**CLIOTOP REGIONAL PROGRAMME REPORTING FORM 2023**

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

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 Grand Challenge Factsheets)*

The CLIOTOP SSC re-engaged in August 2022 after having been severely disrupted by COVID-19 and a leadership restructuring (acquisition of new co-chairs). Activity of all past task teams had been inactive since 2020. Consequently, there are few updates since our last report (August 2022) in relation to specific achievements, outputs or outcomes related to specific IMBeR Challenges over the last 6-12 months.

However, the CLIOTOP SSC have, over the last 6 months, made considerable efforts to revitalise CLIOTOP communications and activities. This included two virtual SSC meetings, and countless communications between the co-chairs, past chairs, and members of the IMBeR-IPO. This also includes putting out a call for new task teams to start work in 2023 in September 2022 with 6 proposals and 3 additional enquiries submitted. The CLIOTOP SSC assessed these proposals and met in November to rank them. Four task teams were selected for funding with 3 of them to run until 2024. Summaries of these task teams have been included on our CLIOTOP webpage: <https://imber.info/science/regional-programmes-working-groups/cliotop/task-teams/>

Here we align the proposed work and activities of each of these four supported task teams to specific IMBeR challenges. This includes reference to:

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

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

Task team 2023-24/3: Global analysis of white shark trophic role led by Charlie Huveneers and Lauren Myers (Flinders University, Australia), along with other co-leads from the USA, Mexico and South Africa.

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)

### **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 will contribute to this grand challenge by understanding the climate impacts of marine heatwaves (MHWs) on commercially fished top predators in tropical oceans. Sustainable fisheries require an understanding of climatic impacts 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 impacted by oceanic biophysical drivers and global climate change. MHWs and subsurface MHWs have the potential to profoundly influence tuna fisheries. To assess the impacts of MHWs on top predators and improve predictions of their spatial distribution, this task team will try to improve understanding of the drivers of tuna distributions, and tuna-dependent communities. Their research proposes to provide a deep interdisciplinary study using cutting-edge AI methods. A primary goal of this task team is to address key questions about top predator habitats and 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 will assist CLIOTOP in supporting Grand Challenge II by identifying limitations and pathways to enhance marine ecological forecasting applications and capacity globally. Ecological forecasting is a field that predicts biological or ecosystem responses to physical variability and change at management-relevant timescales. Marine ecological forecasting is increasing in number, scope, geographic and taxonomic coverage, and management uptake. However, important questions remain regarding the potential limitations, barriers, and bottlenecks in the process of developing forecasts that should be addressed.This is particularly true for the seasonal-to-decadal forecast horizon which has traditionally been the most challenging to produce accurate forecasts over. 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. Recent advances in physical and biogeochemical prediction systems have enabled skilful forecasts of ocean temperature, primary productivity, and chlorophyll-a up to 9 years into the future, providing an opportunity for the field of ecological forecasting. The aim of this task team is to review the current state of knowledge on the regionally varying limiting factors for forecast skill, explore the potential for integrated forecasting applications, share best practice, co-develop next steps, and generate research outputs for the global ecological forecasting community. 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.

Further to this, activities proposed by task team 2023/1 will also assist CLIOTOP in contributing to this Grand Challenge by developing and using predictive models to assess how different food web dynamics (in addition to carbon, nutrient, lipid, and mercury cycling) around the world may change under various future climate and environmental scenarios.

### **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*

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

### **1.d. Innovation Challenge 3**

*To advance understanding of ecological feedbacks in the Earth System*

Task teams 2023-24/1 and 2023/3 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. One of the task teams will focus on better understanding interactions and energy flow between mesopelagic biota and top predators, which has a critical role in regulating global biochemical processes, including carbon and nutrient cycling. The other task team is focused on better understanding the ecological role and feeding ecology of white sharks, a conservation dependent top predator.

Marine organisms are fundamentally linked and explicitly interact through marine trophodynamics (predator – prey relationships). Delineating and quantifying these linkages is challenging on both regional and global scales. Biochemical tracer analyses, including stable isotopes and fatty acids, have 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 regional biochemical tracer studies on top marine predators so there is a large and already collected dataset from which to draw from. Work by these task teams will facilitate future comparative analysis and research into food web structure and functioning, including carbon fluxes. By grouping and quantitatively analysing the biochemical dataset generated in this project from the global ocean, their work will enable 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. Outputs produced by these two CLIOTOP task teams will include measurements of carbon and carbon isotopes that will assist in understanding carbon storage by organisms in the open ocean and thus assisting global and regional carbon transport models, including climate and biogeochemical models.

