) load discharged from the urban creek to Masan Bay during the rainfall event was calculated at 100.3 g, based on measured concentrations and flow data. A substantial portion (84.5g, 84%) of this load was transported during the early 20% of the total runoff duration. This value is comparable to the load derived from FTIR-based data (62.32g), where MP mass was calculated from particle dimensions (length, width, and an assumed height equal to one-tenth of the particle length).

These findings demonstrate the effectiveness of Py-GC/MS as a complementary tool for FTIR in MP monitoring, and highlight the early-stage stormwater runoff as a critical period for MP mobilization. This underscores the need for targeted urban watershed management strategies to mitigate MP emissions into the aquatic environment.

S09, Poster, AbstractID=18591, PosterID: S09-P2

Assessment of microplastic pollution in the surface offshore waters of South Korea (East Sea) using a continuous underway sampling method

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Microplastics (MPs) in marine environments are an emerging concern due to their widespread distribution, ingestion by various marine organisms, and their roles as a source and carrier of hazardous chemicals. This study investigated the levels, geographical distribution, and contamination characteristics of MPs in surface waters of the eastern offshore region of South Korea (East Sea). To date, most studies monitoring MPs in surface seawater have relied on grab sampling, which collects individual seawater samples at specific locations. However, this method offers limited spatial coverage and may not adequately represent the broader patterns of MP pollution. To overcome this limitation, we employed a custom-designed Surface Water Underway Sampler (SWUS), which continuously collects surface water, including the air–sea interface layer, from a fast-moving vessel. In this study, seawater samples (>20 ㎛) were collected along 15 transect lines in East Sea using the SWUS aboard the R/V *Onnuri* in April 2023. MPs were detected in all surface water samples collected across the East Sea, with concentrations ranging from 14.8-315.5 n/m³ (mean: 90.0 ± 79.5 n/m³). Notably, 79% of the MPs were smaller than 200 μm. Fragment-type MPs were the most dominant shape (74.8%), followed by fibers (24.8%) and films (0.4%). The predominant polymer types were polyester/polyethylene terephthalate (PES/PET, 29.3%), polypropylene (PP, 28.9%), and alkyd (10.5%), followed by polyethylene vinyl acetate (PEVA, 6.1%), polyamide (PA, 5.9%), and polyethylene (PE, 4.5%). Overall, high-density polymers (> 1 g/cm³) accounted for 58.7% of the total, indicating a relatively higher proportion compared to low-density polymers such as PP, PE, and PEVA. Higher MP abundance was observed in the central regions of the East Sea despite the lower human activity and industrial facilities, suggesting that physical oceanographic processes may play an important role in the transport and distribution of MPs in the region. To our knowledge, this is the first study to assess the distribution patterns of microplastics (>20 ㎛) in surface waters of the East Sea using the SWUS. This approach improves the representativeness of MP data and provides new insights into the large-scale variability of MP concentrations in the ocean surface layer. The findings of this study highlight the utility of SWUS as a valuable tool for high-resolution and spatially extensive monitoring of microplastics in marine environments.

S09, QR-Poster, AbstractID=18627, PosterID: S09-P3

Characteristics of microplastics in different matrices in Chinese typical coastal area

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Under the multiple stressors of global climate change and extensive human activities, costal ecosystems are under major threats. Degradation of marine ecosystems will lead to pronounced impacts on their functions. The sustainable development of coastal areas faces serious challenges. Microplastic contamination is a growing threat to marine environment and biota, and represent a great risk for marine ecosystems, society and human health. To help design effective plastic reduction and mitigation strategies, cognition of distribution and characteristics of plastic pollution in multiple matrices are required. We took Jiaozhou Bay as a typical area in coast of China, revealed distribution and characteristics of microplastics in multiple matrices, and the emission characteristics of microplastic sources. An index MCI (microplastic complexity index) was used that is to reflect the contrast of microplastics complexity in different matrices. It can be used for quantitative analysis of microplastic traceability process. and provides new ideas for source apportionment and ecological assessment of microplastics. Quantitative source apportionment is continuing to further promote the accomplishment of goal 14.1 in SDGs and decision support.

S09, Poster, AbstractID=18764, PosterID: S09-P4, (ECOP)

Pollution meets nutrition: Investigating microplastics and fatty acid composition in marine fish

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Microplastics (MPs) have become pervasive pollutants in marine ecosystems, raising concerns about their potential impacts on seafood quality and human health. Economically, oilfish (*Ruvettus pretiosus*) and Escolar (*Lepidocybium flavobrunneum*) hold moderate value in certain regions as low-cost alternatives to higher-value species. Ecologically, both are wide-ranging deep-sea predators that play key roles in mid- to deep-water trophic dynamics by preying on smaller fish and invertebrates, contributing to deep-sea biodiversity and nutrient transfer. From a chemical perspective, fatty acid content varies among fish tissues and may influence MPs accumulation due to hydrophobic interactions between MPs and lipids. In this study, we investigated the distribution of 11 common microplastics types in these species and explored their relationship with fatty acid composition, with particular focus on factors such as species, geographical origin, and anatomical location (e.g., head, gonad). Both microplastics and fatty acids were determined using pyrolysis–gas chromatography–mass spectrometry (Py-GC/MS), enabling simultaneous chemical analysis of synthetic polymers and lipid components. Preliminary data show that polyethylene (PE) and polyvinyl chloride (PVC) are the most abundant MPs accumulated in fish tissue. While PE is considered relatively inert, PVC poses greater toxicological risks due to its chemical structure and its tendency to leach hazardous additives. Upon degradation, PVC can also release hydrochloric acid (HCl) and chlorinated organic compounds, contributing to oxidative stress, inflammation, and potential disruption of lipid metabolism in aquatic organisms. The detection of PVC in lipid-rich tissues raises concerns about localized toxicity, interference with fatty acid homeostasis and downstream implications for seafood safety and human dietary exposure. By integrating environmental, biological, and analytical data, this research aims to determine whether microplastic accumulation is associated with alterations in key fatty acids such as EPA and DHA, which are critical to human health. Understanding these relationships not only provides insight into pollutant bioaccumulation patterns but also contributes to evaluating the potential dietary risks of consuming contaminated fish.

SESSION 10: POC/FUTURE Topic Session

Multiscale Physical, Biological and Ecosystem Dynamics Under Conventional and Carbon-Dioxide Removal Based Climate Scenarios

Oral Presentations

S10, Invited, AbstractID=18221

Mesoscale and submesoscale dynamics and their control of ocean alkalinity enhancement efficiency

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Among the various marine carbon dioxide removal (mCDR) opportunities, ocean alkalinity enhancement (OAE) offers a range of potential benefits that include durability of storage, ocean acidification mitigation, and scalability. Here we present an overview of known and unknowns of OAE, we discuss some of the opportunities and challenges it presents, and investigate how estimates of OAE efficiency are impacted by mesoscale and submesoscale dynamics.

We use the Gulf of Americo/Mexico as hypothetical target site for a large scale mCDR application. Comparing model simulations that resolve mesoscale dynamics or permit the formation of submesoscale circulations, we evaluate the relative role of the processes that control vertical and lateral carbon and alkalinity transport and air-sea carbon fluxes, and explore a range of OAE and enhanced rock weathering (ERW) scenarios. Understanding the role played by mesoscale and submesoscale circulations may be critical for evaluating the surface ocean response to proposed anthropogenic interventions in Earth's alkalinity cycle, as they impact the vertical transport of carbon and alkalinity, the air-sea CO uptake, and the solute storage below the mixed layer. A detailed analysis of the various contributions to the air-sea flux budget from a process stand-point completes the analysis.

S10, Pre-RecordedOral, AbstractID=18643, (ECOP)

Subseasonal effects of coastal trapped waves in the northern region of Peru

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The Peruvian Upwelling System represents one of the most productive oceanic areas globally, characterized by dynamic phenomena such as Coastal Trapped Waves (CTWs). These waves play an essential role in modulating physical and biological parameters, including surface chlorophyll (CHL) distribution. However, this region experiences a "Seasonal Paradox," wherein surface CHL concentrations do not immediately reflect the seasonal intensity of upwelling due to variations in Mixed Layer Depth (MLD). This study aims to explore how sub-seasonal CTWs (7–50 days) alter this paradox, using daily GLORYS12V1 reanalysis data from 2015 to 2020. Variables such as Sea Surface Height (SSH), CHL, MLD, and buoyancy frequency are analyzed through spectral techniques and modal analysis (EOF), considering different transects along the continental shelf. Preliminary results suggest a complex interaction between the dynamics generated by CTWs and surface CHL variability, highlighting that the relationship between SSH increases and CHL changes is not always linear and significantly depends on local oceanographic context. These initial findings raise questions about the relative importance of various physical processes in the biological regulation of this region, motivating further analysis to enhance our understanding and support marine ecosystem management and conservation.

S10, Pre-RecordedOral, AbstractID=18756

Application of dimensional reduction in the training of Machine Learning-based emulators for biogeochemical downscaling of the Northeast Pacific ocean

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Some of the key spatial/temporal features captured by dynamically downscaling models can be replicated through Machine Learning-based emulators based on Recurrent Neural Networks, and trained using a mixture of encoded forcing fields, dynamical model output, and regional data. Such emulators consequently have the potential to dramatically expand the ensemble size and sensitivity analyses of dynamically-based downscaling projections. Independent of modern ML development, there is a long history of using EOF decomposition - a popular form of dimensional reduction - in summarizing and understanding the primary dynamics of atmospheric and oceanic phenomena. While broadly popular and frequently effective, there are many situations where EOF decomposition struggles to capture important oceanic phenomena such as propagating waves and spatially localized features. Here we consider the value (efficiency) and limits (lost dynamics) of various encoding methods such as EOFs for spatially complex training data (here, the dynamical forcing and the dynamically produced regional response), prior to their use in training RNN-based emulators. Examples will be presented based on dynamically downscaling models of the Northeast Pacific, and ML-based emulators of these models.

S10, Oral, AbstractID=18284

Research on the intraseasonal to interannual variability of oceanic pCO_2 and its regulating mechanism in the South China Sea

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Multi-spatialtemporal-scale analysis of the oceanic partial pressure of CO_2 (pCO_2) in the South China Sea (SCS) from 1990 to 2021 is conducted based on a high-resolution physical-biogeochemical model to achieve a better understanding of oceanic carbon cycle under the changing climate. The intraseasonal-seasonal-interannual variability of pCO_2 is analyzed, and different responses of the carbon cycle to physical-biogeochemical processes are discussed based on the simulation result.

According to the results, the SCS acts as a weak source of CO_2 to the atmosphere over the past. The long-term trend rate of pCO_2 in the SCS is 1.45 μatm a^{-1}, which is dominated by the increase of the atmospheric CO_2 concentration. The influences from ENSO and PDO are also observed in the interannual-decadal changes of pCO_2. The first principle component (PC) of pCO_2 is positively correlated with the Niño 3 index with a correlation coefficient of 0.51 when the Niño 3 leads 5 months, and PC2 is correlated with the PDO index when the PDO leads 7 months. Seasonal variability of pCO_2 is one of the primary subsequent effects of the East Asian Monsoon. The variation of total CO_2 (TCO_2) due to water mass mixing and biological activity is proved to be the predominant factor of the seasonal change of long-term trend rate of pCO_2 according to the decomposition of influence factors. Moreover, a distinct spatiotemporal correspondence is observed between upwelling and the intraseasonal oscillation (ISO) of pCO_2. The component of temperature is the main contributor to the intraseasonal oscillation of pCO_2 along the southeast coast of Vietnam in boreal summer and the west of Lvzon Island in boreal winter. The cumulative effect of intraseasonal oscillation changes the mean variation background, and affects the seasonal to interannual variability of pCO_2. The results illustrate the unique carbon cycle controlling mechanism in the SCS, which benefits the estimations of the carbon source/sink pattern and carbon fixation capacity in the SCS, and provides useful information for developing carbon-neutral policies.

S10, Oral, AbstractID=18327, (ECOP)

Energy cascade in ocean frontogenetic zones

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Kinetic energy cascades are fundamental to understanding how oceanic multi-scale motions interact and redistribute energy, maintaining the overall energy balance of oceanic flows. Fronts act as pivotal conduits that facilitate the energy transfer from larger scales down to smaller scales, i.e., the forward energy cascade. Based on high-resolution ocean model outputs, we find that globally, the forward energy cascade exhibits significant spatial consistency with frontogenetic zones (where the fronts get sharpened) and shows clear seasonal variability, with its strength dependent on eddy activity. During winter, intensified submesoscale eddies yield more frontogenetic zones by promoting frontogenesis which further drives the forward energy cascade. Strong frontogenetic zones, though covering less than 15\% of the ocean surface, can contribute nearly 100\% of the forward energy flux. Moreover, in regions where strong frontogenesis extends into depth, the forward energy cascade within the mixed layer exhibits a universal vertical structure in normalized stretched coordinates. Our findings highlight the significance of frontogenesis in global ocean energy pathways.

S10, Oral, AbstractID=18336, (ECOP)

Submesoscale Coherent Vortices (SCVs) in the upstream Kuroshio: Insights from high-resolution no tide/tide simulations and in-situ observations

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Submesoscale coherent vortices (SCVs) play a crucial role in transporting water masses and their tracers, typically characterized as lenses of low potential vorticity (PV) with small horizontal scales in subsurface layers. In the Tokara Strait, south of Japan, region populated with seamounts and islands, the Kuroshio Current frequently interacts with topography. In such environments, SCVs can be generated in topographic wakes, potentially accompanied by vertical tracer fluxes, especially toward surface layers. Thus, SCVs can contribute to lateral and upward nutrient transport from the subsurface Kuroshio nutrient stream, enhancing regional biological productivity.

In this study, high-resolution simulations are used to identify the mechanisms of SCVs:
a) Nested grid simulation at 700m resolution, conducted with & without tidal forcing.
b) Ocean reanalysis product at 2km resolution (DIAS-MOVE-JPN 2020), to analyze long-term (>10 years) trends in the region.

In-situ tow-yo multidisciplinary observations are employed to confirm the presence of SCVs and assess their potential implications for ecosystem dynamics. In the simulations, subsurface eddies are identified using the Okubo–Weiss (OW) parameter at depths below the mixed layer depth (MLD). Tracked eddies are classified as SCVs if they have a radius < 5 km and persist longer than 20hours (3days) in the 700-m resolution (2-km resolution). Preliminary results suggest that anticyclonic SCVs are more numerous and have longer lifespans, especially under the scenario with tidal forcing. These SCVs also appear to be more closely associated with regions of high eddy diffusivity and low PV. From in-situ observations, lenses of low PV water have been detected at subsurface depths across multiple seasons, suggesting a possible link between the presence of SCVs and the variability of the Kuroshio path.

S10, Oral, AbstractID=18384, (ECOP)
Seasonal modulation of submesoscale flows by upwelling-favorable winds and their effects on primary production in the Humboldt Eastern Boundary Upwelling System under climate change scenario

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Humboldt Upwelling System (HUS) is the most productive marine ecosystems in the world, generating 10% of the global fish catch from 0.1% of the ocean area. High productivity is supported by the large upward nutrient transport, which phytoplankton utilize for growth, driven by subsurface coastal waters outcropping to sunlit layers, due to alongshore equatorward winds known as upwelling-favorable winds (UFW). Despite the seasonal duality of UFW in the HUS — with peak intensity during the austral winter in the Humboldt Northern Region (HNR), also referred to as the Seasonal Paradox region, and during the austral summer in the Humboldt Southern Region (HSR) — both regions currently maintain high levels of primary production (PP). However, the future balance of the HUS remains uncertain under the influence of climate change and ongoing global warming. Previous studies have shown the key role of submesoscale flows in the phytoplankton cycle, particularly by modifying the distribution of limiting nutrients for PP, In this study, we use the submesoscale-resolving CROCO model, coupled with two biogeochemical models — BioEBUS and PISCES — to simulate two distinct cases a) NHR and b) SHR, aiming to address the following questions: 1. What is the influence of UFW on submesoscale flows, and how do these affect the distribution of limiting nutrients in each region?, 2. What differences in PP arise from the two biogeochemical models?, and 3. What are the main projected changes in the HUS under climate change? Some authors hypothesize that sustained warming could mitigate the effect of the Seasonal Paradox, leading to a convergence in the behavior of HNR and HSR. Our preliminary results indicate that submesoscale flows naturally contribute more significantly to nutrient redistribution in the HNR than in the HSR by subducting upwelled nitrate during winter before being used for PP in the following spring, leading to at least 30% lower PP in the HSR. The implications of climate change will be discussed in the presentation.

S10, Oral, AbstractID=18392

Instability-intensified phytoplankton blooms from meso- to submesoscales in the eutrophic Taiwan Strait

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Phytoplankton blooms occur frequently in the along-shore frontal region of the eutrophic Taiwan Strait during the down-front northeasterly monsoon relaxation period, as consistently revealed by extensive cruise and satellite observations. These blooms have been robustly reproduced by both realistic and idealized models of the Taiwan Strait. High-resolution cruise observations and model results consistently demonstrate the presence of vigorous instabilities in the frontal region. Based on idealized model sensitivity experiments, we decipher the distinct contributions of submesoscale and mesoscale baroclinic instabilities (BCIs) and symmetric instability (SI) to blooms. In three-dimensional fine simulations with both submesoscale and mesoscale BCIs present, blooms are triggered by down-front wind cessation. Chlorophyll-a is higher in submesoscale front regions than in mesoscale regions, primarily due to the more effective restratification by submesoscale BCI. In three-dimensional coarse simulations with only mesoscale BCI present, blooms become weaker with relatively lower upper-ocean stability, consistent with those in mesoscale regions in corresponding three-dimensional fine simulations. In two-dimensional fine simulations without BCIs, blooms are not triggered despite the wind cessation, primarily due to the absence of significant near-surface restratification by BCIs. Although SI is present in two-dimensional simulations, its contribution to blooms is limited because of its minimal restratification effect. These results show that BCIs play the predominant role in triggering blooms in eutrophic coastal front regions such as the Taiwan Strait.

S10, Oral, AbstractID=18422, (ECOP)

Submesoscale processes triggered by tropical cyclones and their role in temperature recovery of cold wakes

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Submesoscale processes (submesoscales) play a crucial role in vertical tracer transport, which are typically stronger in winter than summer. However, recent studies revealed enhanced submesoscale activities following tropical cyclones (TCs) during summer months, though their characteristics, mechanisms, and dynamical impacts remain obscure. Through combining high-resolution satellite and simulation data, we demonstrate that energetic submesoscales are present within TC-induced cold wakes across the northwestern Pacific, which can produce strong upward vertical heat flux (VHF) in the upper ocean. Further analysis reveals that submesoscales are more active in stronger cold wakes induced by slower-moving and stronger TCs and they may be generated through a combination of baroclinic instability and strain-induced frontogenesis. Crucially, submesoscale VHF can accelerate the post-TC temperature recovery of cold wakes which may influence the sequential TC intensification. Our results improve the understanding of TC-ocean feedback and underscore the necessity of resolving or parameterizing submesoscales in TC prediction models.

S10, Oral, AbstractID=18480, (ECOP)

Assessing the efficiency and biogeochemical impacts of marine carbon dioxide removal in high-resolution simulations of the Salish Sea

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Marine carbon dioxide removal (mCDR) strategies, such as Ocean Alkalinity Enhancement (OAE) and Direct Ocean Removal (DOR), are gaining attention for their potential to enhance oceanic CO_2 uptake and mitigate climate change. This study applies the Regional Ocean Modeling System coupled to the Marine Biogeochemistry Library (ROMS-MARBL) to simulate a suite of mCDR deployment scenarios in the Salish Sea, a dynamic coastal-estuarine system in the northeastern Pacific. We simulate CDR deployments at several locations, both individually and as part of a multi-location scaled scenario, to assess how location and deployment size influence CO_2 removal efficiency and distribution, providing critical insight into the efficacy, scalability, and environmental consequences of ocean mCDR interventions. These simulations will highlight local and remote impacts, including potential relief from ocean acidification near OAE sites, informing the design of field experiments with sufficient ecosystem monitoring. The results will also support optimized deployment and observational strategies for accurate carbon accounting, guiding responsible implementation and policy decisions around these emerging climate mitigation approaches.

S10, Oral, AbstractID=18504, (ECOP)

Topographically generated submesoscale processes in the Tokara Strait revealed by a high-resolution model

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Submesoscale processes (SMPs) in the Tokara Strait, where the Kuroshio and complex bottom topographies (many small islands and seamounts) coexist, are investigated using a high-resolution (~0.9 km) model – JCOPE-T-eas1ks. Our model results show that the Kuroshio-topography interaction generates energetic SMPs on the lee side of the topographies. Variations in the Kuroshio, particularly its path, considerably modulate the SMPs. Specifically, SMPs below the mixed layer are intensified when the Kuroshio axis is located in the central strait during autumn. On the other hand, as the Kuroshio axis shifts northward in spring and summer, a remarkable vortex street is generated on the lee side of Yakushima Island. Additionally, the variation of mixed layer also influences the SMPs, particularly in winter. Energy budget analysis of the SMPs indicates that barotropic instability is the primary source of submesoscale kinetic energy, while baroclinic instability and wind work become non-negligible in winter. The forward energy cascade is dominant in the Tokara Strait in the upper 350 m, while the inverse energy cascade emerges below the mixed layer. The SMPs disintegrate through different kinds of submesoscale instabilities. The gravitational instability is dominant within the mixed layer, while the centrifugal instability becomes important below the mixed layer. Our findings provide comprehensive insights into SMPs in marginal seas with complex bottom topography, which behave differently from those in the open ocean.

S10, Oral, AbstractID=18513

A new parameterization scheme of ocean submesoscale processes and its implementation in an eddy-resolving model in the North Pacific

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Submesoscale processes (submesoscales) are oceanic motions with horizontal scales of O(1–10) km. They can generate strong vertical buoyancy flux (VBF) which significantly modulate upper-ocean heat budget. Because submesoscales cannot be resolved by the prevailing ocean models, their VBFs must be properly parameterized in order to improve model performance. Here, based on theoretical scaling analysis, we propose a new parameterization of submesoscale VBF (Zhang23 parameterization) by simultaneously considering baroclinic instability and strain-induced frontogenesis, which are two leading generation mechanisms of submesoscales that typically co-occur in open ocean. Compared with the parameterization of Fox-Kemper et al. (2008; F08) that only considers the mixed-layer baroclinic instability, Zhang23 parameterization can better reproduce the magnitude, horizontal distribution, and vertical structure of "true" submesoscale VBFs directly calculated from submesoscale resolving observations and simulations. By implementing the Zhang23 parameterization into an eddy resolving model (~9 km) in the North Pacific, we find that it can greatly improve the simulations of mixed-layer depth and upper-ocean stratification in the model.

S10, Oral, AbstractID=18574, (ECOP)

Quantification of nutrients and dissolved organic carbon transport in the mesoscale eddies: Insights from dual water isotopes

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Mesoscale eddies are ubiquitous swirling oceanic structures. These dynamic processes play an extremely role in supplying nutrients to the upper ocean to stimulate new productivity, thereby dominating regional marine productivity and biogeochemical processes. Despite their importance in shaping marine productivity and carbon export, the lack of quantitative understanding of the lateral and vertical transport of the biogenic elements in mesoscale eddies limits the deepening of understanding of the eco-environmental effects and efficient carbon export mechanisms caused by mesoscale processes. This study captured a cold eddy and a warm eddy in the western North Pacific Ocean, and found that upwelling driven by cold eddies can provide over 70% of dissolved inorganic nitrogen and phosphorus to the upper ocean, which is much higher than the contribution of in situ subsurface water (~20%), making dissolved inorganic nitrogen and phosphorus concentrations in the region nearly twice those in warm eddies. By contrast, although the contribution of warm eddies to the nutrient content of the euphotic layer is limited, they can transport surface water with high dissolved organic carbon concentrations to the deep ocean (over 40%). These quantitative observations provide new insights into more accurately assessing of the efficient carbon export and the eco-environmental effects caused by mesoscale eddies.

S10, Oral, AbstractID=18582

Diapycnal fluxes of nutrients in the North Pacific Subtropical Gyre

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The supply of nutrients via diapycnal processes from depth to the euphotic zone (EZ) is thought to be a main source sustaining new production in oligotrophic oceans. However, such diapycnal fluxes of nutrients remain insufficiently constrained due to limited observations and the dynamic nature of ocean turbulence. In this study, we present a comprehensive dataset of diapycnal fluxes of nutrients, including diapycnal diffusive (F_{diff_NOx}) and effective diapycnal fluxes (F_{e_NOx}, representing the net diapycnal influx to the upper water column) of NO_3^- + NO_2^- (NO_x^-), based on measurements of turbulence microstructure and nutrients with high vertical resolutions from two cruises conducted during summer and winter in the oligotrophic western North Pacific Subtropical Gyre (NPSG). The F_{diff_NOx} (F_{e_NOx}) exhibits evident spatial variations, with higher values observed at the south boundary of the NPSG near the North Equatorial Current and at the northern NPSG influenced by the North Pacific Tropical Subtropical Mode Water. In contrast, lower values are found in the central NPSG. These spatial variations are primarily attributable to the vertical concentration gradient of NO_x^-. At the base of the EZ, the cruise-averaged F_{diff_NOx} (F_{e_NOx}) are 11.7±9.6 (11.9±8.6) and 8.5±6.1 (11.3±9.3) □mol m^{-2} d^{-1} in summer and winter, respectively, displaying insignificant seasonal variations. Moreover, we observed significantly higher flux ratios of F_{diff_NOx} to diapycnal diffusive flux of phosphate (F_{diff_DIP}), which were 18.2±2.0 and 13.9±2.0, compared to the N/P concentration ratios of 10.4±1.1 and 7.4±1.2 at the base of the EZ during summer and winter cruises, respectively, suggesting that the diapycnal transport could relieve nitrogen limitation in the upper NPSG. Notably, we identified strong linear relationships between the logarithm of F_{diff_NOx} (F_{e_NOx}) and the NO_x^- gradient. Leveraging these relationships, we estimate the climatological distributions of F_{diff_NOx} (F_{e_NOx}) utilizing nutrient data from the World Ocean Atlas (WOA23). The F_{e_NOx} is estimated to be 20.2±16.6 □mol m^{-2} d^{-1} and contributes to 8.5±8.3% of the nitrogen required for new production in the NPSG. These estimates are slightly lower than previous studies, but highlight that diapycnal fluxes play a less important role on nitrogen budget compared to N_2-fixation and atmospheric deposition in the oligotrophic NPSG. In contrast, the effective diapycnal diffusive flux of phosphate (F_{e_DIP}) is 1.5±1.3 □mol m^{-2} d^{-1}, contributing to 18.1±17.9% of the phosphorus required by new production, and is roughly ten times larger than the atmospheric phosphorus deposition in the NPSG.

S10, Oral, AbstractID=18597

Freshwater-driven alkalinity increase regulates carbon dynamics in the Yellow and East China Seas

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Seasonal measurements of total alkalinity (TA) and dissolved inorganic carbon (DIC) from over 9,000 seawater samples collected between 2015 and 2024 in the Yellow and East China Seas reveal a persistent increase in TA, despite a gradual freshening of surface waters by up to 0.2 salinity units. This counterintuitive rise in alkalinity is attributed to enhanced input of bicarbonate-rich freshwater, likely originating from the Bohai Sea, which receives riverine discharge with TA concentrations exceeding 3,000 μmol kg^{-1}. These observations indicate that river-borne alkalinity has become a significant, previously underappreciated driver of regional carbon cycling—modulating net CO_2 fluxes and elevating ocean alkalinity. Given the rarity of natural alkalinity increases in ocean systems, these findings highlight a novel mechanism through which anthropogenically altered freshwater inflows can shape coastal carbon dynamics.

S10, Oral, AbstractID=18614, (ECOP)

Exploring ocean turbulence structure using high-resolution topography data

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Ocean turbulent mixing is critical in controlling climate and marine ecosystems through heat and material circulations. Spatial and temporal turbulence variability has remained unclear because turbulence observations are difficult and scarce. It is known that the main cause of turbulent mixing in the deep ocean is the breaking of internal tidal waves and internal lee waves caused by the interaction of tidal and steady currents with bottom topography. There have been previous studies on near-field (local) turbulent mixing associated with internal tides, but the comparison between wave energy generations and observed dissipations was insufficient. For steady internal lee waves generated by horizontal O(100m) scale bathymetry and steady currents, the relationship with turbulence was unclear due to the lack of resolution of bathymetry observation data. In this study, the turbulent energy dissipation obtained from the newly developed CTD-attached micro-temperature method was compared with the energy generation of internal waves on the seafloor estimated from high-resolution bathymetry and near-bottom current velocity observations, which were conducted across several transects of the GO-SHIP projects. The main purpose of this thesis is to clarify how bottom-generated internal waves form the horizontal and vertical spatial structure of turbulence, with particular attention to the roles of both steady internal lee wave and internal tides.

S10, Oral, AbstractID=18710, (ECOP)

Estimating blue carbon sequestration potential of *Magallana gigas* in Korean aquaculture farms

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This study evaluates blue carbon potential of potential of *Magallana gigas* (Pacific oyster) aquaculture in Korea. Oysters sequester carbon through shell formation and by transferring organic carbon from the water column to marine sediments indicating as the marine-based carbon dioxide removal (mCDR). Oyster and sediment samples were collected monthly from four farms on Korea's southern coast from April 2022 to March 2024. Our analysis showed that oyster shells contained 11.5 ± 0.07% inorganic carbon, while tissues held 39 ± 2% organic carbon. Korean oyster farms sequestered approximately 8.1 MgC ha^{-1} yr^{-1} in shells and 12.1 MgC ha^{-1} yr^{-1} in tissues. Total carbon storage in these aquaculture areas was substantial, with an estimated 11.23 MgC ha^{-1} of organic carbon and 11.81 MgC ha^{-1} of inorganic carbon. These results demonstrate that oyster farming is a significant form of natural mCDR, contributing to a multiscale understanding of marine ecosystem dynamics and providing a valuable model for future climate mitigation strategies.

Keywords: Bivalve, Oyster, Aquaculture, Carbon sequestration, Blue carbon

SESSION 10: POC/FUTURE Topic Session

Multiscale Physical, Biological and Ecosystem Dynamics Under Conventional and Carbon-Dioxide Removal Based Climate Scenarios

Poster Presentations

S10, Poster, AbstractID=18377, PosterID: S10-P1, (ECOP)

High-resolution tidal current simulation in the Seto Inland Sea for tidal stream energy applications

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The Seto Inland Sea (SIS), located in western Japan, is characterized by a complex coastal geometry with numerous small islands and narrow straits. Simulating tidal currents in this region is challenging due to the intricate topography and the importance of capturing small-scale hydrodynamic processes. Precise current velocity fields are essential for resolving such dynamics. To address this, we conducted a high-resolution tidal current simulation using the Princeton Ocean Model (POM) with a horizontal resolution of approximately 100 meters. The model was forced by tidal elevation data from Tidal Prediction Software X/O (version 9) for four principal constituents of SIS (M_2, S_2, K_1, O_1), and it simulated fine structures of tidal elevation and tidal currents. Compared to a low-resolution (1 km) simulation, the high-resolution model significantly improved the accuracy of tidal current amplitude, as indicated by a notable reduction in root mean square error. The greatest improvements in current accuracy were observed in regions with dense island and strait networks, such as Hiroshima Bay and Harima-nada. In particular, the northwestern Hiuchi-nada and the confluence zone between Bisan-Seto and Harima- Nada exhibited $\log10(h/u^3)$ values around 2.5, suggesting the presence of energetically active small-scale processes such as tidal fronts and mixing zones. In a narrow strait region, the maximum tidal stream energy computed by the 100 m resolution model was approximately seven times higher than that of the low- resolution model. Compared to the low-resolution model, the high-resolution model shows an improved ability to capture high velocities and high tidal energy. This work demonstrates that high-resolution modeling significantly enhances our understanding of small-scale tidal dynamics in semi-enclosed, island-rich coastal systems like the SIS.

S10, Poster, AbstractID=18394, PosterID: S10-P2, (ECOP)

Impacts of global warming on Peruvian ocean stratification and its implications

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Our climate is undergoing a continuous global warming, in which the ocean plays a crucial role by regulating Earth's climate. According to reports from the Intergovernmental Panel on Climate Change (IPCC), the ocean absorbes over 90% of the excess heat generated by greenhouse gas emissions. This heat uptake has resulted in greater warming of surface layers relative to deeper waters, leading to increased ocean stratification in many regions (Li et al., 2020). A more stratified ocean limits vertical mixing and reduces the upward transport of nutrients, thereby exacerbating issues such as deoxygenation and acidification, particularly in upwelling zones like the Eastern Boundary Upwelling Systems (Xiu et al., 2018; Aguirre et al., 2018; IPCC, 2019).

Given the ecological and economic importance of the Peruvian marine ecosystem, this study evaluates trends in stratification as an indicator of climate change impacts in the Peruvian ocean by using the squared buoyancy frequency (N^2) to represent stratification levels, calculated from monthly reanalysis data of temperature and salinity up to 200 meters deep, from the GLORYS12V1 reanalysis product, with a horizontal resolution of 1/12º. Long-term trends in N^2 across the Peruvian region are analyzed to identify temporal and spatial changes.

Additionally, through an anomaly-based decomposition method, we separate thermal and haline components to isolate the relative contribution of each variable on N^2. This approach enabled a more accurate assessment on driving factors that modify ocean stratification. In the presentation, we will discuss possible implications on upwelling, eddy activity, and their roles in transport.

S10, Poster, AbstractID=18525, PosterID: S10-P3

Constrained forward energy transfers at ocean submesoscale fronts

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The ocean, as a vast geophysical fluid system, consists of a variety of across scales spanning thousands of kilometers to mere millimeters. Unraveling how energy is transferred and distributed between these scales is essential to deciphering the ocean's role in redistributing heat, nutrients, and gases—processes critical to both marine ecosystems and Earth's climate. In this study, we identify the constrain governing the forward energy transfer at ocean fronts where the submesoscale forward cascade locates. The key finding is that, in frontal coordinate, frontogenetic energy cascade can be decomposed into the contributions from shear strain, convergence, and normal strain, which are constrained by 2:1:-1. This constrain has been tested in the theoretical model of frontogenesis, the idealized simulations of Mixed-Layer instabilities, and a cutting-edge ultra-high-resolution global ocean model (MITgcm LLC4320). This study might improve our understanding of ocean energy pathways and have implications for ocean modeling and parameterization of ocean mixing.

S10, Poster, AbstractID=18527, PosterID: S10-P4

The impacts of typhoon processes on submarine groundwater discharge (SGD) and its nutrient supply in Zhanjiang Bay, China

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Coastal oceans are highly responsive to typhoons, making them one of the most affected regions. However, our understanding of the impact of typhoon intensity and movement path on marine dynamic processes and eco-environmental factors remains limited because there are very few on-site investigations, especially continuous field observations in the bay during typhoon events. This study analyzed the seasonal fluctuations of seawater ^{222}Rn in Zhanjiang Bay from June 2021 to March 2022 as well as combined dual water isotopes parameters through a continuous survey (with a 5-day interval) during ten cruises in Zhanjiang Bay, associated with two typhoons of varying intensities and landing tracks. Nutrients from SGD also showed seasonal fluctuations, and their annual input was comparable to that of rivers, significantly influencing the bay's trophic status. Freshwater contributions to nutrient loads increased significantly during typhoon periods, with a stronger typhoon showing a greater contribution. Typhoons led to a sharp increase in SGD flux, which lasted up to 15 days, nearly double the wet season background values. The highest SGD-driven fluxes of chemical constituents were estimated. After typhoons, water mass mixing intensified and lasted for weeks, emphasizing SGD's crucial role in nutrient transport under the influence of tropical cyclones.

S10, Poster, AbstractID=18530, PosterID: S10-P5, (ECOP)

Vertical hydrological process as a primary driver of organic matter dynamics in the frontal zones

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Previous studies have primarily focused on the effects of horizontal transport processes on ecosystems in the Luzon Strait, whereas vertical hydrological processes have received less attention. This study highlights vertical hydrological processes by investigating ecosystem pathways and OM dynamics in the Luzon Strait. We identified four subregions with distinct vertical processes in frontal zones: cyclonic eddy core (CEC), cyclonic bend (CB), anticyclonic eddy core (AEC), and anticyclonic bend (AB). Each exhibited different pathways of OM transformation, governed by distinct mechanisms. (1) *Upwelling vs. Downwelling*: Upwelling (strong in CEC, weak in CB) enhanced photosynthesis by transporting nutrient-rich deep waters into euphotic zone, while downwelling (strong in AEC, weak in CB) suppressed it, with AB exhibiting simultaneous strong upwelling and downwelling due to submesoscale fronts. (2) *Stratification vs. Mixing*: Stratification promoted photosynthesis and semi-labile dissolved OM (DOM) accumulation by trapping chlorophyll-*a* and balancing light availability and nutrients in mid-euphotic layer, whereas mixing accelerated the fresh particulate OM (POM) and semi-labile DOM degradation through oxygenation. While stratification and mixing coexisted in CEC, CB, and AEC, the AB was dominated by intense mixing due to submesoscale dynamics. (3) *TSM Modulation*: total suspended matter (TSM) facilitated DOM-to-POM conversion via mineral adsorption, with mesoscale eddies elevating TSM levels in CEC and AEC by trapping terrigenous inputs.

S10, Poster, AbstractID=18571, PosterID: S10-P6, (ECOP)

The impact of ocean fronts on the dynamics of dissolved organic matter and their implications for carbon sequestration

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Ocean fronts are characterized by intense physical dynamics and exert profound influences on marine biogeochemical cycles and climate systems. Previous studies in the Beibu Gulf revealed a paradox where frontal zones exhibit high primary productivity accompanied by frequent algal blooms and red tide events, yet demonstrate remarkably low organic matter burial in surface sediments. The mechanisms governing this coexistence of elevated productivity and reduced carbon sequestration remain unresolved. This study systematically investigated seasonal variations in dissolved organic matter (DOM) characteristics, integrated with particulate organic matter and physicochemical parameters, to unravel frontal controls on DOM dynamics. Our findings demonstrated front-dependent modulation of DOM processing pathways. In the vigorous northern front, nutrient enrichment via vertical mixing stimulated phytoplankton growth, generating substantial DOM production that elevates ambient concentrations. By contrast, in the eastern front with weaker frontal activity, the microbial degradation of DOM was the predominant process for the removal of DOM due to the limitation of phytoplankton growth (lack of nutrient supply). These contrasting regimes established nutrient availability as the principal determinant of DOM dynamics across frontal gradients. Furthermore, the west-Guangdong coastal current (WGCC) delivered peak DOM fluxes (32-47% of annual input) during active frontal phases. While enhanced productivity and WGCC intrusion amplified organic loading in frontal water columns, intensified decomposition processes driven by frontal hydrodynamics promoted rapid organic matter turnover. This accelerates the cycling of these organic matter, which may be responsible for the decoupling between high surface productivity and attenuated carbon burial observed in Beibu Gulf frontal sediments.

Keyword: Ocean fronts; organic matter decomposition; marine productivity

S10, Poster, AbstractID=18572, PosterID: S10-P7

Influence of spatial location, vegetation, and benthic macroinvertebrate on organic carbon storage and removal in brackish wetlands

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Brackish wetlands are important blue carbon ecosystems where organic carbon is stored through a variety of biogeochemical processes. This study investigates how spatial location (marine vs. inland), sediment characteristics, benthic macrofaunal communities, and vegetation influence organic carbon storage and removal dynamics. Marine-side wetlands exhibited finer sediment and better grain sorting, while inland wetlands had coarser sediment with poor sorting. Species richness and macrofaunal density were higher in inland wetlands, whereas biomass was greater in marine wetlands. Both the Bioturbation Potential Index (BPc) and functional diversity were also higher in marine wetlands. Although total organic carbon (TOC) and TOC removal rate did not show significant correlation, inland and vegetated wetlands tended to have higher TOC standing stock and removal rates. These results suggest that marine-side wetlands are more strongly influenced by bioturbation-driven carbon redistribution and oxidation, while inland vegetated wetlands favor long-term carbon retention through sediment stability and organic matter trapping by vegetation. This functional complementarity between the two wetland types highlights the ecological significance of spatial heterogeneity in brackish wetlands, where multiple carbon pathways—accumulation, oxidation, and burial—coexist and operate simultaneously.

S10, Poster, AbstractID=18601, PosterID: S10-P8, (ECOP)

How do oceanic suspended particulate matter and transparent exopolymer particles turn into aggregates?: A process of driving the biological pump in the western North Pacific oceans in summer

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The ocean's biological pump is a natural system that can combat climate change by sequestering carbon dioxide from the atmosphere into the deep ocean. Phytoplankton plays a significant role by acting as suspended particulate matter (SPM) and producing transparent exopolymer particles (TEP). SPM and TEP are involved in the formation of aggregates that drive the biological pump because TEP can scavenge smaller particles like SPM. However, the interaction between SPM and TEP in the formation of sinking particle flux is not fully understood. Therefore, this study aims to investigate the process and relation between SPM and TEP that transform into aggregate and drive the biological pump in the oceans. The study was conducted in July 2023 in the western North Pacific. The result indicated that TEP tended to be more concentrated on the upper layer of the ocean. In the case of the subarctic region, TEP concentration peaked after the surface layer similar to the concentration of chlorophyll-a. In contrast, in the subtropical region, TEP peaked on the surface layer; yet, the concentrated trend did not align with the concentration of chlorophyll-a. For SPM, the image analyses revealed a higher amount of phytoplankton at the surface layer and the surface chlorophyll maximum compared to the deeper layer of the ocean. On the other hand, the deeper layer showed larger particles and aggregated than the surface layer. These findings will provide further details on how TEP and SPM transform into aggregate and drive the biological pump.

S10, Poster, AbstractID=18619, PosterID: S10-P9, (ECOP)

Relationships between benthic macroinvertebrate communities and environmental factors in brackish wetlands

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Brackish wetlands are ecotones where freshwater and seawater meet, forming unique ecosystems with high biodiversity and productivity. They play essential roles in ecological functions such as carbon cycling. Benthic macroinvertebrates are key contributors to material cycling and energy flow, and their distribution reflects the ecological status of these wetlands. This study examined benthic macroinvertebrate communities and environmental factors in four Korean brackish wetlands: Munsan, Daedeok, Gochang, and Seocheon. Species richness and community structure varied across location and vegetation. Species richness was 17 species/0.55 m² in Munsan, 69 species/1.45 m² in Daedeok, 104 species/3.1 m² in Gochang, and 83 species/1.15 m² in Seocheon. Daedeok and Seocheon, located near terrestrial zones, had higher proportions of insect taxa, while marine-associated taxa such as polychaetes, crabs, and gastropods were more abundant in Gochang and Munsan. The SIMPER analysis showed that *Perinereis linea* and Oligochaeta spp. dominated mudflats; Oligochaeta spp. and Insecta sp.2 dominated reed stands; Oligochaeta spp. and Insecta sp.35 dominated willow stands. Other dominant species varied among *Phacelurus latifolius***,** *Suaeda japonica*, *Bolboschoenus planiculmis* and *Suaeda maritima* vegetation types. Multivariate analysis revealed that vegetation type, acid volatile sulfide (AVS), and total organic carbon (TOC) best explained community variations, with TOC having the strongest individual effect. These findings indicate that spatial factors, vegetation, and organic matter influence benthic macroinvertebrate communities in brackish wetlands.

S10, Poster, AbstractID=18650, PosterID: S10-P10

Mixing induced nutrient supply in the Kuroshio on the sloping bottom boundary in the Okinawa Trough

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The Kuroshio encounters many topographic features. It flows along the very peculiar halfpipe like topographic structure in the Okinawa Trough between Taiwan and south of Kyushu Japan almost over 1000 km. Although the Kuroshio path is relatively stable due to topographic control, it exhibits small meanders that are often accompanied by intrusions of warm water on the continental shelf and cyclonic eddies with countercurrents on their northwestern sides. The former and the latter can induce respective upslope and downslope Ekman transport in the bottom boundary layer. On the other hand, previous studies indicate that these Ekman transports can be arrested by induced geostrophic shear that may cancel the bottom current, leading to the slippery bottom that prevent further up- or downslope Ekman transport. However, the flow could be unstable and/or detached from the bottom that would restratify the standing isopycnals, promoting the upwelling and onshore eddy fluxes. In addition, strong internal tides propagate in the southwestern part of the Okinawa Trough that could break the Ekman arrest. Thus, roles of countercurrents by cyclonic eddies and internal tide induced mixing in generating fluxes on the realistic topographic slopes remain largely unexplored.

In this study, we employ high-resolution numerical simulations coupled with an ecosystem model with realistic topography of the Okinawa Trough. The model incorporates atmospheric and tidal forcing to simulate multiscale ocean dynamics including the Kuroshio and cyclonic eddies, assess internal tides, and quantify the diapycnal fluxes near the bottom on the continental slopes. In the presentation, we will show where large nutrient diapycnal flux occurs in the trough, comparing the results with and without tides.

SESSION 11: FIS/BIO Topic Session

Applying Innovative and Established Approaches to Assess the Resilience of the Early life Stages of North Pacific Fishes to Changing Oceanographic Conditions

Oral Presentations

S11, Invited, AbstractID=18735

Trophic efficiency in early life: A mechanism for fish recruitment in a changing ocean

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Identifying drivers of fish recruitment strength for a given species remains a central challenge in marine science, often requiring a dual approach that integrates long-term observational programs with targeted ecosystem process studies. Foundational time series like the California Cooperative Oceanic Fisheries Investigations (CalCOFI) provide the essential climatic and ecological context, revealing multi-decadal patterns against which possible mechanisms of survival can be tested. Process studies, in turn, can further our understanding of mechanisms identified as important to recruitment. Through this approach, the Trophic Efficiency in Early Life" (TEEL) hypothesis emerged as a likely driver of larval success across diverse species and ecosystems, from the productive upwelling systems supporting Northern Anchovy to the oligotrophic nurseries of apex predators like Bluefin Tuna. While their habitats differ, the larvae of both species depend on short, efficient food chains to maximize energy transfer to their populations, fueling growth and survival. Research on rockfish further demonstrate how trophic efficiency can enhance larval condition and growth rates. By synthesizing long-term data with mechanistic studies, we can bridge the gap between large-scale ocean change and population-level responses, forging a path toward more effective, ecosystem-based fisheries management in a changing ocean.

S11, Oral, AbstractID=18238, (ECOP)

Patterns of juvenile fish assemblages in the surf zones of tropical sandy beaches

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Surf zones of sandy beaches being an integral part of ocean beaches dominant coastlines across the globe and highly connected with adjacent typical marine ecosystems (i.e., mangroves, seagrass, and coral reefs). Understanding the temporal patterns of fish assemblages in surf zones is a pressing task for conservation, especially in coastal waters. Here, we assessed the temporal patterns and structural drivers of fish assemblages in surf zones to test the hypotheses that 1) fish assemblages in surf zones reflect a combination of species from adjacent typical ecosystems, 2) distinct fish ecotypes utilise the surf zones at different times during the year because of their different reproductive characteristics. We sampled fishes across one year (June 2021 to May 2022) in a surf zone of Gaolong Bay in Hainan Island, China. We found that the studied surf zones are highly connected with other adjacent typical marine ecosystems and support a fish diversity with 83 species and 3 fish ecotypes: coral reef-seagrass-associated species (CS), mangrove-estuarine-associated species (ME), and common coastal-estuarine-associated species (CE). Species abundance and diversity were the highest in May, and most individuals were juveniles. Most CS were abundant from March to May. ME and most CE species were dominant from June to August, and Mugilidae (CE) was abundant from October to February. Tidal level, water temperature, conductivity, pH, turbidity, and dissolved oxygen were important factors determining surf fish assemblages. Our results highlight that effective management and targeted protection strategies, such as starting the fishing ban period from March instead of May in South China Sea, is necessary for conserving the biodiversity and sustainability of fishery resources in coastal seascapes serving as important nursery habitats for fishery species.

S11, Oral, AbstractID=18250, (ECOP)

Growth-development trade-offs constrain feeding success in Japanese anchovy larvae

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Understanding variability in growth rates and feeding success during early life stages would help identify factors driving recruitment variability in fish. Earlier studies on the growth–feeding relationships have shown that larger individuals achieve higher feeding success at a given age. At the same time, growth rate *per se* may also relate to feeding success at a given somatic size. Here, we examined the growth–feeding relationships in Japanese anchovy *Engraulis japonicus* larvae through laboratory feeding experiments, focusing on the roles of growth rate *per se*. Larvae were reared across a wide range of daily ages to ensure variation in growth rates. Feeding experiments were conducted at 22°C using equal numbers of brine shrimp of three different sizes. After a 5-minute feeding period, feeding-related organs were measured for each larva. Our results showed a negative relationship of growth rate *per se* to prey size and feeding success rates. That is, slower-growing larvae achieved higher feeding success at a given size. In addition, slower-growing larvae tended to have larger feeding-related organs (jaw width, esophagus diameter, and eye diameter) at a given size. The negative relationship between growth rate *per se* and feeding success would result from trade-offs in energy allocation between somatic growth and morphological development. Such morphological constraints may underlie individual variability in feeding success at a given size.

S11, Oral, AbstractID=18263

Ontogenetic shifts in diet and their relationship to growth in Pacific saury (*Cololabis saira*) larvae in the North Pacific

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The Pacific saury (*Cololabis saira*) is a commercially important small pelagic species widely distributed across the North Pacific. While previous studies have demonstrated that both sea surface temperature (SST) and prey availability significantly influence larval growth, the direct relationship between ontogenetic dietary shifts and growth performance remains poorly understood.

In this study, we investigated the relationship between diet composition and growth in Pacific saury larvae across different body size classes. Larvae and ambient zooplankton were collected in the central and western North Pacific during January and February 2018. Gut contents and available prey organisms were identified to the order or family level. Larval growth was assessed using the mean width of the three outermost otolith increments.

Our results revealed clear ontogenetic dietary shifts. Larvae < 20 mm in body length exhibited low prey selectivity, feeding on small organisms such as Oithonidae, Oncaeidae, Gastropoda, Corycaeidae, and Calanoida. In contrast, larvae > 20 mm preferentially consumed larger prey, primarily Calanoida and Corycaeidae. Linear model analysis revealed that environmental factors influencing growth varied with larval size: SST had a positive effect on growth in larvae < 10 mm, while both SST and Corycaeidae density positively influenced growth in 10–20 mm larvae. For larvae > 20 mm, Calanoida density had a significant positive effect on growth, whereas SST had no notable impact.These findings highlight the importance of a seamless transition in feeding environments to sustain optimal growth throughout the larval development of Pacific saury.

S11, Oral, AbstractID=18396, (ECOP)

In situ imaging reveals the impact of upwelling associated hypoxia on larval fishes, their predators and prey

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Larval English sole (*Parophrys vetulus*) are among the most abundant winter ichthyoplankton off the coast of Oregon and feed primarily on appendicularians. The combination of high abundance and diet specificity provides an opportunity to link oceanographic conditions to prey availability, larval feeding, and growth. Larval English sole were collected along a cross-shelf transect off Newport, Oregon during a series of research cruises in the winters of 2018, 2019, 2022, and 2023 using a Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS). On these same research cruises, a plankton imager (In situ Ichthyoplankton Imaging System, ISIIS) collected high resolution gelatinous predator and appendicularian abundances along the same transects. From each year, the otoliths of larval English sole were used to estimate early life history traits: total age, recent growth (most recent three days), and daily growth. Recent growth, detrended with age, varied among years and was related to environmental variables. Generalized additive models (GAMs) revealed a variable influence of oceanographic and trophic variables on recent growth. Individual recent growth was modeled as the response to oceanographic (temperature, recent wind stress), trophic (predator, prey concentrations), and life history (mean early growth) covariates. These results illustrate the influence and importance of complex environmental and food web dynamics on the early growth of an abundant and important fish species.

S11, Oral, AbstractID=18401

Sensitive microbial shifts during early life stages of chum salmon: Implications for a warming ocean

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Juvenile stages of chum salmon (*Oncorhynchus keta*) are highly sensitive to environmental fluctuations, particularly during the transition from freshwater to seawater. In the context of global warming and increasing marine heatwaves, understanding how gut microbiota responds to early life transitions is critical to assessing salmon vulnerability. This study investigated the temporal dynamics of gut microbiota in hatchery-reared juvenile chum salmon over the first 90 days post-hatching, encompassing embryonic development, the onset of exogenous feeding, and salinity acclimation. Using 16S rRNA gene amplicon sequencing, we found that prior to feeding, gut microbial communities were unstable and highly variable. However, after first feeding (35 days post-hatching), the gut microbiota rapidly stabilized, with dominant taxa such as *Bartonella* and *Enterococcus*, primarily derived from the feed. Strong host filtering was also indicated by the observation that the gut profiles were different from those of feed. Upon transfer to seawater, a marked shift occurred, with *Aliivibrio* and *Colwellia* emerging as dominant genera. Despite environmental input, several core taxa persisted across both habitats, suggesting symbiotic resilience. Our results highlight the dual influences of diet and environment on microbiota assembly, moderated by host selection. These sensitive microbial transitions coincide with ecologically critical stages and may serve as biomarkers of stress or performance under warming conditions. Given the recent decline in chum salmon stocks in regions like Sanriku, Japan, this microbiome-based insight provides a timely perspective on how ocean warming may alter fish health and survival during early development.

