From the Ocean to the Lab to the Ocean: best practices for ecologically sound inferences in fluctuating habitats

Ocean-Lab-Ocean (OLO)

Chair: Simone Baldanzi

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Title: **From the Ocean to the Lab to the Ocean: best practices for ecologically sound inferences in fluctuating habitats**

Acronym: Ocean-Lab-Ocean (OLO)

a. **Summary/Abstract (max. 250 words)**

Environmental fluctuations shape the diversity of species, communities, and assemblages in the ocean and is therefore of fundamental importance to ecosystems. Yet fluctuations of the environment are often labelled as noise or completely overlooked, with the risk that effects of environmental change on organisms are mis-estimated. The OLO initiative will bring together a diverse community of scientists to advance research in ocean sciences by providing open access, high quality standards and principles of responsible research and innovation (RRI) to underpin robust ecological inference in fluctuating environments. Specifically, OLO will fulfil the urgent demand for standardized methods and protocols to measure environmental variation in space and time at ecologically relevant scales and establish informative designed experiments by: (i) identifying critically overlooked environmental variables and variance scales, from the organismal perspective; (ii) providing guidelines for appropriate mimicry of environmental variability on laboratory experiments; (iii) implementing realistic models to propagate organismal variation into the dynamics of complex ecological networks in fluctuating environments; (iv) providing practical application of results from laboratory experiments for ecological restoration; (v) informing society on the eco-evolutionary consequences of our inherently fluctuating environment to support active and adaptive management of coastal and marine ecosystems. The OLO initiative, through the publication of high-quality scientific papers, inter-disciplinary guidelines and training of young scientists, will impact the ocean sciences community at large. By providing concrete guidelines and cross-disciplinary examples, it will accelerate the transition towards the problem-oriented and interdisciplinary science needed to build the new narrative for the ocean.

b. Scientific Background and Rationale (max 1250 words)

Life in the oceans is shaped by trends, cycles and stochasticity. It is exactly these fluctuations which may mitigate the net impact of a given stressor, increase physiological tolerance and promote adaptation to novel environmental conditions (*1*). For example, fluctuations around a sublethal stressful mean (e.g., hypoxia) may represent alternating phases of (i) high stress (e.g., anoxia) with partial mortality, (ii) low stress (e.g., normoxia) with the potential for recovery, growth and reproduction and (iii) absence of stress (e.g., hyperoxia) with potential for increase tolerance to other stressors (*2*, *3*). Coastal areas are characterized by a heterogeneous scale of environmental variability (*4*, *5*) and new evidence suggests that the magnitude and periodicity of extreme events could be altered in the near future, with significant implications for marine species survival, biodiversity levels and ecosystems' functions (*6*). With the global coastal human population projected to surpass one billion people this century (*7*), it is imperative to understand the effect of costal urban conglomerates and marine infrastructure on microclimatic variability and how they create a level of complexity that differs from natural habitats (*8*). Additionally, urban settings also alter fluctuations in non-climatic variables, e.g., through light and sound. For example, Artificial Light at Nights (ALAN) are characterized by distinct spatial, temporal and spectral patterns that can alter natural fluctuations of light and dark, with consequences across levels of biological organization (*9*). Studies on how fluctuations affect ecological and evolutionary processes are thus urgently needed to inform biodiversity conservation strategies under global change (*10*). Despite the recognition that fluctuations dictate life in natural as well as altered habitats, biologists still largely adopt the 'mean conditions paradigm' when it comes to investigate the effect of the 'environmental change' on physiological and ecological processes through both, laboratory experimental and theoretical approaches (*11*, *12*). Furthermore, an important aspect related to environmental fluctuations is the potential **predictability** that emerges when environmental variables are temporally or spatially autocorrelated ('coloured noise'), creating opportunities for individuals to anticipate and adjust to the near future (physiologically bearable) conditions (*13*). It is critical, therefore, to define these decorrelation timescales in ocean processes [e.g., 15], yet few studies have tested environmental predictability in marine ecosystems [14; but see

