

REPORTING FORM 2024

CLIOTOP – Climate Impacts On Top Order Predators IMBeR Regional Program

CLIOTOP SSC: Heidi Pethybridge, Anne Lorrain, Kylie Scales, Barbara Mueling, Yu Kanaji, Sebastien Villasante, Takashi Kitagawa, Lilis Sadiyah

Supported by IMBeR-IPO members: Fang Zuo, Gi Hoon Hong

1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges

(Among other uses, information will be used to update the [IMBeR Annual Report to SCOR](#))

CLIOTOP has had an active period with a number of notable events and activities taking place.

Anne Lorrain attended in-person the two-day IMBeR SSC meeting in Paris, April 2023.

Barbara Mueling, SSC member and Task Team co-lead, represented CLIOTOP and presented a poster on past and present CLIOTOP activities at the 5th International Symposium on the Effects of Climate Change on the World's Oceans (ECCWO5) in Bergen, Norway in April 2023.

In early 2023, four CLIOTOP task teams, each focusing on different aspects of marine top predator and climate research, were selected for funding to run until the end of 2024. Summaries of these task teams are included on our CLIOTOP webpage: <https://imber.info/science/regional-programmes-working-groups/cliotop/task-teams/>. All task teams have been active, with most of their outlined task activities and milestones completed or on-track for completion. Here we step through the main activities and/or achievement of the four task teams.

Task team 2023-24/1 Global trophic linkages in the mesopelagic zone, led by Anais Médiéu (IRD, France) and Anela Choy (Scripps, USA).

- A global compilation (as of Nov 2023) includes 6,687 specimens with corresponding biochemical and trophic tracer data, covering 124 families of fishes, molluscs, crustaceans, and gelatinous taxa. This corresponds to 6,025 samples with $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, 1,528 with total mercury concentrations, and 952 with both stable isotope and mercury data (Figure 1 below).
- Task Team members met (15 in-person and 17 online) during November 2023 at The Pacific Community (SPC) in Noumea, New Caledonia and at Scripps, San Diego. With the task team consisting of many members (>40) across 8 countries and multiple disciplines, several highly focused workshops meetings were held over a three-week period. This included separately meeting with data providers from the Pacific, Indian and Atlantic Ocean, biogeochemical models and acoustic specialists.
- A comprehensive 20 page workshop report has been provided to the CLIOTOP co-chairs.
- Now in final stages of data gathering with curation taking place in quarters 1 and 2 of 2024. The co-leads have worked with members to ensure high data quality and new auxiliary data are obtained. Preliminary analyses of the compiled datasets have occurred.
- Three scientific manuscripts have been outlined and are on track for submission for publication at the end of 2024 or start of 2025. These have been tentatively titled:
 - (i) Environmental Drivers of Micronekton Trophodynamics from Stable Isotopes Across Global Mesopelagic Provinces;

- (ii) Patterns and Drivers of Mercury Bioaccumulation and Cycling Across Global Mesopelagic Provinces; and
- (iii) Global Trophic Linkages Between Mesopelagic Micronekton and Pelagic Fish Top Predators.
- *Activities and milestones as outlined have been achieved. Databases and several manuscripts are on track of completion in 2024/25*

Task team 2023/2 The climate impacts of marine heatwaves on top predators in tropical oceans, led by Peng Lian (ECR, CAS, China) and Barbara Muhling (NOAA, USA)

- Several online (email and video) communications have occurred between task team co-leads and members with preliminary research results obtained and discussed.
- Two presentations have been given at academic conferences including at (i) the Third AI Oceanography Forum in China May 2024, and (ii) the 9th Youth Geoscience Forum in May 2024.
 - Lian Peng was awarded “Excellent Poster Award”
<https://imber.ecnu.edu.cn/32/d8/c35742a602840/page.htm>
- Research on the impacts of subsurface thermal signals is underway, particularly on the ecological impact of the intensity and cumulative time of marine heatwaves on tuna.
- Plans underway to hold in-person Task Team meeting whilst participating in the PICES annual meeting in Honolulu, Hawaii in October 2024, and the TEDx activity will be launched after PICES.
- A draft manuscript on Task Team outputs is planned for late 2024.
- *Activities and milestones as outlined are on track for completion in 2024*

Task team 2023-24/3 Global analysis of white shark trophic role, led by Lauren Myers and Charlie Huvneers (Flinders University, Australia).