### **1.e. Innovation Challenge 4**

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

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

### **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*

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

## 2. Selected highlights

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

*Last report was submitted to SSC meeting, August 2022*

* re-engagement of CLIOTOP SSC members to undertake activities and decision making
* Re-engagement and communication between CLIOTOP and the IMBeR-IPO
* Engagement with the IMBeR SCC
* Re-engagement with prior and acquisition of new CLIOTOP members
* Development of, and support provided for, four new task teams to assist CLIOTOP contribute to solving IMBeR Grand and Innovation Challenges.

### **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).*

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| --- | --- | --- |
| ***Publication*** *with DOI* | ***Class 1, 2, 3*** | ***Activity***\* |
| Xu, M., Pethybridge, H.R. and Li, Y., 2022. Trophic niche partitioning of five sympatric shark species in the tropical eastern Pacific Ocean revealed by multi-tissue fatty acid analysis. *Environmental Research*, *214*, p.113828. | *3* | *Extended CLIOTOP related engagements* |
| Le Croizier, G., Point, D., Renedo, M., Munaron, J.M., Espinoza, P., Amezcua-Martinez, F., Bertrand, S.L. and Lorrain, A., 2022. Mercury concentrations, biomagnification and isotopic discrimination factors in two seabird species from the Humboldt Current ecosystem. *Marine Pollution Bulletin*, *177*, p.113481. | *3* | *Extended CLIOTOP related engagements* |
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| *[Add more rows if needed]* |  |  |

*\*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 2019](https://www.zotero.org/groups/2448334/imber_library_2/library)  | [Publications prior to 2019](https://www.zotero.org/groups/38770/imber_library_1/library)

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 Symposium and from the activities of the working groups, regional programmes or other IMBeR entity.

***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?](https://drive.google.com/open?id=1OQWn41KJvQ-LyWJlkiYnc5qZ2IuNQOrg)” 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 Regional Programme / Working Group committee meetings and workshops.*

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

1. CLIOTOP SSC Meeting, 1st September 2022, Virtual, attended by 5 current and 2 past CLIOTOP SSC members. For details, see summary at: <https://drive.google.com/drive/folders/1-Au-HWL5-X8yBaKNTAAzCQfguwJAD0Nf>
2. CLIOTOP Chair – IMBeR meeting to discuss budget, 19th September 2022, Virtual, 4 people in attendance.
3. CLIOTOP SSC Meeting to discuss assessments of submitted task team proposals, 16th November 2022, Virtual, Attended by 5 SSC members and 2 IMBeR-IPO members, for details, see summary at: <https://drive.google.com/drive/folders/1-Au-HWL5-X8yBaKNTAAzCQfguwJAD0Nf>

## 3. International collaboration and links

CLIOTOP has an extensive network of participants, which was updated 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. Applications to our most recent call for task teams saw early to senior, male and female led proponents from all habitable continents (Asia, South and North America, Australasia, Europe and Africa).

A summary of previous accounts of CLIOTOP’s reach are published in *Hobday, A.J., Arrizabalaga, H., Evans, K., Scales, K.L., Senina, I., Weng, K.C. (2017). International collaboration and comparative research on ocean top predators under CLIOTOP, Deep-Sea Research II 140: 1-8.*

## 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 6 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)

The co-chairs attended a meeting with Diana Ruiz Pino, chair of IMBeR, and the IMBeR-IPO, virtually on 6th March to discuss CLIOTOP’s past and present contributions to the Grand Challenges. There were also discussions about generating ideas for CLIOTOP to participate in synthesis activities and develop a new post-2025 strategy that supports IMBeR plans and goals.

Anne Lorrain, co-chair, will attend the IMBeR SSC meeting to be held in Paris from 3-6 April. She will represent the CLIOTOP SSC and community and will present on recent CLIOTOP activities and future plans.

Barbara Muhling, active SSC member, will represent CLIOTOP and present 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.

All four of our new task teams for 2023 have passed on content to the IMBeR IPO which was promptly added to the CLIOTOP Webpage: <https://imber.info/science/regional-programmes-working-groups/cliotop/task-teams/>. These provide a good summary of the work and activities that will be undertaken by these teams and provide contact details of the task team leaders.