S11, Oral, AbstractID=18414, (ECOP)

Experimental evaluation of the complex linkages between early growth and survival in pelagic fishes

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The effects of early growth rate on survival in pelagic fishes have been found to be unexpectedly complex, and the conventional assumption of a simple positive relationship—i.e., faster growth leads to higher survival—does not always hold. We have investigated the underlying mechanisms behind this complexity through rearing experiments using pelagic fish species. Our research on chub mackerel (*Scomber japonicus*) revealed that early growth rate influences the development of various traits at the juvenile stage—independent of body size—including locomotor performance (burst speed), external morphology (muscle area, eye diameter), and tissue development (brain size). Moreover, a negative correlation was found between larval growth rate and final body size, indicating that growth during the early larval stage can influence lifetime growth trajectory. To examine whether these relationships are temperature-dependent, we conducted rearing experiments on Japanese anchovy (*Engraulis japonicus*) under five temperature conditions (16°C, 19°C, 22°C, 26°C, and 28°C) and analyzed the temperature reaction norms of morphological and behavioral traits in relation to early growth rate. Similar to chub mackerel, a positive correlation between burst speed and growth rate was observed in anchovy, but only at 22°C. Furthermore, across all temperatures, a trade-off was evident between growth rate and the sizes of eyes and jaws. However, for other morphological traits, such as fin area, the presence and direction of growth effects varied with temperature, suggesting a more intricate relationship than previously anticipated. Based on these findings, we propose the following perspective: to improve the predictive capacity regarding the impacts of current and future climate variability on pelagic fish populations, it is essential to identify which factors should be considered—and how—through controlled experimental approaches.

S11, Oral, AbstractID=18489

Future climate impacts on early marine salmon growth in the California Current Ecosystem

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We use a "climate-to-fish" modeling framework to quantify 21st century climate change impacts on early-marine growth of juvenile Chinook salmon in the central California Current Ecosystem under a high emissions scenario. The approach couples a set of high-resolution, downscaled regional ocean projections with a fish bioenergetics model to predict future salmon growth potential in response to local changes in temperature and prey availability. Our analysis identifies contrasting early salmon growth responses depending on timing and latitude of ocean entry. At southern latitudes, fish entering the ocean later will experience a disproportionate reduction in growth potential in their first few months at sea relative to fish entering the ocean earlier than the current peak time of outmigration. At northern latitudes, end-of-the-century growth potential during the first few months at sea will be enhanced over the entire range of present-day outmigration times, and the frequency of anomalously good growth years is similarly projected to increase. While focused here on juvenile salmon, our "climate-to-fish" framework is adaptable to other species for which bioenergetics models exist and can thus provide broader insights into growth-mediated survival of early life marine fish in the California Current Ecosystem and elsewhere.

S11, Oral, AbstractID=18632

Larva proposes, current disposes: Larval distribution of two snow crab species (*Chionoecetes opilio* and C. japonicus) in the western Sea of Japan

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For marine benthic organisms, larval transport by oceanic currents plays a crucial role in their survival and in maintaining connectivity among local populations. The larval dynamics of snow crab (*Chionoecetes opilio*) and red snow crab (*C. japonicus*) have attracted considerable attention due to their ecological and economic importance in fisheries from the North Pacific to Arctic. In the western Sea of Japan, the distribution of three larval stages (1st and 2nd stage zoea, and megalopa) has been investigated, alongside laboratory experiments examining larval traits such as survival, growth and behavior under varying environmental conditions. However, an integrated interpretation of these findings has yet to be established. To provide a comprehensive overview of the early life stages of the two snow crab species in this region and to explore factors contributing to stock fluctuations, we employed multi-layer plankton sampling and statistical modeling. A total of 1,293 depth layers across 205 sites were surveyed during 2006–2013 as part of the larval sampling. In addition, catch records from 275 depth layers at 25 sites in 1978 and 1979 were incorporated to supplement the zoeal stage data. We further applied a hierarchical Bayesian approach to the dataset to explain larval distribution, modeling both the potential larval density at each site and the depletion from this potential in response to deviations in temperature and bathymetry from their optimal values. The findings align with previous laboratory and field studies, outlining the early development of two snow crab species in the Sea of Japan: first-stage zoea drift near the surface (~<30 m, ~9°C) for about a month before molting and descending slightly deeper as second-stage zoea (mean: 48 m; 95% CI: 12–61 m). After molting into megalopa, they begin diurnal vertical migration below 200 m, where the optimal temperature drops to ~7°C in both species. In the western Sea of Japan, the Tsushima Warm Current (TWC) may facilitate downstream larval transport. However, the wide distribution of megalopa even after prolonged drift suggests more complex movement. Considering seasonal and depth-dependent variability in ocean currents, these species may control passive dispersal through vertical positioning. However, it is likely that broader oceanographic conditions ultimately shape their population dynamics as the strength of the warm water current that retains larvae within the putative spawning area appears to be associated with recruitment success.

S11, Oral, AbstractID=18685, (ECOP)

Temporal and spatial overlap between larval northern anchovy (*Engraulis mordax*) and their zooplankton prey

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Given widespread taxon-specific distribution shifts resulting from climate change, there is a need to better understand how variability in the temporal and spatial overlap of consumers and resources influence consumer fitness. In the northern California Current (NCC), larval northern anchovy phenology and distributions are altered by environmental changes, such as recent marine heatwaves. Variable environmental conditions also influence the abundance of zooplanktonic prey, leading to potential mismatches in the occurrence of anchovy larvae and their prey. To assess the influence of consumer-resource overlap on northern anchovy recruitment, the abundance of northern anchovy larvae in the NCC was monitored biweekly–monthly off Newport, OR, as well as annually–semiannually throughout the NCC, during 1996–2024. We used hindcasts of environmental conditions from the LiveOcean and GLORYS12V1 regional ocean models to construct a species distribution model, which we cross-validated and used to hindcast spatially- (1/12° horizontal resolution) and temporally- (daily resolution) explicit larval northern anchovy abundance within the NCC during 2013-2023. We quantified the annual degree of overlap between hindcasted northern anchovy larvae and zooplankton for these same years. This overlap between consumer and resource was then related to annual adult northern anchovy abundance. Across long time-series (e.g., 11 years), such an index of consumer-resource overlap can provide insight into one mechanism by which changing oceanographic conditions may influence fish recruitment.

S11, Oral, AbstractID=18691

Modeling climate change impacts on anchovy larval growth and survival in Korean waters

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Marine ecosystems are rapidly changing due to climate warming, altering the distribution, growth, and survival of marine species. Understanding species- and stage-specific responses is essential for sustainable fisheries management. In Korean waters, anchovy (*Engraulis japonicus*) is an ecologically and commercially important species, highly sensitive to temperature variability. In this study, we developed two individual-based models using a Lagrangian TRANSport Model and a Dispersal Model for Early Life Stages, incorporating temperature-dependent growth equations to simulate the growth and survival of anchovy larvae spawned in the South Sea of Korea from April to September. The models were driven by outputs from the Korea Regional Ocean Climate Model and applied to both a historical period (2010–2020) and future projections for the 2050s under two CMIP6-based climate scenarios: SSP1-2.6 and SSP5-8.5. Each simulation tracked individuals for 30 days from the egg stage, with survival determined by whether larvae remained within their species-specific thermal habitat range. Results indicated an overall decline in survival in the 2050s under both scenarios, with slight increases during April–June but notable decreases from July to September. Temperature-dependent growth also projected reduced growth rates and smaller body sizes in the 2050s compared to the historical period, especially during June–September. These findings suggest that even subtle warming may shift larvae outside optimal thermal conditions, reducing growth and survival. This study highlights the utility of temperature-dependent IBMs for forecasting biological responses to climate change and underscores the importance of climate-adaptive strategies for sustaining anchovy populations in Korean waters.

S11, Oral, AbstractID=18722, (ECOP)

Dispersal strategies of larval fishes in the central California Current: Implications for recruitment resilience under climate change

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Understanding how early life stages of fish respond to environmental variability is critical for predicting recruitment dynamics in the North Pacific, particularly under intensifying climate change. We examined the depth distribution and behavioral dispersal strategies of larval fishes in the central California Current during peak upwelling seasons across three years at Bodega Head and Stewarts Point (both in California, USA). Using multi-depth ichthyoplankton sampling along two cross-shelf transects, we tested the hypothesis that larval fishes exhibit species-specific, environmentally-cued, and ontogenetically variable depth preferences that regulate cross- and alongshore transport. Despite strong offshore transport forces, over 75% of larvae from 51 taxa remained within 6 km of shore, demonstrating significant behavioral retention. Larvae from different taxa showed diverse responses to upwelling: some remained below the mixed layer, others conducted vertical migrations, and several utilized surface transport to move shoreward. These findings reveal a high prevalence of depth-regulated dispersal behavior among nearshore species. Incorporating these behavioral traits into biophysical and individual-based models will enhance predictions of larval connectivity, recruitment variability, and the resilience of fish populations to novel oceanographic conditions, including climate-driven changes in ocean circulation. This work underscores the importance of species-specific early life history traits in shaping population outcomes under future climate scenarios in the North Pacific.

S11, Oral, AbstractID=18726

Shifting phenology in a warming ocean: Temporal and spatial variability in hatching of Pacific Cod in the northern Gulf of Alaska

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The Gulf of Alaska (GOA) has experienced marine heatwaves (MHWs) that impacted the reproductive phenology of Pacific Cod. We built upon prior research to determine if hatch phenology returned to pre-heatwave conditions and examine how hatch phenology varied across the GOA. Juvenile Cod were collected from bays in four regions (Eastern Kodiak, Kaiugnak Bay, Agripina Bay, and Western Gulf) across 15 years, categorized as "before" (2007, 2009, 2010, 2012-2014), "during" (2015-2017, 2019), "adjacent" (2018, 2020), and "after" (2021-2023) MHWs, and hatch dates were estimated with otolith increment analysis. For Eastern Kodiak, hatch dates shifted two weeks earlier during MHWs but, in years adjacent to MHWs, hatch dates were another 1-2 weeks earlier. After MHWs, hatch dates were 7-10 days earlier than before MHWs, indicating a return towards pre-MHW patterns. However, the duration of hatching expanded, shifting from ~2 months before, during, and adjacent to MHWs to ~3 months after MHWs. Other sites followed a similar trend, but there was a clear spatial trend with hatch dates progressively later at more western sites, which were also cooler. Hatching occurred ~1 month later in the Western Gulf compared to Eastern Kodiak and the duration of hatching did not expand at western sites. Hatch success, predicted using temperature-dependent embryonic survival rates, varied temporally, with hatch success < 75% during MHWs at Eastern Kodiak, and spatially, with longer durations of high hatch success in the Western Gulf. Marine heatwaves may have altered the landscape for selection, resulting in more protracted spawning in some areas.

S11, Oral, AbstractID=18741

Assessing the spawning migration history of southern flounder (*Paralicthys lethostigma*) based on otolith microchemistry

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Southern flounder (*Paralichthys lethostigma*) historically has been the most valuable finfish fishery in North Carolina, USA but, following several years of low recruitment, this species has been classified as overfished. While this species is estuarine dependent as a juvenile, southern flounder migrates offshore to spawn. Little is known about their spawning migration or the whereabouts of southern flounder eggs and larvae in offshore waters, resulting in key questions related to the appropriate spatial scale for fisheries management. Recent evidence from the southern flounder population in the Gulf of Mexico suggests that skip spawning and/or partial migration may be common, but no information is available on whether similar behavior occurs among the Southeastern USA population. To better understand the migration history of this population, we analyzed the otolith microchemistry of 297 specimens collected from four estuarine and offshore locations over two years to track exposure to marine conditions. When examining the distal edge of the sagittal otoliths of these fish, we were able to differentiate between locations where specimens were collected both on a multivariate basis and when solely considering $^{88}Sr:^{44}Ca$ ratios. When data were averaged across sampling events, $^{88}Sr:^{44}Ca$ ratios were able to explain 68% of the variance in salinity at sites where samples were collected. Consequently, we were able to use $^{88}Sr:^{44}Ca$ as a biomarker of previous exposure to oceanic salinities, allowing us to trace the migration histories of individual fish. Among age 2+ flounder captured in commercial pound nets in estuaries, nearly two-thirds had never traveled offshore to spawn based on this proxy. This percentage was higher for age-2 males than females, likely reflecting the slower growth rate of males in this sexually dimorphic species. Even among age 3-4 fish, only 33.3-41.7% of individuals displayed evidence of offshore migration, suggesting that partial migration or delayed spawning may be common. Lastly, fish caught at the same site on the same date showed diverse migration histories based on $^{88}Sr:^{44}Ca$ ratios indicating a high degree of individual variability.

S11, Oral, AbstractID=18750, (ECOP)

Application of deep learning for identification and measurement of zooplankton and fish eggs

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The monitoring and study of fish early life stages and their zooplankton prey are critical for ecosystem-based management of fisheries. However, counts, taxonomic classification, and size estimates of plankton are currently done by humans using labor-intensive and time-consuming laboratory methods. Data production often lags important management decisions due to this bottleneck. Improvements in computational resources and the development of deep learning image processing models have the potential to increase the efficiency, scalability, and precision of plankton data production. Here we demonstrate two image processing pipelines for this purpose: a fish egg and a zooplankton model. The pipelines link image annotation, object detection and classification of microscopy images using the YOLOv7 model, providing data products in the form of counts, classifications, and size measurements. The fish egg object detection model automates the identification and quantification of eggs from Walleye Pollock (*Gadus chalcogrammus*) and Arctic Cod (*Boreogadus saida*), which are commercially and ecologically important species that co-occur in the Bering Sea. The model also annotates developmental egg stages to facilitate back-calculation of spawn timing estimates. The zooplankton model provides taxonomic identification across a broad range of classes and automates size measurement. The application of deep learning image processing tools and pipelines promises powerful new tools for ecosystem scientists to both accelerate existing workflows and produce plankton information that may be applied to management more rapidly and efficiently.

SESSION 11: FIS/BIO Topic Session

Applying Innovative and Established Approaches to Assess the Resilience of the Early Life Stages of North Pacific Fishes to Changing Oceanographic Conditions

Poster Presentations

S11, Poster, AbstractID=18213, PosterID: S11-P1, (ECOP)

Hydrodynamic dispersal and population structure of the prowfish (*Zaprora silenus*) in the North Pacific

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Presented by Anna Kurnosova behalf of Mariia Kolobukhova

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The prowfish (*Zaprora silenus*) is the sole representative of the family Zaproridae. This eurybathic species is widely distributed across the northern Pacific Ocean—from the coast of California and the Bering Sea to Kamchatka and Hokkaido, including the Sea of Okhotsk. In this study, based on data collected during scientific and commercial surveys conducted by TINRO from 1963 to 2024, we analyzed the spatial distribution and size composition of prowfish. The results confirm the species' characteristic biphasic life cycle: larvae and juveniles inhabit the upper pelagic zone and, upon reaching a length of 35–50 cm, transition to a demersal lifestyle. The absence of juvenile prowfish in the pelagic waters of the western part of the range (Bering Sea, Sea of Okhotsk, and the northwestern Pacific Ocean) suggests that the Gulf of Alaska may serve as the species' sole spawning center. Geographic distribution patterns indicate that oceanic currents play a key role in transporting juveniles beyond the Gulf. The Alaskan Coastal Current and its extension, the Alaskan Stream, flow westward along the shelf and through the Aleutian passes into the Bering Sea. These currents likely carry juveniles from the spawning grounds in the Gulf of Alaska along the eastern coast of Kamchatka, southward into the Sea of Okhotsk, and further into the northwestern Pacific. Therefore, pelagic prowfish found in the Bering and Okhotsk seas and the northwestern Pacific are migrants transported by these currents from the central spawning area. After settling to a demersal lifestyle, they do not contribute to local reproduction. These findings highlight the key role of hydrodynamic processes and a single spawning center in shaping the population structure of prowfish.

S11, Poster, AbstractID=18309, PosterID: S11-P2, (ECOP)

Growth and starvation tolerance in reared Japanese anchovy *Engraulis japonicus* larvae

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Starvation is assumed to be a significant cause of mass mortality for fish larvae, which may influence year-class strength. Although faster-growing larvae are considered to have higher probabilities of survival ("growth–survival" paradigm), some studies suggested a possibility of "growth–survival trade-off". Starvation tolerance has not been well understood in relation to growth rate. In the present study, we examined growth and starvation relationship in reared Japanese anchovy *Engraulis japonicus* larvae. Larvae were obtained from the captive broodstock. The larvae were transferred to 1 L beaker at different timings to cover wide ranges of age and somatic size. They were reared at 22°C under non-fed condition and their survival time was recorded. After starvation experiments, standard length and growth rate at the time of start of starvation were estimated by otolith microstructure analysis. The starvation tolerance increased with age. At the same time, the variability of starvation tolerance also increased with age. Similarly, larger larvae exhibited higher starvation tolerance. On the other hand, growth rate *per se* was not related to starvation tolerance. These findings suggest that growth rate may play a secondary role in starvation tolerance, acting primarily through its effect on somatic size.

S11, Poster, AbstractID=18310, PosterID: S11-P3, (ECOP)

Feeding ecology of flathead grey mullet and longspine snipefish larvae and juveniles in the Kuroshio Current region in winter

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The Kuroshio Current region provides major spawning and nursery grounds for commercially important fish species such as Pacific saury *Cololabis saira* in winter. In this region, larvae and juveniles of non- or less commercially important fish species such as flathead grey mullet *Mugil cephalus* and longspine snipefish *Macroramphosus scolopax* are also densely distributed. In the present study, we examined feeding ecology for larvae and juveniles of flathead grey mullet and longspine snipefish to consider any possibility of their trophic competition in the Kuroshio Current region. Gut content analysis was conducted for the larvae and juveniles collected by a neuston net during the egg and larval surveys in the Kuroshio Current region during February and March 2022. The number, mean size, and carbon weight of prey items as well as prey composition were compared among the species and areas. Both species mainly fed on copepods (particularly calanoid copepodites) in general, whereas longspine snipefish mainly fed on planktonic gastropods in some areas, suggesting their flexibility of feeding in response to the environment. There may be a possibility of trophic competition in some areas, since flathead grey mullet did not feed on calanoid copepodites sufficiently in comparison to longspine snipefish. On the other hand, longspine snipefish may avoid feeding competition by shifting their diet to planktonic gastropods. Furthermore, these two species may be potential feeding competitors for Pacific saury, which mainly feed on copepods. Further studies on spatiotemporal variability in their feeding ecology would enable testing the hypothesis of trophic competition.

S11, Poster, AbstractID=18334, PosterID: S11-P4, (ECOP)

Latitudinal differences in Age at First Maturity of largehead hairtail (*Trichiurus japonicus*) under climate change

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The largehead hairtail (*Trichiurus japonicus*) is the ecologically and commercially significant fishery resource in the China Seas, characterized by broad distribution, seasonal migration, extended spawning periods, and high commercial value. Despite persistent overfishing, capture yields continue to increase, and this trend potentially linked to altered recruitment dynamics due to early life history changes. Studies indicate that chronic high fishing pressure and climate change have driven shifts in the species' life history traits, including earlier maturation, reduced body size, and simplified age structures. Age at First Maturity (AFM), alongside mortality, fecundity, and size at maturity, constitutes a fundamental life history strategy parameter. Consequently, understanding AFM variation is critical for predicting climate impacts and developing appropriate management strategies for this overexploited species. This study systematically investigated AFM divergence between temperate (Bohai Sea) and subtropical (East China Sea) populations and identified key environmental drivers. Integrating otolith microstructure analysis with probabilistic maturation reaction norms (PMRNs) and gradient forest modeling revealed that the Bohai population matured earlier than the East China Sea population, primarily driven by sea bottom temperature (SBT). These findings provide information about the early life history of the largehead hairtail in China Seas, as well as help for its stock assessment and sustainable utilization.

S11, Poster, AbstractID=18458, PosterID: S11-P5, (ECOP)

Morphological development and its relationship to feeding habits in juvenile *Sebastes cheni*

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Juvenile *Sebastes cheni* are a dominant species in seagrass (*Zostera marina*) and macroalgal (*Sargassum* spp.) beds in Japan from early spring to summer. As they grow, they are thought to shift their diet from smaller prey items such as copepods to larger ones like amphipods. In general, body size of the predator is the most important factor causing the shift of prey, but other factors such as seasonal changes in prey availability may play an important role in the shift. Here, this study aimed to clarify the factor causing the diet shift in *S. cheni*. Analysis of stomach contents from juveniles collected from macroalgal beds between March and June 1, 2023, showed that copepods were consistently the dominant prey item. Thereafter, in individuals collected on June 29 and July 14, amphipods were more frequently observed, with the proportion of amphipods being higher on July 14. Notably, this dietary shift was observed even in individuals of similar total length. Measurements of eye diameter and mouth size (vertical and horizontal) of *S. cheni* showed significant positive allometric growth from June 1 through July 14. These results suggest that seasonal increases in mouth and eye sizes may be associated with shifts in primary prey items. We will also discuss the potential mechanisms underlying the seasonal variation in feeding-related morphological traits.

S11, Poster, AbstractID=18541, PosterID: S11-P6, (ECOP)

Running the gauntlet: Assessing juvenile salmonid migrations in an urban nearshore environment with eDNA

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Nearshore fish communities are predominantly studied using beach seines and dive surveys, which involve ample training, time, resources, hazards, and limitations. Environmental DNA (eDNA) is an emerging alternative or supplemental methodology that can detect cryptic, evasive, and migrating species traditional methods often miss. This study, conducted in partnership with the Tsleil-Waututh Nation (TWN), occurred in their ancestral waters of Burrard Inlet, which surrounds the City of Vancouver (Canada). TWN conducts beach seining to monitor juvenile salmonids leaving the Indian River, a watershed of immense importance to the nation and the only in Burrard Inlet without an operating hatchery. Salmonid early marine outmigrations are a critical, high-mortality life stage that warrant further study, especially in urbanized environments where habitat degradation and pollution is rampant. Young salmonids require healthy nearshore habitat for food and shelter. We aim to identify these key habitats and interactions in an urban context. Paired eDNA and seine samples and additional monthly eDNA samples were collected between March and August 2024 to obtain spatiotemporal coverage across various nearshore habitat types throughout Burrard Inlet. Samples were metabarcoded with 12S MiFish-U and COI salmon-specific primers to elucidate fish communities. We detected a clear migration pulse of juvenile pink and chum salmon through the inlet and are generating occupancy models to determine important habitats and migration routes for these salmonids while also assessing community structure and possible interactions they may face. These findings will improve our understanding of nearshore fish habitat, migrations, and interactions, and inform coastal restoration and conservation priorities.

SESSION 12: FIS/BIO Topic Session

Understanding the Linkages Between Forage Species and Top Predators and How They May Affect Resilience in North Pacific Ecosystems

Oral Presentations

S12, Invited, AbstractID=18224

Pelagic forage fish and seabirds under the regime shifts: A case study in the western North Pacific

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The biomass and distribution of pelagic forage fish influence the diet and productivity of marine top predators (bottom-up regulation), while predation by the latter may impact populations of the former (top-down regulation). Patterns of these interactions may change under the different climatic regimes. In the western North Pacific, populations of sardine/anchovy showed large fluctuations associated with decadal-scale oceanic warm- and cold-regime oscillations. Rhinoceros Auklets, an abundant piscivorous diving seabird, responded to this fluctuation through the diet but maintained moderate to high chick productivity, while their predation on these major forage fish species was negligible. In the last decade, however, the auklets switched their diet periodically and frequently (<4 years) to low-energy alternative prey (age-0 greenling, sand lance or age-0 salmon). This recent alternation of the auklets' prey species resulted a periodical drop in their chick productivity. On the other hand, such a dietary switch may cause an intermittent increase in the predation rate on the alternative prey. This study suggests that the predation by the auklets on these alternative prey species are unlikely to impact the pelagic forage fish communities. Conversely, the current high interannual variability in the auklets' diet and productivity imply a concern about the resilience of the interaction between forage fish and seabirds.

S12, Invited, AbstractID=18421

Views from top predator fishes: Do top predator fishes decide their distribution by environment or forage species

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As fish species are basically ectotherms, their distribution is severely restricted by thermal condition. In addition, for predator fishes, it is very challenging to achieve positive energy balance when forage species are spatially and temporally heterogeneous. Therefore, predator fishes maintain a capacity for food-processing that exceeds average levels of consumption. Then, it is a big question how top predator fishes decide their distribution under a tradeoff between sever thermal restriction and heterogeneous forage availability. We investigated the relationship between mesoscale eddy distribution and the AIS (automatic identification system) derived global fishing activity. As a result, it was revealed that tuna tend to prefer anti-cyclonic eddies than cyclonic eddies in the mid-latitudes because higher oxygen concentration and warmer temperature could elongate their feeding on forage species in the intermediate layers. The tendency is common for squids in the mid-latitudes, but squids prefer cyclonic eddies in the tropics possibly because of the forage scarcity in the tropical regions. Above results indicate the importance of forage species for the distribution of predators. This hypothesis is also supported by a fact that the prediction accuracy of Spanish mackerel distribution was improved by the input of anchovy distribution. In situ environmental DNA observation also revealed that the distribution of chub mackerel is severely restricted by anchovy distribution. Those results are published in Fish and Fisheries (doi:10.1111/faf.12818), Science of The Total Environment (doi:10.1016/j.scitotenv.2024.175211), Deep Sea Research Part-II (doi:10.1016/j.dsr2.2022.105227), Frontiers in Marine Science (doi:10.3389/fmars.2023.1121088).

S12, Oral, AbstractID=18305

The yearly changes of prey species and prey consumption by common minke, sei and Bryde's whale in the western North Pacific since 2000

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Baleen whales feed on a variety of prey from small zooplankton to fish, playing an important role in the food web in the western North Pacific because of their large biomass. Although these three baleen whale species occur in the western North Pacifc, their feeding habits and distribution differ. The main purpose of this study was to clear the yearly changes of distribution and prey species and estimate the amount of fish resources consumed by the three baleen whale species, accounting for some uncertainties since 2000. For three baleen whale species, the most dominant prey species was Japanese anchovy between 2000 and 2007. However, the occurrence of Japanese anchovy in stomach contents was decreasing since 2012. On the other hand, the occurrences of Japanese sardine and mackerels in stomach contents were increasing. This phenomenon coincided very well with changes in the distribution of prey species. The seasonal prey consumptions by common minke whales *per* year in the 2000-07 and 2008-2016 periods were 79 thousand tons and 67 thousand tons *per* year, respectively. The seasonal prey consumptions by sei whales *per* year in the 2000-07 and 2008-2016 periods were 572 thousand tons and 451 thousand tons *per* year, respectively. The seasonal prey consumptions by Bryde's whales *per* year in the 2000-07 and 2008-2016 periods were 516 thousand tons and 802 thousand tons *per* year, respectively. The consumptions of Japanese anchovy by three baleen whale species in the 2000-07 and 2008-2016 periods were 754 thousand tons and 565 thousand tons *per* year, respectively. There is a need to understand the potential for each whale to have an impact on marine ecosystem, either directly or indirectly using simulation models for specific geographical regions.

S12, Oral, AbstractID=18348, (ECOP)

Effects of noise on Pacific sand lance *Ammodytes personatus* with implications for their avian predators

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As anthropogenic noise continues to grow throughout the world's oceans its effects on fish have increasingly become an area of concern as they are both economically and ecologically important. Forage fish, as they often play a central role in transferring energy from lower to higher trophic levels in the marine food web, are a critical resource for many marine species. However, although noise is known to have negative effects on many fish species, information about how noise affects forage fish condition and behavior remains scarce. Research suggests that noise may affect both the behavior (availability) and condition (quality) of forage fish like Pacific sand lance, *Ammodytes personatus*. Pacific sand lance are unique as they bury in the sand both short-term (hours in summer) and long-term (months in winter) making them inaccessible to predators. To understand how noise affects Pacific sand lance quality and availability as prey in summer, and if winter dormancy buffers them against potential effects, we captured Pacific sand lance and exposed them to anthropogenic noise in summer and winter. We found that fish in control conditions were higher quality and that fish in all treatments varied in their accessibility compared to controls in summer. During winter dormancy fish showed fewer negative effects of noise on quality, though some differences still remained. These results suggest that noise may indirectly affect the seabirds that rely on these fish by lowering Pacific sand lance quality and altering their availability in the summer when they are most important to breeding seabirds.

S12, Oral, AbstractID=18411

Feeding habit of adult Pacific bluefin tuna in the Sea of Japan

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The Pacific bluefin tuna *Thunnus orientalis* is known as a highly migratory species and functions as an apex or near-apex predators, contributing to energy transfer across oceanic regions. Therefore, understanding their feeding habits is essential for elucidating its ecological role in the marine ecosystem. The diet of adult Pacific bluefin tuna (range: 97-216 cm fork length: FL) in the Sea of Japan during the spawning season (June to July) from 2017 to 2024 was assessed from stomach contents. Feeding intensity and prey composition differed by size and fluctuated interannually. Values of %IRI (percentage of the Index of Relative Importance) showed that the top prey for the size classes >140 cm FL and 100-140 cm FL were Japanese common squid *Todarodes pacificus* and small teleost fishes (mostly Japanese anchovy *Engraulis japonicus*), respectively. In particular, %IRI for Japanese common squid has decreased since 2022, which has corresponded with a decline in the stock of this species. Conversely, the consumption of Japanese anchovy and Japanese sardine *Sardinops melanostictus* has increased, suggesting that Pacific bluefin tuna may be considered as opportunistic feeders.

S12, Oral, AbstractID=18430, (ECOP)

A counter-intuitive fishery response to climate-driven forage dynamics: The bigeye paradox in the Pacific Ocean

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The mechanisms by which large-scale climate oscillations such as the El Niño-Southern Oscillation (ENSO) impact tropical tuna fisheries remain incompletely understood. This study undertakes a systematic analysis to characterize the statistical linkages between these climate indices, modeled micronekton prey, and nominal catch-per-unit-effort (CPUE) from drifting Fish Aggregating Device (FAD) fisheries in the Western Central Pacific Region. While yellowfin and skipjack tuna revealed relatively direct trophic linkages, the exploration uncovered a paradoxical relationship for bigeye tuna (*Thunnus obesus*). Bigeye CPUE exhibits a consistent negative spatial association with core areas of high nocturnal forage availability—a phenomenon termed here 'the Bigeye Paradox'. This inverse relationship persists even after accounting for the linear influence of climate drivers and is strong enough to render the statistical significance of ENSO non-significant within the model. Such a finding suggests the paradox is not a simple environmental artifact but rather points to complex, fishery-mediated dynamics. Characterizing this phenomenon generates new, testable hypotheses regarding mechanisms like prey dilution or strategic fleet behavior. Ultimately, these results underscore that effective ecosystem-based management must account for the active role of fisheries in modulating, and in some cases inverting, the expected responses to climate-driven ecosystem changes in the Equatorial Pacific.

S12, Oral, AbstractID=18445, (ECOP)

Foraging traits reveal climate-driven variability in albacore tuna resources in the NE Pacific

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Understanding how predators respond to variations in prey assemblages is critical to forecasting future population dynamics and food-web functioning. Prey traits (habitat, behavior, morphology, nutrition) are emerging as important factors driving predator consumption and predator-prey dynamics. Trait-based frameworks can help simplify complex foraging dynamics, highlighting recurring characteristics across diverse taxa consumed by predators across ocean basins. We used such a framework to understand resource use by and availability for albacore tuna (*Thunnus alalunga*), a species targeted by pelagic fisheries globally that has undergone recent shifts in distribution with climate in the NE Pacific. Applying traits to historical juvenile albacore diet and prey community composition revealed that consistent trait forms are selected across time and space in the California Current System (CCS). We use these trait-based insights as a tool to facilitate short-term predictions and future projections of prey availability for albacore in the CCS under climate change. We first apply these key traits to 15 years of forage community composition to aggregate taxa across shared functional roles relevant to the predation process. We then identify hotspots of prey with desirable traits for albacore and relationships with environmental conditions to develop early-season forecasts of prey distributions. We ultimately explore the utility of a traits-distribution model representing prey, coupled with thermal constraints to provide insights into the unpredictable albacore distributions in the CCS. This enhanced understanding of albacore prey will help anticipate the impact of changes in prey assemblages on predator productivity and distribution as pelagic communities are altered by climate change.

S12, Pre-Recorded-Oral, AbstractID=18554, (ECOP)

Ecological importance of forage groups in the pelagic ecosystems of the subarctic Pacific

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The open subarctic Pacific Ocean provides a crucial feeding ground for numerous predators, most notably salmon (*Oncorhynchus* spp.). Small fish and squid mediate energy flow from zooplankton to these predators. This paper employs mass-balance ecosystem modelling in Ecopath with Ecosim to investigate the trophic roles of forage species in the open subarctic Pacific. Two models were parameterized for open Pacific waters north of 45ºN and seaward of the 1 km isobath, with the boundary between model domains (i.e. PICES areas ESA and WSA) at 170ºW. The SURF key forage fish index and ecological network analysis, including keystoneness indices and mixed trophic impacts (MTIs), were applied to Ecopath food web snapshots to quantify the trophic roles of forage groups. Hindcast and forecast simulations were conducted in Ecosim to examine the impacts of whale population recovery on forage taxa. The SURF index showed that mesopelagic fish and especially micronektonic squid serve as key forage groups across models, with the latter additionally exhibiting high keystoneness. MTIs revealed that mesopelagic fish and particularly micronektonic squid exert strong bottom-up and top-down impacts on higher predators and large zooplankton, respectively, in a pattern reminiscent of wasp-waist control. MTIs also indicated that mesopelagic fish and micronektonic squid mediate interspecific competition among salmonids. Simulations found that baleen whale population recoveries may adversely impact Pacific saury (*Cololabis saira*), an important forage fish, in the western North Pacific. These findings illuminate the key trophic roles of forage groups in the pelagic ecosystems of the subarctic Pacific Ocean.

S12, Oral, AbstractID=18699, (ECOP)

Establishing baselines, risks, and mechanisms of thiamine deficiency in British Columbia Chinook salmon

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Chinook salmon (*Oncorhynchus tshawytscha*) accumulate large amounts of lipid during their time at sea. This stored marine energy is necessary for their long spawning migrations, but also makes them a high value prey for resident killer whales. Despite the significance of their lipid accumulation, little is known about its ocean or trophic drivers. In this study, we sought to resolve this question with an inter- and intra-annual analysis of lipid levels of four populations of Fraser River (British Columbia, Canada) Chinook salmon with known differences in mean lipid content (Fall-4_1, Summer-4_1, Summer-5_2, Spring-5_2). First, we measured lipid content of returning adult Chinook salmon over three years (2020-2022). A subsample of Chinook from 2020 and 2021 were collected for bulk carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) and compound specific amino acid (CSIA-AA) stable isotope analysis. All sampled Chinook were genetically stock identified. We analysed the effect of size, bulk isotope signatures, and CSIA-AA calculated trophic level on lipid levels between and within each of the four Chinook populations for 2020 and 2021. We then measured mean population lipid over the three-year study and correlated these data with large scale climatic variables. Our presentation will examine the interannual comparison between 2020-22. Preliminary results from the intra-annual comparison indicate no effect of size or trophic level on Chinook salmon lipid content. Lipid content was negatively correlated with $\delta^{13}C$, implying high lipid Chinook resided in colder or more offshore waters. Our results may have important implications for Chinook marine energy accumulation in a changing ocean climate.

S12, Oral, AbstractID=18702

Predation impact on early life stages of Northern anchovy by juvenile salmon in the eastern North Pacific Ocean

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Although predation is thought to be the major limiting factor in fish recruitment, there have been few studies examining the effects of predators on prey populations. Juvenile Chinook and coho salmon are highly piscivorous (60-90% of their diets by weight) in their first summer at sea and are likely to be one of the most important fish predators on larval and juvenile fishes in coastal waters. The aim of this study was to examine the consumption of larval and juvenile Northern anchovy (*Engraulis mordax*) prey by Chinook and coho salmon in coastal regions of the Northern California Current (Oregon and Washington) by: 1) examining proportions of the anchovy prey in the diets of each predator by season and year and comparing these to available anchovy from contemporary pelagic trawl sampling, 2) comparing sizes of anchovy prey consumed relative to available sizes, and 3) estimating overall anchovy consumption by coho and Chinook salmon using bioenergetics modeling. Juvenile anchovies were the dominant prey consumed in late summer and fall over a seven-year period (2005-2011). Chinook salmon had higher consumption rates than coho salmon in every year examined. Anchovy prey ranged from >10 mm to <100 mm, and size-selectivity of anchovy prey varied by oceanographic regime. Consumption rates of anchovy by Chinook and, to a lesser extent, coho salmon indicated that a substantial portion of the population was consumed over the years examined and suggest that predation may be a factor in regulating anchovy survival in some years.

S12, Oral, AbstractID=18707, (ECOP)

Population-level survival impacts of Harbour seal predation on juvenile Pacific salmon, and the mechanistic links

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Harbour seals (*Phoca vitulina*) in British Columbia have experienced exponential population growth in the past four decades, after rebounding from previously low levels. Coincident with seal population growth, numerous stocks of Pacific salmon have faced persistent declines in productivity. Research has found strong negative associations between pinniped abundance and salmon productivity, but the precise influence of predation by top predators on salmon survival is difficult to elucidate given the diversity of mortality sources salmon face during their marine phase. Juvenile salmon may not classically be considered forage fish, but their trophic position and smolt migration puts them at similar risk to ecological factors as other forage species. Our work aims to assess the impact of a growing Harbour seal population on smolt outmigration survival. We compare the relative contribution of seal predation mortality to a suite of environmental and ecological factors impacting juvenile salmon survival using multivariate stock-recruit models of Fraser River sockeye (*Oncorhynchus nerka*), coho (*Oncorhynchus kisutch*), Chinook (*Oncorhynchus tshawytscha*), and chum (*Oncorhynchus keta*). Because seals are opportunistic foragers, another consideration when using coarse spatiotemporal overlaps to understand patterns in salmon productivity with stock-recruit models, is to explore how seal foraging at smaller scales translates to population-level effects. Therefore, we use diet information from spatiotemporal ecosystem model outputs, and empirical diet data from scat sampling, to further explain the mechanisms underlying our population models. Our results, using an integration of models and data types, aim to clarify the role that seal predation plays in juvenile salmon marine survival.

S12, Oral, AbstractID=18713

Temporal shifts in salmon-killer whale synchrony reveal complex predator-prey linkages

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Fish-eating killer whales (Southern Residents) are thought to closely track the seasonal availability of Chinook salmon (*Oncorhynchus tshawytscha*) in the Salish Sea (British Columbia), but recent shifts in whale presence suggest a more nuanced relationship. We analyzed interannual patterns in killer whale sightings (2010–2023) alongside abundance indices for Chinook and other salmonids from the Fraser River's Albion Test Fishery to assess how tightly whale presence is linked to prey availability. Our results show that the killer whales consistently tracked seasonal returns of Chinook, particularly in late summer and early fall, with moderate to strong correlations in most years. However, we also found increased whale presence during late fall, coinciding with the return of an important secondary prey—chum salmon (*O. keta*). In addition to these direct linkages, we found a minor springtime alignment with Pacific herring (*Clupea pallasii*) which may aggregate Chinook near spawning sites—and a negative association between pink salmon (*O. gorbuscha*) abundance and killer whale presence in July of odd-numbered years when huge pink returns may interfere with Chinook detection. Collectively, our findings suggest that both direct and indirect forage cues shape southern resident killer whale distributions, revealing that they respond to a broader prey landscape than previously recognized. These results highlight the complexity of predator-prey linkages and underscore how the timing and composition of available forage are critical to interpreting temporal changes in whale presence and informing effective conservation actions.

S12, Oral, AbstractID=18727, (ECOP)

Post-release predation on hatchery-reared spotted halibut (*Verasper variegatus*) monitored using acoustic predation tags

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The spotted halibut (*Verasper variegatus*), a rare and commercially valuable flatfish in the coastal waters of Japan, has been subject to stock enhancement programs. However, little is known about the survival of hatchery-reared juveniles after being stocked in high densities, as is commonly practiced. Here, we estimated the effect of stocking density on the predation mortality of hatchery-reared spotted halibut using acoustic telemetry. In 2023 and 2024, a total of 160 hatchery-reared juveniles (95–109 mm in total length) were tagged with V5D transmitters (Innovasea, USA), which can detect predation events involving tagged fish. Each year, we conducted small-scale (SS: 40 tagged fish alone) and large-scale (LS: 40 tagged fish plus 8,500–10,000 untagged fish) release experiments. From detected predation events and movement patterns, we evaluated predation by three predator types: piscivorous fish, birds, and crustaceans. The number of tagged fish preyed upon by piscivorous fish was 4 (SS) and 6 (LS) in 2023, and 12 (SS) and 11 (LS) in 2024. For bird predation, the numbers were 4 (SS) and 10 (LS) in 2023, and 8 (SS) and 16 (LS) in 2024. For both predator types, Cox proportional hazards models indicated higher predation rates in LS compared to SS experiments ($p<0.05$). Predation by crustaceans was minimal (≤1 per experiment). These results suggest that piscivorous fish and birds were the primary predators of hatchery-reared spotted halibut. The higher predation observed in LS experiments may reflect increased predator foraging activity in response to the higher fish density at the release site.

S12, Oral, AbstractID=18729, (ECOP)

Food for thought: Using predators as samplers to identify foraging landscapes in the Gulf of Alaska

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Though species' habitat use is often correlated with environmental characteristics, few studies have quantified how predator distributions respond to localized prey densities. This is often due to a lack of spatially and temporally representative data for mid- and lower-trophic level prey. Through foraging, predator species can serve as voluntary samplers for prey and provide an opportunity to assess trends in prey abundance. We used readily available diet data from groundfish predators to to estimate distributions and densities of key prey throughout the Gulf of Alaska (GOA) _ a highly unpredictable and predator dominated ecosystem. We simultaneously modeled all prey using a joint species distribution model to quantify interspecific correlations and improve predictive skill for those taxa that are more rare. We modeled prey that commonly occurred in our predator diets which focused our analysis on euphausiids, non-pandalid shrimp (Caridea), pandalid shrimp (Pandalidae), crabs (Brachyura), and forage fish (Actinopterygii) as focal prey. Predator characteristics and environmental variables were included as predictor variables to capture variation in diet composition across predators and habitat use by prey. A predator-specific spatially varying coefficient was used to account for differences in prey consumption trends across the region. We also used spatial and spatiotemporal random effects to evaluatue foraging landscapes by tracking prey hotspots through time and space (1990 to 2023). Predicted distributions and densities can also be used as ecological covariates for essential fish habitat (EFH) models or competition and predation studies in the GOA, thereby advancing ecosystem-based management in a region with ever-changing community dynamics.

S12, Non-Scheduled-Pre-Recorded-Oral, AbstractID=18742

Interdecadal shifts in seabird distributions relative to the velocity of climate change in the Northeast Pacific Ocean: A long-term observational study

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Climate change is altering marine habitats, prompting shifts in the distribution of marine organisms as they seek to occupy preferred environmental conditions. This study examines whether seabird redistributions in the Northeast Pacific Ocean correspond to spatial displacements in sea surface temperature isotherms, also known as the velocity of climate change (VoCC). Using 47 years (1975–2021) of breeding season seabird observations archived in the North Pacific Pelagic Seabird Database, we applied Vector Autoregressive Spatio-Temporal modeling to analyze distributional changes for nine taxonomic groups. We assessed leading edge, range core, center of gravity, and area-occupied metrics, and related these to VoCC. Our results reveal substantial decadal variation in seabird distributions, particularly during two periods of major oceanographic change: 1991–2010, when isotherms shifted southeastward in the Gulf of Alaska, and 2001–2021, when isotherms shifted strongly northwestward in both the Gulf of Alaska and Eastern Bering Sea. Most seabird groups expanded their range eastward during the first period and shifted westward or northward during the latter. The magnitude of longitudinal shifts generally exceeded that of latitudinal shifts. Increased area occupied was noted for auklets, murres, and shearwaters in the Bering Sea, corresponding to northward leading edge movements. Our findings highlight complexity in seabird distributional responses to climate-driven habitat changes in the Northeast Pacific.

S12, Oral, AbstractID=18773

On recent increase of the pacific cod feeding stock in the northwestern Bering Sea

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Variations of the pacific cod feeding stock in the northwestern Bering Sea (EEZ of Russia) in 1999-2021 are analyzed. The autochtonous part of the stock is estimated by cohort analysis and the rest of the stock is considered as the fish migrated from the eastern Bering Sea. Prominent increasing of the cod abundance is observed since 2014 to 2019; this period is known by extreme warming in the Bering Sea, with mean monthly SST anomalies up to $+3^{o}$, twice decreased ice cover, and almost disappeared cold water pool at the bottom on shelf. The total feeding stock has exceeded $1.3 \cdot 10^{6}$ t in 2017. Taking into account that the allochtonous part prevails in the stock (80-90 %), this increasing is interpreted as strengthening of the cod northwestward migration from the eastern Bering Sea for feeding. The routes of migrations coincided with the streams of Bering Slope Current and Alaska Coastal Current, which encircled the cold water pool from two sides. The currents strengthening in 2014-2019 induced by prevailing southerly winds caused extreme heating of water and destruction of the cold water pool and promotes more active far-distance migration of cod. A hypothesis is proposed that the cod migrations are driven by northward transport of krill *Thysanoessa inermis* by these currents from the area of reproduction at the continental slope, accompanied by feeding migration of their main grazer — walleye pollock. The study results allow to optimize the cod fishery in the Bering Sea for comprehensive utilization of this strongly fluctuating stock.

SESSION 12: FIS/BIO Topic Session

Understanding the Linkages Between Forage Species and Top Predators and How They May Affect Resilience in North Pacific Ecosystems

Poster Presentations

S12, Poster, AbstractID=18701, PosterID: S12-P2, (ECOP)

Inter-specific overlaps of foraging sites and diet in three sympatric seabirds breed in Tai Island, Tsugaru strait, Japan

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Sympatric seabirds might face inter-specific competitions especially around its colony. It is important to understand their ecological niche partitioning / sharing among coexisting multi-specie. In this study, we compared foraging site selection by GPS-logger and ship-based survey data, and prey selection by bill-loads or regurgitation analysis in the three sympatric seabirds, during the breeding season, Rhinoceros auklet; RHAU, *Cerorhinca monocerata* (diving forager) and Black-tailed gull; BTGL, *Larus crassirostris* (surface forager), Slaty-backed gull; STGL, *Larus schistisagus* (surface forager), breed in the same colony (Taijima island), Tsugaru Strait, Japan. Foraging areas of the BTGL and SBGL relatively overlapped near the colony and around coast line (UDOI = 0.25) but BTGL used slightly farther and offshore area than SBGL. SBGL tended spend most of time around coastal fishing ports. RHAU used more distant open ocean areas (UDOI <0.1). Ship-based survey also supported similar trends in the distribution of those species. Anchovy was the main diet in RHAU (FO% = 81.3%), but sardine in BTGL (FO% = 40.0%) and SBGL (FO% = 50.0%). In addition, anchovy did not occur from the SBGL but some demersal fish. Although, there were some overlaps in foraging location and diet among sympatric species, statistically detectable differences were found in each feature. This ecological difference might mitigate interspecific competition among sympatric species. The data was still insufficient, our results suggested that each seabird species would be impacted differently by the annual changes in the prey community in the surrounding waters, through the bottom-up effects, even at the same colony.

S12, Poster, AbstractID=18708, PosterID: S12-P3, (ECOP)

Continuous use of mesopelagic micronectons by coastal surface-feeding black-tailed gulls: A case study

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The Black-tailed gull *Larus crassirostris* is a coastal related, diurnal surface-feeding gull, breeding in the Far East region. Previous study revealed that Black-tailed gulls forage manly on pelagic fish species such as anchovy, sardine and sandlance. In this study, however, we found the continuous use of the deep-sea living mesopelagic micronekton species by Black-tailed gulls. We collected the stomach contents of the gulls from three islands in the Tohoku region, Nisaijima Island, Iwate (in 2019), and Bentenjima Island (in 2014, 2019, 2022 and 2023), Taijima Island (in 2022-2025), Aomori, Japan. We conducted conventional stomach content analysis and DNA analysis for detailed species identification for the samples. We also obtained GPS tracks from breeding the gulls. Though, the major prey species of the gulls in those islands were Japanese sardine *Sardinops melanostictus* or Japanese anchovy *Engraulis japonicus*, mesopelagic micronekton species such as Garnet lanternfish *Stenobrachius nannochir,* Spotted barracudina *Arctozenus risso*, Deep-sea Shrimp *Bentheogennema borealis* and mesopelagic living squid *Eogonatus tinro* appeared substantially especially in Nisaijima Island in 2019, IRI: 37%. In Bentenjima Island, IRI was low, lanternfish were observed continuously (except in 2022). But not in Taijima Island. The GPS tracks revealed that the gulls conducted trips not only to the coastal area, but also far pelagic area such as the area 800-3000 m in bathymetric depth in Nisaijima and Bentenjima islands. The tracks also revealed their substantial amount of night time trips during the study period. Those behavioral characteristics might be closely involved to their mesopelagic micronekton use.

S12, Poster, AbstractID=18771, PosterID: S12-P4, (ECOP)

Diet and foraging area selection of Rhinoceros auklet on Todojima Island, Hokkaido, Japan

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Seabirds, as marine top predators, adjust their diet and foraging site selection in response to changes in availability of prey items. We examined the diet, foraging site selection, and chick growth of Rhinoceros auklet *Cerorhinca monocerata* in 2018 and 2019 and 2024 at Todojima Island, the northern most colony in Japan. Previous studies suggested that availability of Japanese anchovy *Engraulis japonicus* for auklets crashed after 2014 and increase again from 2022 in the northern Sea of Japan, about 100 km south from the island. The auklets highly prefer anchovy as their chick diet, so we hypothesized that (1) auklets use cold-water masses to feed on cold-water fish in 2018 and 2019, and shift their foraging area to warmer southern area to feed on anchovy in 2024, and (2) chick growth would be better in years when anchovies more available. As predicted, most of their diet was cold-water living juvenile Japan sea greenlings *Pleurogrammus azonus* in 2018 and 2019, and anchovy dominated in 2024. Chicks growth was higher in 2024 than in 2018-2019, when auklets mainly fed on anchovies. However, their foraging locations were consistent during all the years at the cold-water area (SST; approximately 7°C) around the Soya Strait. In Todojima Island, the auklets might consistently use the cold-water masses around the colony because they could capture high profitable anchovies (and sandlance) even in the cold-water below the optimum temperature of anchovy (12 - 15°C) by wide expansion of anchovy distribution after 2022.

SESSION 14: MEQ/HD Topic Session

The Status and Future of Urban Oceans of the North Pacific – Pathways to Resilient and Sustainable Coastal Cities

ORAL PRESENTATIONS

S14, Invited, AbstractID=18267

Ecosystem modeling of Tokyo Bay for climate resilience and ecological restoration

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Tokyo Bay, a heavily urbanized coastal area, offers a unique opportunity to explore the interconnected dynamics of water, sediment, land and atmosphere. In this talk, I present an integrative approach using mathematical ecosystem models to evaluate Tokyo Bay's capacity to mitigate climate change and support marine ecosystem restoration. Shallow coastal waters like Tokyo Bay are increasingly recognized as critical zones for achieving both climate action and biodiversity conservation. The Global Risks Report 2025 by the World Economic Forum identifies environmental threats—such as extreme weather, biodiversity loss, and systemic Earth changes—as the top long-term global risks through 2035. In response, Japan has implemented its Sixth National Biodiversity Strategy (2023–2030), aligned with the Kunming-Montreal Global Biodiversity Framework, accelerating efforts to protect over 30% of terrestrial and marine areas by 2030 under the "30 by 30" target. This aligns with multiple Sustainable Development Goals (SDGs), especially SDG 14 (Life Below Water), SDG 13 (Climate Action), and SDG 17 (Partnerships for the Goals). Achieving these goals in urban coastal zones requires transdisciplinary collaboration across science, policy, industry, and communities. This talk addresses three key questions: Can Tokyo Bay serve as a key to marine resilience and climate mitigation? If so, to what extent? And how can we mobilize this potential? By combining mathematics with physics, biology, chemistry, and environmental science, we aim to develop ecosystem models that serve not only as analytical tools but also as platforms for stakeholder communication and collaborative policy planning.

S14, Invited, AbstractID=18318

Characteristics of macrozoobenthic community structure at natural and anthropogenically disturbed tidal flats along the highly urbanized Osaka Bay Coast, Japan

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Osaka Bay is a semi-enclosed bay system located at the eastern part of the Seto Inland Sea, western Japan. The inner bay is highly eutrophicated and the coastline is mostly reclaimed during past 100 years. In this presentation, we show the results of biological surveys focusing on benthic invertebrates conducted at eight tidalflats around Osaka Bay, which are characterized by different habitat types (e.g., natural tidalflat, reed marsh, rocky zone, seagrass beds, estuary, and anthropogenically regenerated coast). The results showed that the biodiversity of macroinvertebrates was distinctively low at the sites in inner Osaka Bay, where the community was predominated by few brackish and/or invasive species. We found that the surface water salinity was less than 20 in most of these areas since they were isolated from the main bay by reclaimed islands. Contrastingly, three natural tidalflats in southern portion of Osaka Bay (i.e., outer bay) maintained much higher diversity of benthic invertebrates including many threatened species, due to the high habitat diversity such as sandy tidal flats on open shore, seagrass *Zostera marina* beds, salt marshes, and mudflats in estuaries. Present results suggest that past reclamation works in inner Osaka Bay may negatively affect the diversity of macrozoobenthos in intertidal zones, through the loss of microhabitats and restriction of sea- and fresh-water exchange in the areas.

