

REV Ocean

SCIENCE AND SOLUTIONS PROGRAMME

2020-2030

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1. Introduction

REV Ocean is a not-for-profit company created with one overarching purpose and ambition: to improve the ocean's health. We need more data and knowledge to understand the environmental impacts of human activities on the ocean, we need to make the knowledge available, and to transform that knowledge into concrete solutions. That is the REV Ocean action agenda.

REV Ocean will seek solutions to three of the most significant drivers of ocean degradation today:

- Plastic pollution
- Climate change impacts, including ocean warming, acidification and hypoxia
- Overfishing and environmental impacts of fishing

This document outlines the REV Ocean Science and Solutions Programme (SSP), which will be conducted, mainly, on the REV Ocean vessel and includes:

- Identification of the core research questions that will lead to new knowledge and innovation.
- Description of solution-type actions that can result from operations on board RV *REV Ocean*.
- Central role of diversity, equity and inclusivity considerations for the REV Ocean programme to succeed.
- Measures to assess the success of the REV Ocean Science and Solutions Programme.

2. What makes the REV Ocean vessel unique?

RV *REV Ocean* is one of several research ships funded through philanthropy in operation around the world. These vessels are used in a combination of activities including exploration, research and communications. Amongst these vessel operators, RV *REV Ocean* will focus on solutions to current ocean challenges globally in the following ways:

- It is aimed at undertaking research into major challenges to ocean health that will lead to solutions to these problems.
- It will support high-risk-high-reward research and innovation.
- It gives priority to young, unestablished scientists and scientists from small island developing states and developing nations.
- It has an extended range and endurance.
- RV *REV Ocean* is, in itself, unique in terms of being purpose-built, its size, global range of operations, green technology, range of equipment and abilities to support large (up to 55 science and technician berths), multidisciplinary projects.
- RV *REV Ocean* is particularly well suited as a testing platform for new technologies and sustainable business concepts, which is reflected in the "Selection Procedure for Science Projects".
- RV *REV Ocean* forms part of an integrated approach to solving ocean challenges through science, business, policy, awareness raising, education, capacity building and the use of data tools.
- In terms of data management, activities are coordinated and integrated with its sister organisation [HUB Ocean](#) and the Ocean Data Platform (ODP), an open collaborative tool that unlocks and aggregates ocean data to encourage scientific collaboration, industry transparency and regulatory power.

- The REV Ocean Science and Solutions Programme is based on multidisciplinary and transboundary research and innovation, involving a range of experts from natural sciences, social sciences, economics, business, policy and governance, and communications to find and promote the implementation of solutions to complex problems affecting the ocean.
- The REV Ocean Science and Solutions Programme will focus on innovation to identify solutions to ocean health challenges, including scientific and technological innovation, but also innovations in policy, awareness raising, education and capacity development.
- Solutions to ocean health challenges will be sustainable in the long term through commercialisation of new technical innovations, adoption of new practices that lead to long-term gains in ocean health, as well as in economic sustainability through value creation, and by changes in regulation at international, regional and local (coastal state) levels.
- RV *REV Ocean* will also be a “think tank” through hosting solutions-focused workshops, “show-and-tell” cruises and other activities aimed at creating a healthy ocean.
- The RV *REV Ocean* will operate in two modes:
 - **Science and Solutions:** the vessel will be provided to experts around the world to conduct ground-breaking research, test novel technologies and methodologies, organise think-tank workshops and high-level policy meetings, contribute world-class footage and content for ocean documentaries and awareness raising, and conduct educational and capacity development programmes.
 - **Charter:** the vessel will provide discerning travellers the unique opportunity to explore the ocean in a totally different way, offering life-changing experiences. Opportunities will include expeditions with world-leading researchers, innovators and guides who deliver extraordinary experiences for custom cruises in some of the most remote and exotic locations in the world. The revenue generated during the Charter mode will be re-invested in supporting the Science and Solutions mode.

As many other research vessel operators, RV *REV Ocean* will be operated under a code of conduct with clear actions to ensure zero tolerance to any sort of discrimination, harassment or bullying on board.

3. The REV Ocean Science and Solutions Programme

Priority areas

Although REV Ocean recognises the variety of challenges the ocean faces today, we chose to focus on the 3 priority areas stated above for the science programme 2020-2030: plastic pollution, climate change and overfishing and impacts of fishing.

The REV Ocean Science and Solutions Programme will focus on specific topics within the three priority areas as outlined below. The SPP will undergo a light-touch review annually by the Science and Innovation Advisory Board (SIAB) and a major review every three years. However, the SIAB will remain flexible in reviewing specific requests or changes in direction where they offer a high likelihood of impact on a regional ocean problem or to support specific international efforts, such as the UN Decade of Ocean Science for Sustainable Development.

