DynamOx

DYNamic Approaches for assessing Marine biota responses to changing OXyscape.

Co-Chairs: Marco Fusi and Simone Baldanzi

a. Summary/Abstract (max. 250 words)

Deoxygenation is predicted to worsen over the next decades which will affect marine life, especially in coastal habitats. Deoxygenation will lead to loss of biodiversity and ecosystem services, exacerbating the already detrimental effects of rising temperature, acidification, and pollution. The dynamic nature of oxygen availability in marine ecosystems is however not yet considered in correctly predicting the responses by marine species and adaptation by communities. The DynamOx (DYNamic Approaches for assessing Marine biota responses to changing OXyscape) will bring together experts to advance research on oxygen dynamics in marine systems, providing standards for empirical research which will develop new actions for the effective management against deoxygenation. Specifically, DynamOx will (i) quantify the extent oxygen fluctuation in shaping the marine benthic communities physiology and ecological interactions, (ii) provide guidelines for appropriate 'mimicry' of oxygen environmental variability in controlled dynamics laboratory experiments, and (iii) implement mechanistic models to account for organismal variation in oxygen fluctuating environment. Additionally, DynamOx will (iv) develop a set of new indicators to capture the ecological relevant oxygen variability and provide guidance on environmental oxygen logging and, analysis. Lastly, DynamOx will (v) interact directly with society, policy-makers and science communicators to produce science-based and media outputs to realistically portray the role of oxygen fluctuations in shaping marine life under a changing ocean. By providing concrete evidence produced by qualified experts, DynamOx will create an interdisciplinary framework needed to build a new narrative for the ocean under the threat of deoxygenation.

b. Scientific Background and Rationale (max 1250 words)

The need for an ecologically relevant approaches to capture and test the real fluctuations of oxygen

Life on earth evolved in an anoxic environment[1]. As oxygen increased and species evolved oxidative pathways to exploit the energy produced by aerobic metabolism, life evolved an unprecedent diversity of morphology and species[2]. Life in coastal environments adapted (and still are adapting) to ever-changing conditions of temporal and spatial oxygen fluctuations[3]. For example, in marine productive habitats, light availability drives strong fluctuations in water chemistry at diurnal scale, by acting on the rates of photosynthesis and respiration of aquatic primary producers and consumers[4]. *In situ* oxygen measurements and other environmental variables (*e.g.*, pH, temperature, salinity) in a range of coastal marine habitats including estuaries, kelp forests, shellfish reefs, coral reefs, mangroves and upwelling regions[5–9], revealed considerable oxygen fluctuations, even over short (*e.g.,* hours, diel) to intermediate (*e.g.,* synoptic) timescales (*e.g.*, [10]). Indeed, in coastal waters the environment can change from hyper oxygenated to anoxic within tens to hundreds of meters, and in a given place from minutes to days, exposing organisms to extreme oxygen fluctuations. Nevertheless, biologists still largely adopt the 'mean conditions paradigm' when it comes to investigate the effect of the deoxygenation on physiological and ecological processes through both, experimental and theoretical approaches[11,12]. There is abundant evidence that oxygen fluctuations can increase physiological tolerance and promote plasticity of marine biota to novel environmental conditions[13,14]. The magnitude of oxygen fluctuation, its spatial and temporal scales and how it interacts with other environmental drivers to shape species adaptation is, however, misrepresented and sometimes simply overlooked. Benthic communities that rely on aerobic metabolism are sensitive to changes in oxygen because their limited motility will expose them to the conditions in the ecosystem they live[15]. Importantly, the magnitude and periodicity of the oxygen fluctuations, including the extreme events, could be altered in the near future[16], with significant implications for marine species survival, biodiversity and ecosystem functions[17]. Studies on how oxygen fluctuations affect ecological and evolutionary processes and standardized methods on how to quantify these fluctuations are thus urgently needed to develop biodiversity conservation strategies under global change[18,19]. So far, the investigation of the effect of oxygen on marine benthic species, focused mainly on hypoxia[20] overlooking, however, what really happen to the oxygen dynamics, aka the Oxyscape, defined as the spatial and temporally heterogeneous aquatic oxygen landscape. A crucial aspect of oxygen fluctuations is the temporal and spatial autocorrelation, including its cross-correlation with other environmental variables, which determines the predictability of the oxygen variation over the time and creates opportunities for individuals to anticipate and adjust to the near future changes (physiologically bearable conditions; Figure 1) [21,22].

