



Institut
de Ciències
del Mar

KNOWLEDGE TRANSFER PORTFOLIO





Introduction

ICM Transfer

- 01 Sustainability of renewable living resources**
- 02 Observation and modeling of the ocean and climate**
- 03 Biodiversity, function and health of marine ecosystems**
- 04 Assessment of marine geological hazards**





INTRODUCTION

The ocean is essential for life

The ocean plays a key role for life in our planet and provides crucial ecosystem services, making it essential to the well-being of our society. Human activities, however, are causing rapid global changes affecting the health and productivity of the ocean. Global warming, changing weather patterns, sea level rise, ocean acidification and extreme weather events, among others, profoundly affect the planet and our socioeconomic system.

The Institut de Ciències del Mar (ICM) is the largest marine research center of the Spanish National Research Council (CSIC). It is also the first and so far the only marine science center accredited as a Severo Ochoa Centre of Excellence, a recognition that demonstrates its leadership in marine research in Spain.

Under the motto “Marine Research for a Healthy Planet”, the ICM-CSIC conducts frontier research and promotes the transfer of knowledge and technology on issues related to ocean-climate

interactions, conservation and sustainable use of marine life and ecosystems and mitigation of natural and anthropogenic hazards. With this mission, the ICM-CSIC identifies itself as an agent of change towards sustainable development, based on in-depth knowledge, decisive action and coordinated management of marine issues.

ICM-CSIC research challenges

ICM research is organized around three major challenges that address global issues, seeking solutions to improve the quality of life and to foster sustainable development:

CLIMATE: We study the interaction between ocean and climate. Our goal is to understand the dynamics of the ocean and its role in regulating the Earth’s past, present and future climate.

LIFE: We study marine life in its various forms to better understand its basic functions and move towards the conservation and the sustainable use of marine life and ecosystems.

HAZARDS: We study threats to marine life in the ocean arising from both natural hazards and human activity in order to mitigate their impacts.



ICM TRANSFER

The ICM-CSIC is engaged to the valorization and exploitation of results through its Knowledge Transfer Strategy: ICM Transfer. We are committed to transferring our research results through ad-hoc channels, reaching stakeholders for the benefit of our society and planet.

ICM Transfer aligns with the quadruple helix innovation framework in which academia, industry, public administration and the society pledge in the conservation of the environment.

OUR VISION: Bridging the gap between knowledge and action. Promote action-oriented knowledge for the benefit of society, in line with the Sustainable Development Goals.

OUR MISSION: Being a key player in the Blue Economy and innovation ecosystem, striving to become a leader in the Mediterranean region.

Knowledge Transfer Channels

ICM Knowledge Transfer is carried out through the following channels, which allow the research results to reach the end-users:

Partnership: collaborative relationships linking relevant stakeholders and scientific research projects to foster the mutual exchange of knowledge at the local, national, and international level, in both the public and private sectors.

Advocacy and Lobbying: offer advice and consultancy to governmental and intergovernmental decision-makers, providing expert support to policy-makers and the private sector.

Scientific and Technical Offers: promotion of scientific and technological capacity packages for research centers and public-private entities.

Capacity Building: support the development of internal training, as well as transfer skills or assets to potentially interested stakeholders.

Intellectual Property: assets, products, services or processes that give rise to an innovative activity suitable for the exploitation of the results.

Entrepreneurship: bringing scientific knowledge to companies, either internally (spin-off) or externally (start-up), to transform the research outcome or idea into a tangible asset.