16,17], and there is a dearth of knowledge about how and to what extent fluctuations and 'predictability' change between urban (human-altered) and natural frameworks. Recently, the experimental manipulation of environmental drivers and the response of organisms to multiple climate change-related stressors has received considerable attention (*17–19*). The SCOR project "Changing Ocean Biological Systems" (COBS https://scor-int.org/project/changing-ocean-biological-systems-cobs/) seeks 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. Stochasticity is, however, still not explicitly considered within the COBS project, and, where variation is incorporated, the variance is insufficient in comparison to natural fluctuations. In situ measurements of environmental variables (pH, dissolved oxygen concentrations, temperature) in a range of coastal marine habitats including estuaries, kelp forests, coral reefs, mangroves and upwelling regions (*3*, *20–22*) reveal considerable natural fluctuations, often over short (diel) timescales (e.g., (*3*, *23*)). Several recent studies have considered fluctuations within their experiments (*24–28*) finding that contrasting results (e.g. higher tolerance) emerge when fluctuating- rather than constant conditions are considered. We argue that including both variance and spatio-temporal autocorrelation of fluctuations (including frequency, duration, and magnitude) around mean values will improve our understanding of organismal physiology, biodiversity, ecological networks, ecosystem processes, and evolution (*13*, *29*). Measuring the environment as organisms experience and incorporating those variations within laboratory-based experiments will provide new insights with respect to the true role of environmental conditions in ecosystem structure and functioning (e.g., *30*).

The challenge

There is a clear **need for experiments to better reflect (mimic) conditions** experienced by organisms in nature as well as **measure response variables that can be scaled up to populations** to obtain a 'true' reflection of functioning and understanding of organismal (and community) resilience to climate change. The challenge in this SCOR proposal is threefold. First, effort should be placed on **reframing and underscoring the collection of *in-situ* environmental data** over multiple (interannual; seasonal, intra-seasonal, synoptic, diurnal, semi-diurnal) scales and contexts (e.g., natural and urban/peri-urban systems) to improve characterisation of conditions which living systems

are exposed to (i.e., the spatio-temporal fluctuations in niche suitability) and the capability to calculate niche condition predictability. Secondly, emphasis should then be placed on **replicating the most 'biologically-relevant' fluctuations of those climatic and non-climatic variables in multiple contexts** (e.g., natural, urban or peri-urban areas) and across temporal scales using laboratory-based and/or small field-based experiments, thereby implementing **dynamic manipulative experiments (DME).** All scales of variation can affect an individual's response, and hence we will find a consensus among eco-physiological scientists and information about population regulation to decide on the immediate biological-relevant fluctuation scales. Third, **outcomes must be synthesised and disseminated to decision-makers to support justification for existing, or development of, new conservation and management interventions** (e.g., restoration projects, *31*) that maximise **environmental sustainability** and the likelihood of meeting **UN Sustainable Development Goals (SDGs)**. Much of management interventions is aimed at achieving specific goals, such as the construction of hectares of reef or increase in commercially important fish stocks (*32*). It is difficult to determine ecologically meaningful goals unless there is a clear understanding of the system given the variable conditions (e.g. *32*).

Why a SCOR Working Group?

Regardless the current strong multidisciplinary effort put forward by scientists to advance knowledge in manipulative experiments, two core aspects are still overlooked. First, **environmental variability is overshadowed** by the traditional, and sometime necessary, reductionist approach followed in manipulative experiments (*e.g*., few drivers or use of average values). Here, we highlight how exposing organisms to fluctuating conditions for a long/medium term could bring up new understanding of ecological responses to climate variation (*34*, *35*), including the effect of past environmental fluctuations on present-day organismal and community responses (environmental/climate legacy, *sensu* (*36*)). Secondly, even though most biological systems, from individuals to ecosystems, have long-term memory (past experience that transform the system and conditions new responses), our understanding of its consequences remains vague, at best. We must therefore push forward this understanding to include the **environmental/climate legacy as explanatory variable to study individuals and community-level interactions under a fluctuating**

environment. It is therefore critical to identify the individual-based variables that can modulate population-level responses that ultimately shape the niche of the species. Through the implementation of Ecological Network Analysis (ENA), we can investigate and model the effects of the environmental fluctuations on the realized niche of the component species, and assess the dynamics, resilience, and robustness of complex multi-species communities from multiple contexts [36, 37,38].