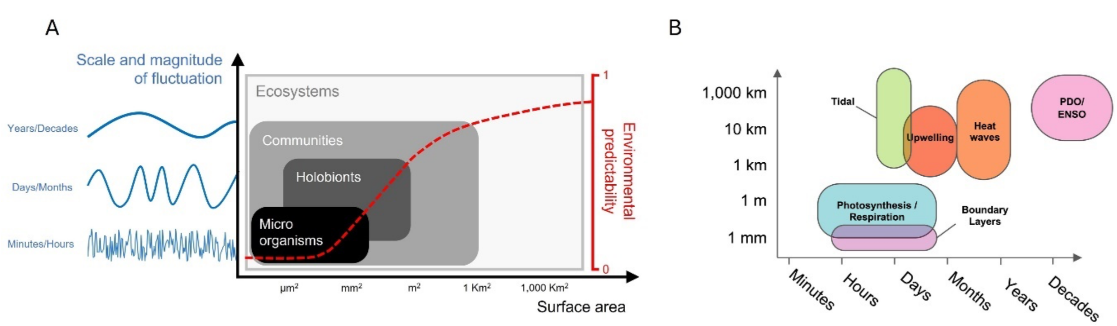

Figure 1. *Schematic representations of (A) spatio-temporal scales of Oxygen fluctuations (adapted from [23]) and (B) processes dominating at those scales (modified by [24,25]). Different levels of biological organisation experience different scales of spatial and temporal environmental variability (and predictability), thus, showing the importance of integrating across different environmental scales that connect organisms/communities/ecosystems to climate and anthropogenic changes. At micro/millimetres scales, oxygen can display random variations across time (rather than a regular, e.g., cyclical, pattern)*

which make that variability difficult to predict. For example, cyanobacterial biofilms are characterized by a high variability of oxygen and pH fluctuations over time because of different micro-conditions (i.e., irradiance, photosynthetic performance). At larger scales, holobionts and communities experience more predictable patterns of variation. Corals in tropical marine systems live in a predictable pattern of daily temperature variation; likewise, benthic communities in marine productive ecosystems experience regular daily fluctuations of dissolved oxygen driven by photosynthesis and community respiration. At the ecosystem level, the predictability of environmental variables further increases because of the seasonal pattern corresponding to the latitude where the ecosystem is located.

It is critical to define the correlation timescales of the oxygen with the other drivers affected by climate change and anthropogenic impacts, since global warming and pollution can make marine environments less predictable[26–28], and therefore disrupt the ecological and evolutionary response of the marine biota[4,29,30]. Few studies have incorporated environmental predictability in marine ecosystems[31,32] of which (to our knowledge) none focus on oxygen predictability at small spatial and temporal scale[33], and there is a dearth of data about how and to what extent deoxygenation will affect oxygen fluctuations and its predictability in an ever-changing ocean[34,35]. Theoretically, global change will increase short term extreme events that affect oxygen availability and will decrease the predictability of patterns. For example, in Mediterranean Sea and western boundary currents like the Gulf Stream, Marine Heat Waves are unpredictable and intense, disrupting the oxygen diel fluctuations of those marine ecosystems[36,37]. In contrast, shallow productive ecosystems show periodical and predictable patterns of daily fluctuations which provide a shelter/buffer from climate change. Manipulative experiments have been extensively used to understand how climate change affects marine biota and, recently, the experimental manipulation of environmental drivers and the responses of organisms to multiple climate change-related stressors has received considerable attention[38]. The SCOR activity “Changing Ocean Biological Systems” (COBS https://scor-int.org/project/changing-ocean-biological-systems-cobs/) sought to train scientists worldwide to successfully perform well-designed multi-driver manipulative experiments that are required to tackle the multi-faceted challenges of contemporary climate change. The extent of the magnitude and the predictability of the environmental fluctuation of the drivers is, however, still not considered within COBS. For example, high concentrations of dissolved oxygen present at the microscale (i.e., within the *diffusive boundary layer*, the discrete microlayer on inert or organic surfaces where the micro-environmental conditions differ from those of the surrounding water column and which are usually measured) in small turf of red macroalgae as a result of photosynthetic activity can favour the respiration of small mobile organisms, the settlement of marine species during hypoxic events and thus explain understudied ecological patterns. We argue that, although designed in a multifactorial fashion, laboratory experiments still lack to consider the real occurrence of oxygen in marine ecosystems and are subjected to under- or overestimation of organisms' responses to stress. Further, as suggested by recent studies[39–41], exposing animals to field-simulated, oxygen fluctuating conditions in the laboratory, increases their capacity to perform well in response to stress and allows scientists to rely on more precise, resolute, and realistic results to predict how oxygen availability will shape oceans communities response.