In addition to the research priority areas, REV Ocean has a clear goal of ensuring diversity, equity and inclusivity (DEI) in its science and solutions programme and all operations. To this aim, several specific actions have been adopted and are described in Section 4 in this document and [REV Ocean's DEI statement](#).

3.1. Plastic pollution

Five to 12 million tons of plastic are entering the ocean each year, with an increase of an order of magnitude predicted by 2025. Marine plastic debris is ubiquitous in the marine environment, with the large ocean gyres acting to gather this material in oceanic waters. Plastic debris has been recorded as impacting at least 700 marine species through entanglement and ingestion and is sufficient to contribute to extinction risk in some species (e.g. monk seals). Plastics are incorporated into the base of the food chain and have been found throughout the tissues of human food fish such as anchovies and sardines. However, many aspects of the distribution of marine plastic debris, including microplastics, its impacts on marine species and the role of plastics in exposure of marine life, and ultimately humans, to toxic chemicals are unclear. The result of this is that identifying effective solutions to the marine plastic pollution problem is difficult. The influence of plastics on processes at the ecosystem level are not understood, although it is suspected that they may represent a planetary-boundary threat (largely irreversible impact on Earth-system scale processes). The new knowledge acquired by REV Ocean will contribute to the negotiations and implementation of the UN Global Plastics Treaty. Key areas of research include:

- Improved resolution of the **distribution and transport** of plastics in the ocean through continuous monitoring, specific research activities and technological innovation (e.g. to collect and measure concentrations of micro- and nano-plastics). This knowledge will enable the **development of business and management solutions** to the marine plastic pollution problem.
- Assessment of the **impacts** of plastics on **ecosystems and ecosystem functions** (e.g. the ocean carbon cycle) to elevate and drive the **political and legal process** to eliminate input of plastics into the ocean, for example through the UN Global Plastics Treaty currently under negotiation.
- Assessment of whole **life-cycle risk** of plastics on **threatened marine species** for identification of specific solutions to **mitigate these risks**, including technical innovations leading to **long-term business solutions** (e.g. development of perishable fishing gear; targeted and economically sustainable removal of plastic debris).
- Assessment of the **toxicological risks** of marine plastics to the health of marine ecosystems and, in turn, to humankind, to identify how to **mitigate such risks** through technological, commercial, political and other solutions.

3.2. Climate change impacts (including ocean warming, acidification and hypoxia)

Greenhouse gas emissions are now driving large-scale physical, biological and biogeochemical changes throughout the ocean. Effects include ocean warming, acidification and deoxygenation and have already resulted in significant shifts in populations of marine species (e.g. krill), damage to marine ecosystems (e.g. coral reefs, regime shifts of kelp forests) and habitat loss with associated loss of ecosystem services (e.g. Arctic sea-ice). Yet, understanding the full impacts of climate change on marine ecosystems and at the Earth-system level, including climate feedbacks, is still lacking in observations and studies linking cause to effect. Therefore,

predicting how the ocean will change in the future and how to mitigate such changes is extremely difficult. The REV Ocean Science and Solutions Programme will focus on identifying the risks arising from climate change to Earth system-level processes (e.g. processes that feedback positively or negatively to atmospheric CO₂-levels) as well as to marine ecosystems in the context of ecosystem service provision. The aim will be to help drive climate negotiations at an international and national level and to identify strategies to mitigate climate change and its negative impacts on ecosystems and humankind. Key areas of research include:

- Research on **processes** within the ocean that may **feedback strongly to the atmosphere and climate**, especially tipping-points to drive implementation of **CO₂-emission reduction programs** through **policy** change at national, regional and international levels.
- Understanding the **biological carbon pump**, especially the active transport of carbon into the deep ocean. This will ensure that human activities, such as fishing, are managed so that the biological carbon pump is maintained or enhanced. This research will also ensure that active biological transport of carbon into the deep sea is accurately represented in **Earth system models** used for **predicting the effects of climate change in the future**.
- Research into how **marine ecosystems** can be used to **mitigate climate change** (e.g. blue carbon, restoration) so that they can be **included in carbon accounting** and managed to maximize their impact on CO₂-sequestration. This should enable a framework for developing **new financial mechanisms or commercial approaches** to habitat conservation, restoration or cultivation.
- Research on the positive and/or negative impacts of **Carbon Dioxide Removal approaches**, such as sinking kelp to the deep sea. Understanding the consequences of such methods will contribute to their **sustainable development and legislation**.
- Research to understand the likely **impacts** of climate change on **other aspects** of biodiversity, ecosystem function and service provision and to identify solutions to **mitigate** such impacts (e.g. restoration of coral reefs, specimen banks of endangered coral species).

