

The seventy-year history of the Institut de Ciències del Mar and the Unitat de Tecnologia Marina mark the beginning of the Ocean Decade: towards an inclusive and transformative ocean science

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The Institut de Ciències del Mar (ICM) is one of the leading centres of the Spanish National Research Council (Consejo Superior de Investigaciones Científicas, CSIC), fully dedicated to the interdisciplinary study of the marine environment. Under the motto “Ocean science for a healthy planet”, the ICM connects studies of local processes and ecosystems with the complexity and intelligence of our ocean planet, promoting the transfer of science and technology on topics related to the interaction between ocean and climate, conservation and sustainable use of marine ecosystems, and mitigation of the impact of natural and anthropogenic hazards. As a major acknowledgement to its scientific achievements and its commitment to society, the ICM has been recognized as a Severo Ochoa Centre of Excellence, joining some 30 Spanish centres that currently have this accreditation and becoming the first and only marine centre yet to achieve it.

The main objective of the Unitat de Tecnologia Marina (UTM) is to provide services and technical support to the entire Spanish community of marine and polar science and technology. To this end, it is a major actor in the management of two large scientific and technical facilities (ICTS) of the Spanish Ministry of Science and Innovation: –ICTS FLOTA, which

coordinates ten oceanographic research vessels, and ICTS BAEs, composed of an international camp and two Antarctic bases. The UTM also has cutting-edge scientific and technological equipment and instrumentation and is a national centre for oceanographic and polar data, forming part of the European infrastructure for marine data and international polar data.

In 2021, the ICM and the UTM are celebrating seventy years of history, with twenty years already in their current headquarters in front of the Somorrostro Beach in Barcelona. The CSIC was created on 24 November 1939, with José Ibáñez as its president and José María Albareda as its ideologue and first general secretary. According to Guerra and Prego (2003), Albareda arranged the creation of the Institut de Biologia Aplicada (IBA) in Barcelona on 10 April 1943. The IBA was attached to the CSIC but based at the Universitat de Barcelona, and its first director was Francisco García del Cid. On 18 February 1949, the IBA created the Marine Biology Section, which in the same year set up laboratories in Blanes, Castelló and Vinaròs.

On 14 January 1949, Buenaventura Andreu wrote a report entitled “Project for the creation of a fisheries research centre dependent on the CSIC”. On 3 October 1951, by resolution of the CSIC governing board, this report led to the

The seven great outcomes of the Decade of Ocean Science for Sustainable Development

Outcome 1: A clean ocean, where sources of pollution are identified and reduced or removed. Society generates a wide variety of pollutants and marine litter, such as toxic and persistent organic compounds, heavy metals and plastics. It also causes various physical and biogeochemical alterations of the aquatic environment, from eutrophication caused by excess nutrients to underwater noise of anthropogenic origin. These disturbances come from a wide variety of land and marine pollutant sources, including localized and non-localized sources. Their effects endanger ecosystems, human health and natural resources. It is essential to fill the interdisciplinary knowledge gaps on the causes and sources of pollution and its effects on ecosystems and human health. These insights will underpin the joint formulation of shared solutions to eliminate pollution at source, mitigate harmful activities and contribute to the transition of society towards a circular economy.

Outcome 2: A healthy and resilient ocean, where marine ecosystems are understood, protected, restored and managed. The degradation of marine ecosystems is accelerating due to unsustainable activities carried out on land and at sea. To manage marine and coastal ecosystems sustainably, and to protect or restore them where necessary, we need to improve our understanding of ecosystems and their reactions to multiple stressors. This applies both to the local degradation of the coastal and marine environment and to the global effects of climate change on the marine environment. This knowledge is essential in order to develop tools for implementing actions that create resilience, avoiding situations of no return and thus guaranteeing that ecosystems continue to provide their services for the health and well-being of society and the planet as a whole.

Outcome 3: A productive ocean, supporting sustainable food supply and a sustainable ocean economy. The ocean is a key pillar in global economic development and future human health and well-being, especially in terms of food security and livelihoods for hundreds of millions of the world's poorest people. Knowledge and tools are essential to support the recovery of exploited stocks with sustainable fishing and aquaculture practices while protecting essential biological diversity and ecosystems. The ocean also provides essential goods and services to a wide variety of industries, including the extractive industry, energy, tourism, transportation and pharmaceuticals. Each of these sectors has specific needs in knowledge, technology and innovation, as well as in decision-support instruments that minimize risks and optimize the development of a sustainable ocean economy. Governments also need information and tools to guide the development of sustainable ocean economies and to promote the marine sectors.