The integrative and broad approach of OLO WG is based on (i) improving the understanding of the realistic environmental effects at the organismal level, (ii) providing guidelines for appropriate mimicry of environmental variability on laboratory experiments, (iii) implementing models to understand the dynamics of complex ecological networks in response to environmental fluctuations; (iv) providing practical application of results from laboratory experiments for ecological restoration to support improved management of coastal areas and ocean resources, as proposed by world leading rehabilitation projects (e.g., *31*, *39*). These avenues of research represent an innovative area within the field of ecological sciences, which will impact the larger ocean sciences community such as marine molecular, and evolutionary ecologists, eco-physiologists, climatic modelers, geographer, and experts in climate change as well as inform urban and marine landscape ecologists on how to preserve, improve and facilitate the restoration of the Natural Capital of the oceans.

c. Terms of Reference (max. 250 words)

1. Identify, quantify, and prioritise through a systematic review and published protocols, the knowledge gaps on field and laboratory-based research to develop a conceptual framework that accommodates the 'scales of variation' and the scales of biological responses (e.g., species interactions, physiological responses, molecular mechanisms), grounded on actual patterns of environmental fluctuations.
2. Produce an open-access manual of best-practice methods, generate educational, graphical abstracts of the processes and tools for field investigations of organismal and community responses under fluctuations in both natural and urban frameworks.
3. Develop habitat-specific (including urban habitats) new practices and methodology for implementing dynamic manipulative experiments (DME) and modelling based on how biological systems (from organisms to communities) filter, integrate, respond to, and anticipate environmental fluctuations at the ecologically relevant spatio-temporal scales.
4. Develop methods that provide practical application for- and integrate monitoring of ecosystem responses to restoration actions for sustainable approaches in coastal management with particular focus on seascape architecture and urban ecology, in line with the UN 2030 Agenda for Sustainable Development and UN sustainable development goals (SDGs 1-2-9-13-14).
5. Build capacity on environmental data-logging, ecologically relevant DME and network analysis, share knowledge on methods for monitoring ecosystems response to restoration actions, and transfer technical skills, particularly to scientists and students in developing nations.

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

The main activities for the work plan are:

a. ToR1: Undertake an extensive **systematic review and published protocols** to build holistic viewpoint of the effects of fluctuating environments on marine organisms, community assembly and responses. In specific areas of intensive 'factor-response' research, we will conduct a formal meta-analysis to assess changes in response effect sizes under different fluctuating regimes. More generally, the review will provide information that can be used to (i) assess the flaws of current static experimental approaches and promote experimental procedures able to reproduce sufficient environmental fluctuation and deliver reliable outputs, and (ii) infer on the current estimation of how climate change affects living systems in the ocean.

b. ToR 2 and 3. We will share expertise in conceiving **new field sampling protocols and set-up of dynamic manipulative experiments** to establish benchmark practices to investigate and reproduce ecologically relevant environmental fluctuations and their effect on ecosystem structure and functioning. Recent technological advances can provide a large portfolio of options for environmental logging. OLO will (i) review and propose best practice for capturing environmental variation experienced by marine biota across different ecosystems, (ii) build a website (e.g., https://www.wix.com/; https://wordpress.org/) providing guidance for logging environmental data and hosting open-access reference guides and software tools. **Guidelines for field sampling and measuring community responses** to environmental fluctuations will be developed and published. The WG will also define standards to reconstruct network interaction among species using molecular analysis, supported by latest remote sensing, acoustic and operative techniques. This will provide the basis for laboratory DMEs that mimic environmental fluctuations and allow assessment of the response, assembly, and networking of the marine communities.

c. ToR4. OLO will create a dedicated session to advance our understanding how ToR2 and 3 will contribute to **inform society** about methods that integrate monitoring of ecosystem responses to restoration actions in those particularly variable socio-ecosystems, such as

urban systems, to restore, rehabilitate and promote resilience among the marine community. Although restoring the natural range of environmental dynamics may be impossible in such highly human-constrained environments, where multiple stressors act in conjunction on deeply modified systems, such methods are scarce. In this context, a suite of indicators is being looked upon with the objective of providing standards for monitoring early signs of water quality variations and degradation in such rapidly changing environments.

d. ToR5. Create the *OLO teams* to **produce a series of knowledge exchange opportunities** for students, scholars and technicians, production of online courses on time-series and fluctuation analysis accessible by all OLO members and their post-graduate students, internship in the hosting lab of the members aimed to form early career scientist to set experiment on environmental fluctuation and provide workshop to train the member to integrate analysis of time series with ecological network analysis.