This portfolio summarizes ICM-CSIC's scientific and technical offers to solve problems of societal relevance by addressing the needs of a variety of end-users, including public administrations, public and private companies and the general public. These offers derive from the research of excellence performed at the ICM-CSIC and attest our strong social commitment. The scientific and technological offerings of the ICM-CSIC are structured in four thematic areas:



01

SUSTAINABILITY OF RENEWABLE LIVING RESOURCES

We study the biology and ecology of commercial and non-commercial marine species, their communities and ecosystems. We provide fisheries and marine ecosystem modeling solutions to support science-based policies and assess socioeconomic impacts. We identify solutions to improve the performance of sustainable aquaculture and fisheries. We analyze related global environmental changes as well as the effects of human activities on marine organisms and ecosystems. End users of this information include public administrations such as the Generalitat de Catalunya, different ministries of the Spanish government, the European Commission, the Food and Agriculture Organization of the United Nations (FAO), as well as international organizations such as the International Union for Conservation of Nature (IUCN).

Scientific and Technical offers

- 1.1. Fishing stocks monitoring and assessment.** We determine the status of exploited marine resources by collecting and analyzing data on commercial species. We monitor fishing activities and the effect of fishing on discards, bycatch and vulnerable habitats. We assess the socioeconomic and ecological dynamics of fishing to ensure a proper balance between exploitation and conservation.
- 1.2. Aquaculture innovation.** We provide solutions to the aquaculture sector to improve the reproduction, growth, immunocompetence and welfare of high-value farmed fish, mollusks and crustaceans. Solutions include environmental, nutritional and endocrine management of broodstock, as well as the use of different types of biomarkers (transcriptomic, epigenomic, lipidomic and metabolomic), to select the best-performing individuals. We have developed protocols for the control of the proportion and early determination of sex in fish, as well as biotechnological solutions to improve fish reproduction in captivity and to cryopreserve fish gametes and embryos.



1.3. Marine biodiversity and vulnerable species state assessment. We study the occurrence, distribution, ecology and conservation status of marine species, communities and ecosystems. We develop and apply a variety of methods including DNA species identification, monitoring and tracking, analysis of ecological relationships with biogeochemical markers and biodiversity indicators using GIS, big data and ecosystem modeling.

1.4. Environmental pollution assessment. We provide ecotoxicological and ecophysiological approaches to assess the effects of exposure to pollutants and to climate change on the physiology, reproduction, and health performance of a wide range of aquatic species.

1.5. Tools and data to support decision-makers and promote a sustainable management of marine resources. We use monospecific, multi-specific, and ecosystem-based perspectives using marine ecosystem models. We provide advice for sustainable commercial fishing, identification of marine protected areas, spatial planning, and improving of fishing gear selectivity as well as reduction of waste and seabed impacts.

- **The Institut Català de Recerca per a la Governança del Mar (ICATMAR)** is a cooperation body between the General Directorate for Fisheries and Maritime Affairs of the Generalitat de Catalunya and the Institut de Ciències del Mar (CSIC) with management autonomy to contribute to the Catalan Marine Strategy and Governance about fisheries.
- We have filed several **patents for the control of various aspects of the reproduction of farmed fish.**





02

OBSERVATION AND MODELING OF THE OCEAN AND CLIMATE

We conduct basic and applied research in physical oceanography, with an emphasis on technological development. We observe and analyze the ocean's physical environment on spatial and temporal scales and study the role of the ocean in the Earth's climate. We are a group of physicists, engineers, oceanographers and experts on other disciplines working on various topics aimed at understanding ocean dynamics through fieldwork, theoretical and numerical studies, as well as new data analysis and Earth observation technologies.



Scientific and Technical offers

2.1. Monitoring Systems: Satellite Remote sensing (Barcelona Expert Center, BEC).

BEC is a multidisciplinary observatory relying on remote sensing to monitor multiple ocean variables. BEC produces and distributes multivariable maps and provides advisory services to institutions and companies to help them solve specific problems related to risk and the environment through the design of customized solutions.

2.2. Monitoring Systems: In situ and proximal sensing.

We design, build and deploy state-of-the-art in situ and proximal sensing systems. We provide support and expertise to ocean monitoring activities, such as attended and unattended radiometric, optical and biogeochemical measurements of the sea surface. These measurements contribute to satellite validation and improved data processing algorithms. We track ocean currents using adapted GPS and drifting buoys.