- In November 2023, 57 attendees from 7 countries attended the CLIOTOP Task Team *Global Analyses of White Shark Trophic Role* workshop at the Conference: White Shark Global 2023.
- Attendees included honours, masters, and PhD students, early career researchers, professors, government officials, tourism operators, and NGO representatives.
- A major objective of the workshop was to identify global priorities and to bring regional diet datasets together for a global meta-analysis.
- Prior to the workshop, attendees identified seven research priorities (coastal vs. pelagic feeding, ontogenetic changes across global distribution, diet around the world, contribution of non-pinniped sources, specialist or generalist feeders, isotopes to trace movement and habitat use, and diet shift in response to human impacts), and ranked them by importance.
- Attendees compiled a register of available research outputs and datasets, including the context (e.g. age classes, regions, sex) and key findings from 43 available works. This work forms the basis for future data compilation and collaborative efforts.
- A qualitative assessment of human impacts on white shark diet is being led by L. Meyer and J. Moxley for submission in Wildlife Research WSG special issue December 2024.
- Two scientific manuscripts were outlined during the workshop and continued to be worked on by Task Team members, including:
 - (i) Global trends and recommendations on methods used to research white sharks; and
 - (ii) Global analysis to look at ontogenetic and spatial (coastal vs pelagic) diet shifts.
- *Activities and milestones achieved as outlined. Manuscript on track of completion in 2024.*

Task team 2023-24/4 Exploring new horizons, barriers and bottlenecks in marine ecological forecasting for oceanic top predators, led by Kyle Scales (University of Sunshine Coast, Australia) and Stephanie Brodie (CSIRO, Australia)

- The Task Team have held five international hybrid in-person meetings and video meetings between March 2023 and April 2024. These have been focused on assessing the current state of knowledge in the field of marine ecological forecasting for oceanic top predators and scoping a collaborative study.
- A focus group with IATTC team members was established to present a case study on bycatch in purse seine fisheries in the Eastern Tropical Pacific Ocean, to be included in a manuscript. A request to create a data sharing agreement has been submitted to IATTC, to allow for the Task Team to access confidential fisheries data to develop the case study, currently under review.
- A manuscript is in preparation, entitled, “*A roadmap for ecological forecasting for the management of living marine resources*”. This manuscript will (i) evaluate current practice regarding the development of ecological forecasts for applied management settings in the marine environment and, (ii) provide recommendations in the form of a “roadmap” for researchers and practitioners seeking to develop ecological forecasts for applied management, such as the mitigation of bycatch of oceanic top predators in tuna fisheries.
- *Activities and milestones as outlined are on track for completion in 2024/25.*

IMBER Funding Grant

In addition to task team activities, eleven CLIOTOP SSC and task team members participated in a two-day CLIOTOP synthesis paper writing workshop between 14-15th November 2023 at the Pacific Community (SPC) in New Caledonia. The workshop was largely funded through the IMBeR Funding Grant awarded to the CLIOTOP co-chairs in addition to in-kind contributions from participant institutions. A workshop report was compiled and is available through the co-chairs. A major output from this activity was the outline and draft of a scientific manuscript tentatively titled: *Advances in oceanic top predator research through international collaboration and global data sets.*

1.a. Grand Challenge I

Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:

Research Objective 1. Evaluate and predict the cumulative effect of multiple stressors

Research Objective 2. Integration of climate change and climate variability

Research Objective 3. Impacts on society – preparation for a changed future

Task team 2023/2 are contributing to this grand challenge by understanding the climate impacts of marine heatwaves (MHWs) on top order predators in tropical oceans. Sustainable fishery industries are underlain by the principle of understanding the climatic impact on the fishery ecosystem. Top predators such as yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), and skipjack (*Katsuwonus pelamis*) are critically important to the world’s fishing industry. However, those resources are threatened by oceanic biophysical drivers and global climate change. As a curial indicator of climate change, MHWs have key ecological effects on tuna distribution. MHWs and subsurface MHWs profoundly influence tuna fisheries. And we also want to know how it affects tuna communities and where would tuna go under the circumstance of high-frequency MHWs in the future. To describe impacts of MHWs on top predators and the way to improve the predictions of their spatial distribution, this task team will try to bring a better understanding of tuna. Their research proposes to provide a deep interdisciplinary study with a new AI method. A large goal of this task team is to make sure that key questions about top predators’ habitats are answered so that their work can contribute to the United Nations’ Sustainable Development Goals (SDGs).