Why a SCOR working group?

To understand the complex pattern of deoxygenation and its effect on marine life, the DynamOx working group (WG) will propose a multifactorial dynamic approach to study the fluctuating nature of oxygen and its pattern of periodicity and predictability to understand adaptation/acclimation for different types of benthic organism and inform ecosystem management. This constitutes a huge theoretical and technical challenges that goes far beyond the issue of addressing multiple environmental drivers because it includes timeseries in the assessment of oxygen. This justifies the formation of a new SCOR working group with close collaboration with other groups. We believe SCOR is the ideal platform advance understanding at this stage because the proposed activities which are rarely fundable by standard research grants from national research agencies, providing the ideal basis for developing a consensus across the ocean community. The outputs of DynamOx WG will both stimulate new type of measurements of oxygen in the environment at a scale that is relevant to the ecology of marine species (e.g., diffusive boundary layers) and advance our ability to design relevant experimental strategies and to simulate oxygen fluctuations in Dynamic Manipulative Experiments (DME, as opposed to manipulative experiment with static conditions[25]). Although the scope of our proposal applies to many marine systems, we will focus on benthic aerobic species because are those most exposed to fluctuating oxygen conditions, living at the boundary layer with primary producers and consequently they are particularly threatened by climate change and pollution[42]. These avenues of research represent an innovative area within the field of ecological sciences, which will impact the larger ocean sciences community (included marine policy makers and stakeholders) and train present and future marine molecular and evolutionary ecologists, eco-physiologists, climatic modelers, geographers, and experts in climate change. That is why we are approaching SCOR.

c. Terms of Reference (max. 250 words)

ToR1. Develop low-cost oxygen monitoring system for further application in, e.g., citizen science, able to measure oxygen fluctuations at relevant temporal scales, to provide novel approaches to measure the magnitude, frequency and predictability of oxygen experienced by marine benthic organisms.

ToR2. Tackle technical challenges and propose new experimental designs for both mechanistic understanding and an appropriate ‘mimicry’ of oxygen fluctuation in DME. Simultaneously, to develop cost-effective methodological standard practices which can be applied in any laboratory, everywhere in the world to measure ecological response under fluctuating conditions and modelling how biological systems filter, integrate, respond to, and anticipate oxygen fluctuations.

ToR3. Create relevant specific indicators of ecosystem performance (i.e., diversity and functionality), able to capture and quantify oxygen fluctuations and predictability by scaling up experimental results with conceptual models to understand the dynamics of benthic physiology and complex ecological interactions in response to the magnitude of oxygen fluctuations.

ToR4. Building capacity and disseminate methods on real time environmental loggers and DME by transferring and sharing knowledge on (i) environmental data retrieval, analysis, and storage, (ii) novel experimental design able to incorporate the fluctuation component and (iii) train and use the developed indicators as tools to improve marine management decisions, iv) set the foundation for a larger ocean observatory on oxygen dynamics.

ToR5. Outreach society, policy-makers and science communicators to produce publications and media to disclose the role of variability and predictability of multiple drivers to integrate the concept of oxygen fluctuations in marine management strategies and indicators development.

d. Deliverables (state clearly what products the WG will generate. Should relate to the terms of reference. Max 250 words). A workshop is not a deliverable. Please note that SCOR prefers that publications be in open-access journals.