S14, Oral, AbstractID=18241, (ECOP)

Utilizing satellite imagery to monitor the spatial-temporal distribution of aquaculture activities in coastal areas

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Coastal aquaculture plays a crucial role in supporting global seafood protein supplies, particularly in China. In 2020, China accounted for approximately 60% of the world's aquaculture production, contributing significantly to global food security. However, the rapid expansion of aquaculture facilities has profoundly altered the natural environments of coastal zones, posing threats to the health and sustainability of coastal ecosystems. For instance, in Shandong Province, the area of aquaculture ponds expanded dramatically from 428 km² in 1986 to 2,012 km² in 2020, resulting in substantial losses of natural wetlands. Remote sensing has demonstrated strong potential for monitoring the spatial distribution and temporal dynamics of aquaculture activities at large scales. Medium-resolution satellite imagery, such as that from the Landsat and Sentinel series, has been widely utilized for this purpose. Meanwhile, high spatial resolution imagery offers enhanced capabilities for fine-scale management of regional offshore aquaculture. When combined with advanced classification models, these datasets enable the accurate extraction of individual aquaculture facilities from complex marine backgrounds. In this study, we identified over 40,000 oyster rafts in the offshore waters of Rushan City that had been largely overlooked in previous classifications based on medium-resolution imagery. These findings highlight the importance of selecting appropriate satellite data and classification techniques based on the spectral characteristics of different aquaculture methods to achieve accurate extraction of aquaculture infrastructure.

S14, Oral, AbstractID=18253, (ECOP)

Artificial seaweed on a fishing-port seawall restores abundance and diversity of marine amphipods in human-altered coastal areas

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Construction of marine structures negatively affects coastal ecosystems through modifying various properties of marine environments, leading to the decline in biodiversity and the degradation of multiple inherent ecosystem functions in coastal waters. Amphipods are one of the most taxonomically and ecologically diverse groups of crustaceans, and they are often numerically dominant in epifaunal communities in a variety of marine environments. Despite the critical roles of amphipods in marine ecosystems as secondary producer and ecosystem engineer, the influence of anthropogenic disturbance including marine constructions on amphipod assemblages has not been fully understood. In the present study, artificial seaweeds (ASs), which are suggested to function as a habitat for amphipods by our previous observation, were deployed on the existing seawall in a fishing port located in the northwestern coast of Hokkaido, Japan, and seasonal changes in abundance and composition of amphipod communities on AS and the seawalls were investigated over a one-year period. AS harbored more diverse amphipod communities (higher taxonomic richness and diversity index) than the surface of the proximate seawall of AS throughout the study period. Additionally, AS showed 1.9 to 12.1 times higher abundance of amphipods than the seawall from 6 months after the deployment, with the different dominant taxa (*Apocorophium* spp. and *Jassa* spp.) from those of the seawalls. The present study suggests that installing AS on marine structures such as seawalls can enhance the diversity and production of marine amphipods, potentially contributing to maintain the integrity of ecosystem function in anthropogenically modified coastal areas.

S14, Oral, AbstractID=18260 (ECOP) (CANCELLED)

Assessing water and sediment heavy metals with radiometric core dating for environmental reconstruction: A North African lagoon case study (Marchica Lagoon)

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Heavy metals in coastal ecosystems represent an environmental issue of concern especially in lagoons through agricultural effluent, urban effluent, and anthropogenic activity. In Marchica Lagoon, an integrated geochemical analysis of water-column and sediment revealed substantial spatial heterogeneity of metals. Sulfur (S), Strontium (Sr), and Boron (B) had their greatest concentrations in the sediments closest to the connection to the sea, while Aluminum (Al), Iron (Fe), and Silicon (Si) had their greatest concentrations in the sediment closest to the main freshwater sources. Some of the other trace elements of interest included Lithium (Li), Molybdenum (Mo), and Barium (Br) which formed separate hotspots elsewhere in the system. Sediments were also indicative of active partitioning of redox-sensitive metals such as Zinc (Zn), Copper (Cu), and Lead (Pb) between dissolved and particulate phases. Principal-component analysis and multivariate clustering showed chemically distinct zones highlighting the impacts of biogeochemical cycles of water and sediments on metal mobility and retention. These spatial aspects provide a sound basis for predictive contaminant-fate modeling and influencing monitoring and remediation approaches focused on maintaining Marchica Lagoon's ecological integrity.

S14, Oral, AbstractID=18270, (ECOP)

Pacific Herring (*Clupea pallasii*) spawning-site abandonment: marine vegetation deficits as local barriers, not broad constraints

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Spatial fidelity in Pacific herring (*Clupea pallasii*) spawning has severely declined in the Strait of Georgia, British Columbia, where once-diverse spawning sites have been abandoned in favour of a narrow coastal corridor. The mechanisms preventing reoccupation of these historical sites remain unclear. Using a 35-year Fisheries and Oceans Canada (DFO) dive-survey dataset (1988–2024) we developed a generalized additive mixed model to quantify egg-layer density as a function of vegetation type, density, and depth, and paired this with a spatially weighted selection-ratio analysis linking egg deposition to local vegetation availability. Across regions, egg deposition increased moderately with vegetation density and slightly with depth, but vegetation type was the dominant predictor: the invasive *Sargassum muticum* supported the highest predicted egg densities, while flat kelps and seagrasses were consistently avoided. Applying model predictions to vegetation maps (collected via ROV) of both active and abandoned sites revealed that many historical spawning areas retain vegetation assemblages sufficient to support spawning, indicating that local vegetation loss is not the primary barrier to reoccupation. These findings suggest that behavioural entrainment and demographic constraints, rather than broad habitat deficits, underpin spawning-site abandonment, underscoring the need to integrate behavioural ecology into herring recovery and habitat restoration strategies.

S14, Oral, AbstractID=18351

SATOUMI creation in the Nanao Bay, Japan

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SATOUMI is a coastal area where human beings harmoniously coexist with nature. SATOUMI creation aims to increase material cycle, biological productivity and biodiversity through various actions by local stakeholders, as well as to develop a sustainable relationship among the stakeholders.

Nanao Bay, which is located in Ishikawa Prefecture, central part of the northern coast of the central island of Japan, is a semi enclosed bay. In the bay, aquacultures of oyster (*Magallana gigas*) and Bloody clam (*Anadara broughtonii*) are operated. Seagrass beds were distributed widely there in the past, and high productivity and rich fishery resources provided various ecosystem services. However, such valuable seagrass beds have decreased rapidly in recent years, and the coastal environment and ecosystems have changed accordingly. In addition, a big earthquake hit this region in 2024, and it made a serious impact on local industries and tourism.

To restore seagrass beds, and to recover from the damage by the earthquake and to develop a sustainable network for SATOUMI there, a new project; “SATOUMI creation in the Nanao Bay” started in 2025. This project is one of the SATOUMI creation projects supported by the Ministry of Environment, Japan, which aims to develop a plan to enhance activation of local tourism, fishery and engagement of various stakeholders in the bay. Northwest Pacific Region Environmental Cooperation Center supports this project through monitoring surveys of seagrass beds and their ecosystems using remote sensing techniques, satellite image analysis and environmental DNA analysis. During the session, past and current surveys in the Nanao Bay will be introduced.

S14, Oral, AbstractID=18543, (ECOP)

Diversity amidst adversity: Investigating nearshore fish diversity metrics along a spectrum of urbanization and development

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Marine and brackish coastal waters support an immense diversity of habitats and organisms and are also the interface between humans, land, and the ocean. As such, they are often first and most heavily impacted by urbanization and development. This is epitomized by the Salish Sea, the coastal water body adjacent to several large metropolitan cities including Vancouver, British Columbia and Seattle, Washington. Despite being highly developed, this region supports a rich variety of nearshore habitats including kelp forests and eelgrass beds, and impressive populations of keystone fish species such as Pacific salmon and herring. Marveling at this diversity amidst adversity prompts the question: how might urbanization impact fish diversity within and across nearshore habitat types? The theory that urbanization homogenizes diversity within and between ecosystems is hotly contested and inconclusive thus far. This study seeks to test this concept by evaluating multiple fish community environmental DNA (eDNA) datasets from sites spanning highly developed to relatively unimpacted nearshore habitats within the Salish Sea. eDNA methodologies enable a broader characterization of fish communities, often detecting species that traditional survey methods miss. Using these datasets, we fill in biodiversity blanks and examine the impact of urbanization on species, trait, and functional diversity at the alpha, beta, and gamma scales for fish communities. The findings of this collaborative study will illuminate the effect of coastal development on fish community diversity and functioning and inform priority habitat types and techniques for urban restoration in order to maximize biodiversity across scales.

S14, Oral, AbstractID=18557, (ECOP)

Assessment of seasonal trophicity of Amur Bay (the Japan/East Sea) through hydrochemistry and plankton communities

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The Razdolnaya/Suyfen River, one of the largest rivers in the Japan/East Sea, forms a vast estuary that plays a key role in maintaining the productivity of the Amur Bay. The river originates in China and carries with it not only natural nutrients but also potential pollution associated with transboundary runoff. Monitoring results from 2024 show stable seasonal patterns of eutrophication in the bay: in spring, the E-TRIX index indicates low nutrient levels (3.6±0.7), but by summer, it rises to 5.4±0.6 due to inputs of phosphates ($r = 0.63$) and nitrogen from river runoff and urban wastewater. This stimulates phytoplankton blooms, including potentially toxic diatoms and dinoflagellates, whose constant presence reflects long-term human impacts. Seasonal phytoplankton blooms shape zooplankton dynamics: predatory species like *Parasagitta elegans* dominate in early summer, while cladocerans (*Evadne sp.*) and copepods become more abundant by autumn, showing adaptation to high water productivity. Small-sized zooplankton (74.7–94.7% of biomass), including fish larvae, shows resilience to changes. Despite the bay's self-cleaning ability (E-TRIX drops to 4.5±0.5 by autumn), coastal urbanization, shoreline changes, and altered river flow require integrated management. Further research into the links between seasonal plankton dynamics, water chemistry, and climate factors will help identify critical risks and create early warning systems for ecological crises like hypoxia and toxic algae blooms.

S14, Oral, AbstractID=18558, (ECOP)

Applying Bayesian network analysis to explore Okinawa coastal fishers' perceptions of climate change impacts on well-being

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Numerous studies have highlighted how climate change can pose significant threats to people's livelihoods and cause a decline in ecosystem services, particularly in coastal areas. Even though fishers are increasingly recognized as local knowledge holders intensively interacting with their environments, and the well-being of fishers is increasingly studied as a key performance indicator for determining sustainable fishing practices, the relationship between fishers' perceptions of climate change and their well-being remains underexplored. We address this knowledge gap by analyzing extensive data collected through a questionnaire survey conducted across Okinawa, Japan's southernmost prefecture, comprising 160 islands of varying sizes. Responses were obtained from 511 fishers, belonging to 33 fisheries cooperatives. The questionnaire included sections on fishers' demographic details, perceptions of local climate change, health status, fishing prospects, fishery utilities, and well-being. The resultant data were analyzed using factor analysis and Bayesian network analysis to examine the causal relationships among all responses related to fishers' perceptions of climate change and their well-being. Our study helps inform climate-change adaptation strategies by the perceptions of coastal fishers, thereby enhancing their well-being.

S14, Pre-Recorded-Oral, AbstractID=18575, (ECOP)

Power to the ports: How cities could advance marine conservation in the North Pacific Ocean

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This paper discusses the prospects for port and coastal cities around the North Pacific Ocean to reduce their environmental footprints and support marine conservation. These approaches include reduction and mitigation of chemical and plastic pollution, restoration and creation of coastal habitat, reduction and biological capture of carbon emissions, and mitigation of threats to marine mammals. Various combinations of these strategies have been implemented in San Francisco Bay, Vancouver, and Yokohama. The efficacy of these individual approaches could be greatly increased by adoption of an integrated marine management framework and its collaborative implementation by multiple levels of government, from the municipal to the national. Furthermore, through their influence on the shipping industry, port cities could incentivize advances in marine conservation extending from shore to the high seas. These could include development and implementation of cleaner and quieter design and use of marine propulsion systems, improved avoidance of collisions with whales, and safer handling of environmentally hazardous cargoes. This beneficial influence would be facilitated by multilateral cooperation among port cities on shared standards and best practices to be applied to all ships. These standards and practices could be implemented through financial incentives to voluntary compliance and/or penalties for violations. Thus, port cities could help advance marine conservation throughout the North Pacific and create a regional blue economy.

S14, Oral, AbstractID=18607, (ECOP)

Research on the application of visual sensory characteristics of land crabs in ecological conservation

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The land crab *Discoplax hirtipes* is an important species in Kenting National Park, Taiwan. Coastal highway construction disrupted its migration, increasing roadkill risk as egg-carrying females cross roads to spawn. To manage habitat fragmentation in coastal cities, the park implemented traffic control and installed culverts as crab tunnels.This study examined *D. hirtipes* phototaxis under various LED colors to reduce roadkill and improve tunnel passage success. The research conducted from September 2022 to October 2024, included laboratory and field experiments using LED lights of various wavelengths: blue (458 nm), green (526 nm), red (630 nm), and white (460 nm). Indoor tests showed higher walking speeds under red (0.785 cm/s) and blue light (0.730 cm/s). Blue light induced stable positive phototaxis, while red light often triggered aggression in indoor tests. Field experiments showed forward-movement rates of 83.6% (no light), 82.1% (blue), and 100% (red). Some blue group individuals stayed still for over ten minutes, while over half moved forward without light, suggesting tunnel conditions did not impair navigation. In the 2024 field experiment, an additional analysis was conducted on evening tidal conditions The results showed that the majority of forward-moving individuals occurred during ebb tide, which may be related to a reduced risk of predation and is consistent with the findings of Carr et al. (2004). Though not statistically significant, the findings emphasize integrating species behavior and environmental cues in designing wildlife crossings for sustainable coastal urban development.

S14, Oral, AbstractID=18621

Estimating the influence of river nutrients on the eelgrass via the coastal-offshore seamless simulation

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Historically, due to the limitation of the computational resources, ocean simulation model has been divided into the two groups; local/regional models with ultra-high-resolution and largescale (global or basin scale) models with low-resolution. In studies targeting coastal areas, ultra-high-resolution regional models limited to bay-area scales have often been used due to the need to reproduce detailed coastal processes. The ecosystem of the Urban Ocean, which extends along the coast, is believed to be strongly influenced by human activities through the supply of river-derived nutrients. However, nutrients that sustain coastal ecosystems are supplied both from river and from offshore. Therefore, in order to assess the impact of human activities, it is first necessary to quantify the relative contributions of river and offshore-derived nutrients to the ecosystem. For this purpose, models that are either spatially limited to the coastal area or that cover a wide area but at low resolution are inadequate. Recent advancements in computational capabilities have enable us to develop a physical-ecological (NPZD) coupled ocean model that seamlessly covers both the coastal and the offshore regions surrounding Japan. By forcing the eelgrass growth model with nutrient concentrations calculated from the NPZD model, we compared the simulated above-ground biomass of eelgrass under scenarios with and without river nutrient inputs, and estimated which areas are most strongly affected by river nutrients.

S14, Oral, AbstractID=18675

Quantifying and tracing material flux from Vancouver (British Columbia, Canada) to the coastal ocean, and its fate and impacts in the marine ecosystem

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Coastal marine ecosystems are some of the most productive and biodiverse regions of the global ocean. A key factor contributing to this is organic matter and nutrient inputs from the land. These terrestrial inputs are increasingly being modified by land-use change, one of the most pervasive of which is urbanization. Among other effects, urbanization increases impervious surfaces, changes vegetation composition, and introduces novel ocean inputs in the form of wastewater and stormwater. Understanding the impacts of urban derived materials on adjacent marine ecosystems requires quantification of these inputs and the ability to trace them in the environment. In this study, we characterized and quantified marine relevant biogeochemical parameters of stormwater and urban rivers in Vancouver, British Columbia (Canada), and compared these with data for wastewater treatment plants. As expected, urban inputs of macronutrients, dissolved and particulate organic carbon (DOC and POC) and particulate nitrogen (PN), were substantial but varied significantly among sources. Surprisingly, fatty acid concentrations were 1-2 orders of magnitude higher in stormwater than urban rivers. We estimated that the total flux of DOC and PN exceeded that of previous estimates for Vancouver's wastewater treatment plants. Using a combination fatty acids and C and N stable isotopes, we were able to effectively distinguish organic matter sources and trace these materials into the adjacent marine ecosystem. We discuss the implications of these urban inputs for marine ecosystem health.

S14, Oral, AbstractID=18725

How do we measure positive change in urban seas? An example using cumulative effects evaluation for salmon habitat restoration from Washington, USA

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In the Salish Sea, salmon habitats have been lost or diminished in quality due to land conversion, and the ecosystem processes that form and sustain habitats have been degraded as well. This loss is especially prevalent in estuaries, where up to 90% of former salmon habitat has been lost or compromised. Salmon species are integral to the identities and cultures of people in the Pacific Northwest, yet salmon abundances remain at historic lows, especially in urbanized areas. Habitat restoration is a common tool for re-establishing ecosystem structures and functions to improve biodiversity and ecosystem services in urbanized coastal and estuarine ecosystems and investments in restoration are creating rearing habitat and repairing lost ecosystem function. However, in this region, restoration efforts often proceed at the site scale, with less attention to consideration of how multiple restoration actions will effectively recover degraded or lost habitats for target species, specifically salmon. As a result, no landscape-scale evaluation program exists, and the cumulative benefits of multiple interventions are unknown, yet large scale restoration efforts are critical to recovering urban coastal systems. Using innovative methods for science synthesis related to the evaluation of cumulative effects of ecosystem restoration for Pacific salmon, and years of existing but disparate data, we use causal inference across numerous hypotheses in a framework to assess the cumulative benefits to Pacific salmon from multiple estuarine restoration projects. We present the framework as a method that can be used to address many complex questions with disparate data. The framework draws on science synthesis from numerous fields and uses a hierarchy of hypotheses, causal analysis at multiple scales, and hierarchy of synthesis for assessing multiple lines of evidence documenting restoration effects on Pacific salmon. Restoration is a key tool for rebuilding function in urban coastal ecosystems and evaluating positive change requires new methods that can leverage existing monitoring efforts to draw inference at larger scales.

S14, Oral, AbstractID=18755, (ECOP)

Effects of riverine discharge on planktonic food web in a temperate estuarine bay

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Riverine discharge is a defining urban stressor that mediates land–ocean connectivity and ecosystem resilience in rapidly industrializing estuaries. We assessed its influence on the planktonic food web of Gwangyang Bay, Korea—a low-turbidity estuary bordered by major steel and petro-chemical complexes—by tracking depth-integrated primary productivity, nitrate and ammonium uptake, phytoplankton biomass and composition, and mesozooplankton clearance and ingestion along a salinity gradient. Principal-component analysis confirmed freshwater input as the master environmental axis, jointly lowering salinity, delivering nitrate, and preserving light penetration. In the river-influenced reach, primary productivity and nitrate uptake were several-fold higher than in offshore waters, and the f-ratio remained high, indicating strong new production.

The combination of abundant nitrate and clear water favored a diatom-dominated phytoplankton assemblage whose bloom generated a pronounced chlorophyll maximum in the mixing zone. This diatom surge approximately doubled mesozooplankton feeding on micro-sized prey, shortening trophic pathways and boosting energy-transfer efficiency—an outcome rarely observed in the highly turbid estuaries typical of many North Pacific cities. Beyond the freshwater plume, declining nutrients, salinity-driven shifts in prey, and intensified interactions with microzooplankton curtailed mesozooplankton feeding, lengthening the food chain and reducing transfer efficiency.

Collectively, our findings show that a moderate, nutrient-rich yet optically clear freshwater plume can sustain high new production and short, diatom-centered food chains while reshaping plankton communities and trophic dynamics. Embedding coupled river-plume and plankton indicators in adaptive monitoring and coastal-city planning will support resilient, sustainable urban oceans.

SESSION 14: MEQ/HD Topic Session

The Status and Future of Urban Oceans of the North Pacific – Pathways to Resilient and Sustainable Coastal Cities

Poster Presentations

S14, Poster, AbstractID=18303, PosterID: S14-P1, (ECOP)

Discussion on key issues regarding the promotion of large-scale utilization of seawater desalination in coastal cities of China

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Presented by Hanwen Song behalf of Hao Guo

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Under the global context of climate change, the water resource crisis confronting China's coastal cities has been intensifying progressively. Seawater desalination, a critical technology for coastal cities to address water scarcity issues, is increasingly drawing attention. China's seawater desalination industry is currently in a phase of rapid development. By 2023, the nation's seawater desalination capacity had reached 2.8 million tons per day. Nevertheless, the actual utilization rate of desalinated water remains relatively low. For instance, in the case of Tianjin, the capacity utilization rate stands at approximately 50%. The primary contributing factors encompass the limited public acceptance of desalinated water for direct consumption, coupled with the inadequate compatibility of existing water supply infrastructure and application scenarios, which consequently constrains alternative utilization. This paper focuses on two key issues: the water quality safety when desalinated water enters municipal pipelines, and the corrosion control during long-distance transportation of desalinated water for industrial direct supply. It also explores suitable water supply models for municipal and industrial uses with different quality requirements. By expanding the application scenarios of desalinated water, it aims to promote the improvement of its capacity utilization rate, thereby supporting China's efforts to ease the water crisis and combat climate change.

S14, Poster, AbstractID=18326, PosterID: S14-P2, (ECOP) NO SHOW

Does marine ecological civilization demonstration zone policy improve environmental governance efficiency in coastal cities?

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Enhancing environmental governance efficiency is crucial for advancing sustainable development in China. Using a super-efficiency slack-based measure model, this study quantifies environmental governance efficiency across 53 Chinese coastal cities from 2009 to 2019, and uses policy of marine ecological civilization demonstration zones as a quasi-natural experiment to evaluate the policy's impact on the environmental governance efficiency using a double machine learning model combined with a difference-in-differences approach. Results indicate that the implementation of marine ecological civilization demonstration zone policy significantly enhances environmental governance efficiency, albeit with negative spillover effects on adjacent regions. Heterogeneity analysis further reveals stronger policy effects in coastal urban agglomerations along the the Bohai Sea and Yellow Sea, and cities with lower fiscal pressures. Finally, mechanism analysis of positive incentive and reverse forcing are analyzed, revealing that the pilot policy can enhance efficiency through four channels: green technology innovation, green finance development, energy structure optimization, and resource allocation efficiency.

S14, Poster, AbstractID=18429, PosterID: S14-P4

Community-led governance strategies for sustaining particulate matter-mitigating green spaces in coastal industrial complexes

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This study examined community-led governance strategies(CLGS) for sustaining particulate matter-mitigating green spaces(SPM-MGS) in coastal industrial complexes in South Korea. In view of the escalating challenges posed by particulate matter pollution in these areas, the present study adopted the concepts of CLGS to ascertain the public perceptions of SPM-MGS.

A methodical approach was implemented, which included the conduction of surveys targeting residents in the vicinity of coastal industrial complex in the South of South Korea. The subsequent data analysis concentrated on key frameworks 'place-keeping' with its dimensions, governance, funding, monitoring, partnership, and maintenance.

The results demonstrate that the perceptions of SPM-MGS are predominantly positive, but critical barriers to its feasibility have been identified. These include limited community involvement, insufficient institutional coordination, and inadequate sustainable funding mechanisms. In order to address these challenges, this study proposes a wide range of community-led governance for SPM-MGS that integrates self-governance, mosaic governance-based partnership, adaptive monitoring, active maintenance, and a multi-sector partnership model for income generation. Integrating self-governance necessitates the empowerment of local communities to manage SPM-MGS projects through involvement in decision-making processes. Mosaic governance fosters collaboration among multiple stakeholders, including public authorities, private enterprises, and civil society organisations. Adaptive governance for monitoring is predicated on the promotion of decentralised air quality monitoring through community-based systems, thereby enhancing transparency and trust. The multi-sector partnership model under discussion highlights the need for diversified funding sources that combine public sector allocations, corporate contributions, and community-driven fundraising. This multi-sector-involved funding approach ensures financial sustainability while fostering local ownership and accountability.

In conclusion, this study emphasises that a comprehensive CLGS is essential for enhancing the acceptability and feasibility of SPM-MGS initiatives. By integrating community involvement, multi-level collaboration, and sustainable financing, this study offers actionable insights for policymakers who aim to implement sustaining management strategies in coastal industrial regions.

S14, Poster, AbstractID=18443, PosterID: S14-P5, (ECOP)

Human impact affects seaweed beds inside bays through rivers: Case study of Yamaguchi Prefecture, Japan

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Seaweed beds are one of the most important ecosystems in the coastal area, and their conservation is required to maintain biodiversity. However, a more integrated approach for conservation is needed because the coastal area is easily affected by land activities. In this study, we focused on the change of seaweed beds area over the period from 2016 to 2022 in five bays of Yamaguchi Prefecture: Yamaguchi Bay, Aio Bay, Shirikawa Bay, Chudo Bay, Omi Bay, and tested human impact from land to seaweed areas. At first, we used satellite image data to investigate the change of seaweed beds area in each bay. Next, we investigated the water quality data and socio-ecological characteristics of each bay. We used COD, chemical oxygen demand, as a water quality indicator to test human impact. Finally, we considered the relationship between the change of seaweed bed area and human impact by summarizing all information. Result showed that 90% of seaweed beds had disappeared in Yamaguchi Bay and Omi Bay, which have rivers. We also found that these two bays had high COD values compared to other bays which have no river and low change of seaweed beds area. Therefore, it is thought that water pollution in the bays through rivers is causing the decline of seaweed beds. This result suggests that there is the need for an integrated approach, including river management, to conserve the seaweed beds in the bays.

S14, Poster, AbstractID=18496, PosterID: S14-P6, (ECOP)

Technological innovation and regional development patterns of China's marine economy (2000–2023)

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From 2000 to 2023, China's marine-economic growth index consistently outpaced the national GDP growth rate, with the gap widening over time, underscoring its strong driving effect on the national economy. Based on time-series growth indicators, patent statistics, and policy text analysis, this study finds that cumulative invention patent filings in the marine industry reached 36,577, showing steady growth, with a marked acceleration in core-layer patents after 2016. Under the GB/T 20794-2021 framework, the core layer—comprising high-barrier, high-value-added sub-sectors (shipbuilding, marine engineering equipment manufacturing, marine information services, and marine biomedicine)—has consistently dominated both filings and grants. A regional comparison using 2016 as the cutoff reveals that northern and southern coastal areas share similar patent structures, each led by marine biomedicine and shipbuilding, while the eastern coast exhibits a multi-sector collaborative innovation pattern. Patent filings and grants in all regions surged after 2016, reflecting significantly enhanced regional innovation vitality. Since 2016, diversified central and local policies—spanning planning guidance, financial support, and technology R&D—have been introduced and show a strong positive correlation with patent growth in key coastal cities. Although the marine economy's average contribution to GDP approaches 9 %, its share of patent filings and grants is only about 3 %, indicating considerable room for improvement in technology transfer and innovation output. The study further recommends strengthening multilateral cooperation in the Western Pacific region to share deep-sea exploration and renewable marine energy technologies and to promote coordinated development of the regional marine economy.

S14, Poster, AbstractID=18611, PosterID: S14-P7, (ECOP)

A study on university students' attitudes toward mangrove-based blue carbon coastal walkway

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There have been accelerating transformations in coastal ecosystems by climate change which require integrated strategies to ensure the sustainability of urban coastal areas. In particular, the southern coast of Korea is shifting towards a subtropical climate, making it more ecologically feasible to introduce blue carbon vegetation, such as mangroves. Accordingly, mangrove-based coastal walkways are gaining attention as a nature-based solution (NbS) that can help to achieve carbon neutrality. This study examines university students' perceptions, an awareness of the concept of a blue carbon-centric mangrove coastal walkway, focusing on long-term management strategies. A survey of 267 students was conducted to assess their awareness of mangrove coastal walkways, their perceptions of place-keeping elements, and their walkway usage behaviour. Descriptive statistics, independent t-tests and correlation analyses were employed to interpret the findings. Students who recognised the importance of mangrove conservation demonstrated a greater understanding of blue carbon ($r = 0.72$, $p < 0.01$), while those with prior climate education showed a greater awareness of mangrove protection ($r = 0.76$, $p < 0.01$). Environmental concern was positively associated with willingness to participate in management ($r = 0.58$, $p < 0.05$). Furthermore, 63.2% of students had heard of blue carbon, 77.3% had heard of mangroves, 49.3% had received climate change education and 36.2% had learned about blue carbon. Students who recognised the climate benefits of mangroves showed greater support for policy ($r = 0.65$), budgeting ($r = 0.68$), governance ($r = 0.67$) and maintenance ($r = 0.70$). These findings emphasise the importance of education, policy support and participatory governance in ensuring the long-term management of mangrove-based coastal walkways in coatal areas.

S14, Poster, AbstractID=18616, PosterID: S14-P8, (ECOP)

Toward the development of coastal resilience assessment frameworks in South Korea: Insights from stakeholder perceptions and policy implications

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As coastal disasters intensify due to the climate crisis, the importance of coastal resilience—covering not only short-term resistance but also long-term adaptation and recovery—is increasingly emphasized. This study explores the applicability of a coastal resilience assessment framework in South Korea and analyzes stakeholders' perceptions and essential elements for long-term management. A bibliometric analysis was conducted using the keyword "coastal resilience" to identify key research trends. Additionally, a questionnaire was developed based on the Coastal Resilience Index by NOAA and Blue Flag certification standards. A total of 267 valid responses were collected, and data were analyzed using IBM SPSS Statistics 27 through descriptive statistics, correlation analysis, and one-way ANOVA. The bibliometric results indicate that explicit academic focus on coastal resilience remains limited. Respondents showed low conceptual understanding but a strong agreement on the importance of institutional and governance factors. Items such as "Installation of Drainage Facilities" ($F = 6.62$, $p < .01$) and "Establishment of Beach Management Committees" ($F = 5.22$) showed significant differences by region and age. Legal compliance and facility planning standards also demonstrated statistical significance ($F > 4.0$). Most variables showed positive correlations. Long-term management had strong correlations with budget allocation ($r = .561$) and collaborative partnerships ($r = .465$), underscoring the need for a governance strategy based on place-keeping. These findings suggest that the implementation of a coastal resilience framework in Korea should include region-specific communication and institutional planning. The study provides foundational data for long-term coastal management rooted in stakeholder perspectives and supports sustainable, community-based policy development.

SESSION 15: HD Topic Session

The Rise of Bibliometric Analyses to Address Sustainability Solutions Through a Human Dimension Lens

Oral Presentations

S15, Invited, AbstractID=18407

Conserving ecosystem integrity: Ecological theory as a guide for marine protected area monitoring

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Global policies increasingly focus on the importance of maintaining or improving the integrity of ecosystems, but defining, assessing, and monitoring integrity in marine protected areas (MPAs) remains a challenge. In this paper, we conceptualized ecological integrity along dimensions of heterogeneity and stability containing seven components: physical structure, diversity, function, persistence, resistance, resilience, and natural variability. Through a structured literature search, we identified indicators and metrics used for quantifying ecosystem status components in the marine environment, then reviewed MPA management plans worldwide for inclusion of these components. We evaluated 202 papers applying 83 ecological indicators built from 72 metrics. Ecosystem components were most comprehensively addressed by metrics of taxa presence, organisms count, and area occupied by benthic organisms, and community structure, biomass, and percent cover indicators. Of the 557 MPA management plans we reviewed globally, 93% used at least one ecosystem status term or its synonym in an ecologically relevant context, but 39% did not address any components of stability. In particular, resistance was mentioned in only 1% of management plans, but in some cases it may be inferred from indicators and metrics used to track the best addressed component in management plans, diversity. Plans for MPAs with both an ecological/biological purpose and a research and education purpose contained ecosystem status terms more frequently than other plans, suggesting that engagement with the scientific community may have improved the application of these terms. An improved understanding of how to operationalize and measure ecological integrity can help MPA monitoring and management.

S15, Invited, AbstractID=18475

Quantifying the scientific landscape of marine research: Insights from bibliometric and content analyses

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Bibliometric and quantitative analyses of scientific outputs are increasingly used to understand the dynamics of knowledge production, collaboration, and dissemination in marine science. These approaches can help us see how research agendas evolve over time, how scientific communities are structured, and what roles different institutions, journals, and individuals play in shaping the field.

In this presentation, I will demonstrate how methods such as text mining, co-authorship network analysis, topic modeling, and citation analysis can be applied to explore knowledge production in the context of organizations like PICES or ICES. These approaches allow us to address questions such as: How do research topics change over time within key marine science organizations? What patterns of gender representation and early-career researcher involvement can be observed? How do conferences and journals function as sites of knowledge exchange? I will also discuss methodological considerations related to data processing and statistical modeling, emphasizing how these tools can support robust and reproducible analysis.

This presentation contributes to the session's goal by showing how bibliometric and quantitative approaches can help us better understand interdisciplinarity, co-production, and the impact of marine science. It also highlights the potential for using these methods to support cross-organizational collaboration and reflection within PICES and ICES, particularly in the context of working groups such as WG51.

S15, Invited, AbstractID=18778, (ECOP)

Scientific mapping of marine species under the changing climate: Past perspectives, current conundrums, and future potential

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Marine organisms are a foundational group in the ocean ecosystem and make a significant contribution to the world's blue economy. However, climate change is altering abiotic factors such as temperature, precipitation patterns, and ocean chemistry, which, in turn, modifies species distributions, reproductive cycles, and interspecies interactions. Thus, the present study aims to present the outcome of previous authors' works on fish, shellfish, and aquatic plants-related literature, drawing on the potential learning experience of this scientific mapping under the changing climate. By leveraging the Web of Science Core Collection database and utilizing CiteSpace software (advanced version), the present synthesis provides a holistic overview of the research landscape, revealing trends and thematic research and trajectories. The empirical evidence shows the necessity of integrating climate change projections into the management and sustainable strategies for aquatic marine species. Most of the studies offer a quantitative map and strategic gaps to show the need for interdisciplinary approaches to build climate-resilient and adaptive marine systems in the future.

S15, Oral, AbstractID=18174

In your impact era: Tracking your science-policy influence

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Measuring the impact of scientific work is a key challenge. Quantifying influence on both science and policy is critical for justifying funding, guiding strategic research planning, and ensuring science informs decision-making. However, academics are busy and there is often little training given on how to do this. Here, we present a replicable, evidence-based framework to quantify and communicate the scientific-policy impact of scientific work, developed through the evaluation of scientific papers and policy outputs from the UK Pelagic Habitats Expert Group (UKPHEG).

Bibliometric and policy citation analysis were integrated to assess impact. Scientific impact was assessed using Web of Science data from 130 papers authored by UKPHEG members, analysing citation rates, time to peak citations, institutional collaboration networks, and thematic keyword mapping. Policy impact was evaluated via the Overton evidence connection platform, tracking policy documents citing these scientific papers, as well as policy documents directly or indirectly authored by UKPHEG, with metadata on geographic reach, organisational type, and citation frequency.

Most UKPHEG papers reached peak citations within three years, highlighting their immediate science-policy relevance. Half of the publications were cited in policy, and policy outputs themselves generated 583 downstream citations, spanning 130 organisations in 26 countries. Top themes across both science and policy outputs included biodiversity, climate change, and ecosystem services.

This simple, flexible, transparent, and scalable framework offers a robust approach for any researcher or group seeking to understand and demonstrate scientific and policy impact.

S15, Oral, AbstractID=18190, (ECOP)

Bridging academic gaps and emerging technologies in Taiwan's sustainable fisheries: Insights from bibliometric and qualitative analyses

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This study investigates the academic gaps and opportunities for introducing emerging technologies in Taiwan's sustainable fisheries, using a dual-method approach that combines bibliometric analysis and qualitative insights from key informant interviews. The bibliometric analysis, based on 951 articles from the Web of Science (2015–2024), reveals global research trends and Taiwan's relative positioning, showing strong foundations in artificial intelligence, IoT, and GPS but underrepresentation in emerging areas such as biodegradable materials, blockchain, unmanned underwater vehicles, and vessel monitoring systems. Complementing this, in-depth interviews with 17 representatives from academia, industry, and government provide qualitative evidence of the persistent gaps between research, industry, and policy sectors—highlighting issues such as limited knowledge flow, trust deficits, and inadequate institutional mechanisms, particularly for small-scale operators. Aligned with the four strategic pillars emphasized by relevant management agencies—Smart, Sustainable, Resilient, and Safe—this study offers insights into how integrating quantitative and qualitative methods can help bridge interdisciplinary divides, inform co-produced policy strategies, and enhance the practical application of research in support of sustainable fisheries development.

S15, Oral, AbstractID=18289, (ECOP)

Social network analysis of partnership structure under the UN Ocean Decade Actions

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Along the mid-term evaluation of the UN Ocean Decade, in-depth and quantitative assessment of collaborative network under the Decade Actions is meaningful to provide insights about the engagement that the Decade has facilitated. The objective of this study is, through social network analysis scheme, to examine the partnership structure under the Decade Actions and deliver strategic implications on the further expansion of the stakeholder engagement. Based on the published database of the Decade Programme, Project and Contributions up to December 2024, organizational partners of each Action and their countries were identified in reference to their website. Undirected social network was created based on the relationships between lead organization's country and its partner(s). As a result, the constructed graph consists of 171 nodes and 581 edges with 4.0% density and 6.8 average degree. Based on the betweenness centrality, which suggests the bridging potential between nodes, European and North American countries play a key bridging role of other countries (Belgium: 0.54, United States: 0.16, United Kingdom: 0.11, Italy 0.06). China also scored the third highest betweenness centrality (0.15), and the edge between Belgium and China represented the highest betweenness centrality among all edges (0.04). Japan scored 0.004. The results imply that, to expand the engagement under the Decade Actions, it is valuable for those 'hub' countries to reach out new partners who have high demand of capacity development. Furthermore, encouraging to form new regional hub other than the existing ones will be effective to involve local and regional stakeholders. Updated results will be presented at the conference.

S15, Oral, AbstractID=18375, (ECOP)

Opportunities and challenges of Japan's new anti-IUU policy: Insights from national stakeholder groups

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(Intro) As the third-largest t seafood-importing country, Japan implemented the Act on Ensuring the Proper Domestic Distribution and Importation of Specified Aquatic Animals and Plants (Anti-IUU Policy) in 2022. However, there is limited literature examining its effectiveness and challenges.

(Objective) This study aims to summarize stakeholders' experiences and perspectives regarding the effectiveness, challenges and future possibilities of the Anti-IUU policy, and identify similarities and differences in their opinion.

(Method) Semi-structured interviews were conducted with 20 stakeholders across government, private sector, civil society, researchers, and finance sector using the questions selected from a systematic review and pre-interviews. Qualitative data were analyzed using thematic coding, while text mining techniques were used to identify key terms and patterns.

(Result) Whilst common concerns verification and digitalization emerged across several stakeholder groups, there were different views on species expansion and its timing.

(Conclusion)Taken together, most of the interviewees expressed support for to the introduction of the Anti-IUU policy. However, their views on future initiatives varied, highlighting the need for data collection of overseas cases.

S15, Oral, AbstractID=18469, (ECOP)

Visualizing the annual transition of ocean policy in Japan using text mining

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In the field of ocean studies, research on evidence-based marine policymaking is still immature, especially regarding the utilization of text data. This study visualized the transition of ocean policy in Japan using text mining technique applied to the text data of three white papers: the Fishery white paper (2007 – 2020), Environmental white paper (2008 – 2020), and Ocean white paper (2004 – 2020). The results of the analysis were compared with the expert interviews on each subject. Based on latent Dirichlet allocation topic model analysis, significant differences in topics were observed among these white papers, while they all clearly responded to the Great East Japan Earthquake occurred in 2011 with their unique topics. Major transitions in topics occurred several times over the years for all white papers. For the Fishery white paper and Environmental white paper issued by the government agencies, notable transitions occurred in 2011, 2013, 2017 and 2012, 2018, respectively, which were mainly caused by the revisions of relevant laws; while for the Ocean white paper issued by non-government organization, transitions occurred in 2009 and 2016, which were closely related to the development of worldwide ocean initiatives. The expert interviews revealed that the experts' views on the topics and the transitions of policy focuses were generally consistent with the unsupervised analysis results. By visualizing the policy transitions within various organizations, the extraction of each organization's direction and role in policymaking can be accelerated. This is expected to provide scientific evidence for the formulation of future ocean policies.

S15, Oral, AbstractID=18617

A systematic review and bibliometric assessment of extreme climate events in the North Pacific to document key drivers, impacts, and indicators for coastal communities

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There is recognition of increased risks in the marine environment associated with more frequent and more severe extreme climate events (ECEs). Within the North Pacific domain and PICES region, existing research has identified substantial ecological and socioeconomic impacts of ECEs. However, there has been no systematic review of ECEs, such as marine heatwaves, hypoxia, and acidification events, in this region to date. There is now a pressing need to census ECEs reported in scientific literature, and to understand their attributes, including drivers, pressures, impacts, and indicators across physical, ecological and social-cultural elements of the North Pacific domain. In this study, we conduct a systematic review of North Pacific ECEs by constructing a database of scientific literature. We show preliminary results of a bibliometric analysis to identify potential drivers, pressures, impacts, and indicators associated with each type of ECE based on peer reviewed literature. Investigation of existing knowledge on North Pacific ECEs will help to establish commonalities and differences among events and regions, to identify potential indicators and key impacts as targets for management and policy, and to describe gaps in our understanding for future research.

S15, Oral, AbstractID=18740

Toward multi-modal metrics: Bridging bibliometrics, AI, and public narrative

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This presentation explores a novel integration of bibliometrics and multi-modal analysis to support sustainability solutions through a human dimension lens. We focus on how socially stored texts, visual and verbal narrative including human memory, and artificial intelligence can be woven together to reimagine future coastal environments. Specifically, we utilize archival photographs of coastal landscapes in Japan, citizen narratives collected via social media, and GAN (Generative Adversarial Networks) technology to generate speculative visualizations of future scenarios. By converting memory-based data into dynamic, future-oriented imagery, we bridge the gap between historical identity and anticipatory governance. Our approach offers a bottom-up alternative to conventional sustainability metrics by foregrounding emotional, aesthetic, and narrative dimensions of place. These "multi-modal metrics" are not just complementary to bibliometric insights, but essential in capturing what communities value, fear, and hope for in the face of environmental change. In this sense, the project serves as a prototype of how citizen-authored visual and textual data can be processed and re-expressed through AI to inform participatory foresight. We argue that integrating GAN-based visual storytelling into bibliometric frameworks can contribute to more inclusive and transdisciplinary models of knowledge co-production. In doing so, it opens new methodological pathways for the Human Dimensions community to analyze, visualize, and design sustainable futures.

S15, Oral, AbstractID=18760, (ECOP)

Evolving interdisciplinary and international social networks: Insights from Canada's Department of Fisheries and Oceans in the Pacific Region (1990–2025)

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This presentation builds upon the preliminary text and correspondence analysis we presented at a WG 51-led Workshop during the 2024 PICES Annual Meeting in Honolulu, USA. Using Canada as a case study, we characterized the evolution of key research topics in the North Pacific region by analyzing over 5,400 publication records from DFO personnel in British Columbia between 1990 and 2024, retrieved and compiled from Web of Science. Unsurprisingly, "salmon" dominated the research landscape over the past three decades, particularly before 2015. That said, we also identified a clear temporal shift in DFO's main research keywords—from fish biology and ecology in the 1990s and early 2000s towards more ecosystem-based, human-centered, and climate-related studies in the 2010s and 2020s.

Through a social network analysis based on co-author affiliations and more detailed Natural Language Processing techniques, we aim to highlight the principal interdisciplinary research themes at DFO Pacific and assess how research collaborations and knowledge co-production have evolved since the early 1990s. Specifically, we will explore what topics DFO scientists are investigating with partners across the North Pacific region, which countries and institutions they collaborate most closely with, and whether there is a discernible internationalization trend in DFO's research networks—particularly since the foundation of PICES in 1992.

This analysis will delve deeper into the human dimension of DFO Pacific's diverse and extensive research portfolio, offering a clearer picture of how transboundary and interdisciplinary collaborations have supported ocean sustainability in the North Pacific basin.

SESSION 15: HD Topic Session

The Rise of Bibliometric Analyses to Address Sustainability Solutions Through a Human Dimension Lens

Poster Presentations

S15, Poster, AbstractID=18477, PosterID: S15-P1

The rise of bibliometric analyses to address sustainability solutions through a human dimension lens

Nikki Furmanek[1], Szymon **Smoliński**[2], Ruth Anderson[1], Silvana Birchenough[1], Krishia Desabelle-Mulligan[1], Jo Foden[1], Nils Olav Handegard[3], Colm Lordan[1], Jan Jaap Poos[4], Dave Reid[1], Barbora Valach-Rasul[1] and Nathalie A. Steins[1]

Presented by Szymon Smoliński behalf of Nikki Furmanek

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This study explores the 120-year-old ICES publications archive to follow the development of the human dimension lens within the International Council for the Exploration of the Sea (ICES) science and its influence on marine management. By integrating social sciences and humanities, the human dimension has increasingly informed ICES work. The adoption of the stakeholder engagement strategy has added value to purely ecological and biological perspectives on the use of marine resources, helping move to a more holistic approach. Through a bibliometric analysis of reports, conference contributions, and scientific articles, this study explores how knowledge systems within ICES are evolving to incorporate social sciences and humanities alongside natural sciences, and how these diverse perspectives enhance marine management strategies. This study is possible due to the ongoing work of digitizing the ICES publications archive and making it fully open access in ICES Library. This poster will include information on the process and tools used in this project and will inspire others to use this rich scientific historical archive in their own work.

SESSION 16: POC Topic Session

Radiocarbon Studies in the North Pacific and its Marginal Seas

Oral Presentation

S16, Invited, AbstractID=18444

Studies on oceanography in the Northwestern Pacific using radiocarbon

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Cosmogenic nuclides produced in the atmosphere and their ratio to a terrestrial counterpart can depict detailed pictures of climate, carbon cycle, oceanography etc., and have therefore been widely used since their measurement became possible through Accelerator Mass Spectrometry (AMS: Yokoyama and Sproson, 2025). In particular, radiocarbon (^{14}C) has been used to understand for climate and geochronological sciences (Larsen et al., 2017; Yokoyama et al., 2025a). Over the past two decades, smaller AMS machines have been developed. One of these machines is the single-stage accelerator mass spectrometry (SSAMS) developed by the National Electrostatic Corporation (NEC), which was installed at the Atmosphere and Ocean Research Institute (AORI) at the University of Tokyo in 2013 and has operated smoothly since then (Yokoyama et al., 2019; 2022). NEC developed a completely new concept of AMS called positive ion mass spectrometry (PIMS), which was installed at AORI for the first time outside of Europe in March 2025 (Yokoyama et al., 2025b). These two AMS systems enhance the capability to conduct a wide range of scientific research using small-scale radiocarbon measurements (eg., Otosaka et al., 2024; Nakamura et al., 2025).

In this presentation, we will introduce applications of oceanographic studies in the northwestern Pacific, using radiocarbon in seawater and corals (Lan et al., 2024; Zeng et al., 2024) to understand the dynamics of the Kuroshio Current. We will also discuss ecological applications of radiocarbon (Larsen et al., 2017; Ando et al., 2024, 2025).

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S16, Oral, AbstractID=18228

POC transport to the interior of the basin in the Tsushima Warm Current region of the Japan Sea

Shigeyoshi **Otosaka**[1], Yoko Ishiyama[1,2], Shigeaki Kojima[1,2], Taku Wagawa[3], Yusuke Kawaguchi[4], Itsuka Yabe[5], Taketoshi Kodama[6], Takehiro Shimonaka[6], Jan Meissner[7], Charlotte Schnepper[7], Negar Haghipour[7], and Timothy I. Eglinton[7]

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Sinking particles in the ocean are an important factor driving material transport on relatively short time scales of several days to several tens of days. We have moored sediment traps in representative areas of the Japan Sea, including the Tsushima Warm Current, and have discussed the distribution of sinking particle flux and its linkage with physical processes in the surface layer. Elemental composition and isotopic characteristics of sinking particles are useful for verifying the validity of the observed values of sinking particle flux and for analyzing the source and transport processes of particles. In this study, we focused on the radiocarbon characteristics of particulate organic matter (POC) from the observations conducted from 2022-2023 at Station FATO (38°43'N, 137°48'E), southeastern Japan Sea, and estimated the POC transport into the basin in this area. The $\Delta^{14}C$ values of POC in sinking particles ranged from -20 to -110 ‰, lower in winter and higher in summer. The $\Delta^{14}C$ values of sinking particles in the Japan Sea generally show a negative correlation with the concentration of manganese, a scavenging element, and it can be interpreted that the longer the residence time in the seawater column, the lower the Δ14C value. However, the sinking particles observed at the Station FATO in winter deviated from this general characteristic and showed characteristics closer to those of riverine particles. These results suggested that particles originating from the shelf and slope regions were transported rapidly horizontally to at the station during winter.

S16, Oral, AbstractID=18232, (ECOP)

Radiocarbon signatures of long-term sinking particles collected in the Northwest Pacific (Ulleung Basin)

Minkyoung **Kim**[1*], Young-Il Kim[2], Negar Haghipour[3,4], Timothy I. Eglinton[3]

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This talk will include 10-years of sinking particle data collected by conical-type sediment traps deployed at 300, 1000, and 2000 m depths in the Ulleung Basin, southwestern part of the East/Japan Sea (EJS) to understand the dynamics of carbon cycling and biological carbon pump (BCP) efficiency in the EJS. Especially, we analyzed carbon content and radiocarbon values as one of the key tool, trying to examine the role of the BCP on oceanic carbon sequestration.

Overall, this presentation will cover importance of using radiocarbon to understand the carbon cycling in the deep ocean.

S16, Oral, AbstractID=18345, (ECOP)

Aged dissolved organic carbon supply through submarine groundwater discharge in Jeju Island, South Korea

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Submarine groundwater discharge (SGD) is a key but understudied pathway in the terrestrial-oceanic dissolved organic carbon (DOC) cycle. In this study, fresh and saline groundwater samples were collected from two sites on Jeju Island, South Korea: Hwasun Bay and Bangdu Bay on the western and eastern coast, respectively. DOC concentrations in fresh groundwater were extremely low (5 ± 3 μM), with pre-aged radiocarbon values ranging from –469 to –407‰. In the brackish zone of Bangdu Bay, distinctive spectroscopic signals, elevated DOC concentrations, and Δ14C-DOC values along the groundwater-coastal continuum suggest a stronger influence from enhanced coastal primary production, likely driven by anthropogenic impacts. This study highlights the potential role of SGD in transporting aged DOC. Furthermore, the results suggest that highly decomposed DOC in fresh groundwater may be a minor but possible source of pre-aged DOC in the subsurface waters (75–100 m) of the East/Japan Sea.

S16, Oral, AbstractID=18570, (ECOP)

Radiocarbon characteristics of dissolved organic carbon in the East Sea (Japan Sea) revealed by serial UV-oxidation experiments

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Radiocarbon analysis of dissolved organic carbon (DOC) in the Ulleung Basin of the East Sea (also known as the Japan Sea) has previously suggested that refractory organic matter from the Northwest Pacific is transported into the East Sea via the Tsushima Warm Current. Therefore, studying DOC in the East Sea provides important insights into the behavior and characteristics of the refractory DOC. To investigate the degradability of refractory and labile DOC in the East Sea, we conducted serial-UV oxidation experiments and obtained radiocarbon ($\Delta^{14}C$, ‰) values on samples collected from the Korea Strait, where the Tsushima Warm Current enters, and from the Ulleung Basin. The DOC oxidized in the initial stages consistently showed higher $\Delta^{14}C$ values. In addition, $\Delta^{14}C$ values of the samples that originates from the Tsushima Warm Current were more similar to those of deep waters rather than surface waters. Based on these findings, we will discuss the characteristics and behavior of DOC in the East Sea.

SESSION 16: POC Topic Session

Radiocarbon Studies in the North Pacific and its Marginal Seas

Poster Presentation

S16, Poster, AbstractID=18223, PosterID: S16-P1, (ECOP)

Dynamics of dissolved organic carbon in the western North Pacific Ocean revealed by radiocarbon

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Dissolved organic carbon (DOC) in seawater constitutes one of Earth's largest organic carbon reservoirs (~1.7×10^{18} gC), which contributes to long-term carbon sequestration and informs predictions of climate-related feedback. Recent studies suggest that DOC serves as a carrier of trace nutrients, facilitating their transport to the open ocean and thereby controlling primary production in the subarctic region. In this study, we investigated the distribution and dynamics of DOC in the western North Pacific Ocean using radiocarbon (^{14}C) as a tracer, which can provide age information to identify DOC endmembers and interpret their mixing processes. Seawater samples were collected during two cruises of *Hakuho Maru* in 2022 and 2023. DOC was extracted using a UV oxidation-based processing flow, and its radiocarbon signatures ($\Delta^{14}C$) were measured with a Single Stage Accelerator Mass Spectrometer. The $\Delta^{14}C$ results revealed three distinct DOC endmembers: refractory DOC as a background component, labile DOC derived from surface primary production, and a third endmember with a region-dependent $\Delta^{14}C$ signature, attributed to allochthonous DOC. This allochthonous DOC signal was primarily observed within the σ_θ=26.6–27.5 potential density range. The injection of allochthonous DOC appears to be influenced by the interannual variability of intermediate water. Combined analysis with ^{228}Ra tracers indicates that this allochthonous DOC primarily originates from the continental shelf and marginal seas. This study presents the first extensive ^{14}C characterization of DOC in the western North Pacific, providing new insights into carbon cycling processes and the connectivity between marginal seas and the open ocean.