Outcome 4: A predictable ocean, where society understands and can respond to changing ocean conditions. The enormous volume of the ocean has not been adequately mapped or observed, nor is it fully understood. It is essential to improve the exploration and understanding of the elements that control changes in the ocean, including its physical, chemical and biological components and their relationships with the atmosphere and cryosphere, particularly in relation to climate change. This knowledge ranges from the shoreline to the high seas and from the surface to the deep ocean, including past,

current and future ocean conditions. A comprehensive understanding of the interconnections and responses in ocean ecosystems will support the predictions necessary for a dynamic ocean management that is adapted to changes in the environment and use of the ocean.

Outcome 5: A safe ocean, where life and livelihoods are protected from ocean-related hazards. Hydrometeorological, geophysical and biological hazards, as well as those caused by humans, have devastating, cascading and unsustainable effects on coastal communities, ocean users, ecosystems and economies. The changing frequency and intensity of weather- and climate-related hazards are exacerbating these risks. Mechanisms and processes are necessary to assess priority risks, mitigate, predict and warn of these hazards, and to formulate flexible responses to reduce short- and long-term impacts on land and sea. This means having higher density ocean data and better forecasting systems, including those related to sea level, marine meteorological conditions and climate in near real-time and at the scales of decades. These improvements, accompanied by education, outreach and communication, will allow the formulation of policies and decisions aimed at greater individual and community resilience.

Outcome 6: An accessible ocean, with open and equitable access to data, information and technology and innovation. The data must be managed under the FAIR principles, which ensure that they are Findable, Accessible, Interoperable and Reusable. Educational inequalities in ocean science and knowledge of our environment must be eradicated, and it is therefore essential to ensure access to knowledge, technology and data resulting from experimentation and observation of the ocean, together with precise knowledge of its origins and quality control. This must be accompanied by increased skills and opportunities to collaborate in data collection, knowledge generation and technological development, particularly in less developed countries, landlocked regions and small island states, whose well-being is not unrelated to the global knowledge of our planet. The management, innovation and adoption of sustainable strategies and policies will improve with a greater and better dissemination of oceanic knowledge among the scientific community, governments, educators, companies, the industrial sector and the general public, contributing to the social objectives related to sustainable development.

Outcome 7: An inspiring and engaging ocean, where society understands and values the ocean in relation to human well-being and sustainable development. In order to encourage a change in behaviour and ensure the effectiveness of the solutions formulated within the framework of the Ocean Decade, a profound change in the relationship between society and the ocean is necessary. This can be achieved through approaches based on marine culture, traditional and innovative education and awareness tools, and measures to ensure equitable physical access to the ocean. Together, these approaches will generate a broader societal understanding of the economic, social and cultural values of the ocean and of the multitude of roles they play in advocating for health, well-being and sustainable development. This result will highlight the beauty and inspirational nature of the ocean, thereby influencing the next generation of scientists, policy makers, government officials, administrators and innovators.

transformation of the Marine Biology Section of the IBA into a new CSIC institute: the Instituto de Investigaciones Pesqueras (IIP). The IIP, whose first director was Francisco García del Cid, had its headquarters in Barcelona, with its initial facilities at the Universitat de Barcelona and laboratories in Blanes (under the direction of Carles Bas), Castelló (under the direction of Buenaventura Andreu) and Vinaròs (which depended on Castelló).

The IIP expanded in September 1952 with the addition of the Vigo centre and in the summer of 1957 with the addition of the Cádiz centre. On 22 June 1963, a new IIP headquarters was inaugurated in a two-storey building with a large aquarium on its ground floor, which was located in the present-day Plaça del Mar, in Barcelona's marine district of Barceloneta.

In 1979, the IIP split into four independent centres: the central headquarters of the institute in Barcelona, which in 1987 was renamed the Institut de Ciències del Mar, the Institut de

Investigacions Mariñas in Vigo, the Institut d'Aqüicultura Torre de la Sal in Castellón and the Instituto de Ciencias Marinas de Andalucía in Cádiz (Guerra and Prego 2011). In October 1985, the Blanes laboratory became the Centre d'Estudis Avançats de Blanes. In 1992 the Oceanographic Vessel Management Unit was created, and in 2000 it became the UTM.