First year. The **kick-off meeting** for all WG members will be held in **Chile**. Non-SCOR funding 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 of the team and the conceptual pathways to push these goals forward, (ii) overall planning logistics (meetings, reviews, document writing etc) and specific deliverables (papers, white papers, workshops), (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 *e* for details). Specifically, online courses on thematic related to ToR2, 3 and 4 will be developed to be delivered in the second semester of the year. Online meetings will be implemented over the year (at least four), to achieve ToR1 and 5 deliverables and to plan the best practice guide for field and DME (see section 5). Starting from the first year and for the entire duration of the project, the WG will publicise OLO activities to society to achieve ToR2. This will be accomplished by approaching scientific journalists to publish public articles, sending articles to online journals (see section *e.*) as well as by creating and sharing social media profiles/pages of the OLO WG.

Second year. WG **Meeting for all WG members** to be held in **South Africa**. During this meeting, the OLO WG will (i) work on the delivery of ToR1, (ii) work on the planning of the online courses to be delivered in the second semester, (iii) closely plan to advance with ToR2 and 3 deliverables, (iv) preparing the workshop for the 3rd year (see below). During the year, online meetings with subgroups will focus on the preparation and submission of scientific papers for ToR2 and 3 and we will review and prepare the final version of the best practice guide for field and DME (see section *e.*). Online courses should be uploaded to open platforms over the year. During the second semester of the second year, a workshop that will be held at the beginning of the third year (see below) will be advertised through social medias and through emails.

Third Year. A **third meeting** will be held in **Portugal**. The meeting will mainly concentrate on two aspects, concerning ToR4 and 5. First, raising awareness of the importance of eco-engineering solutions to the challenge of coastal adaptation to anthropogenic impacts by publishing and disseminate guidelines (see section *e.*) that will be prepared and submitted during the third year. Second, we will develop the content for a **large hybrid workshop** (50% laboratory- and 50% field based) that will be held at the Research Center in Biodiversity and Genetic Resources (CIBIO) hosted by Dr Fernando Lima immediately after the OLO meeting#3 with those members that express full intention to participate. This workshop will serve as capacity building to achieve the ToR5 and it is explained in detail below (see section *f*)**.**

e. 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 1-3 and ToR 1). A a **systematic review and published protocols** (tentatively titled "*The importance of ecologically relevant studies in field and laboratory experiments for understanding environmental change and improving societal impacts"*) in an open-access peer-reviewed scientific journal. In addition, the overall OLO scientific activity/results will be disseminated to a wider audience by **publishing articles** in online journals, such as *The Conversation Global* (https://theconversation.com/global) and social media (e.g., Twitter).

(Years 2-3 and ToR 2-3). Produce a **guidance document** summarizing best practices/protocols for: (i) capturing environmental fluctuations *in-situ* and their predictability; (ii) reproducing ecologically relevant laboratory DME (see for example (*30*)). These protocols will be **deposited in the SCOR collection at the Ocean Best Practices platform** (https://www.oceanbestpractices.org/). In addition, **two scientific publications** will be submitted to open-access peer-reviewed scientific journals. The tentative title of publication#1 will be "*From the field to the lab: depicting and reproducing environmental fluctuations for ecologically relevant experiments*"; the tentative title of publication#2 will be *"Modelling environmental variability and fluctuation to understand marine ecological networks*".

(Years 2-3, ToR 4). Produce two peer-reviewed publications: (i) a **systematic review and published protocols** on the last advances in urban ecology for the monitoring of ecosystem responses to restoration projects in human impacted habitats; (ii) **a publication** of the most relevant variables to be measured in urban/impacted habitats for representing the dominant assets of stress factors in a given area, and how reproducing the environmental dynamics through DME. Protocols will be deposited in the SCOR collection at the Ocean Best Practices platform.