S16, Poster, AbstractID=18472, PosterID: S16-P2

Particle flux in the central Yellow Sea in summer

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Sinking particles were collected using an array of surface-drifting sediment traps at a station in the central Yellow Sea from 31 July to 4 August 2024 to understand export and resuspended particle fluxes during the summer season. During a short-term deployment for 115 hours, the stratified condition of the water column was maintained with a clear thermocline depth at 40 m. The average sinking particle fluxes at 30 m, 40m, and 50m depths were 273 ± 114, 1,458 ± 486, and 3,205 ± 224 mg $m^{-2}d^{-1}$, respectively. Fluxes measured in the lower layers of the thermocline are probably overestimation of the net sinking particle flux because of the flux from resuspended sediment particles. The increase in total particle flux with depth corresponded well with the vertical profiles of suspended particulate material (SPM) concentration. SPM concentration increased dramatically from 35 m to 70 m water depth, corresponding to the thermocline depth. In addition, the vertical profile of aluminum (Al) concentration in SPM increased monotonically from 35 m to the seafloor. These findings clearly demonstrated that the active resuspension of bottom sediment in the benthic layer significantly contributes to the carbon flux in the central Yellow Sea. Thus, we concluded that export particle flux should be measured below the surface mixed layer or at the thermocline layer.

Keywords: drifting sediment trap, export flux, sediment resuspension, aluminum concentration, the Yellow Sea

SESSION 17: MEQ Topic Session

What Can we Learn About the Occurrence of Karenia spp. Blooms in the North Pacific?

Poster Presentations

S17, Poster, AbstractID=18255, PosterID: S17-P1

Field trial of kelp bed introduction to enhance algicidal bacterial supply for biological control of Karenia mikimotoi bloom in a fishing port

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The potential use of algicidal bacteria (AB) to control harmful algal blooms has been studied worldwide. Recent findings suggest that natural macroalgal beds act as reservoirs for AB, indicating that the introduction of macroalgae may enhance AB supply to neighboring waters. In this study, we compared the densities of AB against the harmful dinoflagellate *Karenia mikimotoi* at two stations (Stn. A: inner-port, introduced kelp bed; Stn. B: port mouth) in Furubira fishing port, Hokkaido, Japan, over a year. Using the June values of AB density (1.9×10^5 CFU g^{-1} wet weight) and total cultivated kelp biomass, we estimated that the introduced kelp bed at Stn. A harbored approximately 1.0×10^{11} CFU of AB. AB densities in seawater and sediment increased from June to September, both peaking in September (Seawater: 7.4×10^2 CFU mL^{-1}, Sediment: 6.3×10^4 CFU g^{-1} wet weight) at Stn. A. Assuming that the entire AB stock in June at Stn. A had dispersed into the water column of the introduced kelp bed (1.8×10^5 L), the resulting theoretical density showed close agreement with the AB density detected in seawater in September. In contrast, AB were also detected in seawater at Stn. B, but densities were about half those at Stn. A in June and only one-twentieth of those at Stn. A in September. Our findings offer new insights into utilizing macroalgae to augment AB supply as a biological control measure against *Karenia* blooms, which is crucial for future sustainable aquaculture.

S17, Poster, AbstractID=18357, PosterID: S17-P2

The role of biological interactions during bloom outbreak of *Karenia mikimotoi* in northern Fujian, China

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The blooms of *Karenia mikimotoi* in coastal areas have frequently occurred globally, posing a serious threat to marine ecosystems and the marine economy. In May and June 2021, as well as May 2024, three blooms of *K. mikimotoi* occurred in the waters of Fuzhou and Ningde. We adopted a combined approach using microscopy observation, high-throughput sequencing technologies targeting 28S and 16S rRNA genes, and metagenomics to investigate the potential contributions of heterotrophic dinoflagellates, parasitic dinoflagellates, and microorganisms to the decline of these blooms. During the demise phase of the two *K. mikimotoi* blooms in the Fuzhou waters, a significant presence of heterotrophic *Gyrodinium* spp. was observed, indicating their role in promoting the decline of the *K. mikimotoi* blooms through predation. Although a large number of parasitic dinoflagellates were detected in the water, none were found within the cells of *K. mikimotoi*, suggesting their limited impact. The bloom in Sansha Bay, Ningde, lasted for a shorter duration, but heterotrophic dinoflagellates were not observed. In the early stages before the bloom outbreak, there was a positive correlation between the microbial community and parameters such as pH, temperature, and salinity. However, this relationship shifted to a negative correlation as the bloom developed and subsequently declined. Notably, cyanobacteria were enriched before the *K. mikimotoi* bloom, with their relative abundance decreasing during the bloom, while the relative abundance of Thermoplasmatota increased and remained high after the *K. mikimotoi* decline. Throughout the process of the *K. mikimotoi* bloom, changes in microbial functional metabolism were observed, reflecting the effects of different stages of the bloom on microbial basal metabolic pathways, the synthesis of secondary metabolites, and amino acid biosynthesis. These changes may be linked to the adaptive strategies of microorganisms in the bloom environment.

BIO PAPER SESSION

Oral Presentations

BIO-P, Oral, AbstractID=18237, (ECOP)

Distribution, abundance, and grazing impact of *Salpa fusiformis* in relation to environmental conditions in Korean waters

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The highly abundant pelagic tunicate *Salpa fusiformis* blooms in the Korean Peninsula. In this study, we examined the composition of mesozooplankton species and the environmental parameters in the *S. fusiformis* bloom areas in the East China Sea, the East Sea and the South Sea to understand the possible reasons behind this bloom. Salps abundance ranged from 0 to 547 ind. m^{-3} in the East China Sea, 0 to 161 ind. m^{-3} in the East Sea and 0 to 124 ind. m^{-3} in the South Sea. High salp abundance was associated with elevated chlorophyll *a* concentration and a shallow thermocline, particularly in regions where chlorophyll *a* concentrations did not exceed 1.5 μgL^{-1}. Other mesozooplankton abundance was negatively correlated to salp abundance. Salp clearance rate estimated from Chl *a* concentration of the water ranged from 0.74 to 2.1 L $ind.^{-1}$ h^{-1}, and the grazing impact of salps was as high as 68.7% of the primary production at station J3 with moderate to high salp abundance in the South Sea. Salp ingestion rate positively correlated with both salp length and volume. The results suggest that episodic blooms of the salps can play a significant role in shaping the distribution of the plankton community and potentially carbon flux in this region.

BIO-P, Oral, AbstractID=18237, (ECOP)

Metagenomic insights into the stronger ecological coupling between particle-attached prokaryotes and eukaryotic plankton

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Marine plankton communities form the foundation of oceanic ecosystems, with complex interactions between prokaryotic and eukaryotic components driving key biogeochemical processes. This study investigated the distinct ecological relationships between particle-attached (PA) versus free-living (FL) prokaryotes and eukaryotic plankton through a year-long time series in Daya Bay, China. Our results revealed significantly stronger associations between PA prokaryotes and eukaryotes, as evidenced by: (1) closer diversity covariation patterns (Shannon index at OTU level), (2) more frequent positive correlations (Spearman's rho > 0.6, $p < 0.01$), and (3) fewer negative interactions (Spearman's rho < -0.6, $p < 0.01$) compared to FL prokaryotes. Metagenomic analyses provided mechanistic insights into these differences. PA communities exhibited significantly higher diversity in carbohydrate-active enzymes (CAZymes), including glycoside hydrolases (GHs), polysaccharide lyases (PLs), carbohydrate esterases (CEs), carbohydrate-binding modules (CBMs), and auxiliary activities (AAs). PA communities also showed enrichment in functional genes related to biofilm formation, chemotaxis, nitrogen metabolism, quorum sensing, and ABC transporters. Metagenome-assembled genomes (MAGs) further demonstrated that PA prokaryotes possess significantly larger genomes with greater gene content. These findings collectively demonstrate that PA prokaryotes have evolved enhanced genomic capabilities for surface colonization and complex substrate utilization, enabling tighter ecological coupling with eukaryotic plankton. The expanded metabolic repertoire of PA prokaryotes facilitates their adaptation to particle-associated niches and explains their stronger interactions with eukaryotes compared to FL prokaryotes. This study provides important insights into the functional differentiation between PA and FL prokaryotic lifestyles in marine ecosystems.

BIO-P, Oral, AbstractID=18273, (ECOP)

Quantitative assessment of mortality in the short-neck clams based on carbon budget in the Midorikawa River tidal flat: Effects of predation and freshwater discharge

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Tidal flat ecosystems provide essential environmental services such as water purification and high biological productivity. Bivalves play a central role in supporting these systems. However, bivalve populations have been declining worldwide due to predation, exposure to low-salinity water, and burial in mud from freshwater inflow. But the direct comparison of mortality factors and secondary production of bivalves in carbon weight remains difficult. In this study, we surveyed population dynamics of short-neck clams in the Midorikawa River tidal flat from April 2022 to August 2023. In this study, the secondary production of short-neck clam as well as mortality rates caused by predation of stingrays and ducks, and burial in mud, were quantified in terms of carbon weight. Stingray predation, based on density of feeding pits and clam biomass, peaked at 0.104 g C m^{-2} day^{-1}. Ducks consumed approximately 360 individuals m^{-2} over five months, which corresponding to a maximum predation rate of 0.03 g C m^{-2} day^{-1}. Net bag experiments during freshwater inflow events revealed 36.1 g C m^{-2} of mortality mainly due to mud burial, with field observations indicating 12.1 g C m^{-2} day^{-1} during floods. Secondary production exceeded 0 gC m^{-2} day^{-1} in many months and reached approximately 1.0 g C m^{-2} day^{-1}. When summed annually, mortality from a single three-day flood exceeded combined predation by stingrays (9.9 g C m^{-2}) and ducks (1.9 g C m^{-2}) by more than threefold. With heavy rainfall increasing, freshwater inflow and sediment burial may become the dominant mortality factor in tidal flat.

BIO-P, Oral, AbstractID=18274, (ECOP)

Quantification of bioturbation by black sea bream (*Acanthopagrus schlegelii*) in tidal flats of the Yatsushiro Sea using UAV imaging and environmental DNA

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Bioturbation in tidal flats is driven not only by macrobenthic invertebrates but also by larger vertebrates. However, fish-mediated bioturbation, particularly by bony fishes like the black sea bream, remains poorly quantified. This study aimed to assess fish-driven bioturbation using a combination of environmental DNA analysis and UAV-based aerial imaging. The study was conducted monthly from June 2023 to January 2024 at the Oshima tidal flat in the northern Yatsushiro Sea, Japan. For eDNA analysis, sponges were deployed to capture DNA over 24 hours, followed by sequencing and species identification. Dominant fish species were defined based on both eDNA detection and the presence of sediment foraging pits identified in UAV imagery. The relative occurrence of each species was calculated based on sequencing read counts. UAV surveys captured orthomosaic images to measure pit areas around fixed points. Bioturbation rate ($cm^2\ m^{-2}\ d^{-1}$) was calculated as the increase in pit area per unit surface area between two days. Additionally, macrobenthic animals were sampled inside and outside predator-exclusion nets to assess predation effects. Bioturbation rates were higher in summer ($441 \pm 72\ cm^2\ m^{-2}\ d^{-1}$) than in winter ($43 \pm 35\ cm^2\ m^{-2}\ d^{-1}$), correlating with water temperature. Areas without predator nets had lower macrofaunal density and species richness. Seven dominant fish species were detected, with black sea bream showing the highest occurrence and activity during warm months. Our results demonstrate the utility of eDNA and UAV imaging in quantifying fish bioturbation and highlight the seasonal influence of fish activity on sediment disturbance.

BIO-P, Oral, AbstractID=18343, (ECOP)

Year-round habitat use of black-footed albatrosses from the western North Pacific, and their distribution overlap with fisheries

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Fisheries constitute a major and dynamic threat to marine biodiversity worldwide. In particular, for migratory megafauna the risk of individual bycatch in fisheries may vary across seasons and marine regions because of the movements of both the animals and fishing fleets. To examine the seasonal distribution of the largest western population of black-footed albatrosses *Phoebastria nigripes* and its spatial overlap with fisheries, we tracked 20 individuals from Torishima, Japan, year-round using geolocators. During the breeding season (November–May), the birds were distributed in neritic waters off the Pacific coast of central Japan, while during the post-breeding season, they moved north-eastward and used neritic waters off northern Japan and the Kuril Islands. They showed the widest distribution in October, predominantly in the northern part of the Sea of Okhotsk and the eastern North Pacific. Seasonal changes in habitat use also included the selection of productive waters characterized by lower sea surface temperature (SST), higher surface chlorophyll *a* concentration, shallower seafloor depth with weaker slope, and stronger SST gradients during the nonbreeding season than during the breeding season. Importantly, the birds' at-sea distribution overlapped more intensively with industrial fishing fleets, including pelagic and demersal longliners and trawlers, during the breeding season than during the nonbreeding season. Our results highlight the importance of assessing the population-specific dynamic patterns of bycatch risk to develop adequate conservation strategies for such wide-ranging marine organisms.

BIO-P, Oral, AbstractID=18370, (ECOP)

Primary production of microphytobenthos enhanced by submarine groundwater discharge (SGD): Comparison between muddy and sandy tidal flats

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Tidal flats are periodically exposed due to tides, allowing microphytobenthos (MPB) to photosynthesize. While sufficient light is available during exposure, primary production (PP) of MPB may be limited by sediment drying and nutrient depletion in pore water. Submarine groundwater discharge (SGD), a major nutrient source in coastal zones, is known to enhance phytoplankton PP; however, its effect on MPB remains unclear. SGD may benefit MPB by maintaining sediment moisture and supplying nutrients during exposure. Our study investigated the relationship between SGD and MPB PP on the Midori River tidal flat, adjacent to Ariake Bay, characterized by abundant groundwater and distinct muddy and sandy zones. We hypothesized that SGD enhances MPB PP during exposure by alleviating water stress and nutrient limitation. We measured PP using a chamber method during summer, comparing SGD and non-SGD sites in both muddy and sandy flats. In muddy areas, the SGD site showed significantly higher PP (104 mgC m^{-2} h^{-1}) than the non-SGD site (47 mgC m^{-2} h^{-1}). In sandy flats, PP in the SGD area (126 mgC m^{-2} h^{-1}) was also notably greater than in the non-SGD site (7 mgC m^{-2} h^{-1}). These results suggest that SGD substantially enhances MPB PP under exposed conditions. Our study provide new insight into how SGD contributes to the spatial heterogeneity of benthic primary production in tidal flats.

BIO-P, Oral, AbstractID=18454

An atypical phytoplankton bloom observed off the Sanriku coast using a multi-wavelength excitation fluorometer integrated into a UCTD profiling system

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To obtain high-resolution, wide-area observations of phytoplankton community structure, a tow-yo transect survey was conducted by R.V. *Wakataka-maru* in May 2025 in the off-Sanriku area of the northwest Pacific Ocean, at the confluence of the Kuroshio and Oyashio currents, using a multi-wavelength excitation fluorometer (MEX by JFE Advantech). For this study, the MEX sensor was mounted on the BioUCTD probe (JFE Advantech) to obtain detailed phytoplankton distribution data and other environmental parameters. The tow speed was approximately 3 knots, with vertical casts repeated every 10 minutes to enable efficient vertical section observations. The horizontal spacing between profiles was approximately 1 km. A warm-core ring was present in the observation area, and a highly productive streamer-like bloom was clearly visible along the eddy edge in satellite imagery. Its internal structure was elucidated by the present observations in the vertical section. According to MEX analysis, this bloom consisted mainly of small eukaryotes and cyanobacteria, with some profiles showing chlorophyll-a concentrations exceeding 10 μg/L. The water mass in which the bloom was observed had a temperature of around 14 °C and a salinity of 34.5, classifying it as a warm and salty Kuroshio water mass. The timing and location of the observations were in an area where diatom blooms influenced by the Oyashio Current are commonly reported. Therefore, without MEX phytoplankton community analysis and detailed water mass observations by the BioUCTD, the observed high chlorophyll concentrations could have been misinterpreted as a diatom bloom influenced by the Oyashio Current. However, a comprehensive analysis of these observations suggests the presence of a non-typical bloom for this region and season.

BIO-P, Oral, AbstractID=18556, (ECOP)

Shifts in phytoplankton and bacterioplankton communities induced by simulated freshwater intrusion near ice shelves in the Pacific sector of the Southern Ocean

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Microbial communities are central to marine biogeochemical cycles and the oceanic food web. Bacteria are key players in recycling phytoplankton-derived organic matter, while phytoplankton drive nearly half of global primary production and regulate major carbon and oxygen fluxes. These tightly linked groups are highly sensitive to environmental perturbations. The Amundsen Sea is characterized by high macronutrient concentrations but can experience iron limitation, which may restrict phytoplankton growth despite nutrient availability. With rising global temperatures, this region is expected to undergo intensified freshening due to sea ice and glacial melt, potentially altering microbial community composition and their ecological interactions. To investigate these impacts, we conducted microcosm experiments using seawater collected from the deep chlorophyll maximum (DCM) layer near the Thwaites Glacier and Dotson Ice Shelf, diluted with freshwater at concentrations of 0%, 5%, 10%, and 25%. High-throughput sequencing of 16S and 18S rRNA genes was performed to characterize prokaryotic and phytoplankton communities, respectively. Freshening resulted in an increased relative abundance of *Flavobacteriales*, while *Pseudomonadales* and the *SAR11* clade decreased. In the phytoplankton community, *Chaetocerotales* became more dominant with higher meltwater levels, whereas *Thalassiosirales* (including diatom groups) and uncultured Dinophyceae showed a marked decline. The co-occurrence network interactions between the microbes indicated greater meltwater intrusion eroded microbial network stability, highlighting freshening's disruptive impact on community interactions and ecosystem functioning. These findings suggest that continued freshening could substantially reshape microbial community structures and interactions, ultimately impacting ecosystem functioning and biogeochemical processes near ice shelves in the Pacific sector of the Amundsen Sea.

BIO-P, Oral, AbstractID=18600, (ECOP)

Selective aerosolization of marine prokaryotes at the air–sea interface in the Western North Pacific

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Sea spray aerosol (SSA), generated by wave breaking at the ocean surface, is a major source of natural aerosols. It contributes to ambient aerosols and acts as cloud condensation nuclei and ice-nucleating particles, influencing cloud microphysics, radiative forcing, and atmospheric circulation. In biologically productive waters, SSA can carry marine microorganisms and organic matter, yet the processes governing microbial incorporation and selection into aerosols remain poorly understood. In this study, we investigated the microbial community structures in surface seawater, SSA, and ambient aerosols during the KH-23-3 cruise of R/V *Hakuho Maru* across subarctic and subtropical regions in the western North Pacific. Microbial communities in surface seawater were fractionated into particle-associated (PA) and free-living (FL) communities. SSA was generated by using an onboard bubbling system, and ambient aerosol was continuously collected on deck using a high-volume sampler, separating coarse and fine fractions. Microbial communities were analyzed via 16S rRNA gene sequencing. SSA communities exhibited significantly lower diversity compared to seawater and displayed regional variation, with more similarity to PA communities in the subarctic and FL communities in the subtropics, suggesting selective aerosolization based on microbial lifestyle and particle association. Ambient aerosol exhibited distinct and variable microbiota with limited ASV overlap with SSA and seawater, indicating that SSA-derived microbes may not be a dominant contributor to long-range transported airborne microbes. Our findings highlight the importance of selective microbial transfer at the air-sea interface and provide new insights into the biological and biogeochemical dynamics influencing aerosol composition and climate-active particles over the open ocean.

BIO-P, Oral, AbstractID=18690

Effects of ocean acidification on biological vitality and behavior of Disk abalone *Haliotis discus hannai*

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Accelerated anthropogenic CO_2 emissions have caused ocean acidification, which may have an impact on aquatic organisms. In this study, the effects of ocean acidification on survival, respiration, feeding, and behavior of Disk abalone (*Haliotis discus hannai*) were investigated. Juvenile disk abalones were raised for 70 days in OA incubation system formulated at four pH levels: control, pH 7.8, pH 7.5, pH 7.2. When abalones were cultured in ocean acidification environments, the average survival period was found to be shorter in more acidic environments. The average survival period in the control group was 68.64 days, meaning that most individuals survived until the end of the experiment, whereas in the pH 7.2 group, mortality continued to increase as the experiment progressed. The respiration rate measured at the beginning of the culture showed a tendency for the oxygen consumption rate to be lower in more acidic environments (R^2=0.54), but the respiration rate measured after about 60 days showed an opposite trend in higher in more acidic environments (R^2=0.63). It is inferred that when a sudden environmental change occurs, the control group gradually adapts, whereas in an acidic environment, the respiration rate is maintained high due to continuous stress. Abalone showed lower feed intake in more acidic environments (R^2=0.92), and the intake gradually decreased as the experiment progressed. These results are consistent with the fact that the growth rate gradually slowed down as the experiment progressed. When the juvenile abalone were turned over with the shells facing the bottom, the time it took to recover to the original state was determined. The more acidic the environment, the longer it took to recover (R^2=0.85). These results suggest that ocean acidification is a major factor that may affect the survival and behavior condition of disk abalone juveniles.

BIO-P, Oral, AbstractID=18749, (ECOP)

Stage classification of female gonadal development and estimation of egg production rates of *Paracalanus orientalis* (Copepoda: Calanoida) in Sagami Bay, Japan

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Paracalanus orientalis is an important prey for larval and juvenile fish in the northwestern Pacific. We investigated the seasonal changes in the female abundances of *P. orientalis* and their stage composition of gonadal developments from December 2018 to July 2019 in Sagami Bay, Japan. Plankton samples were collected by vertical hauls from 100 m depth. Based on the gonadal characteristics, we proposed a final gonadal stage (GS), GS4', which is defined as individuals with a mature oocyte at the lower oviduct. Female abundance, prosome length (PL), and ratios of GS4' individuals to total adult females (RI') were calculated. Using stepwise multiple regression, we constructed a model to estimate *in situ* egg production rate (EPR) based on the RI', temperature (T), salinity (S), chlorophyll *a* (CHL), and PL as predictors. The data set of *in situ* EPR was obtained from experiments conducted at the same time (Kawano, unpublished data). The highest female abundance (104.2 inds. /m³) was in June 2019. Their PL varied seasonally between 651 and 743 μm. The resulting model, $EPR = 0.89RI' + 6.20T + 0.22PL - 288.64$ ($R^2 = 0.968$). The model can be applicable in mesotrophic coastal environments where temperature strongly regulates EPR. Although *P. orientalis* is an epipelagic species, the gonad structures resembled the "*Aetidius*-type (Niehoff, 2007)", which were found in meso- and bathypelagic copepod families such as Aetideidae. Future research on female gonad types and EPR should extend to comparisons with other Paracalanidae and Aetideidae species to understand their adaptation process to different environments.

BIO PAPER SESSION

Poster Presentations

BIO-P, Poster, AbstractID=18195, PosterID: BIO-P1, (ECOP)

Prediction of the impact of climate change on the reproduction of the sea urchin *Mesocentrotus nudus*—Toward future scenarios of fisheries availability

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Ocean warming has led to shifts in the distribution of marine ectotherm species. The sea urchin *Mesocentrotus nudus* is commercially harvested in northern Japan. Lately, the extension of *M. nudus* distributions into colder water has been reported. The aims of the present study were to understand the mechanism of how water temperature affects the gametogenesis process, which also relates to the optimal season as a seafood product, of *M. nudus*, and to predict the appropriate water temperature range for the reproduction success. We developed the developmental index (DVI) model, which can be driven with water temperature and calculates the rate of the daily quantitative change in the gonad developmental stages (the developmental rate, DVR) and the integrated values by day (= DVI), to reproduce the annual cycle of the gonad developmental stages of the species by sex. The DVI model successfully simulated the seasonal changes in the gonad developmental stages of *M. nudus* from stage 1 (recovering, before gametogenesis) to stage 5 (spent, after spawning) at three locations in the main distribution areas investigated before 2000. The DVR of male at stage 1, 2 (growing, early gametogenesis) and 4 (mature, late gametogenesis) increased, and that at stage 3 (premature, mid-gametogenesis) decreased as water temperature increase. The DVR of female had similar trends, with the exception of that at stage 4, which decreased with increase in water temperature. Simulations using the water temperatures that imitated all combination of the minimum at the range of 1–15°C and the maximum at the range of 18–26°C, showed that the male and/or female did not reach stage 5 when the minimum temperature was <2°C or >11°C. The appropriate maximum temperature for coincidence of the spawning season between sexes was varied depending on the minimum temperature. The simulations using the daily long-term mean sea surface temperatures (1980–2010) showed that the area where both sexes reached to stage 5 and the distribution of *M. nudus* prior to 2010 were mostly coincident, and the northern boundaries of the distribution of *M. nudus* would be limited by the female gametogenesis failure. The appropriate minimum and maximum temperatures for the reproduction success were suggested to be 4–7°C and 20–22°C, respectively. The simulations using the daily mean sea surface temperature of 2011–2020 showed that the southern limit of the distribution in the Sea of Japan would have moved northward, as reported in 2010s. Extensive and intense marine heatwaves occurred around Japan in 2021 and 2023. Field monitoring and experimental approaches to evaluate the reproducibility of this model under extreme warming conditions would lead to an accurate assessment of climate change impacts for future scenarios.

BIO-P, Poster, AbstractID=18214, PosterID: BIO-P2

Geographical and seasonal variations of copepod communities from Ise-Mikawa Bay to offshore waters affected by the warm Kuroshio Current

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Copepods play a crucial role in coastal ecosystems and support fisheries production. This study revealed distinct spatial and seasonal variations in copepod communities in and around the semi-enclosed Ise-Mikawa Bay. A warm-water community (Group I) dominated the outer bay throughout the year, whereas the communities in the inner bay exhibited strong seasonal transitions. From winter to early spring, cold-water period community (Group IIA) prevailed. This was followed by a spring shelf-slope water community (Group IIB). In summer, a mixed community of cold- and warm-water species (Group IIC) appeared. The duration of these inner bay communities varied between Ise Bay and Mikawa Bay, reflecting the stronger estuarine characteristic of Mikawa Bay. In autumn, copepod communities in the inner bay shifted to warm-water communities (Group I), with an inner-bay community (IC) prevailing in September and a coastal-to-open sea community (IB) in November. These temporal and spatial shifts were shaped by offshore water intrusion, freshwater input, and seasonal changes in environmental factors such as temperature, salinity, and dissolved oxygen level, particularly in the bay. The distribution of genus Acartia that frequently dominates in shallow estuarine environments and has evolved a life cycle involving temperature-cues resting eggs, responded to species-specific fine-scale conditions, providing a valuable indicator of seasonal and spatial environmental change, estuarine influence, and potential climate change impacts in the bay. This study highlights the complex hydrographic-biological interactions, the sensitivity of planktonic communities to physical and chemical environmental changes, and the spatial heterogeneity in semi-enclosed coastal ecosystems.

BIO-P, QR-Poster, AbstractID=18229, PosterID: BIO-P3

Diverse giant viruses obtained from coastal area

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Giant viruses, including marseilleviruses, are a group of double-stranded DNA viruses within the *Nucleocytoviricota* phylum that have a complex biology, which had never been described in other viruses. Here, we isolated some new marseilleviruses infecting *Acanthamoeba castellanii*, from mangroves, namely, Shenzhenvirus, Futianvirus, Dashavirus and Xiwanvirus. Genomic analyses revealed that the four marseilleviruses carried different translation-associated protein gene sets. Shenzhenvirus is the first reported marseillevirus, to our best knowledge, lacking viral peptide chain release factor 3 (vRF3), while viral peptide chain release factor 1 (vRF1) is absent in Futianvirus. The *in-silico* tertiary structures revealed the conserved nucleotide-binding sites of vRF3 with GDP and vRF1 with mRNA and indicated their conserved roles during the termination step of protein biosynthesis. The protein interactome analyses revealed the interactions between vRF3 and eukaryotic RF1 (eRF1) or vRF1 and eukaryotic RF3 (eRF3) in *A. castellanii*. Combining the interface of the *in-silico* cellular-viral RF3·RF1 complex, we suggest that the viral homologs imitate cellular termination protein complex to terminate host protein biosynthesis. Our results reveal that diverse marseilleviruses employ different strategies to hijack the amoeba translation system at the termination step by imitating cellular translation factors.

BIO-P, Poster, AbstractID=18231, PosterID: BIO-P4

Deep sea coral, biodiversity of seamount in West Pacific

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Seamounts have a great effect on circulation patterns and currents, which in turn have very important effects on seamount biota. Seamounts host very diverse and abundant faunas, with important effects on oceanic biology. In this study, we explored seamounts in West Pacific, approximately 400 km northeast from Guam, using ROV and RV Isabu to investigate the deep-sea fauna and biodiversity around the seamounts and aimed construction of the ecological map and discovery of biological resources, particularly from cnidarian. First of all, we purposed sampling of deep-sea coral species among the cnidarian and extracted its RNA and DNA. After comparing DNA sequences of 2 genes from each coral, its species was defined. Also We constructed transcriptomic assemblage of 3 deep sea corals (*Paragorgia sp., Chrysogorgia sp., Narella sp*.) after de novo RNA sequencing to investigate further gene expressions in abiotic extreme environment and also to discover differentially expressed genes comparing between deep-sea environment and shallow water species or cold water and trophic coral species. This research was a part of the project funded by the Korean Ministry of Oceans and Fisheries, Korea (RS-2022-KS221644) and KIMST 20210646.

BIO-P, Poster, AbstractID=18306, PosterID: BIO-P5, (ECOP)

Seasonal and latitudinal variations in material flux by epipelagic zooplankton in the western North Pacific: An application of imaging analysis

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The epipelagic zooplankton in the western North Pacific exhibit significant seasonal and latitudinal variations. While much knowledge is available on abundance, biomass, and community structure, little is known about fluxes: feeding, production, and egestion. This study conducted imaging analysis on formalin-preserved zooplankton samples from epipelagic zones (0–150 m or 200 m) along a north-south transect set at 29°–44°N, 145°44′–155°00’E in spring (May) and autumn (October). Species and taxonomic groups were identified from the image data, and biomass was estimated using previously reported area-dry mass biomass equations that vary by taxonomic group. Respiration rates were calculated using a global bathymetric model, and feeding, production, and egestion were estimated using an energy budget model that varies by taxon. In both seasons, fluxes varied latitudinally, with high rates observed in high latitudes (1.8–2.6 times greater than those in low latitudes). In spring, high latitudes showed significant differences in community structure, particularly large-sized copepod *Neocalanus* spp. contributing notably to fluxes. In autumn, however, *Neocalanus* spp. were almost absent, and other Calanoida and Euphausiacea dominated without a clear latitudinal difference in community structure. The latitudinal differences in zooplankton flux in autumn were due to higher abundance and biomass at higher latitudes. This study demonstrated the usefulness of zooplankton imaging analysis to estimate their flux. Through this study, notable challenges were identified for the effect of diel vertical migration (DVM) by zooplankton on these estimates. Thus, daytime samples may underestimate fluxes due to lower biomass, while nighttime samples may overestimate them due to increased biomass.

BIO-P, Poster, AbstractID=18330, PosterID: BIO-P6, (ECOP)

Utilization of imaging analysis devices to evaluate the diel vertical distribution of oceanic copepods in the Oyashio region during winter

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In the oceanic region, most research on diel vertical migration (DVM) of copepods has been conducted during the summer, with limited information available regarding DVM during the winter. Additionally, most studies have primarily examined adult copepods, leaving a gap in our understanding of their juvenile copepodite stages and ontogenetic vertical migration (OVM). Traditionally, DVM and OVM studies of oceanic copepods have relied on stereomicroscopy. While this method is useful, it poses challenges in accurately assessing the size and biomass of individual specimens. Accurate measurements of size and biomass are crucial for estimating flux, a task that is difficult to achieve with a stereomicroscope. To address these issues, we collected vertically stratified zooplankton samples using a fine-mesh net (63 μm) designed to capture complete copepodite stages. We sampled from eight different layers between 0 and 1000 m over nine three-hour intervals within a 27-hour period (12-13 December 2007) during winter. All samples were preserved in a 4% borax-buffered formalin solution. In the laboratory, we scanned aliquots of the samples using ZooScan to obtain imaging data, which we used to identify copepod species to the lowest taxonomic levels. In the Oyashio region, large copepods of the genus *Neocalanus* are known to dominate the community. However, distinguishing between the sympatric species *N. cristatus, N. flemingeri,* and *N. plumchrus* can be slightly challenging based solely on imaging data. Given that this study was conducted in winter, it's important to note that these species may enter a diapause phase in deeper waters, with some extending beyond 1000 m for this phase. Focusing on two contrasting dominant species—*Eucalanus bungii* and *Metridia pacifica*—we observed that *E. bungii* may enter diapause at shallower depths within 1000 m, while *M. pacifica* continues to perform DVM even during winter. This study discusses the utility of imaging data for analyzing DVM and OVM in copepods.

BIO-P, Poster, AbstractID=18333, PosterID: BIO-P7, (ECOP)

Analysis of imaging data on the population structure, vertical distribution, and growth of two dominant oceanic copepods: *Metridia pacifica* and *Eucalanus bungii* in the western subarctic Pacific

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Traditionally, zooplankton analyses have relied on stereomicroscopes, but recent advancements in imaging analysis have offered significant advantages, including the simultaneous collection of abundance, size, and biovolume data. In this study, formalin-preserved samples were collected from depths of 0 to 1000 m across four seasons at a station in the western subarctic Pacific, using the imaging device ZooScan. Two dominant copepod genera, *Metridia* and Eucalanus, were examined for seasonal changes in abundance, biovolume, and diurnal vertical distribution. ZooScan measurements for each developmental stage were taken to calculate intermolt growth based on the equivalent spherical diameter (ESD) and biovolume. Within *Metridia* species, *M. pacifica*, the dominant species, had an ESD of 2 mm or less, while the other species exceeded 2 mm. *M. pacifica* exhibited diurnal migration to surface layers (0–50 m) at night. Only one species, *E. bungii*, was identified in the genus *Eucalanus*, with size cohorts corresponding to each developmental stage. Its vertical distribution was consistent day and night across seasons, but seasonal changes were evident. In October and February, *E. bungii* was found at depths of 200–500 m. In April, later developmental stages migrated to shallower depths of 50–200 m, while in July, younger stages (C1–C4) were found at 0–50 m, indicating recent reproduction during the spring phytoplankton bloom. For *E. bungii*, it was clear that new individuals emerged in July, but understanding the dynamics of later stages and generation time was difficult due to overlapping size distributions, particularly in C5 and C6. Inter-molt growth for both species ranged from 6% to 48% based on ESD and from 19% to 224% based on biovolume, respectively, with biovolume growth being significantly higher. Both species showed differences in inter-molt growth between males and females, with females being larger. Notably, *M. pacifica* has functional mandible teeth in C6M, while *E. bungii* C6M's teeth are degenerate. *M. pacifica* C6F exhibits significant vertical migration to the surface at night, unlike C6M, which remains deeper. This difference in behavior likely impacts feeding conditions, contributing to the lower inter-molt growth rates for male stages.

BIO-P, Poster, AbstractID=18389, PosterID: BIO-P8, (ECOP)

High species richness observed in hyperiid amphipods in Suruga Bay, Japan

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Hyperiid amphipods are known to play unique and important roles in marine food-webs, feeding on copepods and euphausiids, and having a parasitoid relationship with gelatinous zooplankton. To date, 284 species have been reported worldwide, however, there is still a limited number of studies on the species diversity, seasonal variation, vertical distribution, and community structure of hyperiids in the Pacific waters of Japan, especially in Suruga Bay. Monthly surveys of hyperiids conducted at two stations from January to December 2023, revealed the occurrence of 83 species belonging to 36 genera from the surface to ca. 1000 m depth, showing high local species-diversity. Numerically dominant species differed by season: *Primno abyssalis* and *P. latreillei* dominated from January to June, and *Lestrigonus bengalensis* and *Hyperioides sibaginis* from June to December. A PCA analysis suggested that the transition in dominant species may be due to the differences in response to water temperature and dissolved oxygen. Vertically-stratified samplings showed that their vertical distribution patterns were different between congeners in the genus *Lycaeopsis*, *Parascelus* and *Scina*. Together with the results from stable isotopic analyses and gelatinous zooplankton abundances, possible mechanisms to explain the high species richness of these pelagic amphipods will be discussed.

BIO-P, Poster, AbstractID=18415, PosterID: BIO-P9, (ECOP)

Proteomic insights into molecular mechanisms of nitrogen deficiency-induced chlorosis in the red alga *Pyropia yezoensis*

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Nitrogen deficiency is a major environmental stressor contributing to chlorosis in the red alga *Pyropia yezoensis* in coastal ecosystems. However, the precise molecular mechanisms underlying changes in physiochemical properties and the development of chlorosis in this alga remain poorly understood. In this study, we employed quantitative proteomic analyses using the iTRAQ method to elucidate the molecular basis of chlorosis observed in natural populations of *P. yezoensis*. Additionally, controlled laboratory experiments were conducted to simulate nitrate deficiency and induce chlorosis. Proteomic analysis revealed significant alterations in the expression of structure-associated proteins in response to reduced soluble nitrogen availability. Specifically, polyubiquitin, a protein associated with protein degradation, was upregulated, while ribosomal proteins involved in protein synthesis were downregulated, collectively contributing to a reduction in growth. Furthermore, proteins related to chlorophyll-associated photosynthesis, such as MgPME cyclase and chlorophyll *a*-binding protein complexes, were significantly downregulated. This led to impaired chlorophyll *a* synthesis in discolored *P. yezoensis*, indicating extensive damage to the photosynthetic apparatus. The observed changes in the expression of chlorophyll-associated proteins were consistent with the reduction in photosynthetic pigment content. These findings highlight the critical impact of nitrogen deprivation on the disruption of the photosynthetic and biosynthetic machinery in this red alga.

BIO-P, Poster, AbstractID=18462, PosterID: BIO-P10

Comparison of microzooplankton grazing rates and phytoplankton growth rates at two sites in Korea and their application to marine ecological modelling

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Marine ecosystem models like the NPZ (Nutrient–Phytoplankton–Zooplankton) model often rely on fixed parameters, such as phytoplankton growth and mortality rates, due to the difficulty of applying site-specific values. However, this can increase uncertainty, particularly in ecosystems affected by climate change. In this study, we compared two Korean coastal regions—Jinhae Bay (relatively stable) and the western coast of Jeju Island (influenced by warming and strong currents)—to improve model accuracy using in situ data. Phytoplankton growth and microzooplankton grazing rates were measured during spring and autumn using the dilution method. While physical conditions like temperature and salinity were similar between the two sites, biological parameters—including phytoplankton biomass, growth rate, mortality rate, and grazing rate—differed by more than twofold. Applying these site-specific values to chlorophyll-a simulations resulted in 3–20% lower concentrations compared to models using fixed constants. Seasonal patterns also emerged, with lower chlorophyll levels in spring in Jinhae Bay and in summer in Jeju waters. Nevertheless, some discrepancies remained between modeled and observed values. These results underscore the importance of incorporating region-specific field data to improve the reliability of marine ecosystem model predictions under changing environmental conditions.

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BIO-P, Poster, AbstractID=18463, PosterID: BIO-P11

Three tropical epiphytic dinoflagellate species recently found in Korean coastal waters

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We successfully isolated and established strains of three tropical epiphytic dinoflagellate species from Korean coastal waters. Taxonomic and morphological analyses were conducted on these isolates. *Coolia palmyrensis*, initially described as a new species from Palmyra Atoll in the equatorial Pacific, was isolated from Seogwipo, Jeju, in 2021. Continued monitoring confirmed its further distribution along the Korean coast, including Ulsan and Pohang. *Prorocentrum caipirignum*, first reported from Brazil, was isolated and cultured from Ulleungdo in September 2024, and was found to have morphological characteristics similar to those of *Prorocentrum lima*. Most recently, *Gambierdiscus australes*, originally discovered in the Austral Islands of French Polynesia, was isolated and cultured from the western coast of Jeju in March 2025. All three epiphytic dinoflagellate species identified in this study were found to produce toxins, with *P. caipirignum* exhibiting the highest toxicity. The detection of these tropical dinoflagellates in temperate Korean waters suggests a potential shift in regional marine biogeography, likely influenced by rising sea surface temperatures and increased anthropogenic transport. Given the known harmful algal bloom (HAB) potential and toxicity of these species, their presence raises significant ecological and public health concerns. Continued monitoring and proactive research are essential to assess the risks posed by the introduction and establishment of tropical marine species in Korean coastal ecosystems.

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BIO-P, Poster, AbstractID=18473, PosterID: BIO-P12

Vertical distribution of zooplankton in the surface layer of the Mixed water region

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Analyses of the feeding habitats of juvenile Japanese sardine and chub mackerel have revealed little dietary overlap between the two species. However, differences in the vertical distribution between the juveniles of these species may influence the observed dietary differences. Therefore, to accurately interpret their feeding ecology, it is essential to understand the vertical distribution of prey organisms. This study aimed to clarify the vertical distribution of zooplankton in the surface layer of the Mixed water region, an area for which little information was previously available. The survey was conducted in May 2022 in this region. Zooplankton samples were collected during the daytime at four stations using a 1 m² MOCNESS (mesh size: 0.33 mm) across eight depth layers: 0-10 m, 10-20 m, 20-30 m, 30-40 m, 40-50 m, 50-75 m, 75-100 m, and 100-200 m. The zooplankton were identified to the lowest possible taxonomic level and measured for body size. Both copepods and appendicularians exhibited the highest densities in the surface layer (0–10 m). High densities were also observed in the 30–40 m layer, where large cold-water copepod species were prevalent. Size composition analysis showed that smaller copepod species were dominant near the surface at all stations, while larger species tended to be more abundant in deeper layers, except at one station. These differences in the vertical distribution of zooplankton may contribute to the observed differences in feeding habitats between juvenile sardine and mackerel due to their respective vertical habitat preferences.

BIO-P, Poster, AbstractID=18485, PosterID: BIO-P13

Assessing barcoding completeness by taxonomic group and ocean region using the MetaZooGene Atlas and Database (MZGdb)

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Molecular methods (including DNA barcoding and metabarcoding) are powerful tools for studying zooplankton diversity at multiple levels: populations, species and communities. For all molecular applications, especially environmental DNA (eDNA), taxonomically complete and geographically comprehensive reference databases, including multiple gene regions used to discriminate different taxonomic groups or levels, are essential. While millions of sequences exist in the publicly available archives and databases, many marine zooplankton species are still missing and overall coverage is far from complete. Current barcoding completeness varies by taxonomic group and ocean region, based on cross-referencing NCBI GenBank with species reported in OBIS and COPEPOD. The best coverage is generally found in commercially important groups (e.g., fish, squid, and decapods) and in the larger-sized zooplankton (e.g., euphausiids, ctenophores, pteropods). Even in regions with relatively high completeness levels, e.g., North Atlantic, most taxonomic groups have <30% of accepted species sequenced.

There are several key questions that can be used to guide and prioritize efforts toward comprehensive reference databases for marine zooplankton. These include: which species are found in a region, how many of these species have been barcoded, and which taxonomic groups show lowest levels of completeness? The MetaZooGene Barcode Atlas and Database (MZGdb, https://metazoogene.org/mzgdb) is designed to enable and facilitate these goals, providing new tools, including coverage maps and data tables, to summarize and analyze the status of publicly-available barcode data for marine species by taxonomic group and geographic region across the global ocean.

BIO-P, Poster, AbstractID=18505, PosterID: BIO-P14

Single-cell analysis of marine bacterial surface properties and their potential impact on biogeochemical cycles

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Marine bacteria contribute to biogeochemical cycles by scavenging organic nanoparticles such as cell fragments, viruses, excretions from phytoplankton and other bacteria, and naturally occurring polymeric substances. However, the surface properties of bacteria that influence this process remain poorly understood. Previous studies have shown that marine bacterial surface characteristics vary greatly among individual cells, affecting nanoparticle attachment, which in turn influences bacterial survival and their role in marine biogeochemical cycles. These findings also suggest that bacteria may utilize up to 4% per day of marine dissolved organic carbon (DOC) through nanoparticle-mediated uptake. However, this estimate remains uncertain, as bacterial species and physiological states could cause substantial variability at the single-cell level. To better characterize this heterogeneity, we conducted a nanoscale surface roughness analysis of 601 individual marine bacterial cells. The results revealed significant spatial variation in surface properties even within a single cell, with surface roughness varying by a factor of 1 to 5. In addition, we will present preliminary data from incubation experiments using stable isotopes as tracers to quantify bacterial carbon and nitrogen uptake rates. These findings suggest that measuring bacterial surface properties at the single-cell level provides novel insights into bacterial resource acquisition strategies and their contributions to marine biogeochemical processes.

BIO-P, Poster, AbstractID=18615, PosterID: BIO-P16

Different properties of extracellular proteases in the subarctic and subtropical western North Pacific

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The utilization of dissolved organic matter by heterotrophic prokaryotes is the nutritional basis of the microbial food web and result in nutrient regeneration. Fresh bio-organic molecules, such as proteins, released into seawater could be good foods for heterotrophic prokaryotes, however, these molecules must be downsized extracellularly using hydrolytic enzymes prior to microbial uptake. Proteases are the major extracellular hydrolytic enzymes detected in aquatic environment. Although the subarctic and subtropical regions of the western North Pacific are known to differ in their characteristics of distribution of nutrients, main primary producers and primary production, there is not much information on the differences in organic matter metabolism by heterotrophic microorganisms.

We observed extracellular protease (aminopeptidase and trypsin-type endopeptidase) activities in seawater with some biogeochemical parameters at subarctic and subtropical western North Pacific in July, 2023. At the subarctic station, both extracellular protease activities were highest in the 0-10 m surface layer and decreased with depth. At the subtropical stations, the activities in the surface layer were much lower than those in the subarctic, but increased with depth, reaching a maximum at subsurface (around 60 to 80 m). The ratio of trypsin-type endopeptidase activity to aminopeptidase (exopeptidase) activity, T/A ratio, was higher in the subtropical than in the subarctic, and was particularly high in the subtropical sub-surface layer. The T/A ratio tended to be higher in the layer of nutrient depletion. These results implied that efficient microbial metabolism using extracellular endo-hydrolases by heterotrophic prokaryotes might support regenerative production at the oligotrophic subtropical North Pacific.

BIO-P, Poster, AbstractID=18635, PosterID: BIO-P17

Population prediction of moon jellyfish based on the strobilation effective accumulated temperature

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Temperature is the trigger to regulate strobilation process of moon jellyfish *Aurelia coerulea*. Base on the Effective Accumulated Temperature Rule, the threshold of effective accumulated strobilation temperature(K) and the initial temperature of strobilation(T0) were calculated. Results showed that the increase of accumulated strobilation temperature (AST) would contribute to increase the strobilation rate of *A. coerulea* polyps, however it had no significantly affect on the number of ephyrae released per strobila. Furthermore, the daily variation of spring and summer SST and AST in adjacent waters of Hongyanhe, Bohai Sea from 2017 to 2024 were compared. The active period of strobilation of *A. coerulea*, as calculated by the Effective Accumulated Temperature Rule, usually begins in early May and ends in mid-June. In 2017, 2022, and 2023, the polyps entered the active period of strobilation earlier, beginning in late April. In 2018, SST were lower than those in other years, thus the polyps entered the active period of strobilation about 1 week later. In the case study of Hongyanhe, the changes in the accumulated strobilation temperature (AST) are consistent with the number of ephyra collected by zooplankton net. This study preliminarily confirmed the feasibility of using effective accumulated temperature to predict *A. coerulea* numbers.

BIO-P, Poster, AbstractID=18640, PosterID: BIO-P18, (ECOP)

Spatial variation in microplankton community structure in relation to hydrography in the northern Japan Sea and Okhotsk Sea using PlanktoScope

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The northern Japan Sea and the Okhotsk Sea are major fishing grounds for northern Japan. From summer to autumn, the Soya Warm Current (SWC) flows from the Japan Sea into the Okhotsk Sea. Along its offshore edge, an upwelling zone known as the Cold Water Belt (CWB) is formed. While nutrient supply from this upwelling is a key process supporting biological productivity, the ecological contribution of the CWB remains unclear. We investigated the spatial variation in the microplankton community in relation to hydrography. In June 2023, CTD data and surface water samples were collected. The samples were concentrated using a 20 μm mesh, and microplankton images were captured with a PlanktoScope, a plankton imaging tool. Individual particles were then segmented and classified using EcoTaxa, an online sorting tool. Cluster analysis revealed three distinct communities. The Japan Sea community, associated with the Tsushima Warm Current (TWC), was dominated by small diatoms (*Leptocylindrus* spp.). In contrast, the coastal Okhotsk community, found in both the SWC and the CWB, was characterized by large diatoms (*Chaetoceros* spp.). Although there was a continuous hydrographic transition from the TWC to the SWC, the microplankton community in the warm, oligotrophic SWC was distinct from that of the TWC. Instead, the community was similar to that of the adjacent, cold, nutrient-rich CWB. These findings suggest that the elevated abundance of large diatoms in CWB was entrained into the SWC. Our study showed that plankton imaging systems are powerful tools for revealing complex ecosystem dynamics in hydrographically dynamic regions.

BIO-P, Poster, AbstractID=18671, PosterID: BIO-P19, (ECOP)

Seasonal and interannual variations in mesozooplankton community structure in the inner part of Suruga Bay, Japan: Effects of the Kuroshio large meander

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Suruga Bay is an open bay facing the Pacific Ocean, influenced by both coastal river waters and oceanic Kuroshio waters. The inner part of the bay is an important area for fishery production. Although mesozooplankton play crucial roles in marine food webs, knowledge on their structure and temporal variation in this region is limited. To elucidate the seasonal and interannual variability of the mesozooplankton community, monthly sampling in the inner part of the bay was conducted from July 2015 to July 2019. In addition, the influence of the Kuroshio Large Meander (LM), which began in July 2017, was also investigated. The environmental conditions in the study area showed clear seasonality, characterized by high temperatures and low salinity during summer. Community structure analysis based on abundance data revealed that the mesozooplankton community could be divided into two seasonal groups: one dominated by copepods and/or cladocerans in spring and summer, and the other dominated primarily by copepods in autumn and winter. The expansion of low-salinity coastal water into offshore areas and surface circulation appear to contribute to the seasonal dominance of cladocerans. Although there were no significant differences in zooplankton biomass, abundance, or environmental parameters between the LM and non-LM periods, water temperatures and the abundances of heteropods and amphipods were significantly higher during the spring–summer period of the LM compared to that of the non-LM period. Seasonality of surface circulation in Suruga Bay may influence the extent to which the Kuroshio affects the inner part of the bay.

BIO-P, Poster, AbstractID=18688, PosterID: BIO-P20, (ECOP)

Model-based assessment of nutrient management and its impact on nori (*Porphyra yezoensis*) cultivation in the Seto Inland Sea

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Porphyra yezoensis (Nori) is a major marine resource in Japan, with key cultivation areas in the Ariake Sea and the Seto Inland Sea. In the Hiuchi-Nada region of the Seto Inland Sea, Nori aquaculture has recently suffered from reduced harvests and color degradation. These issues are primarily attributed to low concentrations of dissolved inorganic nitrogen (DIN). To mitigate this problem, nutrient loadings from nearby sewage treatment plants have been artificially increased. However, the effectiveness of these measures in improving Nori yield and color has not been clearly demonstrated. Therefore, it is necessary to verify the impact of past nutrient management efforts and to evaluate future strategies. This study aims to clarify nutrient cycling in the Seto Inland Sea, quantitatively assess the effects of nutrient management measures, and examine the ecological responses to nutrient loading. We developed a new ecosystem model incorporating Nori cultivation, based on the eNEMURO framework (Yoshie *et al.*, 2011), which has been validated for seasonal dynamics in subarctic and subtropical marine ecosystems. Using this model, we conducted sensitivity experiments comparing scenarios with and without enhanced nutrient loading. The results provide a quantitative evaluation of how nutrient inputs influence lower-trophic-level ecosystem components, including Nori productivity.

BIO-P, Poster, AbstractID=18748, PosterID: BIO-P21, (ECOP)

Species-specific characteristics in ammonium excretion rates of large marine copepods revealed by a highly sensitive analytical method

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The regeneration of nitrogen through the excretion of marine mesozooplankton is an important process for primary and bacterial production in the ocean. Although the excretion rates of ammonium by mesozooplankton fluctuate depending on various factors, including body size, temperature, food availability, and physiological conditions, they are often empirically estimated using a model based on habitat temperature and body mass. This approach, however, potentially overlooks species-specific characteristics in the excretion rates, which may also vary with other environmental factors and physical conditions. Furthermore, previous studies have pointed out that the stress, caused by long and high-density incubations employed in deriving the empirical model, hinders accurate estimation of excretion rates in the field. Hence, in this study, we used a highly sensitive method to determine ammonium excretion rates for ten groups of large calanoid copepods with short-time individual incubation, in order to understand their potential variation. Results have shown that excretion rates vary largely among species: the ratios of excretion rates to model-estimation (Ikeda et al. 2001) were generally high in *Neocalanus plumchrus* (1.59 on average), *Eucalanus bungii* (2.28), *Calanus jashnovi* (2.63)*, Euchirella rostrata* (2.82) and *Calanus sinicus* (3.23). In contrast, ratios were considerably lower in *Rhincalanus nasutus* (0.176), Pontellidae sp. (0.0013), and Aetiteidae sp. (0.00087), while species such as *Euchaeta* sp. (1.03) and *Undinula vulgaris* (1.28) showed good agreement with model estimation. These preliminary results suggest a potential underestimation of ammonium excretion values in model estimation and highlights the importance to understand species-specific characteristics in the nitrogen excretion by mesozooplankton.