(Years 1-2 and ToR 1 and 2). Produce a **guidance document** summarizing best practices to use low-cost probes for: (i) capturing real-time oxygen fluctuations and its predictability; (ii) controlling variability in laboratory experiment to develop mechanistic experiments as well as reproducing ecologically relevant laboratory DME. These protocols will be **deposited in the SCOR collection at the Ocean Best Practices Platform** (https://www.oceanbestpractices.org/) and on the Jove platform.

(Years 2-3 and ToRs 3). **Two scientific publications** will be submitted to open-access peer-reviewed scientific journals. The first will be a **metanalysis** with the tentative title: *The effect of oxygen fluctuations and predictability on marine benthic community physiology and ecological interaction*. The second a **synthesis/perspective paper** to create a roadmap to incorporate ecologically relevant oxygen fluctuation in marine benthic ecosystems tolerance studies. The two publications will set **marine indicators** able to capture real effect of oxygen change on marine systems.

(Years 3, ToR 4 and 5). The year 3 will be focused on summarizing and preparing the white paper to outreach to the stakeholders (governmental and non-governmental). Furthermore, a **special issue of a high impact factor peer-reviewed journal** will be coordinated to welcome all recent scientific contributions that deal with the effects of oxygen fluctuations and their predictability from micro to macro spatial-temporal scales. Publications in 'The Conversation UK', one of the world's leading publishers of research-based news and analysis, (or similar magazines) will be coordinated with the handling editor due to their interest in the topic of deoxygenation (*i.e.*, https://theconversation.com/from-the-coast-to-the-deep-sea-changing-oxygen-levels-affect-marine-life-in-different-ways-227703)

e. Working plan (logical sequence of steps to fulfil terms of reference, with timeline. Max. 1000 words)

For ToR1 and ToR2 we will challenge the recent technological advances to provide a large portfolio of options for environmental logging. DynamOx WG will (i) review and propose best practice for capturing dissolved oxygen fluctuation experienced by marine benthic systems, (ii) build a free accessible website to provide guidance for logging environmental data and hosting open-access reference guides and software tools, (iii) produce guidelines to implement cost-effective DME and measure community responses to oxygen fluctuations, (iv) development of packages on an open source environment (*e.g.*, R) that allow anyone to use the approaches generated here, or to create their own models, or to extract the data (need to be in a set format/meet certain standards; *e.g.*, MEDIN, Pangaea) they need for understanding patterns of local variability. For ToR3 we will undertake an extensive systematic review on Web of Science including a metanalysis to conceive and test marine indicators able to capture effect of the ecologically relevant environmental fluctuations on organismal/community level. The metanalysis will focus on the effect of the variability and predictability of oxygen on marine benthic ecophysiology (*i.e.*, metabolism, reproduction, and behaviour) and evolutionary ecology (*i.e*., transgenerational plasticity, epigenetics, adaptation). This work will collate available historical time series of oxygen, identify knowledge gaps and develop a baseline for future studies that consider the 'scales of variation' of the oxygen (*i.e.*, from local to global) and the scales of individual responses (*e.g*., physiological responses, molecular mechanisms), grounded on actual patterns of oxygen fluctuations. This work will identify knowledge gaps and develop a conceptual framework to include fluctuations of oxygen into community assemblage and network analysis. Robust environmental data retrieval and marine benthic community responses will serve to implement a set of indicators to assess the level of natural fluctuation and their predictability of environmental marine drivers. A suite of indicators is being looked upon with the objective of providing standards for monitoring early signs of loss of oxygen in rapidly changing environments.

In ToRs 3 and 4, we will create platform to advance our understanding on how to model the data obtained from the new methodology developed to predict benthic ecosystem responses to climate change. We will produce a series of knowledge exchange opportunities for students, scholars, and technicians, including online events on time-series and oxygen fluctuation analysis provided by the DynamOx WG members and their post-graduate students. We will organise internship in the hosting laboratories of the members aimed to assist early career scientists to set experiment on environmental fluctuation and organize training workshops for members to integrate analysis of time series with ecological network analysis. Findings from the DynamOx WG can be integrated into existing capacity building programs, *e.g.,* through the SCOR WG149 activities and can enhance large scale capacity building program like the on the environmental observatory (https://newcastle.urbanobservatory.ac.uk) led by Newcastle University.