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 OLO WG. To build capacity and training of students as well as postdocs and research associates from developing countries, we will use several approaches:

1. We will create a **consortium of laboratories to establish a common framework where students, academics and technicians can share experiences, ideas and methodologies**. This will be achieved by the creation of a **web-based portal** using website builders (e.g., https://www.wix.com/; https://wordpress.org/) with a shared workspace for **exchange of information, papers, and methods, and host interactive tutorials**. This platform will echo the activity of each members (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).

2. 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 OLO project**, such as those technique implemented to acquire environmental data for ecologically relevant studies, DME, network analysis, modelling and sustainable approaches in costal 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. In January 2021, the chair and co-chair 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 of environmental fluctuations and reproposed to a wider audience that will include students from other developing countries for the entire duration of the OLO WG project.

Another trajectory for capacity building will be achieved by distributing **open an access "best-practice" guide**, especially intended to help students to design their field and laboratory works during

the writing of thesis projects or postdocs during the writing of grant proposals. These guides can be uploaded and shared through the **SCOR collection at the Ocean Best Practices platform**

3. 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 the travel. The workshop will give the opportunity to students and early career scientists to **learn how to improve their understanding of their 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 OLO. To achieve a successful training course, the OLO 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.

4. Furthermore, we will encourage **a scientist member of OLO 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 at least two weeks by an experienced scientist.

5. We will encourage the **co-supervision of thesis projects by senior scientists of OLO** for students from developing countries to offer unique opportunities to network from an early stage with international experts.

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 (chair)	M	Chile	Marine ecophysiology; environmental epigenetics
Marco Fusi* (co-chair)	M	UK	Mangrove restoration; marine ecophysiology; microbial ecology; network ecology
Francesca Porri	F	South Africa	Larval ecology; marine connectivity; urban ecology
Ramona Marasco	F	Saudi Arabia	Microbial Ecology; molecular ecology
Eleonora Puccinelli*	F	France	Trophic ecology; food web; fatty acids
Nicolas Weidberg*	M	Spain	Remote sensing; global change
Antony Knights	M	UK	Marine population dynamics, ecosystem structure and functioning; modelling
Paula Pattrick*	F	South Africa	Shallow water ecosystem ecology, ichthyoplankton taxonomy
Laure Carassou	F	France	Fish trophic ecology; urban ecology
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
David Wethey	M	USA	Global change; sediments; physical environment; modelling
Sergio Navarrete	M	Chile	Marine community ecology; ecological network analysis
Andrea Anton Gamazo	F	Spain	Oceanography, Global Change and Invasive species
Laura Agusto*	F	Hong Kong	Outreach; capacity building expert; science communicator
Louise Firth	F	UK	Conservation; Urban Ecology
Alberto Barausse*	M	Italy	Environmental engineer; modelling
Victoria Cole	F	Australia	Intertidal marine ecology, global change; Shellfish reef restoration
Sam Dupont	M	Sweden	Ocean Acidification; multiple driver experiments; WG149 member
Celia Schunter	F	Hong Kong	Evolutionary and molecular ecology; environmental change

h. Working Group contributions (max. 500 words)

Simone Baldanzi: is a 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 reproductive plasticity, thermal physiology and environmental epigenetics. His expertise will connect the study of environmental fluctuation with eco-physiological and molecular responses.

Marco Fusi is a Postdoctoral Researcher based at The Edinburgh Napier University in the United Kingdom. He is interested in the complex mechanisms of interactions among organisms at several levels, ranging from molecular to physiological and behavioural analysis. His expertise will bridge the study of environmental fluctuation with eco-physiological responses and community assembly of marine organisms integrating logging technology with molecular and physiological methods.

Francesca Porri is a Senior Scientist 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 involved in project related to urban ecology of coastal area. 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 th King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. She is interested in studying plant-microbe interactions in extreme environments, including hot and cold desert, salty system, and coastal-marine areas. Her expertise in many molecular approaches to study microbial-plant interaction under stressing and fluctuating conditions will allow to include microbial communities in network analyses.

Eleonora Puccinelli is a Postdoctoral Researcher based at the Laboratory of Environmental Marine Sciences (LEMAR) in France. She aims at understanding how natural and anthropogenic processes affect food web dynamics in marine environments and which are the consequences of these variations on ecosystems functioning and associated services. Eleonora's innovative and multidisciplinary research will contribute to the effect of environmental fluctuations on food webs dynamics.