BIO-P, Poster, AbstractID=18758, PosterID: BIO-P22

Seabird migration corridors in the northwestern Pacific, and their overlap with wind farms

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In October 2020, Japan declared that it aims to achieve carbon neutrality by 2050. To meet this pressing objective, it has been accelerating efforts toward structural changes in the energy sector and rapidly implementing renewable energy-based options. In this context, coastal and offshore wind farms have become one of the favored options for energy production, with projects rapidly developing along Japan's coastlines. To properly understand the environmental impact of such development, it is essential to identify potential conflicts with key marine biodiversity that may arise in these coastal areas. Marine predators such as seabirds may help indicating ecologically important areas, through their at-sea distribution and habitat use. In this study, we used light- based geolocation loggers to identify favored migration corridors of rhinoceros auklets (*Cerorhinca monocerata*) during their seasonal migration, from three islands located in the northern Sea of Japan and the Western Pacific Ocean, across several years. Our results suggest that the three studied populations, although breeding in distinct areas, use overlapping migration pathways, creating regionally-important migration corridors and distribution bottlenecks, notably in southwest Hokkaido. Rhinoceros auklets are abundant seabirds in this area, with Teuri island hosting one of the world's largest breeding colonies for this species. The seasonally-dynamic but convergent at-sea distribution of the studied populations may put them in contact with wind farms, with local risks of habitat displacement and/or collisions having the potential to affect several, geographically-distant breeding populations.

FIS PAPER SESSION

Oral Presentations

FIS-P, Oral, AbstractID=18227, (ECOP)

Impact of offshore fishery decline on coastal fisheries: An analysis of the Hokkaido, in Japan

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While global demand for seafood continues to expand, marine fisheries production has remained stagnant and failed to meet this growing demand. This gap between supply and demand is particularly pronounced in the Northwest Pacific region, where fisheries catches have experienced dramatic decline, especially affecting offshore Danish seine operations that peaked in the 1980s and have since faced continuous deterioration. While this phenomenon has profound implications for local economic sustainability and marine resource management, empirical evidence on how the closure of offshore fishing activities affects remaining coastal fisheries remains limited, creating a critical knowledge gap for evidence-based fisheries management policies. To address this global challenge, this study investigates the causal impact of offshore fishery decline on coastal fishing activities using Japan's Hokkaido region as a case study, where offshore Danish seine fisheries have experienced similar decline patterns to Northwest Pacific trends. We employed a quasi-experimental design using the Rumoi region of Hokkaido as a natural experiment, where offshore Danish seine operations closed completely in 2000, subsequently relying exclusively on coastal fisheries. Using causal inference methods, we compared fishing outcomes in Rumoi (treatment group) with other comparable regions that maintained offshore operations (control group) to isolate the causal effects of offshore fishery closure on coastal fishing activities. While conventional wisdom suggests that reduced fishing pressure on shared marine resources should enhance coastal fishery yields due to decreased competition, the actual relationship may be more complex, involving multiple pathways including changes in fishing infrastructure, labor mobility, market dynamics, and ecosystem interactions. This research contributes to sustainable fisheries management by providing empirical evidence for policy makers worldwide facing decisions about resource allocation and industry restructuring, with findings that will inform strategies for supporting fishing communities during transitions, optimizing marine resource utilization, and developing adaptive management frameworks that account for complex inter-fishery relationships in the context of global offshore fishery decline.

Keywords: Offshore fisheries decline, coastal fisheries, causal inference, fisheries management, Hokkaido, community resilience

FIS-P, Oral, AbstractID=18239

Applications and prospects of satellite remote sensing in fisheries and aquaculture

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Fisheries have entered the era of big data. The continuous progress of satellite remote sensing technology has provided powerful technical support and high-dimensional and high-frequency observation data for carrying out cross-disciplinary research on the remote sensing of fisheries. Remote sensing technology is deeply integrated in and has led to breakthroughs in aquaculture, conservation, the utilization and development of fishery resources, combating illegal fishing, marine ecological environment and biodiversity protection, etc. Satellite remote sensing plays an important role in marine fishing, providing technical support for the transformation of the marine fishing industry from traditional operations to energy-efficient operations. Meanwhile, long-time-series marine environmental information obtained by satellite remote sensing is also applied in fisheries resources assessment to enhance our ability to recognize and exploit marine fisheries resources. In recent years, with the continuous development of space observation technology; the continuous breakthrough of sensor network, Internet and IOT technology; and the rapid development of deep learning and artificial intelligence, the fishing industry has been continuously moving in the direction of the informational and intelligent, and advancing towards the goal of green and sustainable development.

FIS-P, Oral, AbstractID=18280

AIS-based estimation of fishing gear recovery within the Japan-Korea Northern Interim Measures Water in the Sea of Japan

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The fishing grounds of red snow crab, *Chionoecetes japonicus*, in the Sea of Japan mostly overlaps with the Japan-Korea Northern Interim Measures Water (J-K NIMW). To accurately assess its stock status, we are developing a method to estimate the activities of fishing vessels operating in this area, as a part of Research and Assessment Program for Fisheries Resources, the Fisheries Agency of Japan. This presentation will describe an estimation technique using the Automatic Identification System (AIS) data for counting gear recovery by fishing vessels that may be targeting red snow crab. We collected AIS data from fishing vessels operating at depths of 800–2000 m, the typical fishing ground for red snow crab, within the J-K NIMW. These data were obtained via AIS transponders installed on Japanese research vessels as well as a crab fishing vessel from 2020 to 2024. The fishing vessels observed on board were also analyzed using AIS data received through satellites, purchased from an AIS provider, Spire. As we analyzed consecutive position and speed data of a fishing vessel, an estimation technique for counting fishing gear recovery was considered. A statistical analysis (expectation–maximization analysis) categorized this vessel's speed into three groups, slow (ca. 1 knot) for gear recovery, medium (ca. 8 knots) for gear installation and fast (ca. 10 knots) for movement between fishing grounds and fishing ports. We defined the start of recovery as the two consecutive points where the vessel's speed shifts from medium or fast to slow, and the end as the two consecutive points where the speed shifts from slow to medium or fast. Applying this approach, we estimated the number of gear recovery events conducted by the analyzed fishing vessel within the studied area during early summer of 2023. Furthermore, we analyzed satellite AIS data of fishing vessels in the J-K NIMW, purchased from providers, Shipfinder and Spire. Using the approach developed in this study, we estimated the number of gear recovery events as fishing efforts in the analyzed area from 2017 to 2024. The approach developed in this study is useful for time-series analysis of fishing effort in the J-K NIMW and contributes to improving the stock assessment of red snow crab in the Sea of Japan.

FIS-P, Oral, AbstractID=18282, (ECOP)

AIS-based estimation of fishing grounds and operational drivers in the NPFC convention area: Effects of oceanic conditions and fishery resource abundance on vessel operations

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The high seas of the North Pacific Ocean are inhabited by abundant fishery resources, including Japanese sardine (*Sardinops melanostictus*), chub mackerel (*Scomber japonicus*), and Pacific saury (*Cololabis saira*). These stocks are harvested by multinational fishing vessels operating within the Convention Area established by the North Pacific Fisheries Commission (NPFC) and subject to its conservation and management measures. Effective conservation and management require detailed knowledge of vessel behavior, yet the spatial dynamics and operational drivers of fishing fleets in the NPFC Convention Area remain poorly understood. To estimate the fishing patterns and their environmental drivers within the Convention Area, we analyzed Automatic Identification System (AIS) data of light purse seiners targeting Japanese sardine and chub mackerel as well as environmental reanalysis products between 2020 and 2022. We initially labeled each AIS position as fishing or non-fishing by applying a speed-based threshold to vessel tracks. The monthly mean vessel positions from 2020 to 2022 indicated that the fleet consistently operated east of Tohoku and Hokkaido, Japan with little shift in the centroid of fishing grounds across years and a peak season consistently occurred during July and October. We then collated these label positions with atmospheric variables from ERA5 and oceanic variables from JCOPE2M. Treating fishing presence as binary response, we trained gradient boosted decision tree classifiers with following predictor sets: (1) atmospheric conditions, (2) oceanic conditions, and (3) both combined. According to the area under the receiver operating characteristic curve (AUC), classification accuracy was highest for model 1, followed by model 3, with model 2 performing worst. These results suggest that atmospheric conditions exert a greater influence than oceanographic conditions when classifying fishing versus non-fishing activity. An additional analysis with 2023 data showed a northward shift in fishing grounds and fragmentation of the fleet, coincided with a decline in chub mackerel abundance and an increase in Japanese sardine. While both species were abundant, fleet behavior tended to be spatially stable, influenced by atmospheric conditions, whereas depletion of one species seemed to prompt the fleets to relocate the fishing grounds. These findings provide a basis for improving the efficiency and adaptability of fishing operations in the Convention Area.

FIS-P, Oral, AbstractID=18312, (ECOP)

Environmental Drivers of Shark CPUE in NOAA GulfSPAN Survey (1994–2024)

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This study used fishery-independent gillnet data from NOAA's GulfSPAN survey (1994-2024) to test how environmental conditions predict shark catch-per-unit-effort (CPUE) across four coastal areas near Panama City, FL. CPUE was calculated per gillnet set, and species-specific generalized additive models (GAMs) used water temperature, depth, salinity, dissolved oxygen, turbidity, and year as predictors for CPUE, comparing them between the top five most-caught shark species and over time. Results show that warmer water temps, higher salinity, and shallow-mid depths were linked to higher CPUE; turbidity showed a negative linear relationship with CPUE. Patterns were broadly similar across species, but the strongest fit models were for finetooth and scalloped hammerheads. These results reflect environmental preferences of mostly juvenile coastal sharks and can inform regional fisheries management

FIS-P, Oral, AbstractID=18471

Enhancing ecosystem stability through efficient operation of hatcheries releasing juvenile pacific salmon with a prolonged freshwater period of life

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Catches of Asian Pacific salmon stocks are showing a declining trend due to climate change and anthropogenic impacts. Salmon populations in certain river basins are in critical condition. One way to maintain aquatic ecosystem stability and salmon population numbers is through artificial reproduction.

The life cycle of Pacific salmon includes a transition from freshwater to marine habitats through the smoltification stage – a genetically programmed process in which the organism prepares for life in marine conditions. Understanding the mechanism of juvenile adaptation to marine environments is essential for producing physiologically robust smolts and releasing them at optimal times based on hydrological and hydrobiological conditions. However, the freshwater period for some species (chinook, sockeye, coho, and masu salmon) can last up to three years, significantly complicating their cultivation. To reduce the freshwater life stage, advancements in biotechniques for producing fingerlings smolts are necessary. During smoltification, juveniles undergo noticeable behavioral, morphological, and biochemical changes, including shifts in hormonal balance, leading to adjustments in osmoregulation. To optimize this process, hatcheries are developing specialized feed formulations and hormonal therapies – without genetic modification – to enable juveniles to migrate to the sea within their first year of life.

This approach will help replenish Pacific salmon populations without creating competitive interactions between hatchery-raised and wild juveniles in rivers. Additionally, it will enhance the appeal of artificial reproduction for Pacific salmon with a prolonged freshwater period of life, whose current release volumes are negligible.

FIS-P, Oral, AbstractID=18657, (ECOP)

Effectiveness of quota transfer in the set-net fishery of Ishikawa Prefecture: A structural estimation approach to fisherman's behavior

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In Japanese set-net fisheries, juvenile Pacific bluefin tuna is frequently caught as bycatch, with catch volumes varying widely due to annual fluctuations in migratory patterns. Under Japan's Total Allowable Catch (TAC) system, quotas are assigned to individual prefectures. However, because tuna arrivals are unpredictable, mismatches between allocated quotas and actual catch opportunities often arise. To enhance management flexibility, Japan introduced a quota transfer system that allows fishery management units to exchange quota. While earlier studies have assessed the direct economic impacts of this system, its influence on fishermen's behavioral decisions—such as whether to fish, rest, or release catch—has not been systematically examined. This study addresses this gap by applying a structural estimation model using data from the set-net fishery in Ishikawa Prefecture. The model includes variables such as quota availability, fishing effort, and release patterns. In addition, interviews and questionnaire surveys with fishermen will identify qualitative factors influencing decision-making, including market conditions, weather, cooperative relationships, and administrative signals. By integrating quantitative modeling with qualitative insights, this research aims to provide a more comprehensive understanding of how quota transfer affects fishing behavior. The results will contribute to designing more effective quota management systems.

FIS-P, Oral, AbstractID=18661, (ECOP)

Comparing the sand lances' kinematics of locomotion in sand and in water

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As an important coastal prey species, sand lances (*Ammodytes* spp.) rely on burrowing into sand for survival. However, the kinematics of their subterranean locomotion, compared to their aquatic swimming, remain poorly understood. To clarify how this species adapts its movement to these different media, we recorded sand lances from Funka Bay, Hokkaido, as they moved through a transparent granular substrate and swam in a water tank. Using custom Python scripts, we analyzed video recordings to extract body centerline coordinates. From these data, we quantitatively compared two modes of movement by analyzing: (1) overall trajectories and speeds, and (2) undulatory characteristics such as wavenumber (via Fast Fourier Transform) and amplitude. Our results show that during locomotion in sand, the entire body traces the path of the head's tip, a trajectory that can be approximated by a sine wave. This contrasts with their aquatic, anguilliform swimming, which is characterized by a propulsive wave of increasing amplitude down the body. This comparison reveals strategic trade-offs in balancing energy use, speed, and maneuverability between the distinct media of sand and water. Furthermore, the analytical method developed is broadly applicable, offering a new tool to assess the adaptive potential of other burrowing species and providing ecological insights valuable for conservation.

FIS-P, Pre-Recorded-Oral, AbstractID=18698

Automation of sockeye salmon scale age interpretation

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Sockeye salmon (*Oncorhynchus nerka*) fisheries in Alaska are managed based upon the principle of sustainable yield, wherein fisheries are actively managed to achieve in-river escapement goals while maximizing harvest opportunities to resource users. Escapement goals are established using age structured population models that estimate the number of spawning adults needed to maximize the yield of future returns of sexually mature fish. Age information is produced by highly trained personnel who examine and interpret seasonal growth patterns on scales. These methods require a considerable investment of resources and are subjective, and may benefit from automation using machine vision based classification. In order to test the application of artificial convolutional neural networks to the problem of scale aging, a set of 15154 sockeye salmon scales from the Copper River fishery were scanned from scale impressions with a microscope with a robotic stage and double-blind aged by 5 trained human scale readers. Although there was variability among the human readers, two similar groups clustered together in terms of freshwater age, saltwater ages, and error code assignations. CNNs trained on individual scale agers tended to reproduce the results of the individual ager (with 85-97% correspondence), with similar results on the modal "consensus age" among the agers for each scale. Machine vision methods show promise in streamlining age estimation for salmon stocks.

FIS-P, Oral, AbstractID=18714

Population genetics reveals structure at several levels in "cosmopolitan" mesopelagic fish species

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Mesopelagic fish are some of the most abundant vertebrates on the planet. They represent a major food source for other marine species and, through diel vertical migration (DVM), an important link between the surface and deep ocean. Many mesopelagic species are considered to be cosmopolitan, though prior genetic research has uncovered apparent barriers to dispersal across widespread ranges. Here, we present population genetic data on seven mesopelagic fish species from across the Atlantic and Pacific oceans. These species include hatchetfish (*Argyropelecus aculeatus*, *Sternoptyx diaphana*), bristlemouths (*Sigmops elongatus*, *Cyclothone microdon*), viperfish (*Chauliodus sloani*), snipe eels (*Nemichthys scolopaceus*), and lanternfish (*Ceratoscopelus warmingii*). Within each species, we compared fish from 3-7 distinct geographic regions, using samples collected by a wide network of international collaborators. Fish were initially barcoded with a fragment of the mitochondrial COI gene both to confirm species IDs and to place them in a larger phylogenetic context. Fish from our target species were then processed with Restriction-Site Associated DNA Sequencing (RAD) to identify thousands of single-nucleotide polymorphisms per species with which to conduct population genomic comparisons. We found complex patterns of structure that varied across species and region, including evidence for directional movement of fish between regions. We discuss these results in the context of life-history differences among the seven species, particularly whether or not they are known to conduct DVM. Our results shed light on the factors that shape dispersal and diversity in highly abundant fish species of the Ocean Twilight Zone.

FIS-P, Oral, AbstractID=18796, (ECOP)

An overview of Pacific Arctic marine fauna borealization and the novel approach for process quantification

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Borealization can be defined as a process of Arctic and sub-Arctic ecosystem modification with acquiring features typical of boreal ecosystems (in abiotic and biotic components). During recent warm years boreal species of many functional groups shown northward shifts into the Pacific Arctic, driven by local habitat modifications and advection of warm water and associated species from lower latitudes of the Bering Sea. In the Western Chukchi Sea (WCS) walleye pollock *Gadus chalcogrammus* total biomass dramatically increased from 10.8 t in 2003 to 157188.8 t in 2020. Indices for polar cod *Boreogadus saida* shown reversed trend for the same period: from 117554.9 t (2003) to 3344.0 t (2020).

To reveal the common modifications of composition in biotic functional groups as nekton or plankton caused by shifts in habitat range of several species - a simple biogeographical index can be used. Index of latitudinal zoning (ILZ) implemented by O.A. Ivanov and V. V. Sukhanov shown prospective results for biogeographic zoning of the North Pacific area. The procedure of converting area descriptions (latitudinal zones and subzones) into a numerical scale was as follows. The subzone was chosen as an indivisible minimal area. The boundaries between subzones were allocated ranges from 0 to 6. They increased from tropical (the range of the equator is 0) to northern latitudes (the range of the North Pole is 6). ILZ is calculated as the arithmetic mean of values associated with the species habitat ranges to the subzone for all species revealed in each sample. Index values are suitable for mapping, GIS processing and statistical tests.

The implementation of an index on the data from bottom trawl surveys conducted in the WCS from 2010 to 2024 demonstrated low interannual variability in the zoogeographic composition of nektonic species, despite significant alterations in gadids biomass from 2018 to 2020. A restructuring of the nekton community was observed with a new modification of the ILZ index, where the species biomass values were used as "statistical weights" in the calculations (WILZ). The novel index exhibited a significant decrease in the southern part of the WCS (<71°N) from 4.7 (2010) to 3.8 (2020), which could be described as a transition of the nekton community state from Arctic to Arctic-Boreal. The results from the WCS will be compared with Bering Sea data.

FIS-P, Non-Scheduled-Pre-Recorded-Oral Presentation, AbstractID=18793 (CANCELLED)

~~Aligning stock structure of Pacific sardine with biological reality~~

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~~Best practices for representing population structure in stock assessment involve aligning stock (i.e., management unit) boundaries with the most plausible population (i.e., biological unit) boundaries. Assessment and management of the Pacific Sardine (*Sardinops sagax*) in the U.S. seemingly follow this approach, as management recognizes two separate subpopulations along the Pacific coast based on hypothesized existence of genetically distinct spawning groups with distinct migratory patterns and life history traits. The subpopulation hypothesis shapes the current design of annual, fishery-independent surveys and stock assessments for Pacific Sardine. However, several systematic reviews have found no evidence in support of subpopulations, and emerging research using whole genome sequencing shows a single, panmictic population of Pacific Sardine along the entire Pacific coast of North America that is supported by life history traits associated with reproduction, growth, movement, and ontogeny. Here we describe the incoherent dimensionality that exists between the existing stock structure and the population structure (i.e., distribution, growth, spawning, movements) of Pacific Sardine and how it may impact perceptions of stock status, biological traits, and the effects of climate on future fisheries production. We then outline potential pathways for aligning stock structure with biological reality.~~

FIS PAPER SESSION

Poster Presentations

FIS-P, Poster, AbstractID=18160, PosterID: FIS-P1 (CANCELLED)

~~**Lagrangian structures favorable for fishery in the northwestern Pacific and adjacent areas**~~

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~~The developed Lagrangian methods help to identify Lagrangian structures favorable for fishery. Using historical data on the saury catch locations in 2004–2019, we have shown that feeding and fishing grounds accumulate at strong Lagrangian fronts in the region of the Kuril and Hokkaido islands. After 2014, saury practically disappeared in this region. Lagrangian origin maps showed that after 2012 a large amount of the productive Oyashio water started to penetrate to the open ocean reaching sometimes 170°E, where the fishing locations are concentrated in the recent years. We analyze walleye pollock catch locations in 1997–2021 in the Okhotsk Sea. Identification of the origin and 'age' of water in the sea and statistical analysis allowed us to conclude that pollock catch sites accumulate preferably in the intrusions of Pacific water entering the sea through the northern Kuril Straits. The water of Pacific origin has a higher temperature and concentration of nutrients as compared with domestic waters. The location of Lagrangian fronts and intrusions can be calculated under any weather conditions. Sending the Lagrangian maps with indication of the most favorable fishing grounds to the board of boats would help fishermen to reduce the fuel consumptions and greenhouse gases for effective energy use of saury and pollock fishing operation.~~

~~*The work was supported by the Russian Science Foundation (grant no. 23-17-00068).*~~

FIS-P, Poster, AbstractID=18196, PosterID: FIS-P2, (ECOP)

Spatial distribution and oceanographic drivers of Japanese anchovy (*Engraulis japonicus*) in Peter the Great Bay, Japan/East Sea (summer 2024)

Vladimir Polyanichko, Anna **Kurnosova**

This study presents the first comprehensive assessment of the spatial distribution and biomass of Japanese anchovy (*Engraulis japonicus*) in Peter the Great Bay during the summer of 2024, using hydroacoustic surveys (Simrad EY-60 scientific echosounder at a frequency of 70 kHz and 200 kHz) and concurrent oceanographic profiling (ASTD 102 probe). Maximum anchovy densities were recorded in central Amursky Bay and the southeastern coast in Ussur Bay. This species exhibited heterogeneous distribution patterns, with seasonal shifts toward thermocline zones (~10 m depth), where chlorophyll-α peaks coincided with late-summer phytoplankton blooms.

Oceanographic conditions strongly influenced aggregation dynamics. Surface temperatures in Amur Bay reached 27.5°C (salinity: 5.9–32.2 psu), while Ussur Bay exhibited lower thermal maxima (24.6°C) and fresher coastal waters (22.4 psu). Vertical stratification featured a warm surface layer (6–8 m), a sharp thermocline, and colder, saline bottom layers. Anchovy concentrations aligned with intermediate depths, where thermocline-associated chlorophyll-α maxima likely enhanced prey availability. These findings support the hypothesis that thermohaline parameters and phytoplankton productivity drive species distribution in the bay. However, the limited temporal scope (July–September) and absence of trawl data underscore the need for extended monitoring to resolve long-term trends.

This study establishes a point for understanding climate-mediated shifts in pelagic fish populations in the Sea of Japan. Future work should integrate trawl sampling, expand seasonal coverage, and monitor interannual variability to inform adaptive fisheries management in this rapidly changing ecosystem.

Keywords: Japanese anchovy, thermocline, chlorophyll-α, hydroacoustics, Sea of Japan.

FIS-P, Poster, AbstractID=18197, PosterID: FIS-P3, (ECOP)

Assessment of mixed herring aggregations in the Bering Sea

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Presented by Anna Kurnosova on behalf of Denis Kurnosov

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Climate change in the northern Pacific Ocean, including the Bering Sea, may significantly affect the migration and spatial distribution of marine fish species, including the Pacific herring (*Clupea pallasii*), an important commercial resource. In this study, based on 263 genetic samples collected during the pre-spawning and spawning periods from 2007 to 2019 in the Bering Sea, we performed an identification of the composition of mixed feeding aggregations using the R package RUBIAS, which applies a Bayesian approach to genetic stock identification (GSI) and mixture proportion estimation. Reference data were derived from samples collected in the southern Bering Sea (Karaginsky Bay) and the northern Bering Sea. The herring from these areas belong to the "Karaginskaya" and "Eastern Bering Sea" populations, respectively, which exhibit significant genetic differentiation. The analyzed marine samples included three aggregations containing individuals of unknown population origin. The results revealed admixture of the two populations in all three samples, with the Karaginskaya population dominating, comprising 49% to 72% of individuals. Particularly noteworthy is the high proportion (72%) of Karaginskaya herring in the Anadyr Gulf, suggesting a northward range expansion beyond the previously assumed boundary near Cape Navarin. These findings have important applied significance, as they indicate that under changing climate conditions, the population structure of commercial aggregations may not be adequately accounted for in fisheries management. Thus, implementing genetic methods for assessing catch composition could form the basis for more sustainable herring fisheries management and spatial harvest zoning in the Bering Sea.

FIS-P, Poster, AbstractID=18215, PosterID: FIS-P4, (ECOP)

Population genetic structure of Baird's beaked whale around Japan based on mtDNA analysis

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Baird's beaked whale (*Berardius bairdii*) is an endemic species in the North Pacific and is a target of land-based whaling in Japan. Understanding its population structure is important for effective fisheries management of this species. Using the sequences of mtDNA control region (314 bases), 585 individuals caught in the three ocean basins, namely the Sea of Okhotsk (Abashiri; $n = 51$), the Sea of Japan (Hakodate; $n = 46$), and the Pacific Ocean (Kushiro, Ayukawa, and Wadaura; $n = 488$), were analyzed for the evaluation of genetic diversity within and among the population samples. Among the 585 individuals, a total of eight haplotypes were identified. The haplotype diversity (h) and nucleotide diversity (π) ranged from 0.0435 to 0.5203, and from 0.000278 to 0.003157, respectively. Compared to other cetacean species, the within-population genetic variabilities were low, likely due to the past bottleneck and subsequent genetic drift. The level of genetic differentiation among the samples was quantified by *Fst* (0.062–0.343). No statistically significant difference was observed among the three samples from the Pacific Ocean, while significant differences ($p < 0.05$) were found among the three ocean basins. This study supported the previous stock hypothesis: the presence of three genetically and morphologically different populations around Japan. However, because of the non-recombinant nature and maternal inheritance of the mitochondrial genome, limited information can be obtained from mtDNA data. The use of more information-rich nuclear DNA markers, such as microsatellite DNA and single nucleotide polymorphisms (SNPs), will shed light on the underlying population structure.

FIS-P, Poster, AbstractID=18247, PosterID: FIS-P5, (ECOP)

Life history characteristics of blacktip grouper *Epinephelus fasciatus* around Koshikishima Island, southern Japan

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The blacktip grouper *Epinephelus fasciatus* is a commercially important medium-sized grouper widely distributed in the Indo-Pacific region. In this study, we investigated age, growth, and reproductive biology around Koshikishima Island, southern Japan. From May 2022 to January 2024, a total of 176specimens were collected by line fishing around Koshikishima Island. The maximum size and age were 418.0 mm total length (TL) and 15 years, respectively. The von Bertalanffy growth parameters were estimated as follows: L_∞=460.5 mm TL, K=0.095 year^{-1}, t_0 =-5.945 year. The size and age of 50% sex change were estimated to be 365.8mm TL and 9.8 years, respectively. The number of individuals increased in the order of female, transitional, and male phases. Male-phase gonads revealed traces of prior sexual maturity as females, suggesting that all males experienced spawning as females and then transition to males. The sex ratio was significantly biased toward females (male: female = 1: 4.2). Males (382.5 ± 12.5 mm TL, 11.5 ± 3.5 years) were significantly larger and older than females (292.5 ± 107.5 mm TL, 5.5 ± 6.5 years). These results strongly suggested that *E. fasciatus* exhibits monandric protogynous hermaphroditism. Spawning occurred between May and July. All females reached sexual maturity phases, the minimum size and age of which were 185.0 mm TL and 1 year, respectively. Transitional individuals occurred over a prolonged period regardless of the spawning season.

FIS-P, QR-Poster, AbstractID=18316, PosterID: FIS-P6

An ecosystem-based assessment of the Bering Sea pollock recruitment and spatial distribution

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Results of study of the Bering Sea pollock recruitment indicated that there are two large completely geographically isolated reproductive stocks in the Bering Sea: in the eastern Bering Sea and in the western Bering Sea. The spawning area of the eastern Bering Sea pollock is located from the central and eastern Aleutian Islands, across the southeastern Bering Sea shelf, to Anadyr Bay. The reproduction area of the western Bering Sea pollock is located in the Olutorskiy and Karaginskiy Bays.

The time series of surveys suggested that in the eastern Bering Sea, there are two distinctly different stable spawning grounds: one on the shelf area and one in the deep water adjacent to the eastern and central Aleutian Islands. Spawning pollock behavior in the eastern Bering Sea supported the hypothesis that shelf and deepwater spawning pollock are completely independent reproductive stocks.

The deep water pollock spawning stock recruits annually migrate from the outer shelf onto the adjacent continental slope in the area of large underwater canyons by the end of winter. After spawning at depths of 320-450 meters, they migrate northwest and distribute along the continental slope and adjacent shelf in the area between the Eastern Aleutian Islands and Zhemchug Canyon. The Bering Sea pollock recruitment and year-class abundance exhibit high annual variability, but there were no clear relationships between pollock year-class strength and spawning biomass, water temperature, ice distribution, or survival during early ontogenesis stages (eggs and larvae).

At the same time, the survival of young-of-the-year Bering Sea pollock varied dramatically interannually during winters. The multiyear survey data confirm the assumption that there is a connection between the survival rate of pollock in their first year of life during winter and year-class abundance.

The annual variation in the spatial distribution of eastern Bering Sea pollock during summer-autumn depended on the abundance and distribution of large zooplankton, water temperature, total biomass of pollock, and its age composition. The annual changes in physical oceanographic conditions, productivity, and species composition of the zooplankton community were associated with significant differences in pollock seasonal migrations and distribution, reproduction, survival of recruits at early stages of development, and ultimately the abundance of year classes and total biomass of pollock.

FIS-P, Poster, AbstractID=18321, PosterID: FIS-P7 (CANCELLED)

Local aquaculture resilience in Gwagwalada: A case study for global climate adaptation in aquatic food systems

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The global imperative to foster climate resilience and sustainable development in aquatic ecosystems necessitates understanding diverse regional challenges and adaptive strategies. While broad scientific findings and advanced technologies (e.g., AI, remote sensing, biotechnology) are crucial, the practical realities and fundamental production issues in local contexts often present unique insights. This study examines the core principles and challenges of fishing production (aquaculture) within the Federal Capital Territory's Gwagwalada Areas Council, Nigeria, serving as a microcosm for broader discussions on sustainable freshwater food systems.

The research investigates established cost-cutting and sustainability practices, alongside critical operational risks. It specifically focuses on the challenges associated with the use of various containers for fish culture, and the necessity of installing efficient piping systems for water replenishment to counteract evaporation – a concern exacerbated by changing climatic conditions. Through systematic observation, the study analyzes fish feeding practices, general farm management, and the application of basic technologies for maintaining water quality, including the informal use of materials like nylon.

Findings from Gwagwalada underscore the direct impacts of environmental variability (like increased evaporation rates) on local aquaculture and highlight the persistent need for effective water resource management and robust infrastructure. The insights gleaned from these grassroots production methods offer valuable lessons for designing adaptive strategies, integrating appropriate technologies, and fostering community engagement to enhance the resilience of aquatic food systems worldwide. This local case study emphasizes that practical, ground-level innovations and challenges are fundamental to building global climate resilience and ensuring sustainable development in the face of changing ecosystems.

Keywords: aquaculture, Nigeria, Gwagwalada, climate resilience, water management, sustainable fisheries, local practices

FIS-P, Poster, AbstractID=18342, PosterID: FIS-P8, (ECOP)

Abundance indices for the autumn and winter-spring cohorts of neon flying squid based on Japanese driftnet surveys

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Indices of abundance are important components in stock assessment for many marine species. The neon flying squid in the North Pacific comprises two cohorts (autumn cohort and winter-spring cohort), and both cohorts are important fishery resources. To develop fishery-independent abundance indices for these cohorts, we standardized catch per unit effort (CPUE) derived from driftnet surveys conducted during the summer in the western North Pacific from 2001 to 2024. A total of 28,187 neon flying squids were collected and they were divided into two cohorts based on their size. We standardized cohort-specific nominal CPUE (squid abundance per driftnet panel) using generalized additive models that incorporated temporal (year and tendays), spatial (latitude and longitude), and environmental (SST and lunar illumination) variables. For both cohorts, the spatial variable (latitude and longitude) was the most important predictor, followed by SST. Although the standardized CPUE showed large interannual variations for both cohorts, there were no significant increasing or decreasing trends over the years for either cohort. Additionary, we found no significant relationship between the annual changes in standardized CPUE of the two cohorts (Pearson's $r = 0.29$, $p = 0.18$), suggesting that the factors (e.g., environmental conditions and fishing pressure) influencing the annual changes in the neon flying squid stock may differ between the two cohorts. Our study can provide useful information for understanding and assessing the stock level of this species.

FIS-P, Poster, AbstractID=18432, PosterID: FIS-P9, (ECOP)

Feeding cessation physiologically enhances red tide resistance in aquacultured fish

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Red tides frequently hit the aquaculture industry worldwide, resulting in mass mortalities. Their effects can be mitigated by feeding cessation. However, specific methods to maximize the technique's effectiveness and provide physiological support remain limited. We investigated the effects of the period of feeding cessation on fishes' resistance to a harmful red tide microalga, the *Chattonella marina* complex ("*Chattonella*"), using yellowtails (*Seriola quinqueradiata*) of two ages and body weights (74 days after hatching and ~15 g, 201 days after hatching and ~860 g). Feeding cessation for >4 days significantly increased survival in both groups but significantly reduced body weight, although survival rate was not statistically influenced by body weight. Feeding cessation also increased the fishes' hypoxia tolerance. Histological analysis of the younger group showed that a longer feeding pause reduced damage to the secondary lamellae of the gills and decreased oxygen consumption. These results suggest that feeding cessation physiologically enhances red tide resistance. This study was supported by (a research grant of) Agriculture, Forestry and Fisheries Research Council, 22678311.

FIS-P, Poster, AbstractID=18437, PosterID: FIS-P10

Population genomic structure of Pacific halibut in the Northeast Pacific Ocean

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The Pacific halibut (*Hippoglossus stenolepis*) is a key flatfish species in the North Pacific Ocean ecosystem that supports important commercial, recreational and subsistence fisheries, and is currently managed as a single stock by the International Pacific Halibut Commission (IPHC). The primary objective of the present study is to advance our understanding of Pacific halibut population structure and dynamics in the northeast Pacific Ocean to inform fishery management. We have generated genomic sequences for 731 Pacific halibut collected during the spawning season (winter) from five known spawning areas within IPHC's Convention Waters in the Gulf of Alaska, Bering Sea, and Aleutian Islands, using low-coverage whole genome resequencing, a method that allows the characterization of genomic variation at a very high resolution. Following alignment to the Pacific halibut reference genome that IPHC developed in 2022, we observed average sequencing depths of 2.4x and identified millions of single nucleotide polymorphisms (SNPs) throughout the Pacific halibut genome. We used principal component analysis and clustering to detect and characterize population structure using approximately 3.7 million SNPs. Additionally, we conducted assignment testing using a subset SNPs showing elevated levels of differentiation to assign individuals back to the spawning groups they were sampled from and used cross-validation techniques to evaluate assignment accuracy. Our results suggest that there is a lack of genetic structure among spawning groups of Pacific halibut in IPHC Convention Waters. Furthermore, the lack of genetic structure limits our ability to accurately assign (~33% assignment accuracy) individuals back to their population of origin. These results suggest the presence of considerable amount of geneflow among IPHC regulatory areas, as supported by our current understanding of migration, resulting in a single genetic group of Pacific halibut in the Northeast Pacific Ocean. Additionally, these results support IPHC's current stock assessment practices that model the stock as a single coastwide unit.

FIS-P, Poster, AbstractID=18438, PosterID: FIS-P1

Spatial and temporal patterns of maturity for female Pacific halibut (*Hippoglossus stenolepis*) as estimated by histological assessment of female ovarian development

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The maturity state for female Pacific halibut (*Hippoglossus stenolepis*), a key input for estimating female spawning biomass, is currently assessed by the International Pacific Halibut Commission (IPHC) using macroscopic visual criteria from fish collected on the annual IPHC fishery-independent setline survey (FISS). However, estimates of maturity-at-age for use in stock assessment have not been updated in recent years despite uncertainty in the method used to assess maturity in the field, and to the apparent stability in maturity-at-age during recent decadal decreases in size-at-age. Therefore, we recently developed more accurate microscopic (i.e. histological) criteria to revise maturity estimates for Pacific halibut. In 2022, we initiated studies to revise maturity schedules based on histological data for female Pacific halibut throughout its distribution range in the Northeast Pacific Ocean, including the U.S. West Coast, British Columbia, Gulf of Alaska, Bering Sea, and Aleutian Islands. A total of 3,252 aged Pacific halibut ovarian samples were collected on the FISS across its distribution range during the period 2022 – 2024. We estimated maturity ogives for four distinct geographic regions to examine spatial and temporal trends. We then used average abundance estimates across regions to weigh regional estimates to generate a new coastwide ogive. Based on analyses of the histology-based maturity assessment data, we now estimate the coastwide maturity-at-age A50 value (i.e. age at which 50% of the females are mature) to be 9.8 years of age, representing a two-year decrease from previous A50 estimates using macroscopic (field) data. Furthermore, significant spatial differences in maturity-at-age are apparent across the various sampled geographic regions. This study is the first to identify both spatial and temporal differences in histology-based maturity schedules for female Pacific halibut in the Northeast Pacific Ocean, and the obtained results will be integrated to provide population-level maturity schedules for use in the Pacific halibut stock assessment that IPHC conducts annually.

FIS-P, Poster, AbstractID=18526, PosterID: FIS-P12

Environmental changes in the seasonal migratory grounds of Japanese pink salmon in recent decades

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Pink salmon (*Oncorhynchus gorbuscha*) is the most abundant and widely distributed among the Pacific salmonids, with population structure represented by distinct brood lines that spawn in odd and even years. In Japan, it primarily occurs in the eastern Hokkaido and Okhotsk Sea, where its abundance had shown dramatic declines in recent decades. Here, we examined the environmental conditions during its coastal residence (April-July), feeding (August-November), and overwintering (December-March) migrations during the last 26 years (1998-2023). This period is characterized by a regime shift from a high (1998-2010) to low (2011-2023) abundance, dominated by odd- and even-year brood lines, respectively. Temporal trends of sea surface temperature across the different migratory grounds showed an overall increase, albeit, the zooplankton biomass highlighted declines over time. Timing-wise, we observed contrasting patterns in the number of days with optimal temperature range (5-12°C) in the coastal (0-25 km) and offshore (≥100 km) waters of the Okhotsk Sea between periods of high and low abundance. In particular, the high (low) abundance period was defined by a shorter (longer) coastal residence with a later (earlier) onset/availability of optimal temperatures, accompanied by a longer (shorter) feeding days with an earlier (later) onset/availability of optimal temperatures in the offshore waters. These suggest that phenology and temporal trends of environmental conditions across its marine habitats are likely influential in regulating the abundance and brood line dominance of Japanese pink salmon.

FIS-P, Poster, AbstractID=18528, PosterID: FIS-P13

Mesopelagic fish assemblage in the time-series station K2, western subarctic Pacific

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Although mesopelagic fish dominate the oceanic ecosystem, they remain one of the least investigated components. From the vertically stratified sample collections, we investigated assemblage structure, vertical distribution and diel/ontogenetic vertical migration covering four seasons for larval and juvenile/adult mesopelagic fish at the time-series station K2 (47N, 160E) in the Western Subarctic Gyre of the North Pacific. We collected 10 and 20 species of larval and juvenile/adult fish, respectively. Among the larval fish assemblage, *Leuroglossus schmidti* was the most abundant; total abundances except *L. schmidti* were low throughout the year; species richness of myctophids were low. Among the 20 species of juvenile/adult fish, larvae of only six species were collected; thus, most mesopelagic fish species do not use the Western Subarctic Gyre as their nursery. In the juvenile/adult fish assemblage, *Stenobrachius leucopsarus* and *Stenobrachius nannochir* were abundant. Species diversity and total abundance in the warm seasons (summer and autumn) were higher than in the cold seasons (winter and spring). The decreasing of species diversity and total abundance during the cold seasons was probably affected by horizontal migrations of fish for reproduction toward the southern transition or subarctic slope areas.

FIS-P, Poster, AbstractID=18559, PosterID: FIS-P14

Spawning season and maturity rate of Japanese amberjack (*Seriola quinqueradiata)* in the waters off San'in, Nagasaki and in the East China Sea

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Knowledge of maturation and spawning is one of the most important biological information in fish stock assessment and fisheries management. The Japanese amberjack *Seriola quinqueradiata* is commercially valuable and an important fishery resource around Japan. Therefore, a more detailed understanding of the current status of spawning by spawning ground and the reproductive characteristics (e.g., the maturity rate or body length at maturity), allows for better stock assessment and fisheries management of this species. The present study examined the reproductive characteristics of Japanese amberjack caught in 2018 off the coasts of San'in and Nagasaki and in the East China Sea were determined based on gonad histological examinations. To understand the spawning period in each sea area, the monthly changes in GSI, the frequency of occurrence of various developmental stages and maturity rate were analyzed. The spawning season was estimated to be in May in San'in and from April to May in Nagasaki. In the East China Sea, samples were obtained between March and April, and this period was estimated to be within the spawning season. The maturity rate at each age was calculated only in San'in and Nagasaki, where samples were collected throughout the year. This study clarified the maturity rates of Japanese amberjack for the first time based on histological observation, albeit only in some sea areas. In this presentation, the spawning season and reproductive characteristics in 2018 are compared with previous study, and the factors that influenced them are discussed.

FIS-P, Poster, AbstractID=18568, PosterID: FIS-P15

The Ayan-Shantar population of the red king crab (*Paralithodes camtschaticus*) abundance dynamic

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Presented by Vladimir Kulik on behalf of Igor Chernienko

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The Ayano-Shantar population of the red king crab inhabits the northwestern part of the Sea of Okhotsk. This population is unique in a number of its ecological and biological features. Severe hydrological conditions and low fertility of females on the one hand, and the lack of information on the number of females and the survival rate of juveniles on the other, determine the need for close attention to the reproduction processes in this population. It was previously shown that red king crab aggregations in the North Okhotsk subzone (west of 147º E) can be considered isolated and self-reproducing. The modeling was performed using a delay-difference model. Two abundance indices were used. The first is estimates of commercial biomass made on the basis of trap surveys using the area method. The second is standardized catches per vessel-day. Data on recruit weight, height and age are taken from previously published materials. Modeling showed that in 2003-2014 the stock was stable, in 2014-2018 its growth was observed and since 2020 the stock has been at a consistently high level, with an upward trend.

FIS-P, QRPoster, AbstractID=18676, PosterID: FIS-P16, (ECOP)

Evaluating the impact of a fishing-gear data management system on fishery productivity

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The rapid adoption of smart technologies has become imperative in the fisheries sector. In Japan, shrinking manpower and the need to enhance sustainability have underscored the importance of developing and deploying smart-fishery solutions that can drive industry growth. Worldwide as well, leading fishing nations and major corporations are actively investing in IoT applications for fisheries. Against this backdrop, Lighthouse Inc. has developed and introduced ISANA, a fishing-gear data-management system that aggregates gear data—traditionally managed on a vessel-by-vessel basis—and shares it across an entire fleet. By facilitating information sharing, ISANA is expected to improve operational efficiency. This study statistically verifies the effect of ISANA on fishery productivity by analyzing catch volumes, fuel consumption, and vessel-behavior logs from fleets that have adopted the system. Its contributions are twofold: (i) it examines an IoT application designed to directly enhance productivity—as opposed to the more common resource-monitoring IoT tools—and (ii) it provides a statistical assessment of that application's impact, filling a gap in the existing literature. Using catch and fuel-consumption records together with GPS coordinate logs from ISANA-equipped fleets, we conducted two analyses: A difference-in-differences (DiD) estimation of catch volume, fuel consumption, and catch-per-unit-fuel. A behavioral analysis tracing changes in vessel speed and heading to measure search-time dynamics. The DiD results indicate that ISANA increases catch per unit of fuel but does not significantly affect total fuel consumption. The behavioral analysis further suggests a reduction in search time during fishing operations. In conclusion, statistical evidence from catch, fuel, and positional data implies that the implementation of ISANA enhances overall fishery productivity.

FIS-P, Poster, AbstractID=18682, PosterID: FIS-P17

Temperature-dependent growth modeling for pre-flexion Pacific cod larvae

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Understanding species- and age-specific responses to changing environmental conditions in a warming ocean is essential for sustainable fisheries management. In Korean waters, Pacific cod (*Gadus macrocephalus*) is a commercially and ecologically important fish species. However, explicit temperature-dependent growth equations for the critical pre-flexion larval stage, which strongly influences survival, recruitment, and fisheries yields, are currently lacking. We analyzed length-at-age data from our (6.34°C, days 1–19) and published (7.0, 10.0 °C, days 1–40) experiments using three thermal-growth models. The first, a Gompertz–Laird model, was specified as $L(t)=38.5126\cdot(0.31/38.5126)\cdot\exp[-\alpha\, t]$ with $\alpha=0.0028\cdot\exp(0.0971\, T)$, yielding a residual standard error (SE) of 0.295 mm. The second, a polynomial temperature–rate model, defined instantaneous growth rate as $a(T)=a_0+a_1T+a_2T^2$ and length as $L(t)=L\infty\cdot[1-\exp(-a(T)\, t)]^b$, achieving superior fit (SE = 0.185 mm). The third, a Gaussian optimum model, described growth rate as $a(T)=a\cdot\exp[-(T-T_{opt})^2/(2\sigma^2)]$, with SE = 0.197 mm and estimated $T_{opt}\approx 10.0 \pm 4.8$ °C. Model comparisons identified the polynomial model as clearly superior (ΔAIC>26 vs. Gompertz–Laird), highlighting a pronounced quadratic temperature–growth relationship. Simulations predicted time-to-asymptotic length durations of 63.4, 67.7, and 62.5 days at 6.34, 7.0, and 10.0 °C, respectively, demonstrating that subtle (<1 °C) temperature shifts significantly alter development duration by up to five days, impacting predation risk, dispersal, and survival. These derived growth equations provide robust, age-specific inputs for bio-physical coupling models to predict Pacific cod survival, recruitment, and fisheries yields under climate change, thus supporting climate-ready fisheries management strategies.

FIS-P, Poster, AbstractID=18719, PosterID: FIS-P18

Conceptual Model for Sailfish (*Istiophorus platypterus*) in the Eastern Pacific Ocean

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Creating Conceptual Models of fish stocks before developing stock assessment models and providing management advice is considered good practice. Conceptual Models consolidate and illustrate all the available information about a stock, serving as a foundation for the development of the stock assessment. They include information on the stock's population dynamics and biology, its fisheries, and the environmental conditions where it exist. Understanding the relationships among these factors – particularly between the stock and the environment - are important for developing definitions of stock structure and characterizing how the population dynamics and fishing processes change over time. It is also important to account for uncertainty related to the environment for risk analysis and management strategy evaluation (MSE), and to evaluate the consequences of climate change on the assessment and how to develop monitoring and management that is robust to climate change. We discuss how the environment can be included in conceptual models and how it can be translated to the development of the stock assessment.

Our working project utilizes known information about Sailfish (*Istiophorus platypterus*), the fisheries that interact with it, and climate data to create a Conceptual Model in the Eastern Pacific Ocean (EPO). The data is sourced through IATTC, NOAA, and through scientific collaborations from the science community.

Fisheries and climate data are used to analyze and understand how the changing climate and oceans affect sailfish distribution within the EPO. A broader scope for this project includes species interactions and environmental factors needed when the objectives are related to evaluating the ecosystem impacts of a fishery. For example, alternative hypotheses for how the species may respond to climate change could be incorporated within the development of the Conceptual Model and form the basis for climate-based projections or climate-based operating models within a Management Strategy Evaluation.

Through this approach, we aim to support ecosystem-based fisheries management by building models that are scientifically robust, climate-aware, and adaptable to uncertainty.

FIS-P, Poster, AbstractID=18747, PosterID: FIS-P19, (ECOP)

Changes in skipjack tuna CPUE in the equatorial Pacific and its relationship with ENSO and fishing methods

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Skipjack tuna (*Katsuwonus pelamis*) constitute a key component of tuna purse seine fisheries in the Pacific Ocean, and their spatial distribution and catchability are closely linked to large-scale oceanic and atmospheric variability. In particular, the El Niño–Southern Oscillation (ENSO) exerts substantial influence on ocean thermal conditions and primary productivity, thereby modulating tuna behavior and habitat. This study examines spatial and temporal changes in catch per unit effort (CPUE) for skipjack tuna based on different fishing methods from 1980 to 2024. Results show significant differences in CPUE depending on the ENSO state as well as the fishing strategy. The zonally extended spatial distributions of CPUE during El Niño and neutral conditions, in comparison with those under La Niña conditions, are apparent for both free school CPUE and dFAD-associated CPUE. However, the dFAD-associated CPUE seems to exhibit relatively stable temporal variability compared to the free school CPUE. This comparison suggests that fishing efficiency is sensitive to both climate-driven variability and anthropogenic strategies regarding the fishing methods. Further analysis would highlight the importance of accounting for both basin-scale environmental forcing and fishing methods when assessing the changes in skipjack tuna fisheries in the equatorial Pacific.

GENERAL PAPER SESSION

Poster Presentations

GP, Poster, AbstractID=18453, PosterID: GP-P1, (ECOP)

Consumer preferences and willingness-to-pay for sustainable pearl products: A life cycle assessment and choice experiment study in Japan

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Pearl aquaculture is a high-value sector with significant economic benefits but notable environmental challenges, particularly due to marine plastic pollution from discarded aquaculture gear. This study addresses critical knowledge gaps by combining life cycle assessment (LCA) and a discrete choice experiment (DCE) to evaluate the environmental impacts of different cage processing methods and to assess consumers' preferences and willingness-to-pay for sustainable pearl products. Using LCA, the study compares three scenarios for handling discarded pearl aquaculture cages: full recycling, partial recycling, and no recycling. Results demonstrate that full recycling significantly reduces greenhouse gas emissions and energy consumption compared to disposal methods. The DCE, conducted with 600 Japanese consumers, reveals strong preferences for pearls with lower CO_2 emissions, higher luster, and larger size, while price negatively influences choice. Consumers require discounts for pearls with higher emissions, with the required discount increasing substantially for greater emission levels. These findings provide actionable insights for waste management in pearl farming and highlight market-driven incentives for sustainable pearl products.

GP, Poster, AbstractID=18647, PosterID: GP-P2, (ECOP)

Temporal and spatial dynamics of the small multifocal pink spot outbreak on *Porites* spp. in Mo'orea, French Polynesia

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Outbreaks of coral diseases can alter ecosystem functioning and services of coral reefs, and recent evidence suggests they may be increasing in magnitude and duration due to human impacts that will intensify in the Anthropocene. Massive corals in the genus *Porites* have a visually distinctive response to physical stresses, including diseases, by forming lesions that are bright pink, swollen single polyps (hereafter multifocal pink spots (MPS)). While outbreaks of MPS have been observed globally, short-term temporal patterns of intensity (number of MPS per m^2 on affected corals) and change in intensity (weekly % change in average MPS per m^2) within an outbreak have not been evaluated. In 2021, we selected five sites within two human-impacted bays in Mo'orea, French Polynesia, and photographed 7 to 14 MPS-affected *Porites* colonies per site over a four-week period. We discovered that MPS in areas affected by human activities remained significantly high for at least a month and exhibited different patterns in intensity, especially between bays. Four sites maintained consistently high MPS intensities, while one site exhibited persistently lower intensities all four weeks. Weekly average MPS intensities also differed by bay, with one bay showing a steady increase whereas the other displayed synchronized fluctuations over time. These results shed light on the temporal dynamics of an MPS outbreak in a region not previously documented and at a finer temporal resolution than previously assessed. Understanding these trends can help predict when and where outbreaks are likely to occur, allowing for more targeted monitoring and response efforts.

HD PAPER SESSION

Oral Presentations

HD-P, Oral, AbstractID=18157

Methodologies for assessing the quantity, quality and value of marine ecosystem assets

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Marine ecosystems are of significant value to coastal communities, providing essential support for socio-economic development. Marine ecosystem assets are defined as marine ecological resources with clearly defined property rights that contribute directly or indirectly to socio-economic production, and which provide useful flows of products or services. The term "clear property rights" denotes the existence of a documented and legally enforceable claim to ownership or the rights to use, operate, benefit from, or dispose of marine ecosystem assets. Marine ecosystem assets encompass marine biological assets, seawater assets, and surface seabed assets. The value of marine ecosystem assets can be defined as the stock value of the marine ecosystem as a whole, in terms of the provision of ecosystem services to humans. This paper presents a methodological system for assessing the quantity, quality and value of marine ecosystem assets. The system has been constructed, validated for application and transformed into a Chinese national standard. This standard guides the national assessment of marine ecosystem assets and the determination of ecosystem baseline value. It also provides an important management tool for the performance evaluation of marine ecosystem protection and restoration, marine ecosystem asset trading and marine ecological financial policies.

HD-P, Oral, AbstractID=18167, (ECOP)

Broadening the sustainable seafood movement — Systemic and enabling approaches to transform blue food

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The global appetite for environmentally sustainable and just seafood is expected to grow in coming decades. However, the sustainable seafood movement, including private governance tools like certifications and recommendation lists has yet to transform fisheries and aquaculture on a large scale. At the same time, alternative governance approaches have taken shape, each aiming to guide production and consumption toward greater sustainability. In this article, we delve into less-explored yet potentially promising approaches to seafood sustainability, which could help address current limitations to achieving sustainable seafood. Through a critical review, we have mapped and characterized emerging strategies to sustainable seafood and their theory of change and identified three clusters: (i) private sector pre-competitive collaborations (ii) landscape-based approaches and (iii) relational approaches. These are described through looking back on historical developments and giving examples of previous and current implementation, as well as describing how they address key limitations identified from the certifications and seafood rating scheme approaches. We then overlap the approaches onto transformation literature and categorise them into “systemic” or “enabling” approaches to transformation in the food system. Enabling approaches focus on building capacities for change, while systemic approaches target key features of social-ecological systems for focused transformation. From here, compatibilities between approaches are discussed—whether there are fundamental tensions and when these might arise. Finally, based on the literature, we outline a potential new trajectory for the sustainable seafood movement, grounded in pluralism, collaboration, and trust.