1.b. Grand Challenge II

Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:

Research Objective 4. Development of integrated data systems and approaches for predictions and projections

Research Objective 5. Development of predictive models and projections for use at regional scales

Research Objective 6. Development of alternative scenarios to bridge the gap between physical climate sciences and humanities

Task team 2023-24/4 is assisting CLIOTOP in supporting this Grand Challenge by having experts identify the limitations and pathways forward to enhance marine ecological forecasting applications and capacity globally. Ecological forecasting is a rapidly developing field that seeks to predict biological or ecosystem responses to physical variability and change at management-relevant timescales. Forecasting applications in the marine realm are increasing in number, scope, geographic and taxonomic coverage, and management uptake. Forecasting physical conditions and ecological responses on short timescales, from near-real-time to annual, is highly useful to ocean end-users and decision makers who are faced with increasing environmental change (Jacox et al., 2020). The seasonal-to-decadal forecast horizon has traditionally been the most challenging to produce accurate forecasts over, however, this time period has been identified as being highly valuable to resource managers and conservation practitioners. Recent advances in physical and biogeochemical predictions systems have enabled skillful forecasts of ocean temperature, primary productivity, and chlorophyll-a up to 9 years into the future (Krumhardt et al., 2020; Park et al., 2019; Yeager et al., 2018), providing an opportunity for the field of ecological forecasting that relies on these skillful physical fields (Payne et al., 2017). However, many important questions remain regarding the potential limitations, barriers and bottlenecks in the process of developing forecasts that should be addressed as forecasting horizons expand. For example, the limits of predictability in physical, ecological and socio-economic systems, and how these influence forecast potential, are important considerations for forecast development. In particular, the oceanographic drivers of forecast potential, such as regional variation in predictability of ocean state, may be a central limitation to the skill of ecological forecasts, but has not been explored on a global scale.

For marine fisheries, much of the ecological forecasting effort to date has focused on predicting spatial and temporal changes in the distribution of target species, but the potential of ecological forecasting for mitigating fisheries-wildlife interactions with non-target species is yet to be coherently explored. Of particular importance is mitigating fisheries wildlife interactions with top predators, including species targeted by fisheries such as tuna and billfish and threatened, endangered or protected (TEP) species such as sharks, turtles, seabirds and marine mammals. This task team is harnessing ongoing collaborations and projects to review the current state of knowledge on the regionally-varying limiting factors for forecast skill, and explore potential for integrated forecasting applications within the Exclusive Economic Zones (EEZs) of individual nations driven by emergent data streams. Leveraging off funded projects, the task team aims are to share best practice, co-develop next steps and emerging research directions, and generate research outputs of use to the global ecological forecasting community.

Further to this, activities proposed by task team 2023/1 will assist CLIOTOP in meeting this challenge by proposing to produce and use predictive models to provide an assessment of how different food webs around the world may change under various future climate and environmental scenarios. Combining regional studies for meaningful global analyses is inherently challenging and requires an international collaborative effort.