To fulfil ToR5, we will outreach to policy makers through to the established networks at regional level (*e.g.,* OSPAR for north Atlantic marine resource management) and international level (Ocean Country Partnership Programme for protection and management of marine protected areas across the world). The output produced by the WG will be broadcasted through the member established networks. The WG will outreach society through several platforms and thanks to direct connection for example to MERI Foundation (https://fundacionmeri.cl/en/fundacion-meri/) and Ocean Leaders (https://oceanleaders.org/).

To achieve the above activities, we propose the following **timeline**:

First year. The kick-off meeting for all WG members will be held in Chile. Non-SCOR funding (e.g. Royal Society International Exchange, UK; Concurso de Fomento a la Vinculación Internacional de ANID, Chile) will be sought to allow students, postdocs, or scientists from developing countries to attend the meeting. This meeting will focus on: (i) discussing the main goals and activities of the team and the conceptual pathways to push these goals forward, (ii) overall planning of the project calendar and logistics (meetings, reviews, document writing, etc.) and specific deliverables (papers, white papers), (iii) assigning of tasks to subgroups that will be leading the ToRs, coordinated by the chairs. A capacity-building subgroup will be created with the overall aim of transferring knowledge and training of students and early career researchers from developing countries during the 3 years (see section *f* for details). Online meetings will be implemented over the year (at least one per month), to achieve deliverables. Starting from the first year and for the entire duration of the project, the WG will publicise DynamOx activities to the society, to prepare the ground for the ToR5 achievement. The latter will be accomplished by approaching scientific journalists to publish public articles, sending articles to online journals (see section *f*), as well as by creating and sharing social media profiles/pages of the WG.

Second year. WG Meeting for all WG members to be held in South Africa. During this meeting, the WG will (i) review the activities and progress on ToRs (ii) work on the delivery, (iii) work on the planning of the online courses to be delivered in the second semester, (iv) preparing the road map to impact that will be defined in the workshop for the third year (see below). During the year, online meetings with subgroups will focus on the preparation and submission of scientific publications and we will review and prepare the final version of the best practice guide for field and DME (see section *f*). Online courses should be uploaded to open platforms over the year. During the second semester, a workshop that will be held at the beginning of the third year (see below) will be advertised through social media and scientific network.

Third Year. A third meeting will be held in UK at Newcastle University Dove Marine Laboratory. The meeting will mainly focus on ToR4 and 5 with the aim to a) raise awareness on the importance of considering oxygen fluctuations and their predictability in marine planning and management initiatives, b) maximise the impact of the WG through the existing network while outreaching to governmental and non-governmental institutions, to maximise the implementation of indicators, standardised approached, methods and forecasting models in marine management decision making.

f. Capacity Building (How will this WG build long-lasting capacity for practicing and understanding this area of marine science globally. Max 1500 words)

Capacity building will be a core component of the DynamOx WG. Using several approaches, we will build capacity by training of students as well as postdocs and research associates from any country with preferential on developing countries. We will create a **web-based portal** using website builders (*e.g.*, https://wordpress.org/) with a shared workspace to **exchange information, papers, and methods, and host interactive tutorials, as well as establish a common framework where students, scientists and technicians can share experiences and ideas.** This platform will echo the activities of each member (courses, scientific contribution, field and laboratory activities) to gain momentum and to reach a wider audience via live feeds on social media (*i.e.*, Twitter). We will **train students and scientists** from any country (with preferential access/waiving of fees for individuals from developing countries), by using **online tools to teach theoretical concepts of the DynamOx project**, such as those techniques implemented to acquire environmental data for ecologically relevant studies, DME, network analysis, marine data management (*e.g.*, MEDIN, https://medin.org.uk/), modelling and sustainable approaches in coastal management. For example, **open and distance learning methods**, through the implementation of **online courses** can be performed using the MooKit software for **"MOOCs for development"** (https://www.mooc4dev.org/) which offer opportunities in sustainable development. DynamOx WG include experts that **coordinated Postgraduate courses**