HD-P, Oral, AbstractID=18235, (ECOP)

Assessing barriers to establishing OECMs in exclusive fishing rights areas in Taiwan: A qualitative study of expert and fisheries association representative perspectives

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In the context of the Convention on Biological Diversity, Other Effective Area-Based Conservation Measures (OECMs) have become an essential tool for advancing global biodiversity goals. Exclusive Fishing Right Areas (EFRAs) are a distinctive form of area-based fisheries management in Taiwan. These areas are established within three nautical miles from shore or in waters shallower than 25 meters, upon application by local fisheries associations and approval by the competent authority. Once approved, EFRAs confer exclusive fishing rights to local fishers through a licensing mechanism. With clearly defined spatial boundaries and community-based governance, EFRAs demonstrate potential to function as fishery-based OECMs by supporting long-term, in-situ biodiversity conservation. However, establishing OECMs through EFRAs faces multiple barriers. This study adopts grounded theory to analyze qualitative interviews with 19 experts and fisheries association representatives, identifying three dimensions and ten barrier factors: institutional (legal and policy gaps), social (local participation, public support, livelihoods, traditional knowledge, and value consensus), and governance (cross-agency coordination, long-term planning, resource management, and enforcement). These findings highlight institutional and practical challenges within Taiwan's fisheries resource governance. Despite these challenges, the study suggests that EFRAs still hold potential for establishing fishery-based OECMs. This is possible if clear operational standards are developed, initiatives and technical support are implemented, local governance and youth engagement are strengthened, and pilot areas with performance-based incentives are introduced. The proposed policy recommendations serve as a foundation for future institutional design and contribute to aligning regional fisheries management with global biodiversity and sustainability goals.

HD-P, Oral, AbstractID=18328, (ECOP)

Estimation of willingness to pay and evaluation of purchasing environment effects for certified seafood: Evidence from an in-person choice experiment with real purchases

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This study explores how purchasing environments (offline and online grocery shopping) and information provision influence consumer valuation of certified seafood. In March 2025, we conducted a discrete choice experiment involving real purchases by 223 participants in Tokyo, Japan. Participants made choices among red seabream products (150g skinless loin) under four experimental conditions: offline vs. online settings and presence vs. absence of ASC certification information. Product attributes included price, use-by date (same day, next day, two days later), ASC certification, and freshness indicators (Ikejime and K-value ≤10%). Information about the ASC label was delivered via POP/QR codes in the offline setting and via URLs in the online setting, and participants' access behavior was tracked.

Mixed logit model results showed that willingness to pay (WTP) for ASC-certified seafood did not differ significantly between offline and online settings ($p = 0.057$). However, among online participants, those who accessed ASC information exhibited significantly higher WTP (+137 JPY, $p = 0.021$) than those who did not, suggesting a potential association between voluntary information access and product valuation, though causality cannot be confirmed. Freshness indicators had stronger effects online, especially the K-value label ($p = 0.003$), which may have served as a substitute for visual inspection. While Ikejime showed slightly higher WTP than the K-value label ($p = 0.051$), the difference was marginal.

These findings highlight that while purchasing channels alone may not significantly affect WTP, accessible and meaningful information, along with freshness indicators, can enhance overall perceived quality—especially in online retail environments.(248)

HD-P, Oral, AbstractID=18344

Stakeholder perception assessment on the adjustment of regulatory measures in the Chaohjing Marine Conservation Area

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The Chaohjing Marine Conservation Area, located in Wanghaixiang Bay, has become a model for marine protected area (MPA) management in Taiwan. In recent years, it has also emerged as a popular destination for marine recreation such as scuba diving and snorkeling. However, the influx of visitors has increasingly disturbed the marine ecosystem and habitats within the conservation area. In response, the management authority has periodically reviewed and adjusted regulatory measures to strike a balance between ecological protection and recreational use.

This study collected 607 valid questionnaires to assess user perceptions of 13 newly proposed regulatory measures. Using descriptive statistics, mean rankings, and K-means cluster analysis, the study identified four distinct stakeholder groups based on their acceptance levels: (1) the "Total Opposition" group (n=138), mainly frequent scuba divers and water recreation users with consistently low acceptance of all measures; (2) the "Selective Acceptance" group (n=116), primarily high-frequency scuba divers who support technological aids and certification systems but resist quota controls; (3) the "Total Support" group (n=128), composed mainly of well-educated visitors engaging in low-impact activities such as walking and sightseeing; and (4) the "Neutral" group (n=225), characterized by low visitation frequency and minimal opinions on the proposed changes.

The study found that the first two groups, which account for over 40% of all respondents, are mainly composed of diving activity users. Thus, future conservation management should particularly focus on regulating diving-related behaviors. Achieving consensus on issues such as carrying capacity, core zone boundaries, conservation strategies, and visitor flow control will be key to the sustainable success of the Chaohjing Marine Conservation Area.

HD-P, Oral, AbstractID=18383

Sustainability of the outreach program for encouraging harmonious use of fish stock resources: Sustainable, Healthy and "Umai" Nippon seafood (SH"U"N) Project

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"Sustainability" is one of the key themes of modern societies. The SH"U"N project, launched by the Japan Fisheries Research and Education Agency (FRA) in 2016, had delivered a comprehensive and peer-reviewed evaluation on the sustainability of the fisheries products around Japan. Based on the four science-based essential pillars for fisheries sustainability, i.e., stock status, ecosystem impact, governance performances, and socio-economic influences, a transparent evaluation procedure was designed following the criteria of the United Nation's Food and Agriculture Organization's Code of Conduct and eco-labelling guidelines. The webpage of SH"U"N Project had provided comprehensive information on the sustainability of 76 local stocks of 45 fisheries species in total. The SH"U"N Project has been closed March 2025 because of the shortage of funding but has been excoriated by potential and existing users. We analyze the whole evaluation scores of 76 stocks in relation to the four essential scoring axes. Sustainability and cost performance of outreach programs from governmental institutions will be discussed based on the criticism from users after the closure of the webpage.

HD-P, Oral, AbstractID=18759, (ECOP)

An Analysis of the effectiveness of fisheries management in Japan using panel data

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The importance of fisheries resource management has grown globally. While Japan possesses rich fishing grounds and advanced techniques, it has faced criticism for inadequate management, making reforms both urgent and internationally relevant. However, Japan's fisheries are highly diverse across types, species, and management regimes—coastal, offshore, and distant-water—making it unclear which approaches are most effective. This study empirically evaluates the impact of various management practices across Japan by controlling for regional and temporal factors using panel data.

Using national panel data from the 1988–1998 Fisheries Census, we apply fixed effects models to estimate how fisheries management affects catch revenue per operator. The model controls for year and region effects, and includes variables related to management practices and fishery scale. Analyses are further broken down by fishery type and target species, and we examine delayed effects five years after implementation.

Our results show that some management practices have consistently positive effects on revenue, regardless of time or location, depending on the fishery type or target species. Community-based management and fishing ground controls are effective in coastal fisheries, while institutional regulations are more effective in distant-water fisheries. Notably, delayed effects are more visible in coastal areas. These are likely due to smaller stakeholder groups and less mobile species. These characteristics are statistically confirmed in this study.

Overall, our findings suggest that effective fisheries policy should account for local fishery characteristics. In particular, regionally tailored management in coastal fisheries appears especially beneficial for achieving sustainable and effective resource use.

HD PAPER SESSION

Poster Presentations

HD-P, Poster, AbstractID=18200, PosterID: HD-P1, (ECOP)

Bridging ocean science and fisheries: Smart technologies for identifying fishery grounds of wild juveniles for yellowtail farming

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Yellowtail farming is the most important sector in aquaculture production in Japan. It is typical of supply chain business but vulnerable to ambient risks that are difficult to predict or avoid, such as yearly variations in the fishery grounds for wild-caught juveniles. In recent years, information technologies are required for improving labor and fuel cost efficiencies for yellowtail farming, especially for finding fishing grounds of the wild-caught juveniles to follow floating algae in the East China Sea. In this study, we developed information technology identifying potential fishing grounds of wild-caught juveniles for yellowtail farming and evaluated the practical and effective applications to fishermen. On our website (https://nagaremo.fish.kagoshima-u.ac.jp/), two major information are now available for local fishermen: daily maps demonstrating fishing ground conditions and movies showing the migration of floating algae followed by yellowtail juveniles. Based on a questionnaire survey on utilization status and outcomes among local fishermen, the information provided by the website contributed a reduction of 6% in working hours and 7% in fuel costs, indicating active utilization during fishing season to facilitate more efficient exploration of fishing grounds. Multivariate analysis of the questionnaire responses demonstrated that utilization status and outcomes were different among fishermen within a cooperative and among cooperatives and associated with usability and working hours. These findings suggest that the smart technologies are widely utilized by local fishermen, but the outcomes are variable by decision-making and behavior of fishermen and cooperatives.

HD-P, Poster, AbstractID=18230, PosterID: HD-P2 (CANCELLED)

~~Impact mechanism of digital transformation on marine industrial chain resilience: Evidence from micro marine enterprises~~

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~~The development of the digital economy brings new opportunities for enhancing the resilience of marine industrial chains. Existing research primarily focuses on the internal impacts of digital transformation and the construction of macro-level resilience indicators, with scant attention paid to micro-level investigations into how digital transformation of enterprises within the chain affects marine industrial chains. This paper explores the impact of enterprise digital transformation on marine industrial chain resilience. On the basis of analyzing the economic connotation of marine industrial chain resilience, quantitative data from 52 representative marine-related listed enterprises in China was collected and marine industrial chain resilience index system was constructed. The research results reveal that digital transformation improves resilience across three dimensions: chain stabilization, consolidation and strengthening. The process is realized by reducing external transaction costs and promoting industrial chain diversification. Geographic distance between upstream and downstream enterprises has a positive moderating effect. Furthermore, there is heterogeneity due to differences in enterprise type, scale, and the industries in which they operate.This study contributes to the literature on marine industrial chain resilience from an industrial economics perspective and provides critical insights for on-chain enterprises to leverage digital transformation in advancing the modernization of marine industrial chains.~~

HD-P, Poster, AbstractID=18283, PosterID: HD-P3, (ECOP)

Meta-frontier analysis of Japanese fisheries by data envelopment analysis for interval data

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In Japan, fishery productivity is a significant policy issue because responsibility for improving productivity has shifted to both the government and fishers following the 2018 reforms of the Fishery Act. The Fisheries Census, which covers all fishers in Japan (approximately 70,000 entities), provides input data (vessel tonnage, number of crew members, and number of working days at sea) and output (landing value). Since the output data is reported as interval data, conventional Data Envelopment Analysis (DEA) cannot be directly applied. This study aims to estimate the lower and upper bounds of the technical efficiency of Japanese fisheries by applying DEA adapted for interval data (Interval DEA). To examine the discrepancies between the production frontiers of individual fishery types and a common production frontier across all entities (the meta-frontier), we compared the technical efficiency (TE) estimated through subsample analysis by fishery types with the meta-frontier technical efficiency (MTE) estimated through pooled analysis. The MTE ranges from 0.015 to 0.063, whereas the TE ranges from 0.045 to 0.194 for the 2018 Census data, indicating that the efficiency of Japanese fisheries is very low. For most vessels, the MTE tends to be less than 50% of the corresponding TE, with the exception of certain fishery types, such as small-scale trawl fisheries. To improve the productivity of Japanese fisheries, priority should be given to improving the efficiency of low-performing vessels within each fishery type. The use of Interval DEA helps overcome limitations imposed by the data format and facilitates the broader application of productivity analysis across various segments of the fisheries sector.

HD-P, Poster, AbstractID=18335, PosterID: HD-P4, (ECOP)

Marine protected area management: Enhancing effectiveness through stakeholder participation in Taiwan and Japan

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Marine protected areas (MPAs) are widely recognized as effective tools for conserving marine biodiversity and sustaining coastal fisheries. However, the effectiveness of MPA management is often influenced by the extent and quality of stakeholder participation. This study explores participatory approaches in MPA governance, drawing on practical experience and comparative case studies in Taiwan and Japan. A region-specific management effectiveness evaluation (MEE) framework was first developed and applied through participatory action research in Taiwan's Qimei Fishery Conservation Zone. This field-based study led to tangible governance outcomes, including zoning adjustments, co-monitoring activities, and citizen science initiatives. These insights subsequently informed the design of a systematic literature review of 281 peer-reviewed articles published between 1994 and 2023, which examined how MEE frameworks are applied globally and the extent to which they result in follow-up improvement actions. The review revealed that only 12.7% of studies documented stakeholder involvement beyond the evaluation stage. Building on lessons from Taiwan and the systematic review, the ongoing research in Japan focuses on two case study areas: the Hinase eelgrass bed restoration area and the Kasaoka horseshoe crab (*Tachypleus tridentatus*) natural monument, both located in Okayama Prefecture. The semi-structured interviews will be conducted with stakeholders from government agencies, academia, fisheries cooperatives, and local communities. This study aims to examine how institutional settings, local values, and cross-sectoral relationships shape participatory MPA governance. The findings are expected to inform the development of inclusive and adaptive governance approaches that strengthen both the effectiveness and legitimacy of MPA management.

HD-P, Poster, AbstractID=18339, PosterID: HD-P5, (ECOP)

Exploring coastal fishers' ideas about climate change, the future of the fishing industry, and fishers' wellbeing

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This poster details the first transdisciplinary project conducted in partnership with the Okinawa Fishery Cooperative and 36 fishing local associations. This survey study was designed to explore the critical, yet often overlooked, socio-ecological aspects of fisher's communities focusing on Okinawa coastal fishers' perceptions of climate change, the future risks impacting their industry, and their wellbeing. We gather over 511 answers from fishers across the island alongside with in-depth interviews with representatives from all participating fishing associations. The presentation will visually map our projects and present key findings from the survey, illustrating the value of collaborative research practices into marine social research. By focusing on fishers and their experiences, our work provides crucial insights for the future of marine science and policy in the context of Japan, aligning with the session's focus (Human Dimension) on the contribution of social marine sciences.

HD-P, Poster, AbstractID=18448, PosterID: HD-P6, (ECOP)

Development and application of a coastal resilience assessment model

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Climate change and accelerated urbanization have increased the vulnerability of coastal areas to hazards, drawing growing attention to resilience-based adaptation strategies. This study develops a quantitative assessment model for evaluating coastal hazard resilience and applies it to coastal erosion cases in South Korea to identify regional characteristics of resilience performance. The proposed model is based on the 4R framework of resilience—robustness, redundancy, resourcefulness, and rapidity—and quantifies key indicators such as Maximum Resilience Value (MRV), Lowest Resilience Value (LRV), Recovery Time of System Performance Value (RTSPV), and Number of Disturbances (ND). These metrics are integrated into a composite Coastal Resilience Index (CRI), enabling comparative spatial analysis across regions. Application of the model using coastal erosion grade data revealed significant differences in resilience patterns depending on the degree of urbanization, policy interventions, and local conditions. Institutional responses such as coastal maintenance projects were found to contribute positively to resilience performance. Although the main focus of this study lies in the application of the model to coastal erosion, the proposed framework may be extended in future research to assess ecosystem-based resilience. Potential indicators and application methodologies for such extensions remain to be explored further. Ultimately, this study provides an empirical foundation for applying quantitative resilience assessments to support climate adaptation and marine spatial planning strategies.

HD-P, Poster, AbstractID=18457, PosterID: HD-P7, (ECOP)

A study on the evaluation of marine climate change monitoring and forecasting activities

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In response to growing concerns over climate change, the Korean government enacted the “Act on the Observation and Prediction of Climate and Climate Change” in 2023. This legislation reflects an increased national commitment to strengthening R&D and improving systems for marine climate observation and forecasting. This study aims to assess expert perceptions and evaluate the technological readiness of Korea's marine climate change monitoring and prediction activities. A structured assessment was conducted involving experts from government agencies, research institutes, universities, and private companies to evaluate the technological maturity and relative importance of various activities. Sensitivity analysis was also employed to capture differences in institutional perspectives. The findings reveal that experts strongly recognize the need for strategic government involvement and expanded R&D to address the risks posed by natural disasters and marine environmental challenges. Technological benchmarking indicates that the United States leads globally, while Korea's technology level is approximately 74.1% that of the U.S., with a lag of about 8.7 years. The analysis of priorities shows sectoral differences: public sector and industry experts prioritize the application of climate information, while academic experts place greater emphasis on forecasting capabilities. Experts also highlighted the importance of sustainable policy frameworks and expanded national R&D efforts. The study concludes that institutional affiliation significantly shapes how technological importance and urgency are perceived. These insights suggest the need for the Korean government to tailor marine climate policies based on structured priority assessments. The results are expected to provide a foundational basis for more effective, evidence-based policymaking in the face of accelerating marine climate change.

HD-P, Poster, AbstractID=18468, PosterID: HD-P8

Importance of information in digitalized wholesale fisheries markets based on user attributes in case of Nishinihon Uoichi

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This study examined the importance of information accessed via the Production Area Electronic Information Network (PAEIN) within digitalized wholesale fisheries markets. Additionally, it investigated variations in information importance across different user attributes. Participants included sorting workers, jobbers, and longshoremen among PAEIN users. The information available in PAEIN were fishing condition information (13 items), incoming vessel information (11 items), and market price information (12 items). Users were asked to rate the importance of these items of information. A questionnaire, distributed on February 3, 2024, aimed to identify crucial information for users, with data collection completed by March 1, 2024. Out of 101 distributed questionnaires, 29 valid responses were analyzed. Results revealed that users can be classified into four classes according to the information they consider important. Analysis of the characteristics of the four classes revealed that the importance of the information differed among users, particularly with regard to the brand of fish, the date and time the carrier vessel return to port, the planned landing port, fish brand, and the number of fish boxes or containers per fish brand. Variations in information importance were attributed to the characteristics of jobbers who dealt with which type of dealers and whether the jobbers traded outside the Matsuura fish market.

HD-P, Poster, AbstractID=18491, PosterID: HD-P9, (ECOP)

Challenges to the local participation in the "Umigyo" initiative for revitalizing the shrinking fishing villages: A case of Ainan town, southern Japan

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The policy concept of "Umigyo" is gaining momentum in Japan as a means of utilizing resources associated with coastal waters and fishing villages. Umigyo means "sea-related activities" that incorporate fisheries and non-fisheries sectors, including tourism, gastronomy, social welfare, marine conservation, and education, to enhance local livelihoods. As the Umigyo initiative gradually expands to new regions, there is an increasing need to critically assess its outcomes in earlier implementation cases so that we generate implications for the fishing villages amid ongoing depopulation.

This presentation displays the case of the town of Ainan in Ehime Prefecture, one of the leading municipalities for the Umigyo initiative since 2023. Based on the Umigyo initiative, various projects have been implemented in Ainan, including eco-tourism, collaborative promotion of fisheries and agriculture, experiential education programs, and a blue carbon credit project. These efforts are coordinated by the Umigyo Promotion Committee of Ainan, which brings together a diverse group of stakeholders, including fishers, farmers, travel agents, public officials, financiers, researchers, and more. Following the initial two-year campaign, the municipality and local stakeholders established an incorporated association in March 2025 to extend the Umigyo acts in Ainan.

This study examines how the Umigyo initiative in Ainan align with the long-standing tradition of self-governing practices. Although the Umigyo in Ainan is making substantial progress, our findings reveal inconsistent interests and commitments among heterogeneous stakeholders. There are subtle discrepancies among policy concepts and each stakeholder's expectations of what is to be achieved by Umigyo, resulting in varying levels of participation.

HD-P, Poster, AbstractID=18520, PosterID: HD-P10, (ECOP)

Port states taking charge: National legislative responses to the Agreement on Port State Measures in fisheries governance

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Illegal, unreported, and unregulated (IUU) fishing remains a major threat to marine sustainability and global fisheries governance. The Agreement on Port State Measures (PSMA), shifts enforcement responsibility from flag states to port states by requiring inspections, port access denial, and data sharing. While its legal obligations are clear, the treaty's influence on domestic policy implementation is less well understood. This study investigates whether PSMA ratification leads to increased adoption of port state measures (PSMs) at the national level. Using compiled panel data from the FAO database, we apply a staggered difference-in-differences and event study framework to estimate the treaty's policy effects. Results show that PSMA ratification leads to a significant and sustained increase in PSM legislation—around six additional provisions on average. Event study estimates confirm the absence of pre-treatment trends and show a steady rise in enforcement actions following ratification. These findings demonstrate that international agreements like the PSMA can effectively incentivize domestic regulatory responses, contributing to stronger port-based governance in the fight against IUU fishing.

HD-P, Poster, AbstractID=18537, PosterID: HD-P11

A perspective from Mauritius: Learning from cases of adaptive management in North Pacific fisheries communities

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Mauritius is one of the Small Island Developing Countries (SIDCs) of the Western Indian Ocean and has made efforts to establish a resilient socio-economic system with the marine environment surrounding it through the "blue economy" concept. On the other hand, the dynamics of the marine environment and recent changes in ecosystems significantly affect the reality of development. In the North Pacific, climate change has been altering the structure and function of marine ecosystems. The alteration brought challenges to the institutions and governance framework in fisheries communities, but several cases seemingly "reflected" the changes and regained resiliency with adaptive measures. In this study, we investigate the approach of legal resilience of cases in the North Pacific. We focus on how adaptive legal structures assist fisheries governance in the North Pacific, especially in Japan, and respond to ecological changes and challenges. Reviews and semi-/unstructured interviews were conducted to collect necessary information for interpretations. Adaptive co-management practices and community-based models were found as effective approaches for enhancing resiliency with adequate legal designs. The past and present dynamics of the ecosystem and resources, as well as the economy, have shaped stakeholders' adaptive responses and local governance strategies. Policy making and political support for the resiliency of fisheries communities should be done with the involvement of stakeholders, with the proper guidance based on scientific information in the dynamics of the eco-economic system. In Mauritius, the Community scale of Industry-Government-Academia Collaboration with "practical training" process in the dynamics may be effective for finding effective political support and designing the adaptive system.

MEQ PAPER SESSION

Oral Presentations

MEQ-P, Oral, AbstractID=18183, (ECOP)

OCPs and PCBs level in organs of Pacific salmon from the Sea of Okhotsk, Russian Part of Northwest Pacific

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The Sea of Okhotsk is the most productive marine area of Russia, where the main fishery is conducted. Currently, one of the key problems is pollution of the sea ecosystem by toxic chemical compounds. Such xenobiotics as organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) belong to POPs, the use and production of which are prohibited. We analyzed the content of OCPs (DDT, HCH) and PCBs in the muscles, liver, eggs, and male gonads of three important commercial species: sockeye (*Oncorhynchus nerka*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon, collected during 2023–2025 in different parts of the Sea of Okhotsk. The content of POPs was determined by gas chromatography-mass spectrometry. The results showed the presence of POPs in almost all samples. HCH concentrations in nearly all samples were below the detection limits. The ΣDDTs dominated in all studied species, with the highest levels detected in male gonads: sockeye salmon – 48.87 ± 40.87 ng/g lw, pink salmon – 16.61 ± 22.93 ng/g lw, chum salmon – 9.33 ± 13.95 ng/g lw. The highest ΣPCB concentrations in sockeye salmon were recorded in male gonads (1.69 ± 1.32 ng/g lw), in pink salmon – in muscles (0.95 ± 0.33 ng/g lw), in chum salmon – in eggs (1.56 ± 1.45 ng/g lw). In general, the detected concentrations did not exceed maximum permissible levels. But it is necessary to continue monitoring xenobiotics in the Sea of Okhotsk. This work was supported by the Russian Science Foundation (No. 23-74-10032).

MEQ-P, Oral, AbstractID=18192, (ECOP)

Microplastic–alga interactions: The role of *Heterosigma akashiwo* and *Chattonella marina* in aggregation, sinking, and resuspension dynamics

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Microplastics (MPs) are ubiquitous contaminants in marine ecosystems, and their vertical distribution is critically governed by biological interactions, particularly aggregation with phytoplankton. Harmful algal blooms (HABs), through the production of organic exudates, have the potential to substantially modulate MP behavior by facilitating their aggregation, sedimentation, and long-term sequestration. In this study, we assessed the influence of two bloom-forming HAB species, *Heterosigma akashiwo* and *Chattonella marina*, on the fate of polyethylene (PE) and polypropylene (PP) MPs with varying densities and morphologies. Results indicate that MP aggregation was primarily driven by extracellular and intracellular polymeric substances released during algal growth and senescence, rather than by direct cell-to-particle adhesion. Both species enhanced the formation of MP–algae aggregates, thereby promoting the vertical transport of buoyant MPs. *H. akashiwo* induced rapid aggregation and sinking of low-density PE spheres, with sedimentation reaching 28% within 9 days, whereas *C. marina* exhibited a more gradual, yet persistent, sinking trend, attaining 9% over 13 days. Although high-density MPs generally exhibited higher sinking efficiencies, aggregate size and particle load per aggregate did not differ significantly between MP types. Sinking velocity increased in parallel with aggregate growth and algal decay, and a strong positive correlation was observed between chlorophyll *a* concentration and PE sinking rate across both species (R^2 = 0.93). Notably, the settled aggregates remained structurally intact and resistant to microbial degradation for over three months under dark, low-temperature conditions, with no evidence of resuspension. These findings underscore the species-specific roles of HABs in regulating MP aggregation and vertical flux, offering critical insight into the biological mechanisms governing MP fate in the marine environment.

MEQ-P, Oral, AbstractID=18258, (ECOP)

Impact of submarine groundwater discharge and aquaculture effluent on green tide outbreaks in Jeju Island, Korea

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Coastal regions worldwide are increasingly threatened by green tides—massive macroalgae blooms driven by anthropogenic nutrient enrichment. This study investigates the primary nutrient sources fueling green tides on Jeju Island by comparing external nutrient fluxes from submarine groundwater discharge (SGD) and aquaculture effluents in a semi-enclosed bay experiencing severe outbreaks. Using a radon-222 mass balance model, we quantified SGD-driven nutrient fluxes across four seasons and compared them with aquaculture effluent, sediment diffusion, and atmospheric deposition. SGD accounted for 83% of annual dissolved inorganic nitrogen (DIN) fluxes, primarily driven by tidal pumping mechanisms rather than precipitation or hydraulic gradients, reflecting the region's permeable basaltic aquifers and saltwater intrusion dynamics. Conversely, aquaculture effluent dominated ammonium inputs (85%), reflecting organic waste from fish feed and metabolic byproducts. Seasonal variations were observed for dissolved inorganic phosphorus (DIP): SGD contributions were relatively higher in February and May (76% and 80%), while aquaculture effluent dominated in August and October (63% and 54%). Nutrient stoichiometry revealed seasonal shifts from DIN-limited conditions in spring (DIN:DIP=11:1) to DIP limitation in summer/fall (18:1), aligning with *Ulva* growth optima (tissue N:P=16–24). Prolonged water residence time due to breakwater construction amplified nutrient retention, favoring macroalgal proliferation. These findings demonstrate that point-source (aquaculture) and non-point sources (SGD) nutrients act as complementary drivers of eutrophication, necessitating dual management strategies targeting groundwater nitrogen reduction and aquaculture effluent treatment. This study provides critical insight for mitigating green tides in hydrogeologically sensitive coastal regions globally.

MEQ-P, Oral, AbstractID=18514, (ECOP)

Rethinking brine discharge: Should concentrated pollutants be regulated? Insights from China

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Seawater desalination is a vital component of the marine economy and a key strategy for ensuring water security in coastal regions. Seawater desalination concentrate (commonly referred to as brine) is the by-product of the desalination process. In addition to its elevated salinity compared to raw seawater, brine may contain higher concentrations of various pollutants due to the effects of concentration and process-related inputs. As desalination capacity continues to expand globally, increasing attention has been paid to the environmental impacts associated with brine discharge. While salinity is widely recognized as the primary environmental stressor in desalination brine, recent studies have highlighted the potential risks posed by chemical contaminants, especially in offshore waters where pollutant concentrations may be relatively high. Currently, nearly all brine discharge regulations and standards focus exclusively on salinity changes. Whether chemical pollutants in desalination brine should also be incorporated into environmental management frameworks has become an important question.

In this study, a non-target screening method based on comprehensive two-dimensional gas chromatography coupled with mass spectrometry (GC×GC-qMS) was developed to analyze brine samples from five representative seawater desalination plants located across different marine regions of China. A total of 404 organic compounds were identified. Furthermore, 36 organic pollutants, 14 inorganic pollutants, and 3 water treatment agents were quantitatively analyzed and subjected to ecological risk assessment. Interestingly, the study found that some organic pollutants present in raw seawater were partially removed during the desalination process, challenging the common assumption that all pollutants are concentrated in the brine. Once released into the receiving marine environment, the ecological impacts of brine-borne pollutants may be mitigated by the natural resilience of marine ecosystems. To evaluate this hypothesis, a field investigation was conducted to assess the actual ecological effects of brine pollutants in the marine environment. The results supported the hypothesis, showing limited observable ecological impact.

This study provides a theoretical foundation and technical support for brine discharge management and the advancement of environmentally sustainable desalination practices. Key parameters—including pollutant composition, spatial impact range, and effect magnitude—were

identified, offering valuable input for refining environmental impact assessment (EIA) frameworks and guiding regulatory development. Although this is a case study from China, the findings are highly relevant to brine discharge management efforts in other countries.

MEQ-P, Oral, AbstractID=18765 (CANCELLED)

Effects of Hebei Spirit oil spill accident on the reproduction of the toothed top shell *Monodonta labio* in rocky intertidal habitats in Taean on the west coast of Korea

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The toothed top shell *Monodonta labio* Linnaeus 1758, occurs commonly in rocky intertidal habitats on the west coast of Korea, playing a crucial role in the coastal ecosystem as a primary consumer. We examined the reproductive performance of *M. labio* on a littoral rocky shore on the Taean coast and a control site in Incheon two years after the Hebei Spirit Oil Spill (HSOS). The shell height (SH) size frequency distribution suggested that 81% of *M. labio* in the oil spill site were two years old (12-17 mm SH), whereas 82% of the snails in the control site in Incheon were 3 to 5 year-old (17-25 mm SH). Histology revealed a clear difference in the annual gametogenesis and reproductive effort; *M. labio* in the control site showed two spawning peaks (June and September), whereas the snails in the HSOS site showed a single peak in July. The reproductive output measured as the percent gonad area (PGA) in the control site during the spawning peak (35.9%, June 2010) was significantly higher ($P<0.05$) than the area measured in July 2010 (22.6%) from the HSOS site. Histology also indicated that *M. labio* in the control site ripened and spawned a month earlier than the oil spill site. The slow gonad maturation and lower level of reproductive effort of *M. labio* observed in the HSOS site could be explained by the combined effect of the snail age and the environmental parameters. The seawater temperature at the oil spill site was 3-5 °C lower than the control site annually, which may affect the gametogenesis. The smaller reproductive output of *M. labio* recorded in the oil spill site could be attributed to age, as the reproductive output of *M. labio* was reported to be negatively correlated with age, as young snails may produce less quantity of eggs or sperm during spawning. It was also believed that the prevalence of the young snails in the oil spill site was also associated with HSOS, as the oil spill wiped out most of the toothed top shells shortly after the accident, as the rocky shore was entirely covered with the spilled crude oil.

MEQ PAPER SESSION

Poster Presentations

MEQ-P, Poster, AbstractID=18184, PosterID: MEQ-P1

OCPs and PCBs level in commercial fish species (herring, flounder, pollock) from the Sea of Okhotsk

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The Sea of Okhotsk is one of the most productive regions in Russia. In recent decades, particular attention has been drawn to studying the levels of pollutants of different origins in marine organisms, including commercial fish. Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) belong to the group of POPs, the use and production of which are strictly regulated. This study examined OCPs and PCBs contamination in three species: walleye pollock (*Gadus chalcogrammus*), Pacific herring (*Clupea pallasii*), and flounders (*Limanda aspera* and *Pleuronectes quadrituberculatus*). Muscle, liver, male gonads, and eggs collected during 2023-2025 were analyzed using gas chromatography-mass spectrometry. The HCH isomers level was below the detection limit in almost all samples. The ∑DDTs concentration in pollock ranged from 10.3±14.7 ng/g in muscles to 29.2±40.7 ng/g lipid weight in the liver; in herring – from 7.5±19.2 ng/g in muscles to 19.7±28.6 ng/g in male gonads; in flounders – from 14.5±7.9 ng/g in eggs to 54±63.3 ng/g in male gonads. The ∑PCBs concentration of in pollock ranged from 3.9±5.5 ng/g in muscles to 11.5±11.7 ng/g in the liver; in herring – from 2.4±4.5 ng/g in muscles to 7.1±5.4 ng/g in the liver; in flounders – from 3.5±2.6 ng/g in eggs to 13.8±11.2 ng/g lipid weight in muscles. In general, the level of fish contamination in the Sea of Okhotsk is within permissible sanitary and hygienic limits. However, there is a need for regular monitoring of pollutant concentrations, especially in areas with increased anthropogenic pressure. This work was supported by the Russian Science Foundation (No. 23-74-10032).

MEQ-P, Poster, AbstractID=18188, PosterID: MEQ-P2, (ECOP)

Biological regulation of microplastic aggregation and vertical transport by *Chattonella marina*: Implications for sinking dynamics and resuspension stability

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Microplastics (MPs) are widespread pollutants in marine environments, and their vertical distribution is strongly influenced by biological interactions, such as aggregation with phytoplankton. This study experimentally investigated the effects of the harmful algal bloom (HAB) species *Chattonella marina* on the aggregation, sinking, and resuspension of polyethylene (PE) and polypropylene (PP) MPs. Aggregation was primarily induced by intracellular materials released upon *C. marina* cell lysis, leading to the progressive binding of MPs and the formation of large aggregates. Low-density spherical PE particles (PE1.0) exhibited a logistic sinking pattern, with a maximum sinking ratio of 9% and a half-saturation time of 13 days. In contrast, small PP fragments showed negligible sedimentation (<1%), and no significant differences ($P > 0.05$) were observed between PE1.0 and high-density PE (PE1.4) in terms of aggregate size, sinking velocity, or the number of MPs per aggregate. Notably, the mean area of PE1.0 aggregates significantly increased from $0.19 \pm 0.13 \times 10^6$ μm² on day 43 to $0.42 \pm 0.45 \times 10^6$ μm² on day 92. During the declining phase of *C. marina*, larger aggregates exhibited enhanced sinking velocities, reaching up to 78.62 m·day^{-1}. A strong positive correlation was found between *C. marina* chlorophyll *a* (Chl. *a*) concentration and the sinking rate of PE1.0 particles ($R^2 = 0.92$, $P < 0.05$), suggesting that Chl. *a* may serve as a proxy for aggregation-inducing substances produced during cell senescence. The MP aggregates formed with *C. marina* remained structurally stable for three months under dark, low-temperature conditions, showing no signs of degradation or resuspension. Additionally, the number of aggregates remained unchanged over the final 60 days ($P > 0.05$), indicating strong resistance to microbial degradation. This pioneering study comprehensively evaluates MP aggregation and vertical transport throughout the full 92-day growth cycle of *C. marina*, establishing sedimentation thresholds driven by harmful algal blooms and providing empirical data to improve predictive models of MP vertical flux and fate in marine environments.

MEQ-P, Poster, AbstractID=18189, PosterID: MEQ-P3

Temporal dynamics of microalgal biomass and community structure on plastic polymers under nutrient-enriched conditions

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Marine plastic debris (MPD) poses a potential threat to marine ecosystems; however, its role as a vector for transporting harmful microalgae and its ecological impacts on marine habitats remain unclear. To address this knowledge gap, we conducted month-long microcosm experiments using 30 L tanks equipped with plates made from six different plastic polymers—polypropylene (PP), low-density polyethylene (LDPE), high-density polyethylene (HDPE), polyvinyl chloride (PVC), polyethylene terephthalate (PET), and polystyrene (PS). We monitored temporal changes in both planktonic and periphytic microalgal communities. Our results showed no significant differences in periphytic microalgal composition or biomass among the different plastic types ($p > 0.05$). While nutrient depletion led to a decline in planktonic microalgal abundance, it significantly increased the biomass of periphytic microalgae attached to plastic surfaces ($p < 0.05$). Notably, the abundance of benthic harmful algal bloom (HAB) species such as *Amphidinium operculatum* and *Coolia monotis* increased significantly during the latter stages of the experiment (days 21–28; $p < 0.05$). These findings indicate that periphytic microalgae, including HAB-forming benthic species, can readily colonize various plastic surfaces and be transported across marine regions via MPD, posing ecological risks to recipient ecosystems. They also provide foundational insights into the species composition of microalgal communities associated with MPD, which may support the development of models evaluating the impact of transport vectors on the distribution and habitat dynamics of marine microalgae.

MEQ-P, Poster, AbstractID=18208, PosterID: MEQ-P4

Effects of temperature and salinity on germination of resting cysts of toxic dinoflagellate *Alexandrium catenella* (Group I) in Jinhae-Masan Bay, Korea

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To better understand the role of resting cysts in the outbreak of paralytic shellfish poisoning and bloom dynamics in Jinhae-Masan Bay, Korea, this study investigated the germination features of ellipsoidal *Alexandrium* cysts isolated from sediments collected in winter and summer under different combinations of temperature and salinity. Morphology and phylogeny of germling cells revealed that the ellipsoidal *Alexandrium* cysts belong to *Alexandrium catenella* (Group I). The cysts could germinate across a wide range of temperature (5–25 ◦C) with germination success within 5 days, indicating that continuous seeding for the maintenance of vegetative cells in the water column may occur through the year without an endogenous clock to regulate germination timing. In addition, the cyst germination of *A. catenella* (Group I) was not controlled by seasonal salinity changes. Based on the results, this study provides a schematic scenario of the bloom development of *A. catenella* (Group I) in Jinhae- Masan Bay, Korea.

MEQ-P, Poster, AbstractID=18225, PosterID: MEQ-P5, (ECOP)

Visual and chemical cues of plastics influence the behavioral decisions and feeding attempts of ghost crabs (*Ocypode stimpsoni*)

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Numerous studies have documented the ubiquity of marine plastics, from intertidal zones to the deep sea, and even within living organisms. The primary pathway of plastic entry into the biosphere is known to be ingestion, yet our understanding of how animals first perceive and inspect plastics as potential prey remains limited. In this study, we investigated the sensory factors that influence the behavioral interaction between marine plastic and macrobenthos. We conducted two field preference tests on Stimpson's ghost crabs (*Ocypode stimpsoni*), using plastic samples with visual and olfactory cues. In the first experiment, we video-recorded the ghost crabs interacting with three PE plastics with different shapes (rope, fragment, and film) which had been submerged in coastal waters to accumulate biofilm in prior. Ghost crabs prioritized ropes upon contact, but feeding attempts and the behavioral time allocation of the crabs did not vary among different shapes. In the second experiment, films treated with different olfactory cues (biofilm, fish smell, and nothing) were presented. Crabs at first approached the films with fish smell more over the others, and feeding attempts occurred significantly higher for the films with fish smell than ones without treatment. They also tried to feed films with fish smell/biofilms and even take them the burrow, while the plastic without treatment were never tried. Our results suggest that ghost crabs may take both visual and olfactory cues in account, in attempt to feed plastics and adjust their behavioral decisions.

MEQ-P, Poster, AbstractID=18352, PosterID: MEQ-6

Microbial synergistic degradation potential of PE/PP in urban river sediments

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The microbial degradation of polyethylene (PE) and polypropylene (PP) resins in rivers and lakes has emerged as a crucial issue in the management of microplastics. The processes involved in the distribution and degradation behavior of microplastics are complex. This study investigated the distribution of microplastics-degrading bacteria and their synergistic degradation potential for PP and PE in urban river sediments. Empirical core PE/PP degrading bacteria (C-bacteria) and resuscitated PE/PP degrading bacteria (R-bacteria) were screened based on the variation of the abundance of OTUs. C-bacteria enriched in this study displayed higher abundance and standard betweenness centrality in sediments than those in overlying water. In estuarine sediments, the flow rate decreased longitudinally, NH_4^+-N, heavy fraction of organic carbon (HFOC), and small-size microplastics (< 1 mm) gradually accumulated in the deep and downstream sediments. Based on their surface morphology and carbonyl index, these sediments were identified as the potential hot zone for PE/PP degradation. Within the identified hot zone, concentrations of PE/PP-degrading genes, enzymes, and bacteria were significantly elevated compared to other zones, exhibiting strong intercorrelations. Analysis of niche differences revealed that the accumulation of NH_4^+-N and HFOC in the hot zone facilitated the synergistic coexistence of key bacteria responsible for PE/PP degradation within biofilms. The findings of this study offer a novel insight and comprehensive understanding of the distribution characteristics and synergistic degradation potential of PE/PP in natural freshwater environments.

MEQ-P, Poster, AbstractID=18369, PosterID: MEQ-P7

Performance and risk validation of an in-water hull cleaning system under real port conditions

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This study quantitatively assessed the biological risks of hull cleaning using in-water cleaning system, focusing on the potential spread of non-indigenous species (NIS) in Korean ports. Field trials were conducted on two vessels with different levels of biofouling (Vessel 1: fouling rating 3; Vessel 2: fouling rating 1). Samples collected before and after cleaning were analyzed for organism viability, regrowth, and capture effectiveness. Data related to the vessels and the in-water cleaning system—such as port residence time, fouling level, and the capture and treatment performance—were also analyzed to calculate Risk Priority Numbers (RPNs) under various in-water cleaning scenarios. The field performance results of the in-water cleaning system ~~underwater cleaning robot~~ showed regrowth of prokaryotes and macroalgae in both the captured and treated water samples, with capture efficiency estimated to be below 90%. Based on the biological risk assessment, Risk Priority Numbers (RPNs) without debris collection were calculated as 934 for Vessel 1 and 160 for Vessel 2, indicating a medium level of risk. In contrast, assuming a debris collection efficiency of 90–99%, the RPNs dropped significantly to 96 and 20, respectively, corresponding to a low level of risk. These findings emphasize the critical role of efficient debris capture and post-treatment in in-water cleaning and may provide a scientific basis for Korea's guidelines on managing biological risks.

MEQ-P, Poster, AbstractID=18416, PosterID: MEQ-P8, (ECOP)

Radon-222-based estimation of submarine groundwater discharge and associated nutrient and carbon fluxes in the coastal waters off Daebu and Jebu Islands, South Korea

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Submarine groundwater discharge (SGD) is globally recognized as an important pathway for transporting carbon and nutrients to the coastal ocean. In this study, we quantified SGD-derived fluxes of dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), dissolved silicon (DSi), dissolved inorganic carbon (DIC), and dissolved organic carbon (DOC) into the coastal waters surrounding Jebu and Daebu Islands, South Korea, using ^{222}Rn as a tracer. Based on a ^{222}Rn mass balance model, the SGD rate was estimated to be approximately 0.3 m d^{-1} in July 2024. The SGD-derived fluxes of DIN, DIP, DSi, DIC, and DOC were 16 ± 8.3, 0.4 ± 0.2, 39 ± 7.6, 190 ± 126, and 75 ± 57, mmol m^{-2} d^{-1}, respectively. SGD contributed approximately 83% and 48% of the total DIN and DSi inputs, respectively, supporting the elevated microphytobenthic primary production observed in the Daebu mudflat, which exceeded that of other temperate coastal systems. Notably, the high N/P ratio of SGD (mean: ~58) highlights its important role in establishing favorable conditions for seaweed aquaculture, particularly for *Pyropia yezoensis* in this region. Furthermore, the SGD-derived DIC and DOC fluxes were 16 and 6.5 times greater than carbon burial, respectively, underscoring the need to reassess the carbon storage capacity of coastal tidal-flat sediments by accounting for SGD-driven carbon outflux to the ocean.

MEQ-P, Poster, AbstractID=18435, PosterID: MEQ-P9 , (ECOP)

Meiofaunal biofouling on marine plastic debris during golden tide events: Focus on potentially risky species

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During the golden tide event in January 2021, large amounts of non-native *Sargassum horneri* and marine plastic debris (MPD) were stranded on Naechi Beach, located on the southwest Korea. This event highlighted MPD's role as a vector for dispersing meiofaunal biofouling organisms, including harmful, invasive, or parasitic species from outside Korean waters. To investigate such meiofaunal biofouling, this study collects and categorizes foreign-sourced MPDs according to polymer types: polyethylene (PE), polypropylene, polyvinylchloride (PVC), polyethylene terephthalate (PET), and others. Morphological identification and DNA metabarcoding characterized meiofaunal biofouling (40–1,000 μm) associated with the MPD, identifying 14 taxa from 6 phyla and 169 species from 12 phyla, respectively. The integrated abundance was 19–118 ind. 0.1 m^{-2}, with an average of 76 inds. 0.1 m^{-2}. PVC (containers and shoes) showed the highest abundance, and PET (bottles) exhibited the lowest abundance. Most species are non-native to South Korea, but are non-harmful. Notably, invasive species *Ciona intestinalis* and parasitic platyhelminthes *Plagiorchis maculosus* were found on PET, while *Ficopomatus enigmaticus* and *Spinitectus macrospinosus* were found on both PET and PE. Accordingly, MPD-induced species may facilitate the introduction of harmful species into new habitats. PET, despite its lower abundance, may pose a substantially greater ecological risk than PVC, which had the highest abundance of meiofaunal biofouling, due to its stronger association with invasive and parasitic species. These results suggest that PET and PE may pose a higher risk to new habitats than PVC, despite their lower abundance and higher-risk species during golden tide events.

MEQ-P, Poster, AbstractID=18670, PosterID: MEQ-P10, (ECOP) (CANCELLED)

~~Predictive modeling and optimization of polyolefin low-pressure hydrothermal liquefaction for marine plastic recycling~~

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~~The Philippines' "sachet economy" has intensified the plastic waste crisis, with post-consumer polyolefin-based sachets, particularly polyethylene (PE) and polypropylene (PP), contributing significantly to both terrestrial and marine pollution. Improperly managed plastic waste often enters rivers and eventually the North Pacific Ocean, exacerbating marine plastic and microplastic pollution. This study investigates the potential of low-pressure hydrothermal liquefaction (LP-HTL) to convert polyethylene (PE) and polypropylene (PP) into valuable fuel products through data-driven predictive modeling. Six classical machine learning models, Linear Regression, Lasso Regression, Ridge Regression, Decision Tree, XGBoost, and Random Forest, were developed using 78 curated open literature-sourced data points to simulate LP-HTL behavior. Model performance was evaluated using R^2 and mean absolute error (MAE). Random Forest achieved the lowest cross-validation MAE (7.13), while Decision Tree attained the highest test set R^2 (0.84) and lowest MAE (6.08), outperforming linear models failing to capture the inherent nonlinearities of HTL systems. Multi-response optimization using the top-performing models identified eight optimal operating conditions that maximize oil yield (~88%) while minimizing gas and solid yields. Feature importance analysis showed that temperature, pressure, and reaction time are the most influential variables affecting product distribution, while the polyolefin composition had minimal predictive impact within the tested range. These findings affirm the utility of classical machine learning models, particularly Random Forest and Decision Tree, as effective tools for modeling and optimizing LP-HTL processes. More importantly, this approach presents a scalable solution for chemically recycling polyolefin-rich marine debris, supporting circular economy initiatives and pollution reduction efforts in the North Pacific.~~

MEQ-P, Poster, AbstractID=18687, PosterID: MEQ-P11 CANCELLED

Impact of polyethylene terephthalate microfibers on histopathology and molecular responses caused by cadmium in the polychaete, *Perinereis aibuhitensis*

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Heavy metals and microplastics have been found to co-exist in marine sediment environments. Nevertheless, the impact of microplastics on altering the toxicity of heavy metals to marine benthic organisms remains poorly understood. Herein, we investigated the impact of polyethylene terephthalate microfibers (PET MFs, 100 μm in diameter, 500 items·kg^{-1}·dw) on the toxicities and individual/subcellular bioaccumulation of cadmium (Cd, 1, 10 and 100 μg·g^{-1}·dw) to the benthic polychaete, *Perinereis aibuhitensis*, after 28 days of sediment exposure. Either Cd (10 and 100 μg·g^{-1}) or PET MFs alone caused the intestinal inflammation response including cell vacuolation, villi exfoliation and cytolysis, and the presence of PET MFs significantly aggravated the inflammatory response at a Cd concentration of 1 μg·g^{-1}. PET MFs also showed significant impact on oxidative stress biomarkers including lipid peroxidation (LPO), protein carbonylation (PC) and glutathione S-transferases (GST) activity at 500 items·kg^{-1}. In addition, compared to the single Cd exposure, co-exposure significantly reduced LPO and PC levels while enhancing GST enzyme activity at a Cd concentration of 100 μg·g^{-1}, suggesting decreased oxidative damage. Besides, co-exposure also significantly up- or down-regulated mRNA expressions of selected genes involved in stress response (*CAT*, *SOD*, *HSP70*, *HSP90*), metabolism (*CYP4*) and detoxification (*MPII*) as shown by real-time q-PCR. However, Cd bioaccumulation at individual or subcellular level was not affected by PET MFs, suggesting the key role of toxicity contribution of PET MFs themselves in the combined toxicity. The potential adverse effects of the co-existence of MFs and heavy metals in sediment environments under long-term exposure scenarios still require further validation.

MEQ-P, Poster, AbstractID=18767, PosterID: MEQ-P12 NO SHOW

Sulfide Eliminator of Gill Microbiome of the Chemosymbiotic bivalve *Pillucina pisidium* *Axninopsida subquadrata* in Reducing Environments

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Sulfide is concentrated in various marine environments, from deep-sea hydrothermal vents and sewage dumping areas to coastal seagrass meadows where organic matter is continuously supplied. High concentration of sulfide inhibits the activity of oxygen-transporting enzymes such as cytochrome-c-oxidase and often act as a toxin to marine organisms. However, a certain species of marine bivalves in the families Solemyidae, Lucinidae, and Thyasira have evolved to be highly tolerant against sulfide toxicity. The sulfides are effectively removed by sulfur-oxidizing symbiotic bacteria in the gills of the host clam. Ultimately, the mutualistic association between shellfish and chemosynthetic bacteria alleviates the toxicity of sulfide and creates an environment suitable for other organisms. In this study, we investigated the gill microbiome profile and its ecological role of two chemoautotrophic bivalves, *Pillucina pisidium,* and *Thyasira tokunagai,* inhabiting the sulfide-rich environment in the seagrass meadow of Jeju and the East Sea-Byeong (sewage dumping site). The metagenome sequencing revealed *Thiodiazotropha*-like bacteria dominating the gill tissues of *P. pisidium* at an average rate of 90.14%. *Thiodiazotropha*-like bacteria sequences were grouped with other symbiont groups extracted from *Codakia* and *Lucina* clams in the Family Lucinidae in the phylogenetic tree using the 16S rRNA. In addition, RNA sequencing identified chemosynthesis-related genes from *Thiodiazotropha*-like bacteria, including the Iron-sulfur cluster insertion protein ErpA, Sulfur carrier protein TusA, and Adenylylsulfate reductase subunit beta, which is involved in the oxidation. In the East Sea-Byeong, it was also confirmed that sulfur-oxidizing bacteria such as *Sulfurimonas* and *Sulfurovum* were dominant in the gills of *T. tokunagai*. Although these symbiotic bacteria have not yet been reported in other shellfish and further studies on their functions, such as genome analysis, are needed, previous studies on isolation and culture confirmed that they are sulfur-oxidizers. Therefore, the results showed that chemosymbiotic clams play a crucial role in removing toxic sulfide in both reducing environments.

POC PAPER SESSION

Oral Presentations

POC-P, Oral, AbstractID=18166

AI-driven typhoon monitoring: Integrated systems using R/V Zhu Haiyun and blue whale UUVs

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This presentation begins with an overview of the IMO Maritime Autonomous Surface Ships (MASS) Code, particularly its updated provisions for AI-enabled navigation systems as outlined in the 2024 amendments. The focus then shifts to the groundbreaking R/V Zhu Haiyun - the world's first intelligent research vessel, highlighting its dual certification under China's 2025 Smart Shipping Technical Specifications and the IMO MASS interim guidelines.

Subsequently, the operational practices of Zhu Haiyun in autonomous navigation are detailed, special attention is given to the vessel's machine learning-based collision avoidance system, which demonstrated almost 98% accuracy in simulated heavy weather scenarios according to 2023 long range tests.

The concluding section proposes a novel methodology leveraging the synergistic capabilities of Zhu Haiyun and the "Blue Whale" unmanned underwater vehicle platform. This integrated system aims to conduct precision typhoon monitoring.

POC-P, Oral, AbstractID=18182, (ECOP)

Short-term sea surface current prediction using a Physics-Informed 3D-CNN model: A case study in the East/Japan Sea

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Short-term sea surface current predictions are essential for maritime safety, disaster prevention, and marine pollution response. Traditionally, numerical models have been the primary method for predicting sea surface currents. But their high computational cost and memory requirements limit near-real-time predictions, particularly when capturing complex ocean-atmosphere interactions. To overcome these limitations, artificial neural networks (ANNs) have emerged as a promising alternative. Unlike numerical models, ANNs use pre-trained weights, significantly reducing computational costs. Additionally, by incorporating physical information as constraints, ANNs can maintain physical consistency and adhere to oceanographic principles, bridging the gap between numerical modeling and data-driven methods. In this presentation, we introduce a short-term sea surface currents prediction model for the East/Japan Sea using a three-dimensional Convolutional Neural Networks based on the Attention U-Net architecture. To enhance the model's physical reliability, we integrated the continuity equation into the loss function−a key feature of Physics-Informed Neural Networks. This approach proved particularly effective in coastal regions where upwellings frequently occur. The model's performance was evaluated by comparing its predictions with satellite observations and numerical model outputs. Additionally, we analyzed key oceanic phenomena, such as mesoscale eddies and the East Korean Warm Current. Our findings highlight the potential of ANNs as an efficient and innovative tool for surface current prediction, offering a viable alternative to traditional numerical models.