2.3. Monitoring Systems: Cost-effective proximal sensing. Design and definition of cost-effective alternative solutions through infrastructures that promote participatory science for water and ecosystem monitoring through citizen science and low-cost sensors (IoT network, Kduino, etc.).



- **Interdisciplinary Thematic Platform (PTI) TELEDETECT** is a CSIC virtual hub of open innovation space for public-private collaboration coordinated by ICM-CSIC Barcelona Expert Center (BEC) and the National Institute of Aerospace Technology (INTA). The main objective is the transfer of knowledge from the CSIC to the administrations and the private sector in the field of remote sensing.
- **Interdisciplinary Thematic Platform (PTI) POLARCSIC** is a virtual hub of CSIC open innovation space for public-private collaboration to foster co-

operation among CSIC polar researchers as well as to transfer knowledge and produce outreach material for the general public.

- **Institut Català de Recerca per a la Governança del Mar (ICATMAR)** is a cooperation body between the General Directorate for Fisheries and Maritime Affairs of the Generalitat de Catalunya and the Institut de Ciències del Mar (ICM-CSIC) with management autonomy to contribute to the Catalan Marine Strategy through marine observation and prediction.




03

BIODIVERSITY, FUNCTION AND HEALTH OF MARINE ECOSYSTEMS

We study the biotic component and the functioning of marine ecosystems and in particular their biodiversity using a variety of microscopic, molecular and biogeochemical approaches. We monitor water quality and assess the impact of natural and anthropogenic disturbances on ocean diversity, function and health. We provide science-based biotechnological applications in the fields of food production, bioremediation and human health using marine microorganisms. Our expertise supports decision-makers with competences on water quality and coastal health, such as the Catalan Water Agency, the Ministry for Ecological Transition and Demographic Challenge, and the European Commission.

Scientific and Technical offers

3.1. Monitoring biodiversity and function of marine ecosystems. We perform long-term biogeochemical and biodiversity monitoring and assess the effects of climate change on coastal ecosystems. We characterize seawater warming, acidification and microbial biodiversity in the Mediterranean Sea and provide projections for the Catalan Coast. We study the photo- and biodegradation of chemical compounds, from sunscreens and plastic to natural organic carbon, and we are developing sensors to analyze fluorescent dissolved organic matter released by plastic in seawater. We develop scientific knowledge (criteria and indicators of multiple pressures in coastal and offshore waters) to define the state of the marine environment, a significant challenge in the implementation of the Water Framework Directive and Marine Strategy Framework Directive.

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- A large school of mackerel swimming in blue water. The fish are silvery with dark stripes along their sides, and they are moving in a coordinated pattern.
- **Development of specific jellyfish cultures** to be used for scientific and industrial research projects, including obtention and extraction of substances for use in biomedical, food and cosmetic research.
 - We have obtained **two patents**, resulting from a collaboration between a private company specialized in cosmetics and pharmacology and the **ICM-CSIC, on inhibition mechanisms of pelagic jellyfish cnidocyte discharge**, and the development of **protocols to prevent jellyfish and other dangerous marine animal stings**.

3.2. Bioinformatics-based identification of marine organisms and processes. We assess marine microbial biodiversity from DNA-sequence information of viruses, prokaryotes and protists. We identify enzymatic capabilities involved in the degradation of plastics or petroleum-derived compounds. We measure the expression in the environment of key genes related to biogeochemistry or bioremediation.

3.3. Evaluation of natural and anthropogenic impacts on plankton microorganisms. We develop monitoring programs for harmful algal blooms and provide practical guidance for accurate and reliable plankton diversity estimates by implementing and maintaining diverse time series stations to obtain long-term ecosystem and biodiversity data.

3.4. Development of marine organism-based bioengineering tools. We develop gene-based technologies to improve production of targeted microorganisms for various purposes, such as sewage treatment, biomass production, biostimulants and bioremediation. We can help the microalgae production industry to optimize growth conditions, prevent pests and disease outbreaks and to

increase productivity. We identify new genomic-editing systems using marine metagenomics.