on species distribution models- SDMs, in biogeography at UNESCO- IODE; while courses on SDM are currently using static approaches considering average on environmental parameter as predictor for marine species distribution, DynamOx WG will provide a new set of indicators (i.e. magnitude, frequency and predictability of the oxygen and possibly other environmental driver considered) to use in predicting species distribution in changing oceans. During the COVID-19 pandemic, the chairs of this SCOR proposal, jointly coordinated the **online "course on basic statistics using R"** (free of charge for Chilean students), which was supported by COSTAR-UV (https://costar.uv.cl/news/55-con-exito-se-lleva-a-cabo-curso-de-programacion-en-r).

The course will be updated by including statistical analysis on time series to estimate oxygen fluctuations and reproposed to a worldwide audience as online course, including for instance students from other developing countries, once a year for the entire duration of the project.

Another area for capacity building will be achieved by distributing an **open access "best-practice" guide**, especially intended to help students and postdocs to design their field and laboratory works during the writing of thesis projects or grant proposals. These guides will be uploaded and shared through the **SCOR collection at the Ocean Best Practices platform.**

In addition to online tools, **one large workshop/training course** will be organised and held upon funding available for non-SCOR support, although participants from developing countries can apply for the SCOR grant to pay for traveling expenses. The workshop will give the opportunity to students and early career scientists to **learn how to improve their understanding of their study environment** and **design and set up dynamic manipulative experiments** which can be successfully applied in **postgraduate thesis, as well as postdoctoral research projects**. This large workshop is intended for **knowledge transfer and capacity building, to promote**

rapid and wide adoption of field and laboratory methodologies reviewed and developed in this WG. We will also seek opportunities to **secure additional funding sources to ensure maximum international participation**, particularly from developing countries not yet involved in DynamOx. To achieve a successful training course, the DynamOx WG could be cooperate in conjunction with the existing **SCOR activity "Changing Ocean Biological Systems (COBS)"** as well as the **non-SCOR Ocean Acidification International Coordination Centre capacity building program** for the developing of high-level training.

We will encourage **a scientist member of** DynamOx **WG to serve as a SCOR Visiting Scholar**, through the SCOR Visiting Scholars program, which will give the opportunity to students from developing countries to get trained and mentored for a minimum of two weeks by an experienced scientist. We will encourage the **co-supervision of thesis projects by senior scientists of** DynamOx **WG** for students from developing countries to offer unique opportunities to network from an early stage with international experts.

Furthermore, the development of a low-cost environmental logging device, which is one of the primary objectives of DynamOx WG, will significantly enhance community engagement within the project. This innovative device will be designed to be accessible and affordable, making it a valuable tool for a wide range of stakeholders, including industry, civil society, schools, and local communities. By facilitating citizen science initiatives, the device empowers individuals and groups to actively participate in environmental monitoring and data collection. This hands-on involvement not only fosters a greater understanding and awareness of environmental issues, but also cultivates a sense of ownership and responsibility towards resolving local ecosystem challenges. Overall, the low-cost environmental logging device stands to create meaningful connections and collaborations across diverse sectors internationally, enhancing the impact and reach of the DynamOx WG's mission. This broad engagement will not only drive the success of the project, but also contribute to the collective effort towards sustainable environmental logging.

Finally, The activities of DynamOx will contribute to two of the United Nation’s sustainable development goals: SDG14 (Life below water) and SDG13 (Climate Action), and to three of the societal goals outlined in the Implementation Plan for the UN Decade of Ocean Science for Sustainable Development to define the ‘ocean we want’ including a healthy and resilient ocean that will ensure continuing delivery of marine ecosystem services to society, a predicted ocean allowing confident predictions of the future state of the ocean to support business and policy decisions, and a transparent and accessible ocean whereby all nations, stakeholders and citizens have access to ocean data and information.

g. Working Group composition (as table). Divide by Full Members (10 people) and Associate Members, taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists (max. 500 words)

Full Members (no more than 10, please identify chair(s)) *=early career researcher/postdoc