POC-P, Oral, AbstractID=18240, (ECOP)

Estimation of water exchange between the Bering Sea and the Pacific Ocean through the Near Strait using GLORYS12V1, GOFS 3.1 and JCOPE2M

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The Near Strait is the widest pass of the Aleutian Islands. Most of the transport from the Pacific Ocean into the Bering Sea occurs through the Near Strait, what contributes to the transfer of the saltier and colder Alaskan Stream waters. The work is devoted to the quantitative assessment of water exchange through the Near Strait based on four oceanic datasets. A comparison of two CMEMS products, the oceanic reanalysis GLORYS12V1 (DT) and the predictive product GLOBAL_ANALYSISFORECAST (NRT), revealed significant differences over their overlap interval (the first half of 2021). The volume transport calculated on the basis of NRT systematically exceeded the values obtained from DT, with a difference reaching more than 5 Sv (1 Sv = 10^6 m^3/s). The average transport calculated by JCOPE2M turned out to be the highest among all the datasets considered and amounted to 6.2 Sv, whereas according to GOFS 3.1 it was 4.5 Sv, which is close to the NRT values (4.7 Sv). The data from these reanalyses confirm the high variability of water exchange through the Near Strait and emphasize the need to integrate various data sources to improve the accuracy of the assessment.

It was found that despite the predominance of water inflow into the Bering Sea through the Near Strait, there are periods of outflow, the largest of which is recorded in March 2021 (-7.6 Sv). The paper describes the mechanism of water outflow, including meso- and large-scale dynamics, as well as the influence of atmospheric forcing.

POC-P, Oral, AbstractID=18434

Impact of mesoscale eddies on diurnal internal tide propagation in the Northwestern Pacific from observations

Kang-Nyeong **Lee**[1], Jae-Hun **Park**[1], Chanhyung Jeon[2], Hong Sik Min[3], Xiao-Hua Zhu[4,5,6], Chuanzheng Zhang[4,6], and Zhongxiang Zhao[7,8]

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First-mode diurnal internal tides (DITs) generated in the Luzon Strait can propagate long distances in the Northwestern Pacific, transporting energy into the ocean interior. Due to the beta effect, these DITs refract equatorward during their eastward propagation. We conducted in-situ observations over 1-year and 1.5-year periods in the Eastern Philippine Sea, a region slightly off the main propagation path (16.3°–18°N, 139.5°–142°E), using 10 pressure-recording inverted echo sounders (PIES) that measured round-trip acoustic echo time (τ). Since τ is sensitive to vertical displacements of the thermocline, it effectively captures variations in first-mode DITs. The observations revealed stronger DIT signals during winter (October–April) and a clear weakening in summer (April–October). To understand the mechanism behind this seasonal modulation, we used ray-tracing method based on HYCOM ocean model outputs. The results indicate that during summer, enhanced equatorward refraction of DITs causes the ray paths to shift farther away from the observation site. These changes in DIT propagation result from the presence of warm eddies near the upstream region of the ray paths during the summer months. This study suggests that mesoscale eddies play a crucial role in steering DIT propagation paths. Given the close relationship between these eddies and the equatorial current system, changes in equatorial current due to climate change could alter eddy patterns and, consequently, the propagation of DITs. Our findings also imply that the temporal variation of DITs should be considered for improved parameterization of internal-wave-induced ocean mixing in climate models.

POC-P, Oral, AbstractID=18449

Tow-yo motion analysis of an underwater environmental sensor probe using an autonomous surface vehicle winch system

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We have been testing multi-parameter environmental sensors to develop new sensors suitable for tow-yo measurements using an autonomous surface vehicle. Wave Glider winch system (Liquid Robotics) is a suitable platform for conducting field tests for this purpose. From the principle of the operation, it is expected that all the motion parameters such as speed, depth, acceleration, etc. of the measurement instrument change quasi-periodically. It is important to quantify these motion parameters since they may affect the environment measurement accuracies. For this purpose, we attached an inertial measurement unit, IMU (x-IMU3, x-io Technologies) inside the sensor probe (BioUCTD ASTD152-ALC-R02, JFE Advantech), which was mounted on the sinker of the winch system. The experiment was conducted off the west coast of Hawaii Island in January 2025. Programmed casts to the depth of 150 m were successfully performed more than 100 times over a 48-hour period. Frequency analysis shows that strongest lateral acceleration was observed for the longitudinal (moving) direction component at the frequency of 0.6 mHz, corresponding to the profiling interval. Correlation analysis was also conducted between the uncertainties of the measured environmental parameters and various motion parameters. It has been shown that the IMU is effective to obtain valuable motion parameters of underwater instruments, and that the angle of attack is one of the key parameters to affect the noise level of the environmental measurements.

POC-P, Oral, AbstractID=18585

Scale dependence of horizontal diffusion coefficient in the Kuroshio region

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Particle transport experiments using numerical models are now a fundamental analytical method in fields such as fisheries oceanography and biogeochemistry. It is common to parameterize the horizontal diffusion for particle transport experiments, but the parameterization should be applied after careful consideration of its validity according to the model resolution. Observational studies have accumulated GPS-drifter data and presented global maps of horizontal diffusion coefficients, but their horizontal scale dependence for each region is not well understood. Therefore, this study aimed to elucidate the actual scale dependence of horizontal diffusion coefficients at scales ranging from 100 m to 100 km in the Kuroshio region, which is a major transport site of various substances and organisms in the western North Pacific. The analysis used the position data observed by three GPS-drifters (drogue depth: 15 m) deployed almost simultaneously on November 19, 2015 in the Kuroshio jet off Cape Ashizuri during the R/V Hakuho-maru KH-15-4 cruise. Horizontal diffusion coefficients, calculated applying the finite scale Lyapunov exponent to the trajectories of the drifters, demonstrated one order of magnitude larger than those of previous studies at the wide range of the horizontal scale L, indicating strong dispersion in the Kuroshio frontal region. The regression analysis revealed that the horizontal diffusion coefficients were almost proportional to the 4/3 power of L for 100 m < L < 3 km, corresponding to the -5/3-type wavenumber spectrum for kinetic energy, and almost proportional to the 3/2 power of L for 3 km < L, corresponding to the -2-type spectrum.

POC-P, Oral, AbstractID=18592

Multi-month prediction of summertime hypoxia occurrence in the bottom of Funka Bay, Japan, with a focus on the wintertime surface heat flux

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Hypoxic water (< 2 mL of O_2 per L), which can cause mass mortality of demersal fishes, is reported to occur in the enclosed coastal area around the world. Funka Bay, a semi-enclosed and cone-shaped bay with a maximum depth of 107 m, located in the southern part of Hokkaido, Japan, also suffers summertime bottom hypoxic water. Long-term monitoring reveals that the occurrence is greatly variable year by year, yet the controlling factor is still unknown. The present study examined the interannual variability of summertime bottom dissolved oxygen (DO) with the focus on the wintertime heat loss of the water and subsequent convection overturning using year-round moored/ship-board DO observation for the period of 2012–2019. A common feature found in the 8 years was the continuous recovery of bottom DO in winter from the previous summer, which peaked February or March. The first half of the analysis period ceased the DO recovery until February, while one month extension of the DO recovery by March in the second half. The latter tended to show less hypoxia in the following summer as its peak is higher and its DO reduction phase starts later. Wintertime surface heat flux in February created the difference; more heat was lost in the second half because of warmer water temperature under the winter atmosphere. We were successful to predict summertime bottom DO with the accuracy of 0.26 mL/L considering the wintertime heat flux and stratification. This multi-month prediction will be of great help for future fishery activity in the Funka Bay.

POC PAPER SESSION

Poster Presentations

POC-P, Poster, AbstractID=18206, PosterID: POC-P1

A non-interpolated estimate of horizontal spatial covariance from scalar velocities irregularly sampled at time-varying locations

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We present a least squares method to estimate the horizontal (isotropic or anisotropic) spatial covariance of two-dimensional orthogonal vector components, without introducing an intervening mapping step and biases, from the spatial covariance of the raw scalar velocities irregularly sampled at time-varying locations. The field is assumed to be locally homogeneous in space and sampled in an ensemble, so the unknown spatial covariance is a function of spatial lag only. The transformation between the irregular grid on which non-orthogonal scalar projections of the vector are sampled and the regular, orthogonal grid on which they will be mapped is created using the geometry of the problem. The spatial covariance of the orthogonal velocity components of the field is parameterized by either the energy (power) spectrum in the wavenumber domain or the lagged covariance in the spatial domain. We apply this approach to a set of synthetic scalar velocity data obtained from a simple spectral model. This approach will be used to Lagrangian surface drifters and Ocean Dynamics and Surface Exchange with the Atmosphere (ODYSEA) project data, which are sampled at time-varying locations.

POC-P, Poster, AbstractID=18288, PosterID: POC-P2, (ECOP)

Radium isotopes as tracers of submarine groundwater discharge and upwelling dynamics in Posiet bay (Autumn 2024)

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Posyet Bay (Peter the Great Bay, Sea of Japan) is a highly productive shallow-water ecosystem where biogeochemical cycles critically depend on monsoon-enhanced hydrodynamics and Tumannaya River discharge. A POI expedition (R/V “Professor Gagarinsky”, November 2024, 18 stations) studied key nutrient sources—coastal upwelling and submarine groundwater discharge (SGD)—under active autumn monsoon conditions driving wind-driven dynamics. Methodology used radioisotope tracing of short-lived radium isotopes (^{223}Ra, $T_{1/2}$=11.4d; ^{224}Ra, $T_{1/2}$=3.66d) via daughter radon (^{219}Rn, ^{220}Rn). Radium released from sediments/SGD traced water mass origins and time since source contact. The ^{224}Ra/^{223}Ra activity ratio provided "radium age". Integration with CTD profiles and nutrient analyses mapped mixing pathways and nutrient sources. Results confirmed northeastern upwelling initiated by NW winds, advecting cold, saline Sea of Japan water through Gamov Canyon. Elevated seabed Ra activity/minimal "age" indicated recent sediment contact; maximum surface "age" evidenced upwelled waters. An active SGD zone near Cape Crabbe showed high short-lived Ra activity and minimal "age". Nutrient signatures differed: SGD waters (Crabbe) were phosphate/ammonium-dominated, while upwelled waters were nitrate/nitrite-enriched. Divergent N-species and N:P ratios imply consequences for phytoplankton.Thus, the study localized autumn upwelling and identified SGD near Cape Crabbe, demonstrating the efficacy of combining short-lived radioisotope tracing with traditional methods. These results establish a foundation for future research and biogeochemical modeling in Posyet Bay.

The study was conducted with the support of the Russian Science Foundation (RSF) grant No. 25-67-00001, "Assessment of the Chaunskiy Refuge impact on hydrophysical, biogeochemical and hydrobiological regimes of shelf waters in the eastern East Siberian Sea".

POC-P, Poster, AbstractID=18355, PosterID: POC-P3, (ECOP) NO SHOW

Asymmetric influences of ENSO phases on the predictability of North Pacific sea surface temperature

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The El Niño-Southern Oscillation (ENSO) significantly impacts the North Pacific SST; however, the influence of the distinct phases of ENSO on SST predictability remains unclear. To overcome the model limitations, this study assessed SST predictability under diverse ENSO phases using reanalysis. The predictability limit of the North Pacific SST under La Niña (8.4 months) is longer than that under Neutral (5.9 months) and El Niño (5.5 months) conditions, which unveils asymmetry. This asymmetry mirrors contemporary multimodal prediction skills. Error growth dynamics reveal La Niña's robust signal strength with a slow error growth rate, in contrast to El Niño's weaker signal and faster error growth. There exhibits intermediate signal strength and elevated error growth in Neutral condition. Physically, predictability signal strength aligns with SST variability, whereas the error growth rate correlates with atmospheric-ocean heating anomalies. La Niña, which induces positive heating anomalies, minimizes the impact of atmospheric noise, resulting in lower error growth. These results are beneficial for improving North Pacific SST predictions.

POC-P, Poster, AbstractID=18368, PosterID: POC-P4

Subsurface eddy diffusivity across the Pacific

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In the stratified ocean, vertical eddy diffusivity in the subsurface pycnocline plays a major role in new production through transporting nutrients upwards from the darker/nutrient-rich layer. In order to evaluate the diffusivity that was less available in the subsurface layers where indirect estimations are difficult, we conducted direct microstructure measurements in the upper 300 m of the open Pacific during summer, from 40°S to 50°N along 170°W and from 137°E to 120°W across the subtropical North Pacific (21°30′N–23°N). The subsurface pycnocline in the mid and low-latitude regions was occupied primarily by the Subtropical Underwaters characterized by high salinity, and the Subtropical Mode Waters appeared with an increasing depth and latitude. In the North Pacific, low salinity subarctic water with shallow seasonal pycnocline was observed in the high-latitude region. The base level of the diffusivity was $0.14–0.47 \times 10^{-5}$ m^2 s^{-1}, while elevations up to $0.51–13 \times 10^{-5}$ m^2 s^{-1} were observed at the equator where the Equatorial Undercurrents formed the strong shear in the subsurface layer, and in areas high internal tide energy such as the Hawaiian Ridge. The effect of wind on the diffusivity was less clear, probably because the wind energy is generally low during summer. The shear-to-strain ratio showed dome-shaped profiles with respect to latitude, and an increasing trend from west to east in the subtropical North Pacific. The geographical distributions of the diffusivity presented in this study will contribute to better understanding biogeochemical cycles in the stratified upper ocean through improving estimations of the material transport.

POC-P, Poster, AbstractID=18373, PosterID: POC-P5

Correlation between organic carbon regeneration and methane flux in mid-Yellow Sea sediments

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After collecting sediment using a box corer in the mid-Yellow Sea, sub-samples were collected from the sediment chamber and sediment incubation experiments were performed to calculate sediment oxygen consumption rate, nutrient flux, and methane flux. Sediment incubation experiments were conducted at a total 4 sites, and the experiments were conducted for approximately 120 hours (5 days). Organic carbon regeneration rate was calculated as the sediment oxygen consumption rate. The sediments at all sites were fine-grained, muddy sediments, and the organic carbon content ranged from 0.8% to 1.2%. The C/N ratio is in the range of 7 to 10, and most of the organic matter in the sediment is assumed to be of marine origin. The sediment oxygen consumption rate ranged from 0.9 $mmol/m^2/day^1$ to 2.3 $mmol/m^2/day^1$, a relatively low value compared to the sediment oxygen consumption rate in coastal waters. The organic carbon regeneration rate ranged from 3.03 $g/m^2/year^1$ to 7.74 $g/m^2/year^1$. The fluxes of nitrate showed conflicting results at each site. At the A08 site and P13 site, it was being consumed in the water column at –44 $\mu mol/m^2/day^1$ and -51 $\mu mol/m^2/day^1$, respectively. On the other hand, at the A05 site and G06 site, it was increasing at 38 $\mu mol/m^2/day^1$, 8.6 $\mu mol/m^2/day^1$, respectively. At the P13 site, phosphate was being consumed and flux was –11 $\mu mol/m^2/day^1$, and at the A08 site, A05 site, and G06 site, phosphate fluxes were 25 $\mu mol/m^2/day^1$, 27 $\mu mol/m^2/day^1$, and 32 $\mu mol/m^2/day^1$, respectively. At the A08 site, nitrate was leached out from the sediment at the beginning of the culture, but it is believed to be consumed in the water column due to a rapid decrease in nitrate over time. The P13 site shows a relatively low oxygen consumption rate compared to other sites, and it is believed that nitrate and phosphate were generated as organic matter decomposed continuously during the incubation time in the surface layer of the sediment. The fluxes of methane were 0.458 $\mu mol/m^2/day^1$ and 0.056 $\mu mol/m^2/day^1$ at the A08 site and P13 site, respectively, with a very small amount of methane seeped into the water column. A methane seeping was not detected at other sites. After 120 hours of sediment incubation, oxygen depletion not observed, very low concentrations of methane seeped out.

POC-P, Poster, AbstractID=18399, PosterID: POC-P6

Subsurface warming associated with Pacific Summer Water transport toward the Chukchi Borderland in the Arctic Ocean

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Recent rapid sea ice reduction in the Pacific sector of the Arctic Ocean is potentially associated with inflow of Pacific-origin water via the Bering Strait. For the first time, we detected remarkable subsurface warming around the Chukchi Borderland in the Arctic Ocean over the recent two decades (i.e., the early 21st century). A statistically significant decadal trend of 16.6 ± 10.6 MJ m^{-2} $year^{-1}$ in the subsurface ocean heat content during 1999–2020 was captured by shipboard hydrographic data, and associated with the transport of Pacific Summer Water from Barrow Canyon northwest of the Alaskan coast, where similar warming appeared. Satellite-derived geostrophic ocean velocity indicated that the northwestward ocean current flowing from Barrow Canyon to the Chukchi Borderland became faster in the late 2010s, in association with southeastward shift of the Beaufort Gyre, circulating clockwise around the Canada Basin. Therefore, we suggest that warming of the Pacific Summer Water passing over the Chukchi shelf and intensification of the northwestward ocean current along the shelf–basin boundary both acted to enhance the heat transport and contributed to the positive trend in downstream subsurface ocean heat content. Our findings fill important gaps in the understanding of ocean heat distribution/transport, which is a key factor for sea ice freezing/melting, in the central Arctic.

POC-P, Poster, AbstractID=18403, PosterID: POC-P7

Effect of warm eddies on a maintenance of a main spawning region of snow crab (*Chionoecetes opilio*) in the Western part of the Sea of Japan

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Abundance of snow crab (*Chionoecetes opilio*) which densely distributes in the westerns part of Sea of Japan increased intermittently after 2000. The mechanisms for this phenomenon were elucidated by discussing effects of a current system on the transportation processes of C. opilio from the Oki spur which is a main spawning ground in the western part of the Sea of Japan. Particle-tracking experiments were preformed considering vertical motion of snow crab by using a data assimilation ocean model. All particles had different vertical motions behaving as what we expect to C. opilio. The particles were fundamentally transported from its main spawning region to eastern area where the downstream region of Tsushima warm current. When a warm eddy distributed just east of Oki spur, C. opilio particles were trapped by the eddy current and tended to fall on the seafloor within its main spawning/nursery region. Intermittent generations of the warm eddy lead intermittent increasing of particles returning to the spawning region. This experiment provided a time variation of the number of the settling particles around Oki spur resembling the time variation of the estimated abundance of C. opilio in the western side of the Sea of Japan in 2000-2022. This indicates that the returning processes of the C. opilio due to the warm eddies can be maintenance mechanism and causing of the increasing of abundance of C. opilio. The interannual variation of temperature expressing the generation of the warm eddies were shown to be an index of abundance of C. opilio.

POC-P, Poster, AbstractID=18460, PosterID: POC-P8

Could recent variability in the flow of the Tsushima Warm Current be a factor in the shifted distribution of larvae and juveniles of autumn cohorts of Japanese common squid (*Todarodes pacificus*) toward the continental side in the Sea of Japan?

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Since the 2019 fishing season, fishing grounds of autumn cohorts of Japanese common squid *(Todarodes pacificus*) in summer have increased on the Japanese side of the Sea of Japan (SOJ). In contrast, South Korea, on the continental side of the SOJ, has increased its share of the total catch relative to Japan. These results suggest a shift in *T. pacificus* distribution toward the continental side. As one contributing factor to the shifted distribution, we hypothesized that the distribution of larvae and juveniles of *T. pacificus* may have shifted toward the continental side due to variability in the flow of the Tsushima Warm Current. To explore the validity of this hypothesis, particle-tracking experiments were performed using a data assimilation ocean model. Regarding particles released from the East China Sea in November from 2019 to 2021, the proportion of the particles that entered the SOJ and were distributed on the continental side 90 days after release was higher than in other years. This distribution shift was due to northward expansion of the East Korean Warm Current or/and occurrence of offshore flow in the coastal area of Yamaguchi, Japan, during the winters from 2019 to 2021. This result supports our hypothesis regarding November cohorts from 2020 to 2022 fishing seasons.

POC-P, Poster, AbstractID=18497, PosterID: POC-P9

Influence of water mass variability on double diffusion in the East Sea

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Double diffusion is a distinctive mixing process that occurs when water masses with different temperatures and salinities interact. It could manifest in various forms depending on the temperature and salinity gradients. One representative process, known as “salt finger,” occurs when a warmer, saltier water mass overlies a cooler, fresher water, while “diffusive convection” emerges under reverse conditions. In this study, the presence of double diffusion in the East Sea was examined using two methods: (1) identification of thermohaline staircases in the CTD profiles, and (2) calculation of Turner angle. In March, Turner angles ranging from 45º to 90º, indicative of the formation of salt finger, were observed at depths of 100 to 200 m, coinciding with the development of thermocline staircases. Between May and July, a low-salinity (<34 psu) water mass flowed northward along the east coast of Korea, displacing the high-salinity (>34.6 psu) water mass further offshore. The redistribution of water masses influenced the vertical stratification and mixing processes. As a result, the staircases marked by distinct vertical gradients in temperature and salinity were detected from the surface to approximately 300 m. By November, the sea surface was primarily influenced by the intensified Tsushima Current, which introduced warmer and fresher waters. This hydrographic regime led to the development of a high-salinity water mass at depths of 50 to 150 m, accompanied by Turner angles ranging from 45º to 90º, and the presence of thermohaline staircases. The finding from this study suggest that double diffusion is most likely to occur near the thermocline, and that its seasonal variability may be modulated by the spatial position and intensity of the Ulleung Warm Eddy.

POC-P, Poster, AbstractID=18573, PosterID: POC-P10

Swell waves directionally selected at the bay mouth of rias facing the western North Pacific

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Real-time simultaneous monitoring of wind and surface waves in Otsuchi Bay, a ria located in the northeastern portion of Japan, had been continued over four years since October 2012, using a mooring buoy with an ultrasonic anemometer and a single-mode GPS wave sensor. The monitoring revealed that surface waves in the bay were dominated by swells propagated from the northeastern offshore region in all seasons. Time-lag correlation coefficient between the significant wave height in the bay and the offshore wind velocity component blowing in the direction to the bay was maximized in the region several hundred kilometers northeast of the bay, from which waves developed by the local wind are enough accessible within the corresponding time-lag to the bay at a speed of the group velocity of the swell observed in the bay. As an interesting feature common to swell-dominant waves observed in the bays adjacent to Otsuchi Bay, the region of the significant correlation between the wave height and the offshore wind velocity extends to the direction that faces the bay mouth. It implies that the source region of the swell depends heavily on the coastal shape of the bay mouth. Consequently, the relation between the offshore wind field and the decay-rate of the swells propagating to Otsuchi Bay indicates that the source region of the swell influential in the bay is located in the offshore region several hundred kilometers northeast of the bay, which is on the typical migration route of low pressures in the Northern temperate zone.

POC-P, Poster, AbstractID=18605, PosterID: POC-P11

Possible effect of nocturnal hypoxia on the trade-off between blue carbon and fish production in eelgrass bed

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The eelgrass *Zostera marine* is widely distributed in coastal waters of subtropical to subboreal areas of the world. Eelgrass beds are an essential ecosystem that serves as habitat for young and adult stages of fishery resources. Furthermore, the function of high carbon fixation of eelgrass beds, known as ‘blue carbon," mitigates global warming through photosynthesis. However, species richness, abundance and biomass of fishes per unit area do not always increase in proportion to eelgrass density. The photosynthesis of eelgrass stops and oxygen consumption due to respiration becomes predominant at night in eelgrass beds. In the inner bays where the rate of seawater exchange is low, decline in dissolved oxygen concentration commonly occurs from night to early morning. Hypoxic conditions can affect fish populations through lethal and non-lethal damage. In order to sustainably use the overall ecosystem functions of eelgrass beds, clarification of the biotic and abiotic conditions that affect each function is essential. To examine how to maintain a balance between the functions as fish nursery and blue carbon, we conducted field surveys in eelgrass beds in summer and winter in the Seto Inland Sea, the temperate waters of Japan, and laboratory experiments to evaluate the effects of low dissolved oxygen concentrations on fish survival. The number of species, abundance, and biomass of fish in summer were lower at the site with a higher eelgrass shoot density than that with a lower density. The site with higher eelgrass density showed dissolved oxygen concentrations < 4 mg L-1 every day in summer. A laboratory experiment showed that the survival of the black rockfish and marbled flounder juveniles for 10-60 min was reduced as the DO concentration decreased from 4 to 2 mg L-1. High eelgrass shoot density was suggested to have negative effects on fish communities through a decrease in DO concentration in summer. These results provide evidence that the nursery role, one of the important components of the ecological functions of eelgrass beds, does not always increase in proportion to vegetation coverage in coastal waters.

POC-P, Poster, AbstractID=18613, PosterID: POC-P12, (ECOP)

Estimation and interannual variation of blue carbon in eelgrass beds in Wakasa Bay, Japan

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Seagrass *Zostera marina* beds are an essential ecosystem that serves as nursery for fishery resources. Furthermore, the function of high carbon fixation of seagrass beds, known as ‘blue carbon," mitigates global warming through photosynthesis. In recent years, field surveys for blue carbon assessment have been conducted in seagrass beds around the world. In the shallow waters along the Sea of Japan coast, the distribution of seagrass beds is restricted to calm inner bays due to the strong northwesterly winds and waves. Wakasa Bay is located on the Sea of Japan side in the central part of Japan and is composed of several smaller sub-bays. We conducted field surveys in some of these bays to investigate seagrass distribution. Based on the Blue Carbon Assessment Guidebook published in 2023, we examine the spatio-temporal variability of blue carbon of seagrass in Wakasa Bay. Analysis of the data for approximately 30 years has revealed that the area of seagrass beds has repeatedly increased and decreased at intervals of several years. We investigated the environmental conditions that affect the annual fluctuation of blue carbon . based on the analysis of meteorological data and the seagrass growth.

POC-P, Poster, AbstractID=18644, PosterID: POC-P13, (ECOP)

Marine ecosystem modeling of estuarine nutrient dynamics with a benthic–pelagic coupling module: A case study of the Tonegawa Estuary

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In estuarine ecosystems, nutrient dynamics have been viewed as primarily driven by river inputs and offshore water transport via advection, mixing, and upwelling. However, recent studies highlight the significant role of sediment-derived nutrients, which enter the overlying water through porewater diffusion and sediment–water exchange processes such as submarine groundwater discharge (SGD). These findings indicate that benthic sources are a non-negligible contributor to coastal nutrient inputs, challenging the traditional view of river dominance.

In this study, we focus on the Tonegawa River estuary in eastern Japan, near the confluence of the Kuroshio and Oyashio currents. The region is influenced by river discharge, offshore water transport, and recirculated submarine groundwater discharge (rSGD) from coastal sediments, representing a system with multiple nutrient sources. Previous studies based on stable isotope analyses have revealed that the volume of rSGD is comparable to that of river discharge, with fluxes of ammonium (NH_4^+) and phosphate (PO_4^{3-}) of similar magnitude. These findings underline the key role of the sediment–water interface in nutrient cycling, challenging the traditional view of river dominance and highlighting the significance of benthic nutrient inputs in regulating coastal nutrient levels.

To quantitatively assess these processes, we would extend a conventional marine ecosystem model by incorporating a benthic nutrient flux module, and couple it with a regional hydrodynamic model. The model will be used to simulate and evaluate the mechanisms of benthic nutrient release and recirculation in the Tonegawa estuary, thereby improving our quantitative understanding of material cycling in this dynamic coastal system.

POC-P, Poster, AbstractID=18656, PosterID: POC-P14, (ECOP)

ENSO-driven variabilities in the surface cross-frontal flow and poleward heat advection in the ACC Pacific sector

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Surface flows, driven by atmospheric circulation, play a key role in horizontal heat and mass transport, making them crucial to the climate system. Particularly, understanding of cross-frontal flows is important as oceanic fronts typically act as barriers, yet they can transport physical and biogeochemical properties across the fronts. This presentation investigates cross-frontal flows in the Pacific sector of the Antarctic Circumpolar Current (ACC) using observations from 30 undrogued surface drifting buoys deployed as part of the pop-up data shuttle (PDS) system. These buoys transmitted GPS location data via the Iridium satellite constellation while drifting during two periods: November 2022–January 2023 and January–March 2024. Comparisons between observed surface flows, derived from PDS buoy trajectories, and wave models reveal that cross-frontal flows are dominantly driven by Stokes drift. PDS buoy trajectories also show a distinct year-to-year change of cross-frontal flow – downgradient drifts of all buoys during the second release, but not in the first release. Further analysis using approximately 31-year-long datasets reveals that the observed year-to-year change is linked to interannual variability in cross-frontal Stokes drift, driven by ENSO-driven teleconnection. During the El Niño phases, a significant northerly wind anomaly, caused by the change in the Rossby wave train connecting the extra-tropics to tropics, induces the downgradient Stokes drift. Also, the simultaneous downgradient Stokes transport during the El Niño phase induces poleward heat advection, which can contribute to surface warming along with atmospheric heat supplies. Our results provide a better understanding of the impacts of tropical teleconnection on the cross-frontal flows and relevant poleward heat advection in the extra-tropics.

POC-P, Poster, AbstractID=18693, PosterID: POC-P15

Tidal and residual currents in the inner shelf of East China Sea detected from underway ADCP observations

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Characterizing the spatial variability of net flow transport in a tide-dominated area like the East China Sea (ECS) is key to understanding the material and heat budget as well as their impacts on local ecosystem. However, the residual circulation in the ECS was much less confirmed by observations as it can only be derived from very sparse mooring data. Here for the first time we obtain the spatial patterns of tidal and residual currents in the inner ECS shelf from ADCP underway measurements conducted in 12 cruises using a spatial least squares (SLS) fitting technique. The SLS method is validated with the traditional harmonic analysis using numerical simulation results and then implemented with the observational data. The tidal current is dominated by two semidiurnal components M2 and S2 in this area, with the major axis of tidal ellipse along northwest-southeast direction. The ADCP-derived tide parameters are in good agreement with those from the mooring data and barotropic tide model. The annual spatial pattern of residual circulation is characterized by a southward coastal current and a northward shelf current, which are identified as the East China Sea Coastal Current (ECSCC) from Changjiang River runoff and the Taiwan Warm Current (TWC) originated from Taiwan Strait and Kuroshio. Their magnitudes are comparable but of one order smaller than tides. The vertical structure of TWC shows a subsurface-intensified feature in line with previous mooring observations. The north limit of TWC is approximately at 31.5◦N around the submerged valley, beyond which the northward TWC becomes almost invisible. By a series of virtual cruise experiments, we show that the observation data length is the most crucial factor controlling the SLS fitting accuracy, while the role of other factors like sampling frequency is secondary. With a fixed-length dataset, the degree of polynomial function used for SLS fitting must be properly determined to minimize the under-fitting and over-fitting error, and there is also a trade-off in the fitting accuracy between tidal and residual currents depending on the fitting strategy.

POC-P, Poster, AbstractID=18762, PosterID: POC-P16

Evaluation of mixed layer depth in Korean Waters based on reanalysis data focused on Spatial and interannual variability

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The MLD plays a crucial role in regulating climate by controlling the exchange of momentum, heat, and moisture between the ocean and atmosphere. Therefore, improving MLD simulations is essential for reliable climate predictions and projections. However, studies on the interannual variability of MLD using global reanalysis data remain limited. In this study, we analyzed the interannual variability of winter MLD in Korean waters over a 25-year period (1994–2018) using two widely used reanalysis datasets, the HYCOM and GLORYS, which are frequently employed in climate change studies in Korean waters. The reanalysis MLD data were compared with observational estimates from the KODC and NSO for February, the month with the deepest MLD. While the spatial distribution of MLD is generally well simulated, the long-term trend is poorly reproduced. Notably, the models underestimate the long-term mean MLD by approximately 25% in regions influenced by the Ulleung Eddy and the Yellow Sea Warm Current. EOF analysis reveals that the interannual variability of MLD is primarily influenced by variations in 10 m wind and 2 m air temperature (~18%), followed by Tsushima Warm Current (TWC) transport (~11%). These findings highlight the importance of oceanic processes in the interannual variability of winter MLD in Korean waters.

WORKSHOP 1: FIS/HD/POC/MONITOR/TCODE/TCODE Workshop

Climate-Ready Fisheries Management: Reviewing Effective Strategies for Developing Decision Support Tools

Oral Presentations

W01, Pre-RecordedInvited, AbstractID=18780

Tools, frameworks, sharing information = How Australian fisheries are tackling climate change

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Australian fisheries are already feeling the sting of climate influenced ecosystems. In response a multi-pronged approach has been taken. This involves model-based projections, adaptation planning guides and additional climate robustness checks during tactical decision making. Most of all though it has involved information sharing – both in broad terms around what is happening, what is coming and available options (autonomous and strategic), but also in terms of direct briefings by scientists to fisheries, managers and marine users during extreme events (such as marine heat waves). This presentation will provide an overview of how Australia's trying to help its fisheries cope with climate change.

W01, Oral, AbstractID=18287

Fishermen as ecosystem sentinels

Heather **Welch**[1], Allison Cluett[1], Caren Braby[2], Elliott Hazen[3], Joshua Cullen[1], Jordan Watson[4], Matt Callahan[2], Michael Jacox[3], Nima Farchadi[5], Rachel Seary[1], Robert Ames[2], Robert Ryznar[2], and Steven Bograd[3]

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Marine apex predators are promising sentinels for detecting the ecological impacts of climate variability and change. Fishermen are marine apex predators with extensive satellite-based geolocation data from vessel tracking systems. Using one million vessel positions from 600 U.S. vessels, we assess the potential of fishermen as sentinels for ecological impacts in albacore and bluefin tuna during Northeast Pacific marine heatwaves. Fishermen were skillful predictors of extreme northward shifts for both tunas, and extreme inshore shifts for albacore. Fishermen also signaled low albacore availability over a year in advance of a formal fisheries disaster declaration request. This information aids management of transboundary shifts during marine heatwaves of albacore from U.S. to Canadian waters and bluefin from Mexican to U.S. waters. Advanced warning of fisheries disasters expedites the delivery of relief funds for struggling communities. The number of Earth-orbiting satellites is exponentially rising, generating a wealth of geospatial information on fishing vessels. This rich and growing resource can signal otherwise unobserved ecological impacts, aiding rapid management responses to climate extremes.

W01, Oral, AbstractID=18408

Development and application of a resilience framework to assess climate consideration in Canadian fisheries management

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Managing living natural resources in a changing climate is a complex challenge requiring consideration of all available assets. We developed an institution-based resilience framework and survey tool designed to assess how Fisheries and Oceans Canada (DFO) commercial fish stock management is situated to respond to climate change. A collaboration of cross-departmental and external researchers piloted the Fisheries Management Assessment of Climate Consideration (FiMACC) framework and survey for 30 commercial fish stocks within the DFO Maritimes Region. We gathered responses from departmental scientists and managers to explore how climate considerations are incorporated into fisheries management across resilience domains, including fisheries data and scientific analyses ("Assets"), participation and transparency in management ("Organization"), as well as the "Flexibility", "Agency", and "Learning" within DFO. Our score-based synthesis suggests there is greater resilience in some parts of the fisheries management structure (*e.g.*, Information) and lower in others (*e.g.*, Analyses and Integration, and Transparency). The FiMACC framework and survey yield an informational synthesis product and offer a repeatable approach to address relevant accomplishments, uncertainties, and action on climate risks to fisheries management under one framework. This assessment output helps identify challenges and opportunities for improving fisheries management adaptation preparedness, at the individual stock level and, more broadly, from a resilience planning perspective. The DFO Maritimes Region pilot allowed for the operationalizing of this assessment, providing valuable insights into how to refine the survey and demonstrating its potential utility for tracking adaptation over time or in other DFO regions or other jurisdictions. Overall, the FiMACC framework and survey approach demonstrates the value of institutional self-assessment in supporting resilient fisheries management.

W01, Oral, AbstractID=18547, (ECOP)

Examining the role of advocacy coalitions in Bering Sea fisheries management

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The Alaskan pollock (*Gadus chalcogrammus*) fishery represents one of the largest and most economically significant fisheries globally, contributing approximately $1.56 billion to Alaska's commercial fishing sector in 2024—nearly one-third of the total wholesale value of Alaskan seafood. The Bering Sea and Aleutian Islands pollock fishery falls under the jurisdiction of the North Pacific Fishery Management Council. The industry primarily employs pelagic and bottom trawl gear, with bycatch mitigation measures that include salmon excluder nets, adaptive fishing practices, and area closures. Although Chinook and chum salmon bycatch in the Bering Sea represents less than 3% and 1% of total western Alaska returns respectively—as estimated in all but the highest years—the scale of the fishery still resulted in over 80,000 salmon being caught as bycatch in 2024. This has significant implications for rural Alaska, where subsistence communities rely on salmon for an estimated 85% of their diet, and for Alaska Native communities for whom salmon is central to cultural and traditional practices. This study examines public engagement in Bering Sea fisheries management and considerations of food security and food sovereignty within the federal management process in the context of climate change. Focusing on management strategies related to bycatch reduction measures, the research applies the Advocacy Coalition Framework (ACF) to analyze competing belief systems and policy preferences among diverse stakeholders. The study addresses the following questions: (1) What advocacy coalitions are present within the federal management of the Bering Sea pollock fishery? (2) What deep core and policy core beliefs are articulated in public discourse? (3) How are these beliefs manifested in policy preferences and outcomes? Findings contribute to understanding how contested values and scientific uncertainty shape fisheries governance in a changing ecological and sociopolitical landscape.

W01, Oral, AbstractID=18723 (CANCELLED)

~~Revitalizing U.S. fisheries science and management for shifting ecosystems: A focus on regional adaptation and scenario planning~~

~~Lindsey **Kraatz** and Maureen **Trnka**~~

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~~NOAA Fisheries is undertaking a significant revitalization of its science and management frameworks to address the profound and differential impacts of shifting ecosystems on U.S. marine fisheries and dependent coastal communities. Our work, guided by core mandates of ensuring productivity, sustainability, and protected resource recovery, recognizes the critical role of social vulnerability and resilience in adapting to environmental and economic disruption. A cornerstone of U.S. federal fishery management is the regional council system, established by the Magnuson-Stevens Conservation Act. The North Pacific Fishery Management Council, for instance, manages fisheries within Alaska's 200-mile Exclusive Economic Zone, relying on appointees from Alaska, Washington, and Oregon. This decentralized structure, emphasizing public input and local decision-making, fosters successful and sustainable fisheries through transparent collaboration among diverse stakeholders. To enhance adaptive capacity and increase resilience to changing conditions and uncertain futures, NOAA Fisheries and the North Pacific Council are actively employing scenario planning. This structured process allows decision-makers to prepare for plausible future conditions by assessing how climate, oceans, resource conditions, and human activities may evolve. By examining underlying assumptions and exploring diverse options, scenario planning is instrumental in navigating the complexities of ecosystem shifts and building a more resilient future for U.S. marine fisheries.~~

WORKSHOP 2: BIO/MONITOR Workshop

Intercomparison of North Pacific Zooplankton Time Series

Oral Presentations

W02, Invited, AbstractID=18484

Visualizing spatiotemporal trends and variability in plankton and their environment

Todd D. **O'Brien**

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How do you compare time series that vary in length, sampling frequency, methodology, and variable types? How do you identify anomalies, trends, and patterns in these data? How do large-scale climate indices (such as the PDO, NPI, or AO) interact with these time series? The COPEPOD Project's time series toolkit (https://copepodproject.org/toolkit/) can help us explore these questions. It can even integrate corresponding satellite and model data—automatically and in just minutes.

This presentation will begin with an overview of the basin-scale (and global) plankton time series analyses, visualization, and intercomparison techniques developed over 20 years of work with multiple SCOR, ICES, PICES, and IGMETS time series working groups. We will then demonstrate the COPEPOD Project's newly expanded online time series toolkit, which includes a collection of established standard methods and visualizations, as well as brand new ones.

During the W2 *Intercomparison of the North Pacific Zooplankton Time Series* workshop, participants will have an opportunity to explore their own datasets using this toolkit. With a web browser and a few clicks, they can access the toolkit's collection of interactive plots and statistical summaries.

Join us to learn how simple exploration and visualization tools can help us understand our time series and gain broader insights into marine ecosystem patterns and variability.

W02, Oral, AbstractID=18304, (ECOP)

Zooplankton behavioral segregation and vertical positioning in a stratified summer Ulleung Basin: Diel variation in functional composition across ecological boundaries

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Understanding the diel vertical migration (DVM) strategies of zooplankton is crucial for elucidating their ecological role in stratified marine systems. This study examined vertical distribution patterns and behavioral segregation of zooplankton in the summer stratified Ulleung Basin, with particular focus on diel shifts in functional composition across hydrographic layers. Sampling at six-hour intervals and five discrete depth layers revealed clear behavioral divisions between DVM and resident taxa. Resident species were further distinguished into upper and lower layer residents, occupying consistent depths regardless of time, likely constrained by thermal-related metabolic limitations.

In contrast, DVM taxa exhibited vertical displacement patterns shaped by body size. Large-sized taxa generally displayed greater migration amplitudes, often traversing multiple hydrographic layers, whereas small-sized taxa exhibited more restricted movements. Importantly, the timing of these migrations was not synchronous; time lags between size classes led to staggered occupation of key foraging zones, particularly around the chlorophyll maximum layer (CML). These asynchronies created temporally partitioned access to resources, suggesting a size-dependent strategy for minimizing competition while optimizing predator avoidance. Functional trait analyses further revealed that dietary preferences also contributed to spatial segregation, with herbivorous taxa more concentrated near surface production layers and carnivorous forms distributed deeper, reinforcing the influence of trophic role on vertical positioning. Overall, the results demonstrate that vertical segregation in zooplankton arises not only from physical constraints but also from coordinated behavioral and trophic strategies, shaped by trade offs between foraging and predation across both space and time.

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W02, Oral, AbstractID=18456

Copepod responses to ocean warming in the transition region of the North Pacific: Insights from two decades of community temperature and body size changes

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Rocean warming and increasing marine heatwaves have raised concerns about impacts on pelagic ecosystems. This study examines how copepod communities—dominant zooplankton in marine systems—have responded to ocean warming in the North Pacific Transition Region from 2004 to 2023. We used two indicators: the Community Temperature Index (CTI), which reflects the thermal affinity of species, and the Community Size Index (CSI), which represents changes in body size structure. We identified two contrasting regions: the "Warming region" west of 163°E, which showed a steady increase in sea surface temperature (SST), and the "PDO region" east of 163°E, where SST variability aligned with the Pacific Decadal Oscillation (PDO). Both CTI and CSI showed strong correlations with regional SST, indicating that copepod composition and size structure are sensitive to temperature changes. In the Warming region, we observed stronger signs of "tropicalization" (an increase in warm-water species) and "shrinking" (a rise in small-bodied species) than in the PDO region. Specifically, small subtropical copepods such as *Clausocalanus*, *Oncaea*, and *Oithona* increased, while large subarctic species like *Neocalanus*, *Calanus*, and *Eucalanus* declined. This shift suggests that persistent warming exerts a stronger influence on copepod community structure than decadal climate variability. Our findings highlight a long-term reorganization of copepod communities under sustained warming, with potential cascading effects on higher trophic levels and broader ecosystem functioning in the transition region.

W02, Oral, AbstractID=18544, (ECOP)

A decade of nearshore zooplankton dynamics and oceanographic variability in the Strait of Georgia

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Understanding how coastal zooplankton communities respond to marine heatwaves and long-term oceanographic variability is critical for tracking ecosystem change in the North Pacific. Here we will present initial findings from a high temporal resolution 10-year (2015–2025) coastal zooplankton time series collected in the Strait of Georgia (British Columbia) by Pacific Salmon Foundation's Citizen science oceanography program. The time series includes samples collected during the 2015 North Pacific marine heatwave and subsequent oceanographic anomalies and captures high-resolution seasonal and interannual data on nearshore zooplankton abundance, biomass, and size structure across an on-to-offshore depth gradient. To address the significant bottleneck in zooplankton sample processing, this project used semi-automated imaging for rapid classification and quantification of zooplankton from preserved samples. This approach dramatically reduces processing time while expanding the spatial and temporal resolution of ecological analyses. We will also present results from a comparative analysis between traditional microscopy and image-based classification methods, assessing any discrepancies in biovolume estimates and taxonomic classification. Preliminary analysis of the dataset revealed distinct nearshore dynamics at the shallowest site, where an elevated ratio of meroplankton (part of life-cycle as plankton) to holoplankton (entire life-cycle as plankton) and frequent meroplankton pulses suggest strong benthic-pelagic coupling and episodic larval recruitment. In contrast, deeper stations exhibit higher overall zooplankton biomass, dominated by holoplankton during late spring and summer. Next steps are to test whether there are interannual shifts in community structure and size distribution in response to changes in oceanographic drivers, which could lead to greater sensitivity in nearshore zones.

W02, Oral, AbstractID=18564

The change in the mesozooplankton community structure after the mid-2010s in the Oyashio and transition waters, western North Pacific

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The northern limit of the Kuroshio axis has shifted northward since 2018 in the western North Pacific. This change may have affected the plankton community structure in the region. We investigated variations in the mesozooplankton community using data collected from A-line monitoring conducted by our agency. Community structure was classified by cluster analysis, and we examined the occurrence of warm-water assemblages. The proportion of warm-water groups showed an increasing trend during the study period, particularly in July after 2015, except in October. During the same period, the coverage of Oyashio waters decreased while that of the transition waters increased along the A-line transect. This shift in water mass distribution is likely a contributing factor to the observed changes in community structure. We then analyzed biomass trends in three major cold-water *Neocalanus* copepod species. *N. flemingeri* and *N. cristatus* showed a decreasing biomass trend in May along the entire transect. However, when data were limited to the Oyashio water mass, no significant decline was observed. This suggests that the overall decrease in biomass was primarily due to the reduced coverage of Oyashio waters, rather than species-specific changes. In the case of *N. plumchrus*, biomass in July showed a decreasing trend along the transect. While a temporary increase in biomass was observed around 2015 in May, a marked decline occurred after 2020. A similar trend was also evident in the Oyashio region, indicating that this species, which ascends to surface layers during warmer seasons, may be more sensitive to rising temperatures. These changes likely led to earlier phenological timing and reduced productivity.

W02, Oral, AbstractID=18724

Indicators of ocean variability from the Newport Hydrographic Line: High frequency multi-decadal time series of hydrographic and zooplankton observations off Newport, Oregon, USA

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Scientists working on the Newport Hydrographic Line (NHL) off Newport, OR, USA have been monitoring ocean conditions and plankton communities in the Northern California Current twice monthly to monthly, year-round, for 29 years. These data have been key to understanding the connectivity between changes in ocean-climate and ecosystem structure and function. Sampling along the NHL occurs at 7 stations from 2 - 46 kilometers from shore. Routine measurements include 1) vertical profiles of temperature, salinity, oxygen and fluorescence 2) surface water samples are collected for nutrient, chlorophyll, and phytoplankton species composition, and 3) zooplankton are sampled with a ½ m diameter plankton net (200 μm mesh) and 60 cm Bongo nets (333 μm mesh) at night. This long time series spans several "natural experiments" structured by environmental and climate variability, which has allowed the detection of climate-ecosystem correlations at seasonal, and inter-annual to decadal time scales. Zooplankton taxa are used annually as indicators in the Pacific Fisheries Management Council's Ecosystem Status Report. Initial conversations on collaborative efforts within the California Current have taken place and we have a strong interest in collaborating on the identification of common indicators useful at broader scales and exploring standardized data sets.

W02, Pre-Recorded-Oral, AbstractID=18728 (CANCELLED)

NE Pacific zooplankton monitoring programs: From the Bering Sea to the Salish Sea

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Several monitoring programs sample zooplankton in the eastern North Pacific from California to the Arctic. Among these are several conducted in Alaskan marine ecosystems by NOAA's Ecosystems & Fisheries-Oceanography Coordinated Investigations (EcoFOCI) program. This program has been sampling in the Northern Gulf of Alaska since 1994 and in the Bering Sea since 2005, but sampling is at most 2x/year and, in some regions, only biannual surveys are conducted. In the Salish Sea, the Puget Sound Zooplankton Monitoring Program (PSZMP) began in 2014. This relatively new (11-year) program is highly spatially and temporally resolved, sampling bi-weekly at several locations throughout the southern Salish Sea. Both programs were established to provide plankton data in support of fisheries science and management. Although the data are collected at different temporal and spatial resolutions, the protocols and data produced are similar enough to permit cross-comparisons. We will bring data from these time series to the workshop to explore alongside others from across the Pacific for commonalities and differences in response to environmental perturbations, e.g., ENSO and heatwaves.

W02, Oral, AbstractID=18744

Long-term DFO monitoring of zooplankton in the Gulf of Alaska and coastal British Columbia, Canada

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Fisheries and Oceans Canada (DFO) maintains multiple plankton time series within and adjoining Canada's Pacific EEZ. Here we provide an overview of our monitoring programs with a focus on two long-term plankton time series in the Canadian waters of the Salish Sea; and along the shelf-offshore transect, Line P. In addition to standard physical and chemical oceanographic measurements, both programs use similar methods for sampling zooplankton. We rely on detailed taxonomic resolution of samples for analyses of seasonal and interannual variability of both community composition and biomass. Plankton sampling by DFO in the Salish Sea started in 1996 with varying temporal effort in Haro, Juan de Fuca, and Georgia straits. Sampling since 2015 has been more routine and on a biweekly to monthly basis. Zooplankton sampling at Line P's offshore terminus, Ocean Station Papa, started in 1956. However, routine seasonal sampling at seven of the stations along the ~1400 km coastal-offshore transect began in 1997. Here we focus on interannual variability of biomass-based indicators climate-ocean variability and lower-trophic level productivity.

WORKSHOP 2: BIO/MONITOR Workshop

Intercomparison of North Pacific Zooplankton Time Series

Poster Presentations

W02, Poster, AbstractID=18293, PosterID: W02-P1

Change of mesozooplankton abundance at the shelf edge of the East China Sea during the summer from 2006 to 2024

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The shelf edge of the East China Sea is one of the regions with high biological activity, supported by the intrusion of Kuroshio bottom water, a less saline watermass originating in the Changjiang River, and bottom mixing. Accordingly, various fish utilize the shelf edge as their habitat, particularly as nursery ground. To monitor the dietary condition of fish around the shelf edge, we investigated the mesozooplankton abundance by vertical hauls of a NORPAC net associated with hydrographic conditions from 2006 to 2024 at the longitudinal transects along 31º45'N (126º45'E–129º40'E) and 30º30'N (124º15'E-126ºE) wherein we call the CK line and stations sCK, respectively. From the monitoring, we identified interannual hydrographic changes in which surface salinity gradually decreased, whereas surface temperature and chlorophyll *a* were elevated, particularly in the eastern part (>126º30'E) during summer. In contrast, such hydrographic changes were not obvious at a depth of 50 m, except for the temperature at the shelf edge. These features indicate an increase in freshwater input, which drives intense stratification and subsequent warming of the surface water as well as the uplift of phytoplankton abundance near the surface. The abundance of major zooplankton taxa, including Oithonidae, Paracalanidae, Oncaeidae, Ectinosomatidae, and Oikopleuridae, was associated with changes in surface temperature, salinity, and chlorophyll *a*, based on principal component analysis and generalized linear models, hypothesizing that gradual changes in the surface environment drive summertime mesozooplankton assemblages around the shelf edge of the East China Sea.

W02, Poster, AbstractID=18332, PosterID: W02-P2, (ECOP)

Seasonal and interannual variations (2019–2023) in the zooplankton community and size composition in Funka Bay, southwestern Hokkaido

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Funka Bay, located in southwest Hokkaido, is a vital fishing area with a shallow depth of less than 100 m. Seasonal flows of the Oyashio and Tsugaru Warm Currents affect the marine environment, leading to significant changes in zooplankton communities; however, limited information is available on these variations. This study employed ZooScan imaging to examine seasonal and interannual variations in zooplankton abundance, biovolume, community structure, and size composition from 2019 to 2023. Water temperature was low in March to April, and high in September to November, with chlorophyll *a* peaks occurring from February to April. Notable taxa such as Thaliacea, *Noctiluca*, and cladocerans were more common in the latter half of the year. Interannual variations included a decline in large cold-water copepods, *Eucalanus bungii* and *Neocalanus* spp., which were abundant in 2019 but decreased by 2023. Zooplankton abundance and biovolume showed synchronized seasonal changes, correlating with shifts in the NBSS index, which measures size composition. Cluster analysis identified eight zooplankton communities, with Community A dominant from July to December across all years, while Community D was prevalent in early 2019 but was replaced in subsequent years. Community E emerged from March to April in 2021–2023. In 2019, large cold-water copepods were dominant, but from 2021–2023, appendicularians became the dominant group during the March-April period. The decline in large copepods is likely linked to marine heatwaves, influencing yearly changes in the zooplankton community.

W02, Poster, AbstractID=18565, PosterID: W02-P3

Collection and management of zooplankton samples at the Japan Fisheries Research and Education Agency

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Zooplankton play a key role in marine ecosystems, not only by linking primary production by phytoplankton to higher trophic levels such as fish, but also as a crucial component of the biological pump, which transports carbon dioxide from surface waters to the mesopelagic zone through vertical migration and fecal pellet sinking. As zooplankton communities respond sensitively to environmental changes, their ecological functions are expected to shift significantly under climate change. Therefore, clarifying the relationship between zooplankton variability and environmental conditions is essential for understanding changes in marine ecosystems. Since 1949, the Japan Fisheries Research and Education Agency (FRA) has been collecting and archiving zooplankton samples, primarily in the western North Pacific, to study marine environments and zooplankton communities. To date, approximately 390,000 samples have been collected. These samples have been gathered by a wide range of institutions, including prefectural fisheries research institutes, universities, the Japan Meteorological Agency, and international research organizations. The archive includes the Odate Collection and samples collected during CSK, a UNESCO-sponsored international cooperative survey. This presentation will provide an overview of the zooplankton samples archived by FRA, and discuss their current utilization as well as future challenges related to sample management and use.