3.5. Development of advanced early warning systems in the coastal marine environment to detect or predict ecosystem disturbances, based on changes in water quality, productivity and biodiversity, as well as the presence of sentinel organisms and toxic substances.

3.6. Marine organisms as model organisms for human health research. We identify genes in marine sponges. We develop specific jellyfish cultures to be used for scientific and industrial research projects, including obtention and extraction of substances for use in biomedical, food and cosmetic research. Additionally, we look for genes that have antibiotic or nutritionally valuable properties, such as omega-3 production, anti-inflammatory and lesion treatments, and potential new materials.



04

ASSESSMENT OF MARINE GEOLOGICAL HAZARDS

We study the geological, anthropogenic and meteorological hazards and disasters affecting from the coastline to the abyssal plains. We assess their environmental, economic and social impacts at different scales in line with the objectives of the UN Sendai Framework for Disaster Reduction 2015–2030. We aim to understand the geological and geophysical processes that jeopardize coastal regions, continental margins, and oceanic basins at various spatio-temporal scales, using innovative processes and high-resolution technologies.

Scientific and Technical offers

- 4.1. Oceanographic and geological surveying and mapping.** Oceanographic data collection and geological surveying, assessing natural and anthropogenic hazards due to sea level rise, seismic activity, submarine landslides, erosion by bottom currents, tsunamis, and trawling-induced impacts. We perform high-resolution mapping and seabed sediment sampling for the sound and sustainable management of the seabed integrity, hence contributing to the EU's Marine Spatial Planning strategies.
- 4.2. Development of underwater monitoring and surveillance systems with autonomous sensor networks and new technologies.** We develop tools for monitoring seismicity of both natural and induced origin for the safe and sustainable management of industrial activities, such as subseafloor fluid injection. We also develop tools for the surveillance of underwater infrastructures such as telecommunications cables, shipping activities and marine mammal tracking.