Name	Gender	Place of work	Expertise relevant to proposal
Simone Baldanzi (co-chair)	M	Chile	Marine ecophysiology; environmental epigenetics
Marco Fusi* (co-chair)	M	United Kingdom	Microbial ecology; Network ecology, statistical analysis
Francesca Porri	F	South Africa	Larval ecology; marine connectivity; nature-based solutions; indigenous knowledge-led innovations
Ramona Marasco*	F	Saudi Arabia	Microbial Ecology; microbiology, molecular ecology, extreme environments
Eleonora Puccinelli*	F	The Netherlands	Trophic ecology; food webs
Valentina Di Santo*	F	Sweden	Biomechanics and behaviours
Gaitan Espitia*	M	Hong Kong	Phenotypic plasticity; adaptation; functional genomic
Mohamed Ahmed*	M	Kenya	Coastal protection
Joanne Ellis	F	New Zealand	Coastal Ecology; multiple stressors
Fernando Lima	M	Portugal	Global network of biodiversity and thermal data collection; dynamic experiments

Associate Member (no more than 10) *=early career researcher/postdoc

Name	Gender	Place of work	Expertise relevant to proposal
Nicolas Weidberg*	M	Spain	Remote sensing; global change
Sergio Navarrete	M	Chile	Marine community ecology; ecological network analysis
Piero Calosi	M	Canada	Evolutionary physiology; Global Change Biology
Celia Shunter	F	Hong Kong	Evolutionary Ecology

Brezo Martinez	F	Spain	Coastal Marine Ecology, Ecophysiology, Global Change Biology, Distribution Modelling and Biogeography
Alessandro Zaldei	M	Italy	Environmental engineer; modelling
Victoria Cole	F	Australia	Experimental estuarine and marine ecology, global change; Shellfish reef restoration
Stacey Trevathan-Tackett*	F	Australia	Microbial Ecology
Alessia Bani*	F	UK	Coral Biology, Experimental Ecology, Ecological genomics
Hans Dam	M	USA	Transgenerational experiments, adaptation

h. Working Group contributions (max. 500 words)

Simone Baldanzi: is a researcher and professor based at the University of Valparaiso in Chile. His research is focussed on marine invertebrates' responses to environmental changes and local adaptation, including mechanisms of environmental epigenetics. His expertise will connect the study of environmental fluctuation with eco-physiological and molecular responses.

Marco Fusi is a senior lecturer based at Dove Marine Laboratory, Newcastle University. He is interested in the complex mechanisms of interactions among organisms and in statistical time series analysis. His expertise will bridge the study of oxygen fluctuation with eco-physiological responses and community assembly of marine organisms.

Francesca Porri is a professor based at the South African Institute of Aquatic Biodiversity (SAIAB) in South Africa. Her research is centred on larval ecology and ecophysiology, marine connectivity, and recruitment dynamics. She is also dedicated towards human capacity development in the field of coastal ecological engineering. Through her research and focused supervision of postgraduates from rural regions in South Africa, she has the skills and drive for capacity building of individuals from diversified backgrounds.

Ramona Marasco is a research Scientist based at the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. She is a microbiologist and microbial ecologist interested in studying host-microbe interactions in extreme environments, including those occurring in plants and animals in coastal/marine ecosystems. Her expertise will provide a solid background in community network analyses.

Eleonora Puccinelli is an assistant professor at NIOZ, The Netherland. She aims to understand how natural and anthropogenic processes affect food web dynamics in marine environments. Her research will contribute to the effect of environmental fluctuations on food webs dynamics.

Mohamed Ahmed: is a program manager at UNEP Kenya and a PhD candidate at Edinburgh Napier University. He is working on coastal protection and management including coastal restoration in south of Kenya.

Fernando Lima is a researcher based at Research Centre in Biodiversity and Genetic Resources (CIBIO) in Portugal. He is a specialist in intertidal biogeography, studying the mechanisms driving species distributions. His experience based on a multidisciplinary approach will be fundamental to develop our initiative.

Valentina Di Santo is assistant professor of Marine Animal Physiology at Stockholm University, Sweden. She is an experimentalist, eco-physiologist and biomechanist studying fish locomotion. Her work focuses on how locomotor performance of fishes is affected by climate-related stressors such as warming, ocean acidification and hypoxia.