1.c. Grand Challenge III

Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:

Research Objective 7. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation

Research Objective 8. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture

Research Objective 9. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas

Task teams 2023-24/1 and 2023/3 have undertaken work that will directly assist CLIOTOP in addressing the overarching scientific questions in relation to advanced understanding of marine ecology, food web dynamics, movements of top predators in a changing climate, and ocean biogeochemistry. Marine organisms are fundamentally linked and explicitly interact through marine trophodynamics (predator – prey relationships). Delineating and quantifying these linkages is however, challenging on both regional and global scales. Stable isotope analysis has proven to be a powerful tool to establish, represent and quantify linkages, interactions and ecological feedbacks between individual species and marine ecosystems. Most importantly, many global research groups have undertaken stable isotope analyses in top marine predators so there is a large and already collected dataset from which to draw from. The work undertaken by these task teams have facilitated future comparative analysis and research into food web structure and functioning, including carbon fluxes. By grouping and quantitatively analysing the stable isotope dataset generated in this project from the global ocean, the respective scientific papers will allow for a broader understanding of the food webs underlying fisheries production and a more complete understanding of the trophic ecology of commercially important tunas. Furthermore, an understanding of top predator movements in the open ocean is crucial to both stock assessments of commercially important species, and to determine shifts in patterns in a changing climate. The work is focused on elucidating key interactions and linkages between biogeochemical cycles, food webs, potential fishing impacts, and climate variability.

Outputs produced by all CLIOTOP task team 2023/1 include trophic and biogeochemical datasets that will assist in understand carbon storage and nutrient cycling by organisms in the open ocean and thus assisting global and regional models.

1.d. Innovation Challenge 3

To advance understanding of ecological feedbacks in the Earth System

Task teams 2023-24/1 and 2023/3 are advancing our understanding of ecological interactions (predator-prey dynamics, competition, etc.), by providing compiling datasets and developing models that provide insights into how ecological feedback mechanisms operate in response to environmental changes. Task teams 2023-24/1 are compiling and assessing global mercury and carbon isotope datasets that feed into global Earth System and Climate Models. Through sustained monitoring efforts, CLIOTOP tracks changes over time, which is crucial for understanding long-term ecological feedbacks and trends.

1.e. Innovation Challenge 4

To advance and improve the use of social science data for ocean management, decision making and policy development

Collaborative efforts led by all CLIOTOP task teams are improving stakeholder engagement and data sharing. All task teams are attempting to translated their research findings into actionable strategies for managing and mitigating the impacts of climate change on marine ecosystems.

1.f. Innovation Challenge 5

Interventions to change the course of climate impacts

CLIOTOP has not recently sponsored activities directly related to this Innovation Challenge

1.g. Innovation Challenge 6

Sustainable management of Blue Carbon ecosystems

Research conducted under CLIOTOP helps elucidate how climate variability and change affect Blue Carbon ecosystems. Understanding these impacts is vital for developing strategies to protect and restore these habitats. By promoting the sharing of data and research findings, CLIOTOP supports a comprehensive understanding of Blue Carbon ecosystems across different regions, leading to more effective global management strategies.

CLIOTOP promotes the development of integrated management plans that consider the interconnectedness of marine ecosystems and the importance of preserving Blue Carbon habitats for their ecological and climate benefits.

2. Selected highlights

2.a. Selected scientific highlights since last report (1-5)

Last report was submitted to SSC meeting, April 2023

- International representation and presentation by CLIOTOP SSC members.
- Strong engagement and proactive participation of international members in CLIOTOP's four Task Teams. This includes numerous online meetings, in-person workshops, and conference presentations.
- Compilation of global ecological (stable isotope and mercury) databases, including data on 6,687 marine taxa.
- Five scientific manuscripts are currently in the early stages of results formulation or drafting, expected to be completed in late 2024 or the first half of 2025.
- Lian Peng, Task Team co-lead and IMBeR Junior Fellow, received the "Excellent Poster Award" at the Third AI Oceanography Forum in China in May 2024.
- New CLIOTOP members have joined, and new collaborations have been established between several institutions, including among early career scientists.

2.b. Publications since last report

Please add all publications since last report to the table below (see notes for details on "Class" and "Activity" fields).