In 1988 researchers and technicians from the ICM established the first Spanish Antarctic station, which would finally crystallize into the Juan Carlos I Spanish Antarctic Base, run by the UTM since 1999. The UTM is also responsible for managing various oceanographic vessels, including the R/V *García del Cid* (1979), which initially depended on the IIP, and two large oceanographic vessels, the R/V *Hespérides* (1991) and the R/V *Sarmiento de Gamboa* (2008). With the integration of the Instituto Español de Oceanografía as a CSIC centre in 2021, the ships managed by CSIC now make up 90% of the entire Spanish oceanographic fleet.

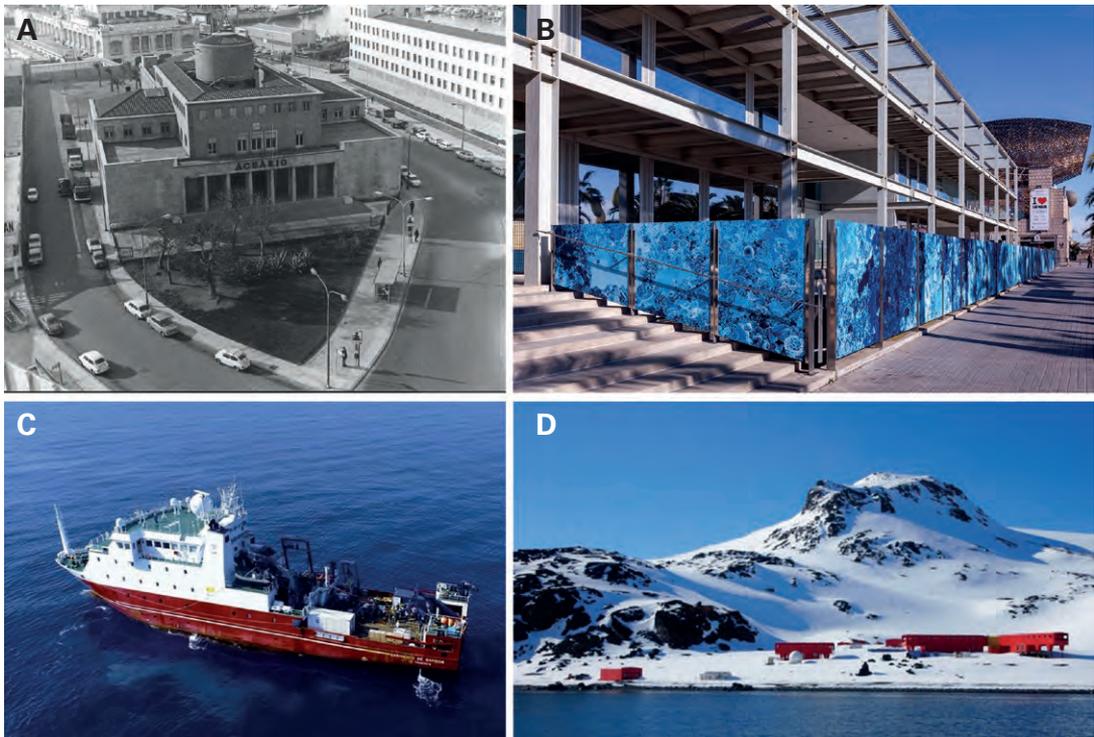


Figure 1. A, former headquarters of the Instituto de Investigaciones Pesqueras in the present-day Plaça del Mar, in the Barceloneta neighbourhood. B, facade of the current headquarters of the ICM, the UTM and CMIMA. C, the R/V *Sarmiento de Gamboa*, one of the ICTS FLOTA vessels. D, panoramic view of the Juan Carlos I Antarctic base.

Directors of the Instituto de Investigaciones Pesqueras, Institut de Ciències del Mar and the Unitat de Tecnologia Marina

Instituto de Investigaciones Pesqueras (1951–1979)

1951–1965 Francisco García del Cid (Bas 2011)

1965–1967 Ramon Margalef (Castellví 2012)

1967–1979 Buenaventura Andreu (Guerra 2012)

Instituto de Investigaciones Pesqueras (Barcelona, 1979–1987) – Institut de Ciències del Mar (1987–present)

1979–1983 Buenaventura Andreu (Guerra 2012)

1983–1987 Carles Bas (Sardà 2012)

1987–1991 Andrés Maldonado (Alonso and Díaz 2012)

1991–1994 Enrique Macpherson (Olivar and Abelló 2013)