Joanne Ellis is an associate professor based at the University of Waikato in New Zealand. Her research focuses on understanding how human drivers of environmental change, including coastal intensification and climate change. Her expertise will contribute to method development linking fluctuations and extremes in the environmental data with ecological responses and the development of indicators.

Juan Diego Gaitan Espitia is an evolutionary ecologist working as assistant professor at the University of Hong Kong. His works aims to develop better understanding of the mechanisms that influence geographic patterns of phenotypic/genetic diversity in nature, phenotypic plasticity, and micro-evolutionary processes driving local adaptation. He is a contributing author for the IPCC AR6.

i. **Relationship to other international programs and SCOR Working groups (max. 500 words)**

DynamOx WG will have a **strict relationship with the SCOR WG 149 "CHANGING OCEAN BIOLOGICAL SYSTEMS (COBS)"** by liaise with one of the WG149 member Dr. Sam Dupont, because it will advance the framework of investigation on how climate change will shape the future of marine biota by focusing on the role of the oxygen fluctuation.

Links could be made between the DynamOx WG and the **Marine Alliance for Science and Technology for Scotland (MASTS) thanks to Dr Marco Fusi who is part of the Steering Committee of the Marine Climate Change Forum.** MASTS consists of a consortium of organizations engaged in Marine Science in Scotland and the Marine Climate Change Forum provides a focal point for climate change related research within the MASTS community. Likewise, the initiative will be advertised in the **Mangrove Microbiome Initiative (MMI)** that aim to gather and disseminate novel procedures for environmental monitoring in mangrove ecosystems. Dr Marco Fusi will also increase the visibility of DynamOx thanks to the **existing networks in governmental and non – governmental program and initiatives in UK and worldwide like The UK Blue carbon forum, JNCC (Joint Nature Conservation Committee as part of the UK Department for Environment, Food & Rural Affairs)** and the Newcastle University Urban Observatory.

Dr Fernando Lima through the **Electric Blue technology transfer start-up coop** (https://electricblue.eu/), and Dr Alessandro Zaldei from the National Council of Research in Italy (https://www.ibe.cnr.it/) will share their state-of-the-art technology and methodology in environmental logging with the research team leading DynamOx WG, facilitating their employment in the field and in the data collection, storage and use. Alessandro Zaldei developed low-cost real-time system of data collection that can serve as repository for long term time series collection: see https://airqino.magentalab.it/.

Dr Simone Baldanzi through the **Centro de Observación y Análisis del Océano Costero** (COSTA-R UV; https://costar.uv.cl/) and **Laboratorio de Ecofisiologia y Ecología Evolutiva Marinas** (*e*°CO_2lab) from the Faculty Sciences of the Valparaiso University will provide support to the Project, hosting the first meeting and offering field assistance for sensor deployment and logistical support. We are in contact with Andreas Oschlies, the Chair of the Global Ocean Oxygen Network (GO2NE; https://en.unesco.org/go2ne), to ensure interaction between DynamOx and the network in terms of capacity building, result dissemination and research in understanding the role of oxygen fluctuation in marine benthic ecosystems. Dr Marco Fusi and Dr Ramona Marasco are also part of the worldwide research project Tea composition H2O (https://www.bluecarbonlab.org/teacomposition-h2o/) for which understanding oxygen dynamics in marine benthic communities can explain patter of carbon degradation in blue carbon ecosystems.

j. Key References (max. 500 words)

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Appendix

For each Full Member, indicate 5 key publications related to the proposal.

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1. **Baldanzi S**, Storch D, Fusi M, Weidberg N, Tissot A, Navarrete SA, Fernández M (2020) Combined effects of temperature and hypoxia shape female brooding behaviors and the early ontogeny of the Chilean kelp crab *Taliepus dentatus*. Marine Ecology Progres Series 646: 93-107.
2. Fusi M., Marasco R., Ramond J.-B., Barausse A., **Baldanzi S.** (2022). Fluctuating Habitats: Ecological Relevance of Environmental Variability and Predictability on Species, Communities, and Ecosystems. *Frontiers in Ecology and Evolution,* 10.3389/fevo.2022.907622.
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