Publication with DOI	Class 1, 2, 3	Activity*
Médiéu, A., Point, D., Sonke, J.E., Angot, H., Allain, V., Bodin, N., Adams, D.H., Bignert, A., Streets, D.G., Buchanan, P.B. and Heimbürger-Boavida, L.E., 2024. Stable Tuna Mercury Concentrations since 1971 Illustrate Marine Inertia and the Need for Strong Emission Reductions under the Minamata Convention. <i>Environmental Science & Technology Letters</i> , 11(3), pp.250-258.	1	<i>CLIOTOP Stable Isotope Trophodynamics Task Team 2008-20</i>

Nichols, P.D., Pethybridge, H.R., Zhang, B., Virtue, P., Meyer, L., Dhurmeea, Z., Marcus, L., Ericson, J.A., Hellesey, N., Every, S. and Wheatley, K., 2023. Fatty acid profiles of more than 470 marine species from the Southern Hemisphere.	2	CLIOTOP Stable Isotope Trophodynamics Task Team 2008-20
Rubbens, P., Brodie, S., Cordier, T., Destro Barcellos, D., Devos, P., Fernandes-Salvador, J.A., Fincham, J.I., Gomes, A., Handegard, N.O., Howell, K. and Jamet, C., 2023. Machine learning in marine ecology: an overview of techniques and applications. <i>ICES Journal of Marine Science</i> , 80(7), pp.1829-1853.	3	
Scales, K.L., Moore, T.S., Sloyan, B., Spillman, C.M., Eveson, J.P., Patterson, T.A., Williams, A.J., Hobday, A.J. and Hartog, J.R., 2023. Forecast-ready models to support fisheries' adaptation to global variability and change. <i>Fisheries Oceanography</i> , 32(4), pp.405-417.	3	
Welch, H., Savoca, M.S., Brodie, S., Jacox, M.G., Muhling, B.A., Clay, T.A., Cimino, M.A., Benson, S.R., Block, B.A., Connors, M.G. and Costa, D.P., 2023. Impacts of marine heatwaves on top predator distributions are variable but predictable. <i>Nature Communications</i> , 14(1), p.5188.	3	
Votier, S.C., Sherley, R.B., Scales, K.L., Camphuysen, K. and Phillips, R.A., 2023. An overview of the impacts of fishing on seabirds, including identifying future research directions. <i>ICES Journal of Marine Science</i> , 80(9), pp.2380-2392.	3	
Pittman, S.J., Yates, K.L., Bouchet, P.J., Alvarez-Berastegui, D., Andréfouët, S., Bell, S.S., Berkström, C., Boström, C., Brown, C.J., Connolly, R.M. and Devillers, R., 2021. Seascape ecology: identifying research priorities for an emerging ocean sustainability science. <i>Marine Ecology Progress Series</i> , 663, pp.1-29.	3	
Ison, S., Cvitanovic, C., Pecl, G., Hobday, A.J. and van Putten, I., 2024. Participatory research in complex marine conservation settings: A review of recent trends and lessons for the future. <i>Ocean & Coastal Management</i> , 253, p.107053.	3	

**If appropriate, please list the IMBeR activity through / by / from / during which the publication arose*

******Notes on publications******

Publications are logged in the IMBeR Zotero library which is publicly accessible online –

[Publications since 2016](#) | [Publications prior to 2016](#)

Publications are categorised by “Class” and linked to “Activities”:

Class 1 publications are specifically generated through/by/from/during **IMBeR activities** - for example, arising from IMBIZOs and IMBeR conferences such as the IMBeR open science meeting and the IMBeR West Pacific symposia and from the activities of the working groups, regional programmes and the SPIS scoping teams.

Class 2 publications are on topics relevant to the IMBeR Science Plan that benefitted from some interaction with IMBeR or **IMBeR activities**, for example by IMBeR symposium attendees, past and present SSC members, working group, regional programme and endorsed project members, or national contacts.

Class 3 publications are on topics relevant to the IMBeR Science Plan but for which there is no direct link to or benefit from an IMBeR activity. These might include publications by SSC members, working group, regional programme or endorsed project members or members of the IMBeR international community that were written as part of the normal scientific activity of the authors and would have occurred irrespective of IMBeR's existence. You can report Class 3 publications, but they will no longer be logged in the IMBeR database.

[See “[What is an IMBeR publication?](#)” for further information]

Why list ‘Class’ and ‘Activity’? This helps us to declare authentically which publications IMBeR has helped to generate, and it makes it easier for us to demonstrate the value of the Regional Programmes, the Working Groups, and IMBeR in general, and it helps us to justify support for IMBeR activities when we can list tangible outputs.