3.3. Overfishing and environmental impacts of fishing

Marine capture fisheries, including finfish, shellfish (crustaceans and molluscs) and other invertebrates, are an essential element of human nutrition and contribute to global food security. With a growing human population, demand for fish is set to rise by at least 30 % by 2050. However, up to two-thirds of the world's fish stocks are overfished and the World Bank estimates that, in economic terms, \$83 billion is lost per annum as a result of poor fisheries management. There are multiple drivers of overfishing, including that 23 % of global fisheries are not subject to any form of scientific assessment and that illegal fishing is still responsible for about a fifth of the world's fish catches. Certain fisheries are associated with significant damage to marine ecosystems (e.g. bottom trawling on cold-water coral habitat) as well as bycatch of non-target species, leading, in some cases, to a threat of extinction (e.g. long lining and albatrosses and petrels in the Southern Hemisphere). REV Ocean will undertake research to increase the sustainability of fishing both in terms of catches of fish and environmental impacts of fishing, including for new fisheries resources. The aim is to secure

sustainable supplies of fish, whilst ensuring the ocean is healthy and able to support all the ecosystem services on which we rely. Key areas of research include:

- Research to improve the **assessment of fisheries resources** to identify **effective changes in policy, management or enforcement practices**, including novel technical advances (e.g. use of AI on big data) in fisheries monitoring and surveillance, to reduce or eliminate overfishing.
- Research to map **fisheries risks to non-target species and habitats** in order to identify **innovative strategies** and **commercially sustainable technical** solutions to prevent destructive fishing impacts.
- Research to assess how/if to exploit commercially **new fisheries** resources without risking significant **environmental impacts** (e.g. mesopelagic fisheries) to provide the necessary scientific data for the **development of policy**.
- Predict change in commercial **fish and shellfish populations** induced by **climate change** to assess changes in their vulnerability and their ability to act as carbon sinks. This information will feed into future predictive models of **fisheries management and economics**.

4. Data management

All data acquired during REV Ocean cruises will be archived in internationally-recognised data management systems that follow FAIR criteria: this is, the data is Findable, Accessible, Interoperable and Reusable. Examples of such databases are the Ocean Biogeography Information System ([OBIS](#)), the Global Biodiversity Information Facility ([GBIF](#)), NIH genetic sequence database ([GENBANK](#)) and Seabed2030 for multibeam data ([Seabed2030](#)). REV Ocean is also working closely with its sister organisation, [HUB Ocean](#) and their Ocean Data Platform to ensure all data gathered during REV Ocean cruises is freely available.

All data will be made open access after 12 months after the end of the cruise. Data that is being used by PhD researchers for their thesis or sensitive to publication in high-level journals can have a longer open-access moratorium of 18 months.

5. Diversity, Equity and Inclusivity

At REV Ocean, we are committed to fostering a diverse and inclusive workplace for employees, partners and colleagues, where every individual is treated with respect, dignity, and fairness both on land and on-board RV *REV Ocean*. Our policy reflects our unwavering dedication to promoting equality and diversity within all parts of our organisation, including activities at sea conducted by our partners and colleagues on board the REV Ocean vessel. We recognise that diversity not only enhances our work environment but also drives innovation and excellence. This is particularly important in ocean research, where unequal access to large infrastructure results in un-balanced research projects hindering the potential for success in developing long-term solutions truly beneficial for the regions where they are implemented (de Vos et al., 2023).

With the aim to ensure robust diversity, equity and inclusivity, a series of specific actions and criteria have been implemented throughout the REV Ocean organisation, that will apply both to REV Ocean employees and our relationships with external actors (e.g suppliers, society, advisors) as well as any participant in missions on board RV *REV Ocean*. The overall REV Ocean DEI criteria can be found in our [DEI statement](#). Additional actions

to be taken in specific REV Ocean activities can be found in the relevant REV Ocean strategic documents. Particularly relevant for the REV Ocean Science and Solutions programme are the DEI criteria in the “Selection Procedures for Projects” document and the [RV REV Ocean Code of Conduct](#).

6. Linking science to concrete solutions

The gold-standard of science dissemination is through peer-reviewed publications. This is a currency that politicians have faith in, and which is difficult to discredit outside of the normative process of scientific investigation, hypothesis testing and evidence. However, communicating the science as well as technical innovations and ensuring they are placed in front of the right people, and implemented in policy and turned into solutions, includes a broader range of activities.