WORKSHOP 3: HD/MEQ/FUTURE Workshop

Present and Future Pressures and Human Activities in the Arctic Ocean and Pacific Gateways

Oral Presentations

W03, Invited, AbstractID=18555

Northern Sea Route and its pressure in the Pacific Arctic

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Since 2010s, maritime activity in the Arctic Ocean has been increasing, such as natural resource exploitation along the Russian Arctic coast and maritime shipping along the Northern Sea Route(NSR). This talk will provide an overview of the pressures on the Pacific Arctic marine ecosystem due to increasing ship traffic along the NSR. In general, threats to the marine ecosystem from ship traffic are caused by the release of pollutants, generation of noise in the air and underwater, generation of wave, disturbance of ice-covered water areas, strike of marine mammals, and so on. In 2017, against the ship strike of marine mammals, the U.S. Coast Guard and the IMO adopted voluntary routing measures, including Areas to be Avoided in the Bering Strait and Bering Sea. The PAME working group of the Arctic Council assessed the potential impacts of the Arctic ship activity on the Arctic marine environment and humans in AMSA(Arctic Marine Shipping Assessment) Report 2009 and some follow up reports. WGICA of ICES/PICES/PAME provided an integrated ecosystem assessment for the Central Arctic Ocean, including the sensitivity and vulnerability of the ecosystem to human activities. PAME has been assessing under water noise in the Arctic Ocean, which is one of the characteristic effects of ship traffic to marine mammals in the Arctic Ocean.

W03, Invited, AbstractID=18779

The Central Arctic Ocean ecosystem: Current pressures, vulnerabilities, and knowledge gaps

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Since 2015, the Central Arctic Ocean (CAO) ecoregion is studied by the circumpolar ICES/PICES/PAME Working Group on Integrated Ecosystem Assessment for the Central Arctic Ocean (WGICA). It is an ecoregion that mainly covers High Seas areas, and consists of deep ocean basins, slopes and underwater mountains. It is remote and inaccessible, and therefore largely unexploited and understudied.

The past five years the working group has conducted a first integrated ecosystem assessment based on the available data and knowledge. The Arctic region is being highly affected by climate change with sea-ice cover and volume decreasing rapidly. Furthermore, the CAO is influenced by human activities taking place within the ecoregion and beyond, with potential pressures of these activities on the Arctic ecosystems.

In this presentation, the applied methodology and main results will be shown, and the major knowledge gaps identified as a basis for future joined activities.

W03, Oral, AbstractID=18292, (ECOP)

Japanese and Russian actors in the North Pacific fisheries regulation after 2022 : Interplay with the Arctic

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Fisheries and broader environmental governance are increasingly shaped by the involvement of substate actors (SNGs) and non-state actors (NSAs), including NGOs, Indigenous groups, experts, and private companies. These actors provide cognitive leadership (e.g., experts and NGOs supplying knowledge) and relational leadership (e.g., facilitating collaboration and conflict resolution). In the Arctic and adjacent regions, multi-actor governance has become especially important due to fragile ecosystems and the reliance of local—particularly Indigenous—communities on marine resources. This trend is reflected in their participation in various arrangements, such as the bilateral fisheries agreements between Norway and Russia, the 2012 North Pacific Fisheries Convention, the 2018 Central Arctic Ocean Fisheries Agreement, and the 2020 Alaska–Chukotka Polar Bear Agreement, as well as institutions like PICES and the North Pacific Fisheries Commission.

Rising geopolitical tensions since 2022 have heightened security concerns, disrupted post–Cold War cooperation, and constrained the activities of SNGs and NSAs. Yet fisheries cooperation between Russia and Norway in the Barents Sea, and between Russia and Japan in the Sea of Okhotsk, has persisted, sustained by continued dialogue and practical management involving scientists, experts, and fisheries associations. This study examines the lessons that Russia–Norway and broader Arctic cooperation on marine resource governance offer for the North Pacific—and vice versa—and analyzes how SNGs and NSAs continue to exercise cognitive and relational leadership under post-2022 geopolitical pressures. The analysis includes a comparison of Russia–Norway and Russia–Japan fisheries negotiations based on official records from Russia's Federal Agency for Fisheries.

W03, Oral, AbstractID=18385

Towards the second expedition of the Synoptic Arctic Survey (SAS)

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The first Synoptic Arctic Survey (SAS I), a coordinated multi-ship and multi-nation pan-Arctic program, was conducted during late summer and fall from 2020 to 2022, involving more than 25 cruises from 11 different nations. To understand ongoing oceanographic trends, a second ship-based sampling campaign (SAS II) is planned for around 2030. To ensure the success of the SAS II, it is essential to establish the Science and Implementation Plan. In this talk, we present key science findings from the SAS I that could form the foundation of the SAS II Science and Implementation Plan. During the SAS I period, the Transpolar Drift off Siberia shifted eastward, and the Beaufort Gyre shrunk toward the Alaska. As a result, subsurface nutrient concentrations and phytoplankton biomass increased in a frontal region between the Beaufort Gyre and Transpolar Drift. Given the rapid changing Arctic environment, what impacts will these shifts have on ocean circulation and nutrient distribution in coming decade? Changes in the marine environment and ecosystem in the Arctic shelves and gateways will significantly impact the Central Arctic Ocean through ocean circulation. Therefore, it is crucial to monitor the areas of the Beaufort Gyre off Alaska and the Transpolar Drift off Siberia, as their locations may shift on a decadal scale. These major currents transport waters toward to the Central Arctic Ocean along the Chukchi Plateau (for the Beaufort Gyre) and Lomonosov Ridge or Mendeleev Ridge (for the Transpolar Drift). These regions have relatively shallow seafloors and are considered fishable areas, making them key locations to monitor. Monitoring with new key biogeochemical parameters like trace metals will enhance a more comprehensive understanding of the interactions between ocean circulation and ecosystems and allow for the assessment of the impacts of climate change on the carbon and nutrient cycles in the Arctic. Additionally, they could also provide critical data for the Central Arctic Ocean Fisheries Agreement (CAOFA). To observe changes over the next decade, the SAS II program will enhance its observation network in collaboration with initiatives such as Pan-Arctic Distributed Biological Observatory (DBO), Beaufort Gyre Exploration Project (BGEP), Nansen and Amundsen Basins Observational System (NABOS), Arctic and Subarctic Ocean Fluxes (ASOF), CAOFA Joint Program of Scientific Research and Monitoring (JPSRM) and others.

W03, Oral, AbstractID=18478

Ecosystem Based Management in a fast-changing Arctic

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The Arctic continues to warm and becomes more accessible with activities expanding into new, and often vulnerable areas. It has therefore never been more important to assess the ecosystem and support a holistic ecosystem-based management to point out solution options for ecological, social and economic sustainability across and beyond National jurisdictions.

Strengthening cooperation on Ecosystem Based Management across the marine Arctic is among the main priorities for the Norwegian Chair ship of the Arctic Council 2023-2025 and facilitating the implementation in the 18 Arctic Large Marine Ecosystems is the main goal across working groups, Indigenous knowledge and Observers in the Arctic Council.

In 2024, the Norwegian Chair ship of the Arctic Council and the Institute of Marine Research hosted a International Conference on the Ecosystem Approach to Management in the Arctic Large Marine Ecosystems in Tromsø, Norway.

The conference spanned across three main components of the EA framework – "Governance/Policy" and "Knowledge/Science" and the "communication links" which includes the goals, advice and value, making the link between "Governance/Policy" and "Knowledge/Science" operative and brought together 246 science, industry, policy and management experts from the Arctic Council states and from Europe and Asia (total 27 countries) as well as three of the six Permanent Participants, including the Saami Council, the Aleut International Association, and the Inuit Circumpolar Council, academics, non-profit organizations, and students to explore implementation of the ecosystem approach in the arctic.

The suggestions and solutions from this conference on how to proceed in develop and implement the EBM in the Arctic Large Marine Ecosystems are presented in this talk.

W03, Oral, AbstractID=18507

Future distribution shifts of fisheries resources in subarctic and Arctic seas

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Climate change is expected to have pervasive effects on marine ecosystems, with cascading impacts on many ocean-dependent sectors. These effects could be exacerbated by future socioeconomic and political factors. Hence, robust projections to represent the range of potential bioeconomic risks and opportunities emerging from climate-driven impacts on fisheries are warranted. We project the future changes in abundance of eight commercially important fisheries in the eastern Bering Sea and Chukchi Sea under different CMIP6 Shared Socioeconomic Pathways (SSPs). Our results showed contrasting abundance and distribution patterns across species, periods, and climate scenarios, underpinning potential winners and losers under future climate change. Smallest changes in abundance and distribution were observed under SSP126. Under SSP585, however, Pacific cod and snow crab abundances showed increases and decreases, respectively. Future projected changes in abundance suggest that fishing at the same distance from the major port in the Bering Sea could yield declining catches for high-valued fisheries under SSP585. This is driven by strong decreases in future catches of highly valued species. These future changes in species abundance and shifting distributions could have bioeconomic repercussions on the productivity of the eastern Bering and Chukchi seas, commercial and subsistence fisheries, and effective management of transboundary resources.

W03, Oral, AbstractID=18533, (ECOP)

Multi-model assessment of future ice-algal production in the Chukchi Sea

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The Chukchi Sea is one of the Arctic regions that has high ice-algal primary production (ice-PP). This study analyzed ice-PP and related environmental variables in the Chukchi Sea, assuming the high greenhouse-gas emission scenario (SSP5-8.5) for three time periods: Phase 1 (1979–2018), Phase 2 (2021–2060), and Phase 3 (2061–2100). The simulations were conducted using a global sea ice–ocean model (UTAS) and two Arctic regional models (JAM; IOS). The JAM and UTAS models show a continuous decline in ice-PP from Phase 1 to Phase 3, which is a result of reductions in sea ice concentration (SIC) and nutrient condition. However, the IOS model simulates ice-PP enhancement until the middle of the 21st century. This is due to the stronger improvement of light condition that overwhelms the reductions in SIC and nutrient condition, despite similar SIC and light intensity to those in the UTAS model.

A series of sensitivity experiments were conducted using the JAM model to evaluate the ice-PP reaction against the changes in model formulation and parameter values related to the growth rate. Results show that all the changes do not alter the ice-PP inter-phase pattern in the JAM model. The combined changes in L formulation and parameter value have the largest impact on the ice-PP inter-phase pattern.

These results indicate that shrinking sea ice and decreasing nutrient condition would potentially cause the future Arctic ice-PP to decline in the Chukchi Sea, but the choices of IA formulation and parameter values might cause substantial inter-model spread.

W03, Oral, AbstractID=18651

Response of the Arctic Marine Ecosystems to multiple stressors

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While recent changes in the Arctic marine environment, as represented by the drastic decrease of sea ice, may increase socio-economic opportunities, they may also cause a degradation of the present marine ecosystems and their ecological services directly or indirectly. Therefore, assessment of the potential impacts from these on marine ecosystem is desired in both socio-economic development and conservation contexts for the Arctic ocean. Assuming that larger environmental change and anthropogenic activities increase the potential impacts on the marine ecosystems, we attempted to identify potentially-vulnerable Large Marine Ecosystem (LMEs) in the Arctic. Using Planetary Boundaries and shipping activities as the natural and anthropogenic forcings, respectively, we evaluated the sensitivity and resilience of the LMEs based on statistical analysis. Our results shows that the Arctic gateways may be more vulnerable than the other Arctic LMEs. While the Pacific gateway may be affected by natural forcings so far, the Atlantic gateway may have been facing an increased anthropogenic pressures already. The present analysis is expected to contribute to marine ecosystem management in the Arctic ocean.

W03, Oral, AbstractID=18772

Utilization of nutrients transported from the Bering Sea to the Chukchi Sea

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Spatial variations of nutrients along the northwestward stream from Bering Strait are considered for dissolved inorganic phosphorus (DIP) on the data of two surveys conducted in early September of 2010 and 2020. The waters of Bering Sea origin have higher DIP than the waters of Chukchi Sea, but in the upper layer gradually loose phosphorus because of both mixing with local waters and consumption for photosynthesis. In the subsurface layer, the DIP decreasing is prevented by its recycling from destructed organics. The fluxes of phosphorus are estimated separately using the balance model with TS-analysis, previously used in estuarine studies. Successive utilization of DIP along the stream is traced, that forms in the Chukchi Sea two zones of high productivity divided by wide low-productive zone. The nutrients from the upper layer are utilized within the southwestern Chukchi Sea providing primary production 0.1-0.2 gC/m^3day, but the main stock of allochtonous nutrients from the subsurface layer is utilized further downstream (at Wrangel Is. or in the northern Chukchi Sea) and provides the production of 0.3-0.4 gC/m^3day. Localization of the high-productive zones is determined by density stratification that possibly depends on the stream strength: the stronger advection through Bering Strait – the further from the strait both zones are located. Recent tendency of the stream strengthening tends to remove the zones of nutrients utilization out the southwestern Chukchi Sea and promotes partial transfer of the nutrients of Pacific origin to the Central Arctic.

WORKSHOP 3: HD/MEQ/FUTURE Workshop

Present and Future Pressures and Human Activities in the Arctic Ocean and Pacific Gateways

Poster Presentations

W03, Poster, AbstractID=18354, PosterID: W03-P1

Decadal changes in ocean circulation and shelf-derived material transport to the Northwind Abyssal Plain in the western Arctic Ocean (2010-2023)

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The reduction of Arctic sea ice alters ocean circulation dynamics and chemical conditions, affecting lower-trophic marine ecosystems and material transport. Decade-long sediment trap observations in the southern Northwind Abyssal Plain (NAP, 74.5 N 161.9W) and north of Barrow Canyon (NBC, 72.5 N 155.4 W), located in the southwestern Beaufort Sea of the Arctic Ocean, revealed that particle flux peaked in summer and during oceanic events like passing eddies. Low silicon concentration in the supernatants of trap samples indicated minimal artificial loss of biogenic matter compared to similar experiments in the Atlantic Arctic Ocean. The collected particles were primarily lithogenic, with some biogenic components, suggesting advection from the shelf to the Canada Basin. An interannual comparison at about 200 m depth at NAP showed that total mass and particulate organic carbon (POC) fluxes significantly increased from the early (2010-2014) to late 2010s (2018-2021), from 31.9 to 101.8 mg m^{-2} day^{-1} and from 2.0 to 5.2 mg m^{-2} day^{-1}, respectively. Settling fluxes at NBC also increased from 2015 to 2023, with abundant lithogenic material. During the late 2010s, increases in the biogenic silicon to POC molar ratio and $\delta^{13}C$ values in POC, approaching the range observed in Chukchi Sea sediments, were detected at NAP, indicating enhanced shelf-derived material supply.

Additional analyses indicated a southeastward shift of the Beaufort Gyre and intensification of the westward shelf-slope current since 2017. The intensified northward current observed at NAP was likely associated with this geographical shift of the Beaufort Gyre. If conditions similar to those of the late 2010s recur and persist, continued hydrographic changes may further impact marine ecosystems and biogeochemical conditions around NAP.

W03, Poster, AbstractID=18509, PosterID: W03-P2

First year-round mixed layer time-series observation in the Barrow Canyon, Arctic Ocean and evaluation of the canyon transport

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Barrow Canyon, in the northeast Chukchi Sea, is a major conduit through which the Pacific-origin water enters the Arctic basin. The Pacific water influences the Arctic basin in a number of important ways. In the winter months, cold Pacific water ventilates the interior cold halocline layer (50–200m), which intercepts upward heat transfer from the warm Atlantic waters. In summer, warm Pacific water is a predominant source of heat and freshwater. The warm Pacific water, which typically resides just below the surface mixed layer in the Canada Basin, likely acts as a subsurface heat source to the sea ice in the Arctic. Year-round oceanographic moorings were deployed in the mouth of the Barrow canyon from September 2000 to September 2025, with an interruption from September 2008 to September 2010. Long-term mooring data showed that annual mean heat transport through the canyon had a decadal increase trend mainly due to the warming of Pacific Summer Water. Heat transport in the canyon heat transport shows a 1.5-fold increase between early 2000s and late 2010s and this change was sufficiently large to explain the increase in the heat content of subsurface layer in the Canada Basin over the same interval. Mooring systems are the only way to conduct year-round time-series observations in the Arctic Ocean where which is fully covered by sea ice in winter. However, observation is typically limited to 30-50 m below the sea surface in order to avoid the damage by the thick sea ice. It was difficult to examine whole water column of Pacific Summer Water, which mainly exits in the surface and subsurface layers by the traditional mooring observation. Since 2021 Barrow Canyon moorings were updated to obtain year-round mixed layer data. High-resolution hydrographic data obtained using a conductivity–temperature–depth (CTD) sensor or eXpendable CTD (XCTD) and velocity data obtained using ship-mounted acoustic Doppler current profilers (ADCPs) along the mooring array were carried out by the R/V Mirai and the USCGC Healy on 23 times between 2002 and 2024 during summer and fall seasons. Using year-round mixed layer data and ship-based high-resolution hydrographic and velocity data, we assess the error in the transports resulting from interpolation/extrapolation of typical mooring data onto the Barrow Canyon section and update the Barrow Canyon heat transport.

W03, Poster, AbstractID=18553, PosterID: W03-P3

Demersal–pelagic relationships of aquatic animals in the East Siberian Sea based on ($\delta^{15}N$) and ($\delta^{13}C$) ratios and fish diets

Konstantin M. Gorbatenko, Vladimir I. **Radchenko**

Presented by Vladimir Kulik behalf of Vladimir Radchenko

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Stable nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) isotope ratios of zooplankton and zoobenthos were analyzed to compare the trophic characteristics of pelagic and demersal communities in the East Siberian Sea (ESS). The carbon isotope ratios of planktonic animals differed from those of benthic invertebrates; their $\delta^{13}C$ ratios varied from -23.2 to -20.8 ‰, while those ratios varied from -21.8 to -17.0 ‰ in the zoobenthos. The relative boundary separating the pelagic and benthic communities corresponded to an average $\delta^{13}C$ value of -20.5 ‰. The $\delta^{15}N$ ratios of the studied species in the pelagic and benthic communities varied from 9.5 ‰ in comb yoldia *Yoldia myalis* to 18.7 ‰ in the sea star *Urasterias lincki.* There were significant differences in the $\delta^{15}N$ ratios at three trophic levels from the filter feeders to predators. Trophic linkages in the ESS manifest a high degree of interdependence between the bottom and pelagic communities since both pelagic and demersal fish consume as benthic- as pelagic-derived food to some extent. Due to more severe ice conditions, ice algae are likely to be an even more important source of organic matter in bottom sediments in the ESS than in the Chukchi and Beaufort Seas. The greater enrichment of benthic organisms by ^{13}C could be a consequence of ice algae phytodetritus processing in the benthic food chain.

WORKSHOP 4: BIO/POC Workshop

Building Framework for Cross-Community Conversation Between Natural Carbon Cycles and Marine Carbon Dioxide Removal

Oral Presentations

W04, Invited, AbstractID=18775

From science to standards: ISO/TC8/WG15 and the international pathway for ocean-based carbon dioxide removal

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Ocean-based carbon dioxide removal (CDR) is emerging as a key strategy for climate mitigation. This talk presents ISO/TC8/WG15, the first ISO working group focused on ocean negative carbon emissions and neutrality. The group, involving experts from four continents, is developing international standards to ensure transparency and comparability of marine CDR technologies. A major milestone is ISO/NP 25283-1, which provides general guidelines for ocean CDR practices. This presentation will explore how scientific and engineering advances—from ocean carbon cycling to maritime decarbonization—are being transformed into standardized methods, supporting global environmental governance and responsible technology deployment.

W04, Invited, AbstractID=18776

Quantification of organic carbon storage and CO_2 removal by coastal macrophytes

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Coastal macrophytes such as seagrasses and macroalgae play a vital role in the coastal carbon cycle by producing and storing organic carbon, including its recalcitrant fraction, which contribute to CO_2 removal. However, quantifying these contributions remains a complex scientific challenge. As an example of efforts to quantify carbon storage processes, we show recent findings from our empirical research estimating the export of macrophyte-derived recalcitrant dissolved organic carbon. Furthermore, based on measurements of CO_2 fluxes inside and outside vegetated areas, along with net primary production of macrophytes, we discuss key processes through which macroalgal farming and natural macrophyte beds support carbon storage in ways that contribute to CO_2 removal. Additionally, we highlight ongoing interdisciplinary initiatives, including our involvement with the World Association for Waterborne Transport Infrastructure (PIANC) and the Global Ocean Decade Programme for Blue Carbon (GO-BC) network. These programs are fostering cross-sector dialogue to bridge scientific insights with policy development for blue carbon-based CO_2 removal. By sharing recent findings and the progress of these programs, we aim to contribute to a more comprehensive understanding of carbon storage mechanisms and their implications for marine carbon dioxide removal (mCDR) strategies.

W04, Invited, AbstractID=18777

Trend of CO_2 increase in the Pacific being observed by the precise measurements of inorganic carbon variables.

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To elucidate the variability of CO_2 in the ocean in space and time and understand the role of the ocean as a sink of anthropogenic CO_2, sustained precise measurements of partial pressure of CO_2 (pCO_2^{sea}) by shower-head equilibrator with NDIR or CRD CO_2 mixing ratio determination (±2 μatm), total dissolved inorganic carbon (DIC) by the stripping of CO_2 with coulometric quantification (±1 μmol kg^{-1}), and total alkalinity (TA) by titration or acid addition with spectrophotometric pH determination (±2 μmol kg^{-1}) have been made together with other physical and biogeochemical Essential Ocean Variables under the internationally-coordinated observing networks. These data have been quality-controlled and synthesized into global data products Surface Ocean CO_2 Atlas (SOCAT) for surface pCO_2 and the Global Ocean Data Analysis Project (GLODAP) for ocean interior data. These data products have been used for evaluating the net sea-air CO_2 flux and the rate of CO_2 accumulation in the ocean. For the Pacific (44ºS - 62ºN), a recent intercomparison exercise made under the REgional Carbon Cycle Assessment and Processes phase 2 (RECCAP2) of Global Carbon Project revealed that the mean sea-to-air CO_2 flux and its mean rate of change were -0.41 ±0.12 PgC yr^{-1} (-0.23 ±0.07 mol C m^{-2} yr^{-1}) and -0.09 ±0.06 PgC yr^{-1} $decade^{-1}$ (-0.05 ±0.03 mol C m^{-2} yr^{-1} $decade^{-1}$), respectively, for the years 1985 – 2018 (Ishii et al., 2025), and two estimates of the rate of DIC accumulation were 0.91 ±0.18 PgC yr^{-1} for 1994 – 2007 (Gruber et al., 2019) and 0.67 ±0.13 PgC yr^{-1} for 1995 – 2005 (Carter et al., 2019).

WORKSHOP 7: BIO Workshop

Response of Top Predators to Unusual Oceanographic, Climatic and Anthropogenic Events in the North Pacific

Oral Presentations

W07, Invited, AbstractID=18168

Unprecedented mass mortality of marine mammals and seabirds on Tuleny Island, Sakhalin, Russia, in 2023

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In late July and August 2023, unusually high mortality was observed among northern fur seals (Callorhinus ursinus, NFS), Steller sea lions (Eumetopias jubatus, SSL), common murres (Uria aalge, CM), and black-legged kittiwakes (Rissa tridactyla, BLK) on Tuleny Island (TI), East Sakhalin, Russia. Regular surveys of SSLs from June 24 to July 19 revealed no abnormal behavior or elevated mortality. Warmer-than-usual weather preceded the first signs of distress among CMs in sun-exposed rookery areas, including fever-like behavior, loss of consciousness, and death. These symptoms later appeared in birds returning from water to rocky areas, walking through hauled-out NFS males, which often sniffed them. The first distressed adult NFS male was recorded on July 15, displaying elevated body temperature, stiffness, tremors, fever, convulsions, shortness of breath, respiratory spasms, foaming at the mouth, and vertical nystagmus. A second adult NFS male was found dead on last survey day July 19. During a follow-up visit on July 29, over 300 dead NFS bulls were documented, with relatively few SSLs, NFS females, or pups affected. In subsequent days, the number of dead NFS bulls increased by dozens daily. By August 6, mass mortality extended to NFS pups, along with rising deaths among NFS females and SSL pups. Numerous dead CMs and BLKs—both adults and chicks—were found on land, in water, and in nests. A later visit to TI on September 25, no fresh carcasses were observed. However, throughout August and September, tens of dead NFS, a few SSLs, and many seabirds washed ashore along Sakhalin's southeastern coast. Survey data from 2024 estimate the 2023 unusual mortality event (UME) caused over 21,000 NFS and 800 SSL deaths. While TI has been monitored for over a century, such a die-off is unprecedented. Potential causes include avian influenza virus or harmful algal bloom biotoxins.

W07, Invited, AbstractID=18179

Assessing exposure to avian influenza in seabirds in Canada

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Since the incursion of the 2.3.3.4.b variant of avian influenza (AIV) to North America in late 2022, the virus has been detected in a wide range of wild bird and mammal species, including numerous seabirds. Through a highly collaborative, multi-partner research network across Canada a national surveillance program has focused on detecting and tracking the virus across species, and throughout the annual system with a focus on waterfowl, seabirds, shorebirds and gulls. Morbidity and mortality in most species was highest in 2023, with at least one species (Northern gannets; *Morus bassanus*) experiencing detectable population level impacts. Long term monitoring of AIV in murres across Canada show that levels of both high pathogenic and low pathogenic increased in this group in 2023, suggesting that while this group did not always present high levels of mortality, exposure across their range in Canada likely increased. Power analyses of data from over 10 years suggest that sample sizes of at least 100 individuals from each region are needed to continue to track trends. Widescale monitoring of seabird eggs for anti-AIV antibodies has revealed that sympatric nesting species can have differential exposure to avian influenza, with most species showing a peak level of antibodies in 2023, the year after the initial exposure, with wanning levels in 2024. Collectively, this work has shown that seabirds can be negatively affected by AIV, this is differs by region and species which may influence how monitoring and surveillance is prioritized.

W07, Oral, AbstractID=18631

Monitoring of life history parameters of small cetaceans: Framework to monitor population dynamics of top-predators

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Many cetacean species inhabit Kuroshio and its adjacent waters. Highly dynamic nature of these waters, such as large meandering and northern shift for recent years, could affect distribution patterns, feeding availability and inter-specific competitions for marine top-predators through the trophic-linkages For several cetacean species, it has been known that Kuroshio path patterns affect the distribution patterns and the number of animals migrating to the coastal waters. However, the direct evidences if the life-history parameters of cetaceans inhabiting there are affected by oceanographic environments have not been reported. We present here the framework to monitor the life history parameters such as age at sexual maturity and growth. This case study is about small cetaceans which are targeted by dolphin fisheries, and thus biological samples has been regularly collected by fishers. Age was estimated by examining the stained tooth sections and counting the growth layer groups. Also we examined reproductive status by recording the presence and the number of corpus luteum and albican on ovaries for female. The maturity of testicular tissue was determined by examining seminiferous tubules in an H-E stained histological section. For the study periods, any clear tendency was not detected between these life history parameters and environmental conditions. This is possibly attributed to the long lifespan of cetacean species, thereby being time-lags in reflecting oceanographic event to biological parameters. On the other hand, monitoring life history parameters is also important to assess human-caused impact, such as direct catch, fishery bycatch, and ship strikes. It will be needed to continue to monitor life history parameters for longer years for better management and conservation of small cetacean species.

WORKSHOP 8: HD/TCODE/FUTURE Workshop

Engaging with Local and Traditional Knowledge Holders to Co-Design Ocean Science in Pacific Small Island Developing States

Oral Presentations

W08, Invited, AbstractID=18400, (ECOP)

Empowering Communities for Sustainable Coastal Fisheries: The Solomon Islands' Experience with Community-Based Resource Management (CBRM)

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Solomon Islands, an archipelago of over 900 islands in the South Pacific, is home to around 700,000 people whose livelihoods and culture are deeply connected to the ocean. More than 80% of the population lives in rural coastal areas and depends on nearshore fisheries for food, income, and identity. To address growing pressures from population, market demand, and climate change, the country adopted Community-Based Resource Management (CBRM) as its primary approach to coastal fisheries governance. Guided by the National CBRM Strategy 2021–2025 and National Fisheries Policy 2019–2029, this approach empowers communities—who hold customary tenure over marine areas—to manage their own resources with support from government and partners. Today, over 200 communities across all nine provinces have established management plans and locally managed marine areas, supported by a growing CBRM network linking practitioners nationwide. The Malaita Province model, driven by trained Community Facilitators, has become a leading example of scaling local stewardship through co-designed science and traditional knowledge. Lessons from Solomon Islands now inform regional learning through networks such as The Pacific Community (SPC), and the Locally Managed Marine Area (LMMA) Network, advancing a Pacific vision for inclusive, community-led coastal fisheries governance.

W08, Invited, AbstractID=18404

Introducing community-based ecotourism in Palau: A case of problem-solving initiative through a people-centered, multi-layered approach

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In 2015, Palau was facing serious social and environmental issues caused by overtourism. To address this situation, we launched a two-pillar, environmentally conscious tourism project in collaboration with the Government of Palau. Since then, we have been implementing and promoting one of the pillars: community-based ecotourism. This form of tourism is led by local residents and utilizes elements of their daily lives, natural surroundings, culture, history, and mythology. Its aim is to preserve natural and cultural resources while also strengthening the economic foundations of the local communities who act as their guardians. This initiative has challenged the conventional notion of tourism as "mass tourism centered on foreign capital," fostering diversification in the tourism sector. It is now recognized as a sustainable tourism practice, and its outcomes are reflected in both Palau's National Tourism Strategy and regional tourism policy in the Pacific islands region. I will introduce this initiative as a case study of problem-solving through collaboration among local residents, municipal governments, the national government, and the broader Pacific region.

W08, Invited, AbstractID=18629, (ECOP)

The Reimaanlok Framework: A national conservation area plan for the Republic of the Marshall Islands

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The Reimaanlok, meaning "Looking to the Future" in Marshallese, is the National Conservation Area Plan for the Republic of the Marshall Islands (RMI). It offers a framework for community-based conservation and management planning. Developed in 2008, Reimaanlok was created after the 2006 commitment by the President of the RMI and other Micronesian leaders, who signed the Micronesia Challenge pledge to conserve 30% of nearshore marine resources and 20% of terrestrial resources by 2020.

To guide this effort, a facilitator's guide was released in 2012, outlining an eight-step process for site-based planning. In 2019, regional leaders recognized the Micronesia Challenge's benefits and expanded targets to effectively manage 50% of marine resources, including offshore areas, and 30% of terrestrial resources.

The process is implemented by the Coastal Management Advisory Council (CMAC), a collaborative body made up of representatives from government agencies, NGOs, and academic institutions committed to the conservation and management of RMI's coastal and marine resources.

Since its inception, Reimaanlok has supported the creation of numerous management plans and protected areas. To date, 19 resource management plans have been developed, protecting about 34% of nearshore marine and 19% of terrestrial resources. It is anticipated that plans will eventually be established for all atolls and islands in the RMI.

A major milestone is the declaration of the National Marine Sanctuaries at Bikar and Bokak Atolls, home to some of the most pristine coral reefs and biodiversity hotspots in the region. CMAC is updating Reimaanlok and plans to pilot the revised approach this year.

W08, Oral, AbstractID=18380, (ECOP)

Advancing Indigenous involvement in ocean monitoring through meaningful engagement and building true partnerships

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The advancement of Indigenous involvement in ocean monitoring through meaningful engagement and true partnerships are crucial for long-term monitoring and stronger data outcomes. Coastal Indigenous communities hold unique knowledge systems of the ocean, derived from generations of living in harmony with marine ecosystems. This knowledge includes traditional ecological knowledge systems (TEKS), forming the basis of localized sustainable management strategies, including for coastal fisheries. Ocean Networks Canada (ONC), an initiative of the University of Victoria, Canada, is an ocean science and technology organization, which operates and manages ocean monitoring programs located in coastal, deep-ocean, and Arctic environments. ONC strives to build meaningful, long-term partnerships with Indigenous communities, which enable the successful integration of Indigenous practices into ocean monitoring. Our approach involves bridging scientific, local, and Indigenous monitoring methods to achieve a comprehensive understanding of marine ecosystems. By combining TEK systems, we can improve decision-making in environmental and resource governance. Indigenous monitoring methods, which are often qualitative and cost-effective, complement scientific approaches by providing valuable insights that traditional science may overlook. Through active engagement and collaboration with Indigenous communities, we can develop co-management strategies tailored to their socio-ecological systems, ensuring their crucial role in understanding marine ecosystem values and risks. By treating Indigenous communities as true partners in research and governance processes, we can leverage their knowledge and expertise to create more effective monitoring frameworks that benefit both communities and the environment. This inclusive approach is vital for regions where Indigenous territorial rights and governing autonomy are increasingly recognized, leading towards a more sustainable and equitable future for ocean monitoring.

WORKSHOP 10: POC/TCODE/MONITOR Workshop

An Examination of Shelf Data collected by Moorings and Other Fixed Stations in the North Pacific Ocean

Oral Presentation

W10, Invited, AbstractID=18268

Mooring observations of subsurface marine heatwaves

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Marine heatwaves are extreme ocean temperature events that can severely impact marine ecosystems. The extent of ecological damage depends not only on the surface expression, readily observed via satellite, but also on the vertical structure of the event below the surface. However, due to the limited availability of in situ subsurface observations, the vertical structure of marine heatwaves remains poorly understood.

Subsurface extremes are particularly challenging to observe, as they require long, continuous records to capture the variability at a given location. Here, we demonstrate the use of long-term mooring data to investigate subsurface marine heatwaves and classify events based on their vertical structures and associated driving mechanisms.

We show that seasonal stratification, large-scale circulation, and local downwelling control where warming occurs in the water column along the southeast Australian shelf. We define three main classes of marine heatwaves: those that extend throughout the water column, those confined to the surface mixed layer, and those that form independently at depth, often undetectable from surface data. We further extend this classification offshore, where distinct thermocline, mixed layer, and bottom boundary layers allow additional structural types to emerge.

Finally, we review the role of different observing platforms in identifying and characterising marine heatwaves, discussing their respective strengths and limitations. As extreme events increasingly affect ecosystems and industries, sustained observations are essential for understanding shifting baselines and anomalies, improving model constraints, and developing predictive systems to better protect and manage our marine environment.

WORKSHOP 11: MEQ Workshop

Harnessing Environmental DNA (eDNA) for Early Detection and Monitoring of Marine Invasions in the Face of Climate Change

Oral Presentations

W11, Invited, AbstractID=18236

Island biogeography of marine nonindigenous species in Japanese Waters

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Surveys of marine nonindigenous species (MNIS) were conducted at 424 sites (218 harbors and 206 rocky, boulder, or embanked shores outside of the harbors) on 64 inhabited islands in Japanese waters from 2014 to 2017. Eleven species of MNIS were discovered during the surveys: the calyptraeid slipper snail, *Crepidula onyx*; three mytilid mussels, *Mytilus galloprovincialis, Perna viridis*, and *Xenostrobus securis*; five balanid barnacles, *Amphibalanus amphitrite, A. eburneus, A. improvisus, Balanus glandula*, and *Perforatus perforatus;* the portunid crab, *Carcinus aestuarii*; and the ascidiid ascidian, *Ascidiella aspersa*. One or more species of MNIS were found at 177 sites on 55 islands. In total, one or more species of MNIS were present at more than 40% of the study sites and more than 85% of islands surveyed. They occurred exclusively at the harbors (148 out of 206 harbors), while they were rarely found on the shores (29 out of 206 shores). Multiple Poisson regression analysis revealed that the latitude, the index of artificial environment, and the number of indigenous sessile invertebrate species at a site had positive relationships with the number of MNIS at a site, and the number of indigenous motile invertebrate species at a site had a negative relationship with the number of MNIS. This suggested that high latitude, a higher degree of artificial environment, and higher species abundance of indigenous sessile invertebrates had positive effects on the occurrence of MNIS, and the species abundance of indigenous motile invertebrates had a negative effect on MNIS. From above, I could suggest that conservation of natural coastal environments and preservation of motile carnivorous animals are essential to prevent invasion of MNIS or establishment of their populations on islands.

W11, Invited, AbstractID=18301

Harnessing eDNA metabarcoding for transregional biodiversity monitoring: Lessons from JSPS Core-to-Core and ANEMONE Global

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Environmental DNA (eDNA) metabarcoding has become an essential tool for transregional biodiversity observation. Through the JSPS Core-to-Core Program launched in 2020, we established an international research framework across Asia and Africa to develop standardized methodologies for eDNA monitoring in mangrove ecosystems. Building on this foundation, additional initiatives such as e-Asia, AJ-Core, and ANEMONE Global have expanded our scope toward global coastal biodiversity observation. Our multi-site surveys under the JSPS Core-to-Core project revealed spatial differences in fish assemblages across Southeast Asia and East Africa, highlighting the utility of harmonized eDNA protocols. Methodological improvements were achieved through coordinated field and laboratory workflows, with Iriomote Station (Japan) serving as a central hub. At this site, time-series eDNA monitoring over five years has begun to detect emerging ecological signals, including consistent patterns of increasing fish species and the episodic appearance of potential invasive species. The first international observation under ANEMONE Global in 2024 involved 17 research groups across 12 countries. Results from synchronized coastal surveys provided initial insights into global biodiversity patterns and set the stage for long-term temporal monitoring. A transition is underway to enable local sequencing in partner countries, empowering regional teams to generate and manage biodiversity data independently. Our network is working toward early detection of ecological anomalies and enhanced biodiversity monitoring by combining standardized eDNA techniques with broad international collaboration. This presentation offers key findings and lessons learned from ongoing efforts to harmonize and expand eDNA-based biodiversity monitoring from local to global scales. (JSPS Core to Core Seminar No. JPJSCCB20240006)

W11, Oral, AbstractID=18222

Molecular approaches to enhancing fish egg monitoring in the Pacific waters off Japan

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Accurate identification of fish eggs is fundamental for understanding spawning ecology, assessing fishery resources, and monitoring marine biodiversity. Traditional morphological identification methods are limited by the scarcity of diagnostic traits and the lack of reference data for many species. To address these challenges, we applied DNA metabarcoding using MiFish primers and Illumina MiSeq sequencing to analyze fish eggs collected from the Kuroshio region off Japan between 2019 and 2023.

A total of 3,061 eggs were collected and preserved using two ethanol fixation methods. Of these, 3,058 eggs were successfully identified to the genus or species level. The analysis revealed 56 fish species across 14 orders and 49 families, including both coastal and mesopelagic taxa. Notably, 64% of these species lacked any morphological trait information for their eggs, and only 9% could be morphologically identified at the species level.

We found that sample preservation methods affected the consistency between DNA-based and morphological identification. We preserved samples by two ethanol fixation techniques: Method 1 (sedimentation) and Method 2 (filtration using a strainer). Spatial distribution maps and Cohen's Kappa coefficients revealed that Method 2 resulted in significantly higher agreement between DNA-based and morphological identification across all species examined. This finding highlights the critical role of sample processing protocols in ensuring the reliability of molecular identification.

Overall, this study demonstrates that DNA metabarcoding, when combined with optimized sample preservation, provides a powerful approach for fish egg identification. It enables high-throughput, expert-independent assessments of fish egg abundance and distribution, with significant implications for fisheries management and the monitoring of a wide range of fish species. Moreover, this approach also has the potential to enhance traditional morphological identification method for fish eggs.

W11, Oral, AbstractID=18264

QuickConc: A highly sensitive eDNA concentration method with cationic-assisted capture

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The detection of non-indigenous species (NIS) is essential for mitigating their growing ecological and economic impacts, which have been amplified by climate change and increased global trade. As species distributions shift due to these factors, the early identification of NIS becomes increasingly important to prevent their spread and protect marine ecosystems. Environmental DNA (eDNA) analysis offers a promising, non-invasive approach for monitoring biodiversity by identifying species presence and estimating the relative abundance or biomass without disturbing their habitats. However, the effectiveness of eDNA techniques for NIS detection is heavily reliant on efficient sample concentration methods. In this study, we introduce QuickConc, a highly sensitive eDNA concentration method that utilizes benzalkonium chloride (BAC) in combination with dispersed glass fibers to enhance the sensitivity of detection. Species-specific qPCR results showed that QuickConc detected 2 to 3 times higher copy numbers than the glass fiber filter and Sterivex methods, suggesting its potential to enhance eDNA concentration efficiency and enable more stable detection of rare fish species with low populations. To overcome the challenge of processing large-volume water samples, we furthermore developed QuickConc Vacuum, which integrates vacuum filtration with the QuickConc method, enabling efficient processing of large volumes of water. We demonstrate the effectiveness of QuickConc Vacuum through evaluations conducted in both aquarium and marine environments using metabarcoding and qPCR. The results highlight its potential to improve the stability and accuracy of NIS detection, offering a valuable tool for early detection in marine monitoring efforts.

W11, Oral, AbstractID=18266

Spatiotemporal dynamics of *Karenia selliformis* during the 2021 harmful algal bloom along the Pacific coast of Hokkaido, Japan

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A large-scale harmful algal bloom occurred along the Pacific coast of eastern Hokkaido from September to November 2021. The bloom comprised several species of *Karenia*; however, the spatial and temporal distribution of each species before and after the bloom has never been reported in detail. In this study, we investigated the distribution of *Karenia* species using metabarcoding and cell counting analysis on DNA extracts and fixed samples collected during the study period. The DNA extracts and fixed samples were taken weekly and daily from July to September 2021 and from September to December 2021, respectively, at the Kushiro Field Station, FRA in Kushiro City (time-course investigation). Additionally, both the DNA extracts and fixed samples were collected at ten stations in the Pacific coastal area of Hokkaido on 1–2 November 2021, when the bloom reached its peak (distribution investigation). In the time-course investigation, *Karenia mikimotoi* was detected from July to September 2021, peaking in September. In contrast, *Karenia selliformis* was detected from September to December 2021, with a peak in September. In the distribution investigation, the dominant rate of *K. selliformis* was 69.4% based on sequences, and the total cell density of *Karenia* species was 434 cells/mL in the western region (Erimo to Otsu). However, in the eastern region (Kushiro to Nemuro), diatoms and ciliates predominated based on metabarcoding analysis, with *Karenia* species detected at only one cell per milliliter. These results demonstrate that species succession within the genus *Karenia* occurred in September. And it suggests that the bloom may have persisted for an extended period in the western region.

W11, Oral, AbstractID=18281

DNA metabarcoding and reference DNA sequence databases toward a better understanding of marine zooplankton biodiversity in the western North Pacific Ocean

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Marine zooplankton play a crucial role in connecting trophic levels and serve as indicators of marine ecosystems due to their rapid response to environmental changes. However, their high diversity, along with cryptic species and immature stages that cannot be distinguished morphologically, makes species identification challenging. Molecular methods, particularly metabarcoding analysis, offer precise identification of zooplankton by leveraging large-scale sequence data from next-generation sequencing. Despite its potential, metabarcoding data and reference sequences for the western North Pacific Ocean remain limited. Here, we obtained metabarcoding data using multiple genetic markers (e.g., COI and 18S) from >400 ethanol-preserved zooplankton samples, primarily collected from the western North Pacific Ocean. These datasets, which span various locations and seasons with diverse environmental conditions, can be leveraged to analyze community structure, diversity patterns, and the presence of target organisms, including invasive species. Since metabarcoding analysis has been integrated into marine monitoring systems, it is possible to track changes in marine ecosystems under climate change. Additionally, to enhance reference sequencing, a genome-skimming technique was developed for marine zooplankton. This method allows for the efficient acquisition of valuable sequences, such as mitochondrial genomes and nuclear 18S-28S regions, surpassing conventional DNA barcoding approaches. Currently, >600 genome skimming data have been obtained, primarily for key zooplankton species around Japan. These sequence datasets not only enhance reference data for multi-region metabarcoding but also contribute to phylogenetic studies, deepening our understanding of zooplankton diversity, ecology, and evolution.

W11, Oral, AbstractID=18341

High-throughput DNA metabarcoding for zooplankton community analysis

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Environmental DNA (eDNA) metabarcoding has gained recognition as an efficient and highly sensitive approach to accurately describing the species diversity of marine zooplankton assemblages. This study utilized net tow samples fixed in 99.5% ethyl alcohol for metabarcoding analysis, with repeated alcohol washes over three days to ensure sample integrity. Genome amplicon sequencing was conducted to determine the composition of zooplankton communities, revealing 209 species with copepods dominating the mesozooplankton community. Major species included Clausocalanus furcatus, Neocalanus gracilis, and Acartia negligens, among others. Species diversity varied across stations, with Rama 3 exhibiting the lowest diversity and species richness.

Comparative analysis of molecular and morphological data showed significant correlations between COI sequence numbers and microscopic counts for most taxonomic groups. However, challenges such as primer mismatch and the absence of certain taxa in molecular data highlight the need for taxonomically-complete COI reference databases. This study underscores the importance of standardized protocols for sample collection, DNA extraction, and sequencing, as well as the integration of automated samplers for consistent, in situ monitoring. International collaborations, such as the Scientific Committee for Oceanic Research (SCOR) MetaZooGene initiative, are crucial for developing interoperable frameworks to support global marine biodiversity monitoring and ecosystem management.

W11, Oral, AbstractID=18374

Comparative analysis of eDNA-based taxonomic assignment in micro eukaryotes from Mombetsu using different databases

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In this study, we compared taxonomic assignments obtained from four different primer sets targeting the 18S and 28S rRNA genes. For the 18S rRNA gene, curated databases such as SILVA (https://docs.qiime2.org/2024.10/data-resources/) and PR2 (https://app.pr2-database.org/pr2-database/) are currently available for metabarcoding analyses. We further evaluated the consistency of taxonomic assignments for 18S rRNA across three reference databases—NorSaSa, SILVA, and PR2—to assess the accuracy of species identification.

In Mombetsu, we have conducted weekly time-series monitoring using metabarcoding for over a decade. Analyses of 10 years of weekly samples using primers targeting the 18S, 28S, dino_28S, and zoopla_28S rRNA genes detected 5,147, 6,571, 1,936, and 2,420 OTUs, respectively. These analyses also identified 1,151 (22.4%), 1,246 (19.0%), 560 (32.7%), and 508 (21.0%) species, respectively. In total, 2,642 species were detected, spanning nine eukaryotic supergroups.

The number of species uniquely identified by each gene was 762 (66.2%) for 18S, 783 (62.8%) for 28S, 183 (32.7%) for dino_28S, and 290 (57.1%) for zoopla_28S. To assess the accuracy of species identification using 18S with the NorSaSa database, we reanalyzed the 762 species detected exclusively by 18S using representative sequences against the SILVA and PR2 databases. Of these, 267 species (35.0%) were confirmed, while the remaining 495 could not be identified. Additionally, 656 of the 762 species (57.0%) were also detected by other universal primer sets, indicating limitations in using 18S alone for reliable taxonomic identification. Possible factors contributing to this include the short and conserved nature of the 18S rRNA gene, as well as insufficient taxonomic representation in current databases. Further improvements in taxonomic resolution may be achieved through verification using both short-read sequencing platforms (e.g., Illumina MiSeq) and long-read technologies (e.g., Nanopore MinION, PacBio).

W11, Oral, AbstractID=18423

Quantitative monitoring and spatial detection of ascidians using environmental DNA

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Monitoring marine biodiversity is crucial for identifying and managing invasive species that pose potential risks to ecosystem stability. Traditional visual surveys, while valuable, are limited by time and physical resources. This study investigated the application of environmental DNA (eDNA) analysis for monitoring ascidian species through two distinct approaches. In the first approach, we examined the correlation between eDNA quantification and surface coverage of two invasive species, *Ciona robusta* and *Didemnum vexillum*, at Gunsan and Yeosu over 16 months. Using species-specific markers in quantitative PCR analysis, we found a positive correlation between eDNA copy numbers and surface coverage for *C. robusta*, though not for D. vexillum. In the second approach, we designed ascidian-specific primers (3.75% barcoding gap) for metabarcoding analysis of seawater samples collected from Mokpo, Yeosu, and Uljin during summer 2021. This metabarcoding analysis detected 19 species, including 10 species not found in visual surveys and one previously unrecorded species in South Korea (*Pyura mirabilis*). While traditional surveys identified 25 species, only 9 were detected through metabarcoding. Both approaches demonstrate that eDNA-based monitoring can effectively complement traditional visual surveys, particularly for detecting cryptic or rare species in marine ecosystems.

W11, Oral, AbstractID=18630, (ECOP)

Risk assessment of paralytic shellfish toxins from Alexandrium species in Japan based on multiple analyses: Diversity, toxin production, and seasonal occurrence revealed by environmental DNA

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The marine dinoflagellate genus *Alexandrium* comprises approximately 30 species, with about 10 known to produce paralytic shellfish toxins (PSTs). Therefore, it is essential to identify species that produce PSTs and evaluate the risk of paralytic shellfish poisoning associated with each species that differs in toxin production and seasonal occurrence. In recent years, changes in the occurrence time and distribution range of this genus, potentially linked to climate change, as well as the toxification of bivalves occurring at different times than previously observed, have begun to be reported across various regions of Japan. Consequently, assessing PST risks associated with each species is an urgent task. However, the overall aspect of this risk in Japan remains unclear. Therefore, this study aims to evaluate the risk of PSTs associated with various species in Japanese coastal waters. Seawater and bottom sediment samples were primarily collected from the western Japanese coasts between 2023 and 2024, and approximately 100 clonal isolates were successfully established. Species identification was conducted based on molecular phylogenetic analysis of the ITS region for these isolates, revealing that they belonged to six species (*A. catenella*, *A. fraterculus*, *A. leei*, *A. ostenfeldii*, *A. pacificum*, and *A. pseudogonyaulax*). The production of PSTs (toxin content and composition) of these strains was assessed using liquid chromatography-tandem mass spectrometry, which revealed the production of PSTs in three species (*A. catenella*, *A. ostenfeldii*, and *A. pacificum*). Additionally, plankton net samples were collected monthly, at a frequency of one to two times per month, over a one-year period in Hiroshima Bay, serving as a model site for an oyster farming area. Environmental DNA analysis was conducted based on the LSU rDNA D1 region for these samples. The analysis detected a total of 12 *Alexandrium* species, each exhibiting distinct seasonal occurrences. Finally, based on the results obtained, the detected species were classified into high-, low-, and no-PST risk groups based on their toxin production, and a provisional PST risk calendar was created for each species in the bay. In this presentation, we will introduce our results based on the ongoing dataset.

W11, Oral, AbstractID=18660, (ECOP)

Evaluating the effectiveness of eDNA for assessing the diversity of octocoral communities in the twilight zone, including fisheries-important species

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The twilight-zone seafloor (100–300 m) is too deep for divers yet too shallow for large submersibles, leaving it one of the least-studied marine ecosystems. Here, cold-water coral ecosystem—primarily composed of octocorals—construct structurally complex, biodiversity-rich habitats. This ecosystem is listed by the FAO as Vulnerable Marine Ecosystems and need robust, convenient monitoring. Environmental DNA (eDNA) metabarcoding could meet this need, but its use for Pacific deep-sea octocorals is limited by (1) scant reference sequences, (2) unknown eDNA persistence and spread, and (3) untested agreement with in-situ records.

To resolve these problems, we (i) expanded a nuclear 28S rRNA reference database usable in Japan by adding sequences from 266 individuals (24 families, 52 genera); (ii) quantified eDNA dynamics in both laboratory and field; and (iii) validated eDNA detections against ROV imagery. Laboratory trials with *Corallium japonicum* showed that eDNA concentration scales with colony number and remains detectable for ≥6 days. In twilight-zone seafloor, seawater collected 6–40 m above the seabed showed that detected genus richness declined with height yet changed little within the first 20 m. Using this depth guideline, bottom-water samples from 27 sites between the Ryukyus and offshore Kyushu identified 79 amplicon sequence variants; for the two genera that could be identified visually, eDNA presence/absence agreed with ROV surveys at 19 sites for *Corallium* and 22 sites for *Pleurocorallium*. Our findings indicate that eDNA has the potential to serve as a practical tool for surveying twilight-zone octocorals.

WORKSHOP 11: MEQ Workshop

Harnessing Environmental DNA (eDNA) for Early Detection and Monitoring of Marine Invasions in the Face of Climate Change

Poster Presentations

W11, Poster, AbstractID=18187, PosterID: W11-P1 , (ECOP)

Dynamics of marine bacterial biofouling communities after initial *Alteromonas genovensis* biofilm attachment to anti-fouling paint substrates

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To determine how bacterial communities succeed after the initial attachment of the bacterial biofilm adhesion using 16S rDNA meta-barcoding in plates coated with copper-based anti-fouling (AF) and non-AF (control) coatings as well as ambient seawater, coated plates were submerged in a marine environment in situ. *Alteromonas genovensis* (Gammaproteobacteria) in AF coating and *Pacificibacter* sp. (Alphaproteobacteria) in the control plate were initially abundant. In the AF coating, the abundance of *A. genovensis* decreased rapidly, whereas that of

genus *Phaeobacter* (Alphaproteobacteria), *Serratia* (Gammaproteobacteria) and *Cupriavidus* (Betaproteobacteria) increased. Bacterial community in the control plate had a strong connection to pathogenic *Vibrio* spp. associated with the growth of invertebrates. Therefore, in the *in situ* AF coating experiment, *A. genovensis* accumulation was initially and intensively increased, and the bacteria responded to chemical antagonism, induced the proliferation of specific biofilm bacteria and influenced the interactions and recruitment of additional bacterial communities.