2.c. Events, Meetings, and Workshops

List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Endorsed Projects committee meetings and workshops.

Format: Title of event. Date. Location. Description of participation. Any other pertinent details.

Anne Lorrain, CLIOTOP co-chair, attended the IMBeR SSC meeting in Paris from 3-6 April 2024. She represented the CLIOTOP SSC and community and will present on recent CLIOTOP activities and future plans.

Barbara Muhling, SSC member and Task Team co-lead, represented CLIOTOP and presented a poster on CLIOTOP activities (past and present) at the 5th International Symposium on the Effects of Climate Change on the World's Oceans (ECCWO5) in Bergen, Norway in April 2023.

CLIOTOP Task Team on micronekton trophic linkages undertook workshops in November 2023 in New Caledonia and USA.

Conference Presentations:

Muhling B, Evans K, Kanaji Y, Lopez J, Lorrain A, Pethybridge H, Sadiyah L, Scales K, Vilasante S. "The Climate Impacts on Top Predators (CLIOTOP) science programme: building collaborations to develop understanding of dynamic marine ecosystems and pathways for sustainable practices. Effects of Climate Change on the World's Ocean (ECCWO), 17-21 April 2023, Bergen, Norway.

Lian Peng, Yurong Mu et al. "XAI Analysis of the Variation Patterns of Tuna Fisheries in the Tropical Pacific". 3rd AI Oceanography Forum. May 27 -29, Qingdao, China. Lian Peng was awarded "Excellent Poster Award" <https://imber.ecnu.edu.cn/32/d8/c35742a602840/page.htm>

Lian Peng. Yurong Mu et al. "Impacts of central-Pacific El Niño and physical drivers on eastern Pacific bigeye tuna". 9th Youth Geoscience Forum, 17 – 20 May 2024, Xiamen, China.

Murphy, E.J., Robinson C., Hobday AJ, Brodie (2023) Developing an Action Plan for the Ocean. 5th Symposium on Effects of Climate Change on the World's Oceans (ECCWO5), Bergen, Norway, 17-21 April 2023 – poster

Murphy, E.J., Robinson, C., Hobday, A.J. and Brodie, S., 2024, February. Developing an Action Plan for the Ocean. In *2024 Ocean Sciences Meeting*. AGU. Poster

3. International collaboration and links

CLIOTOP has an extensive network of participants, which was update late last year and includes 620 members from >30 countries. Our level of diversity and spread across genders, career levels, and geographical regions is impressive and growing. Co-leads and members of our task teams include early to senior, male and female proponents from all habitable continents (Asia, South and North America, Australasia, Europe and Africa).

IMBeR Regional Program Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) have approached CLIOTOP SSC to potentially hold a joint conference, alongside their Open Science Meeting in Japan in

June 2025. This collaborative opportunity has been passed on to all SSC members and selected (Antarctic Top Predator Researchers) members. Two members, Mary Anne-Lea and Rowan Trebilco, have engaged in conversations with the co-chairs of ESSAS and in the process of scoping out this opportunity. CLIOTOP noted that IMBeR have asked us to not hold a stand-alone Symposia but rather than hold a special session at a Future Oceans Conference (should this occur in 2025).

4. Input to management, policy and SOCIETY* over the last year

Add anything that is not covered under "1.c. Grand Challenge III"

**As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

There is nothing additional to report here over the last 12 months

5. Education, outreach and Capacity Development

Outputs from CLIOTOP are made available through the publication of special issues of journals in association with each symposia held. They are also made available via the CLIOTOP website. Webpage content has been updated over the last few months, with assistance from IMBeR-IPO, to enhance our outreach.

6. Planned activities

6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

As described above a number of highly successful and well attended international task team workshops and meetings have been undertaken over the last 12 months. In addition, task team and CLIOTOP SSC members have communicated their and CLIOTOP's research at several international symposia.

The co-chairs and SSC will meet later in 2024 (currently planned for October) to generate ideas for CLIOTOP to participate in synthesis activities and develop a new post-2025 strategy that supports IMBeR plans and goals. We are waiting to hear if there will be an IMBeR Future Oceans Meeting over the coming year to participate in.