A number of task team workshops are planned to be held throughout 2023 to support collaborative works approved by the SCC and SCOR. This includes a task team workshop at the White Shark Global Conference to be held in South Australia in November 2023. Another task team is keen on working with the CLIOTOP SSC and the IMBeR-IPO to engage with the public, including setting up of TEDx activities offline to share their findings on climate impacts of marine heatwaves on top predators.

Initial discussions have been had with the IMBeR office that CLIOTOP will have a special session at the upcoming IMBeR Open Science Conference in 2024 with dates and location still being discussed. The CLIOTOP community will be encouraged to participate in this session and organise coinciding workshops and will continue to work to align the goals and outputs of CLIOTOP with the goals and anticipated outputs from the Decade.

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

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. The special issue will include an opening paper for CLIOTOP SSC and task team leds to review its past activities and outcomes in addition to outlining the communities ongoing and emerging research questions and directions (e.g. advancing interdisciplinary research, identifying the potential for developing technologies, collaboration with stakeholders, and development of new predicting tools).

## 7. Funding

### **7.a. Funding from external sources**

CLIOTOP plans to use external funds acquired some years ago in support of task team activities in 2023.

### **7.b. Funding proposals in progress or planned**

The agenda of the next CLIOTOP SSC meeting will include an item to discuss the possibility of acquiring external funding to support our global activities and/or a synthesis exercise.

The CLIOTOP co-chairs have received an IMBeR Grant of US$7500 to work over two years with international colleagues and make connections with other regional programs, IMECAN members, and working groups of IMBeR. The work will look at ‘*Analysing global pelagic fish biochemical data to address sustainability under climate change scenarios’*. This aims of this work are to: (i) develop an open-access global database of compiled and curated biochemical data obtained from research and monitoring programs that include fine-scaled biological, ecological and spatio-temporal information matched to available environmental data; (ii) develop and implement novel predictive models of pelagic-derived biochemical data under climate change scenarios; and (iii) propose a collaborative interdisciplinary framework to further accelerate progress in sharing and using biochemical data. The model species chosen are abundant, widely-distributed and socio-economically important pelagic fish, representative of different trophic levels (e.g., forage fishes and tunas). The proposed activities will build on successful work undertaken under by long-term CLIOTOP members (WG3 and task teams 2015-2018/01) that brought together dietary, stable carbon and nitrogen isotope, and environmental datasets for tuna species and modelling expertise to undertake global meta-analyses that resulted in 6 high-impact peer-reviewed papers.

### **7.c. Funding requested from IMBeR for 2023-2024**

*Include a brief budget and justify requests*

We request at least the same level of funding ($7,500) as last year to support task team activities and also to fund scientists to participate in the 2024 Annual Science Meeting. Preference will be given to unfunded SSC members and Early Career Scientists. A call for further funding of task teams will be issued once the budget for 2023/24 has been finalised.

## 8. Changes to Organisational Structure (e.g. SSC) of RP / WG / IMECaN

There was a restructure to the leadership of the CLIOTOP SSC late 2022 with the resignation of Joel Llopiz. Anne Lorrain and Heidi Pethybridge took on the role of co-chair with support from the IMBeR Offices. Currently the co-chairs are looking to restructure the SSC, with several members assumed inactive, as they have had no or limited interaction and don’t respond to chair communications. The CLIOTOP Terms of Reference has been updated to provide the chairs with more power in making changes to the SSC. Before the implementation of any change, the chairs would seek approval from IMBeR IPO.

## 9. 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@dal.ca*](mailto:imber@dal.ca)*.\*\*\*\**

## 10. Update on Action Items from 2022 SSC meeting

*Please update the* [*table of Action Items*](https://docs.google.com/spreadsheets/d/1LkI64DNR5eqz294XTtwr_oZjFZTDNRJjHIOEL6rbmVw/edit?usp=sharing)

CLIOTOP are

## 11. Anything not covered above

*Add text…*

Peng Lian, co-led of CLIOTOP Task Team 2023/2 is a member of the IMBeR Young Scholar Program. The CLIOTOP SSC have worked together to ensure that Peng Lian and three of his postgraduate colleagues are well set up for success through the mentorship of Barbara Muhling.

## 12. How to improve this form

*Please give suggestions on how to improve this form and make it better next time.*

*Add text…*

## 13. Appendices

*Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)*

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