Nicolas Weidberg is a postdoctoral researcher based at the Coastal Ecology Group of the Universit of Vigo, Spain, and at the Biological Sciences Department of the University of South Carolina, USAHe is interested in zooplankton distributions, larval dispersal, nearshore ecology and oceanography, remote sensing and climate change effects on environmental variability. His expertise are unique to develop the best methods to measure environmental variability at relevant scales.

Antony Knights is an Associate Professor in Marine Ecology at the University of Plymouth in the United Kingdom. His research focuses on understanding the structure and functioning of marine ecosystems and predicting how species respond to environmental change. His contribution to this project is multifaceted, ranging from modelling of community dynamics and responses to environmental fluctuations, to network analysis and ecosystem management.

Laure Carassou is a researcher based at the National Research Institute for Agriculture, Food and Environment (INRAE) in France. Her research includes ecology of restoration projects, as well as conservation ecology adapted to urban frameworks, or functioning of food webs in diverse aquatic systems. Her field, laboratory and experimental approaches contribute to support the establishment of biodiversity preservation strategies in estuarine and associated urban and peri-urban environments. Her contribution will be fundamental on setting the framework for the urban ecology part of the project.

Paula Patrick is a postdoctoral researcher based at the South African Environmental Observation Network (SAEON) Elwandle Coastal Node. Her research focuses on aspects of the early life history of marine coastal fishes including taxonomy, physiology and ecology. She has also been involved in research related to urban coastal ecology.

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 processes and mechanisms driving species distributions, and the mechanistic links between climate, thermal stress, physiology, and macro-ecological processes. His experience based on a multidisciplinary approach, including climatology, biogeography, electronics, experimental ecology, behaviour, physiology and modelling will be fundamental to develop our initiative

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

OLO WG will have a **strict relationship with the SCOR WG 149 "CHANGING OCEAN BIOLOGICAL SYSTEMS (COBS)"** 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 environmental fluctuation of marine habitats on the marine biota assembly and networking. OLO associate member Dr Sam Dupont will ensure the integration of the two working group subjects in order to produce novel outputs. Furthermore, Dr Dupont will facilitate the **sharing of information with the Ocean Acidification International Coordination Centre capacity building program** (https://www.iaea.org/services/oa-icc/building-capacity).

OLO WG will also be echoed in the **Marine Alliance for Science and Technology in UK thanks to Dr Marco Fusi that is part of the Steering Committee of Marine Climate Change Forum** that is contributing to inform the governmental agency Marine Scotland for the best practice to buffer the climate change detrimental effect along the Scottish marine environments.

Dr Fernando Lima will provide all the necessary conditions (i.e., reservation of a fully equipped auditorium, organization of transportation, accommodation, and meals) to host a project workshop at

CIBIO/University of Porto, Portugal, in the 3rd year of the project. In addition, Dr Lima, through the **Electric Blue technology transfer start-up coop** (https://electricblue.eu/), will share their state-of-the-art technology and methodology in environmental logging with the research team leading OLO, facilitating their employment in the field.

The ***Coastal Observation Center for Marine environmental Risks of the Valparaiso University*** (https://costar.uv.cl/) will provide support to the Project, offering field assistance for sensor deployment and logistical support for meetings and workshop.

The **Coastal Ecosystems & Global Environmental Change Lab (ECCALAB)** from the University of Concepcion (Chile), will support the project by hosting a visit to the micro/mesocosm at the Marine Biology Research Station in Dichato (Concepcion, Chile) which represent a great opportunity for students and early researcher to learn about a state-of-the-art laboratory for simulating environmental fluctuations.

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Appendix

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

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3. **Baldanzi S.** Watson R, McQuaid C, Gowus G, Porri F. (2017) Epigenetic variation among natural populations of the South African sandhopper *Talorchestia capensis. Evolutionary Ecology 31:77–91*
4. **Baldanzi S**, Fusi M, Weidberg N, McQuaid CD, Cannicci S, Porri F (2015) Contrasting environments shape thermal physiology across the spatial range of the sandhopper *Talorchestia capensis.* Oecologia. DOI 10.1007/s00442-015-3404-5.
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