6.b. Upcoming papers (Community-Position-Review-etc)

Seven manuscripts, directly resulting from the activities of the CLIOTOP four Task Teams are expected to be drafted and submitted to high-impact journals over the coming year. Tentative titles are included in the first section of this report.

As a result of a two-day synthesis paper writing workshop attended by 11 researchers at SPC in New Caledonia, November 2023 an additional manuscript is being prepared. This was partially funded through an IMBeR Funding Grant (granted to the CLIOTOP co-chairs).

- Pethybridge H, Allain V, Brodie S, Choy A, Li Y, Lorrain A, Medieu A, Meyer L, Muhling B, Nicol S, Pethybridge H, Young Y. *Advances in oceanic top predator research through international collaboration and global data sets.*

As part of the IMBeR conference, CLIOTOP will aim to proceed with requesting its 4th special issue in DSR-II which have been highly successful at collating important research by a broad range of international members on climate related research on top order predators.

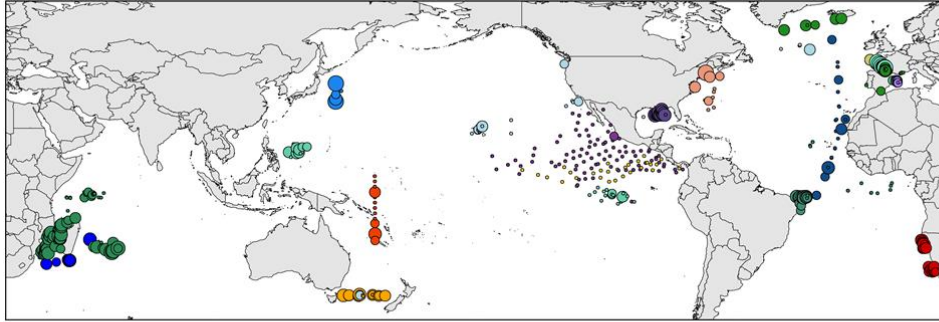
7. Changes to Organisational Structure (e.g. SSC) of Regional Programme

There are no planned restructuring to the current SSC, although we note that several members have been and continue to be inactive, as they have had no or limited interaction and don't respond to chair communications. The terms of conditions were updated in late 2023 to provide the chairs with more power in making changes to the SSC.

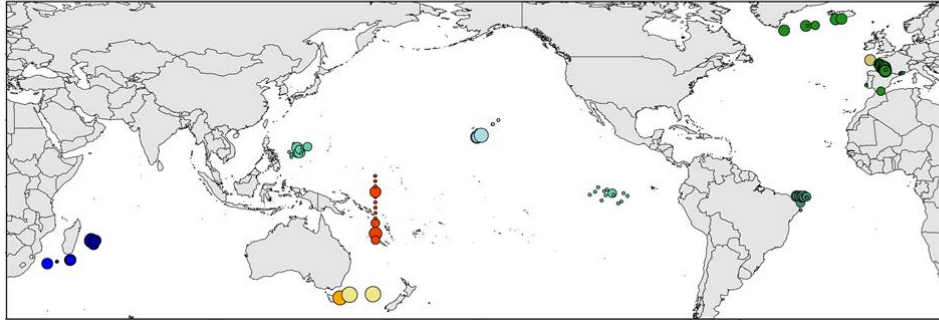
8. Images / Figures

*****It is always good to have some recent photos / figures / infographics to create more exposure for the Regional Programmes, Working Groups, etc. These can range from those suitable for a very scientific audience, to those that would engage the general public. IMBeR would use these, on the website (e.g. <http://www.imber.info/> and <http://www.imber.info/en/news>), in tweets (@imber_ipo), in presentations, etc. In addition, Future Earth (one of our sponsors) regularly asks us to provide high quality images for their glossy reports. These can highlight the activities of IMBeR and their other Global Research Projects (see pdfs of past Future Earth reports here <https://futureearth.org/publications/annual-reports/>) . So, please provide any images that you might think are useful. These can be pasted in this document or emailed as an attachment to imber@ecnu.edu.cn.*****