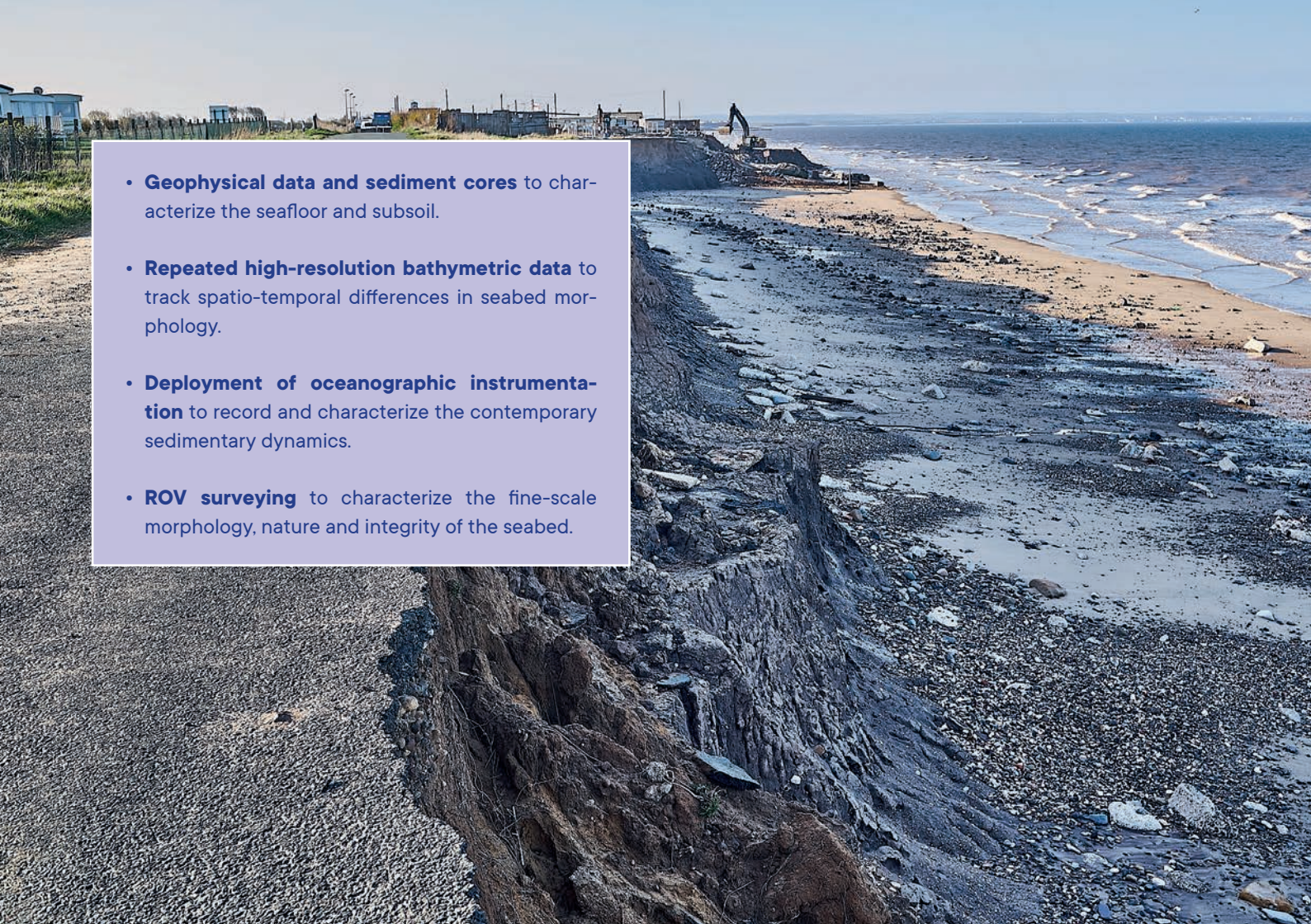
4.3. Assessment of trace metal in sediments. We analyze pollution levels, sources, including deep sea mining, and the spatiotemporal distribution of trace metals in various aquatic environments. We study the sedimentary processes that control the transport and accumulation of particulate contaminants, including monitoring of turbidity plumes caused by polymetallic nodules and crusts collectors from the seabed.

4.4. Ocean seafloor environmental characterization and impact assessment. We characterize the coastal and deep-seafloor environment and associated marine habitats, such as seagrass beds and cold water corals. We assess and propose measures to mitigate the impact of bottom trawling by the implementation of less invasive and more energy efficient trawl doors to reduce trawl-induced sediment disturbance and resuspension.

4.5. Assessment and monitoring of natural and anthropogenic geological hazards. We collect, process and analyze seafloor mechanic, geothermal, stratigraphic and geophysical data to help industry make informed decisions on offshore infrastructure development. These informed decisions should avoid risks related to seabed stability or induced seismicity to ensure sustainable implementation of offshore industrial activity.

4.6. Monitoring coastal changes to support beach management. We provide a complete scientific picture of shoreline erosion, storm impacts and coastal evolution based on in-situ and remote observations. We advise the different administrations on criteria for monitoring the state of beaches and possible strategies for protection and adaptation in the medium and long term.



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- A photograph of a coastal erosion site. In the foreground, a steep, exposed soil bank shows distinct horizontal layers of sediment. To the right, a pebbly beach meets the ocean, with waves breaking. In the background, a line of buildings and a fence are visible under a clear sky. A purple rectangular box is overlaid on the left side of the image, containing a bulleted list of research methods.
- **Geophysical data and sediment cores** to characterize the seafloor and subsoil.
 - **Repeated high-resolution bathymetric data** to track spatio-temporal differences in seabed morphology.
 - **Deployment of oceanographic instrumentation** to record and characterize the contemporary sedimentary dynamics.
 - **ROV surveying** to characterize the fine-scale morphology, nature and integrity of the seabed.



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