The REV Ocean Science and Solutions Programme will:

- Support and require peer-reviewed publication of data generated from RV REV Ocean missions.
- All data from REV Ocean science and solutions cruises are made publicly available through the Ocean Data Platform and linked to internationally-recognised databases (e.g. OBIS for biological data, GEBCO for bathymetry data; Genbank for DNA sequence data).
- Media launches of major new findings / solutions arising from REV Ocean activities, to ensure that the news are spread both internationally as well as regionally where the data were collected.
- Translating REV Ocean findings / solutions into reports / briefs aimed at informing target audiences of in the adequate language (e.g. directed at policymakers, industry, investors, civil society).
- Dissemination by REV Ocean staff or by REV Ocean-supported scientists and other experts of key REV Ocean findings with respect to science and/or solutions at appropriate science, policy, industry and any other relevant conferences and workshops.
- Bilateral meetings with key figures in policy (politicians, ministers, intergovernmental organizations), civil society (non-governmental organizations, community-based organizations) and industry (companies, investors) to jointly develop and implement solutions to ocean challenges.

7. How we measure success of our science and solutions missions

Assessing the success of the REV Ocean Science and Solutions Programme (SSP) in the three key areas identified is not straight forward. These are all extremely complex problems, spanning the global ocean and involving multiple stakeholders, including the public, civil organizations, governmental and intergovernmental institutions and industry. Ideally, the REV Ocean SSP should drive paradigm-shifting long-term and economically-viable solutions to the targeted ocean problems. However, the influence of the SSP through contributing with others in finding and driving solutions or in incremental increases in knowledge that help to create the political landscape to initiate change are also important.

Adopted from the work of The Nature Conservancy (TNC) in measuring project success¹, the REV Ocean SSP will use categories to measure success: Impact, Activity and Capacity. *Impact* essentially measures the success of REV Ocean in achieving its mission (i.e. improving our understanding of the ocean and turning it into

¹ Sawhill JC, Williamson D (2001) Mission impossible? Measuring success in nonprofit organisations. *Nonprofit Management and Leadership* 11: 371 – 386.

concrete solutions) and its vision (i.e. one healthy ocean). *Activity* is a measure of the number of projects and supporting activities undertaken by the REV Ocean SSP. *Capacity* assesses the ability of the REV Ocean SSP to deliver results. We will also ensure that our science is actually used through a number of measurable activities. Below we describe key performance indicators for the REV Ocean Science and Solutions Programme.

7.1. Impact

- Number of SSP actions that provide new knowledge leading to policy, technical or other form of solutions to the global ocean challenges.
- The number of innovative solutions that create new market opportunities for start-ups or for existing company partners in projects supported by REV Ocean.
- Evidence of sustainable value creation with significant economic benefits for the company partners arising from the SSP.
- Investment into new solutions identified by the REV Ocean SSP from external actors.
- The outputs of the SSP contribute specific knowledge to the UN Sustainable Development Goals, The UN Decade of Ocean Science for Sustainable Development, the GEF Large Marine Ecosystem Program or other important present and/or future societal challenges.
- The outputs of the SSP directly contribute to new policy, management and conservation measures.
- Number of marine professionals formed through educational and capacity development activities within the REV Ocean SSP, in particular in terms of young scientists and innovators, as well as scientists and innovators from developing states.
- Number of awareness raising activities that have led to a significant increase of understanding in society about a specific ocean challenge, ocean benefit and/or ocean solution.
- Philanthropic donations following science activities in charter mode.

7.2. Activity

- Number of research grants assessed and awarded by the REV Ocean SSP.
- Number of cruises completed.
- Number of world-class scientists, policy and decision makers, innovators, communicators involved in REV Ocean cruises.
- Number of projects co-developed by young professionals, experts from developing nations and experts from minority groups that lead to missions on board RV *REV Ocean* missions.
- Matching funding provided to projects that the REV Ocean SSP has supported (e.g. staff salaries, sample analyses, etc).
- Number of partnerships or funding proposals in which the REV Ocean SSP is involved.
- Number of scientific papers produced, including impact factor.
- Number of scientific papers lead by experts from minority groups and early career researchers.
- Presentations at major conferences of results arising from the REV Ocean SSP.
- New patents or novel technologies developed and implemented.
- New policy that uses REV Ocean data.
- Amount of REV Ocean data shared, downloaded / used for scientific, policy or other purposes relevant to the science mission.

- Number of Master and PhD theses completed to which data was contributed from the REV Ocean SSP.
- Number of communication products arising from REV Ocean missions (e.g. documentaries, books, media posts, SOME).
- Number of charter missions that include a science component.

7.3. Capacity

- The grant proposal / award scheme is progressing according to schedule.
- There is a clear integration between science and solutions tasks and outcomes.
- Satisfaction of applicants with grant proposal process.
- Satisfaction of applicants with the cruise planning process.
- Number of scientists and other experts, including policy makers, who move into leading positions in their area of expertise after having received training under the capacity development activities of the REV Ocean SSP.
- Satisfaction of expedition or charter guests with science activities / science staff.