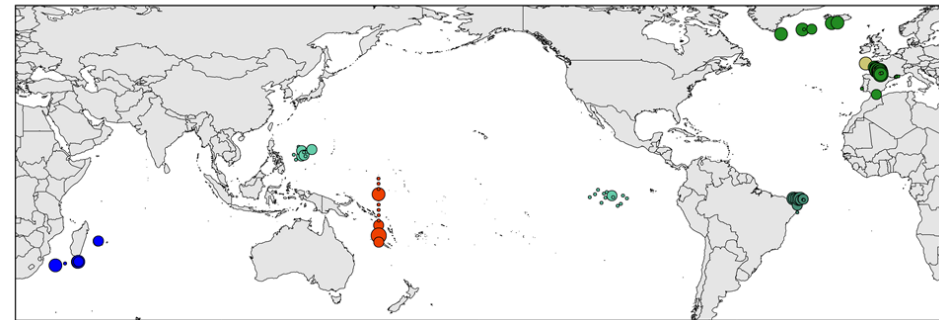
A) Samples with SIA data



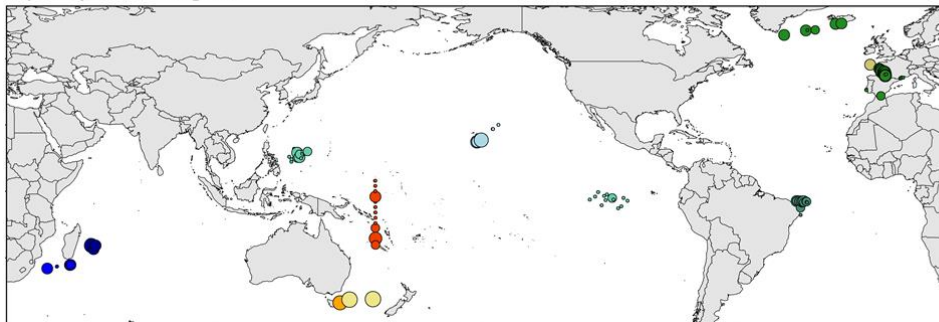
B) Samples with THg data



C) Samples with both SIA and THg data



B) Samples with THg data



Sample owner

- A. Annasawmy/F. Marsac/JF. Ternon
- A. Annasawmy/S. Jaquemet
- A. Choy
- B. Zhang/H. Pethybridge
- E. Hetherington
- F. Menard
- H. Pethybridge
- J. Logan
- J. Navarro
- L. Fuller/R. Olson
- L. Loutrage/J. Spitz/A. Brind'Amour
- L. Nole/F. Lucena
- P. Olivar/A. Bode
- P. Olivar/M. Valls
- S. Duncan/H. Fock
- T. Chauvelon/J. Spitz
- T. Chauvelon/P. Bustamante/J. Spitz
- T. Sutton/T. Richards/RJD. Wells
- V. Allain/A. Lorrain/A. Medieu
- Y. Li
- Zhang2022FMS

Number of samples

- <5
- 5-10
- 10-20
- 20-40
- 40-60
- >60

Sample owner

- A. Annasawmy/F. Marsac/JF. Ternon
- A. Annasawmy/S. Jaquemet
- A. Choy
- B. Zhang/H. Pethybridge
- E. Hetherington
- F. Menard
- H. Pethybridge
- J. Logan
- J. Navarro
- L. Fuller/R. Olson
- L. Loutrage/J. Spitz/A. Brind'Amour
- L. Nole/F. Lucena
- P. Olivar/A. Bode
- P. Olivar/M. Valls
- S. Duncan/H. Fock
- T. Chauvelon/J. Spitz
- T. Chauvelon/P. Bustamante/J. Spitz
- T. Sutton/T. Richards/RJD. Wells
- V. Allain/A. Lorrain/A. Medieu
- Y. Li
- Zhang2022FMS

Number of samples

- <5
- 5-10
- 10-20
- 20-40
- 40-60
- >60

Figure 1. Spatial distribution of mesopelagic samples with trophic and biogeochemical data compiled as of November 2023 by the CLIOTOP Micronekton Task Team undertaking global meta-analyses.