1994–1995 Josefina Castellví

1995–1997 Marta Estrada

1997–2001 Rosa Flos

2001–2009 Dolors Blasco

2009–2018 Albert Palanques

2018–present Josep Lluís Pelegrí

Unitat de Tecnologia Marina (2001–present)

2000–2012 Juan José Dañoibeitia

2012–2013 Enrique Tortosa

2013–2016 Albert Figueras

2016–present Jordi Sorribas

The ICM and the UTM moved in 2001 to their current headquarters, a 15,000 m² building with three floors and a basement located at the end of the Passeig Marítim in the Barceloneta district, and an administrative and logistical structure was created to support the operation of the two institutions: the Centre Mediterrani d'Investigacions Marines i Ambientals (CMI-MA). The main nucleus of marine and polar scientific and technical knowledge, not only in Spain but also in the entire Mediterranean, was

thus housed on the beachfront near the city centre of Barcelona, with strong roots in its social fabric. The ICM and the UTM focus a large part of their work on sustainable development, and the management and staff of both centres maintain a strong personal commitment to the harmonious integration of society with nature.

Coinciding with the beginning of the Decade of Ocean Science for Sustainable Development (UN 2021), the 70th anniversary of the creation of the IIP is an excellent opportunity to present how the current research of the ICM and the technology and services provided by both the ICM and the UTM are fully focused on the goals of sustainable development. This is why this book, largely written by researchers and technologists linked to the ICM and the UTM, is divided into seven chapters focusing on the seven great outcomes pursued by the Ocean Decade: an ocean that is clean, healthy and resilient, productive, predictable, safe, accessible and inspiring.

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DOI: <https://doi.org/10.20350/digitalCSIC/14048>



The Institut de Ciències del Mar we want: marine research excellence with social commitment

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The oceans are essential for life on Earth. They sustain ecosystems, stabilize the climatic system and provide resources that make Earth habitable for humankind. However, human activity is causing rapid global changes that affect the ocean's health and productivity, understood as the resilience to stay within certain boundaries. Global warming, changing weather patterns, sea level rise, ocean acidification and extreme weather events are disrupting the economies of coastal countries and having a profound effect on people's daily lives. Along with the invasion of anthropic structures on the coastline, marine pollution and overfishing, these environmental stressors alter marine populations, harm ecosystems and threaten biodiversity. Moreover, oceans are the sources of devastating natural hazards that hit the coasts episodically, causing huge human and economic losses.

Ocean science for a healthy planet

Facing these global challenges and achieving the sustainable development of humankind will require basic and applied research, resolute action, social commitment and coordinated management. In recent years, the Institut de Ciències del Mar (ICM) has devoted much effort to adapt its vision to this reality and to contribute effectively to reach a sustainable relationship with nature. Under the motto "Ocean science for a healthy planet", the ICM staff have pledged to face these challenges through cutting-edge research and knowledge and technology transfer based on three research challenges: understanding

ocean and climate interactions; conservation and sustainable use of marine life and ecosystems; and comprehending and mitigating anthropogenic and natural hazards. These research challenges and a shared vision were identified through a long process of reflection and analysis. The outcome was an institutional roadmap designed to consolidate strengths, minimize weaknesses and capitalize on strategic opportunities through a collective endeavour.

This cooperative work towards developing an organizational structure that is as participatory as possible has brought about a change of paradigm in the ICM's vision, mission and governance. In order to accommodate all views, the classical top-down governance model (staff representatives, tenured researchers and the general assembly) has incorporated several bottom-up committees and working groups engaged in research strategy, core facilities, knowledge transfer and equality (see Garcés *et al.* 2022), and in outreach and communication. In addition, an external social board and a scientific advisory board have also been appointed to provide advice and guide our evolution. As a result of our conviction that we must establish a fluid social dialogue, these changes have led to a new corporate image and enhanced outreach in an effort to get closer to society.

From research excellence to social commitment

The new ICM corporate image is part of an institutional strategy driven by research ex-



Figure 1. Part of the staff of the Institut de Ciències del Mar. Source: ICM-CSIC.

cellence, social commitment and a desire for grassroots linkage in addition to international outreach and recognition. This momentum was supported in 2020 by a major milestone in the ICM's history: its accreditation as a Severo Ochoa Centre of Excellence, which is awarded by the Spanish Ministry of Science and Innovation to Spanish research institutions that are international benchmarks. Of some 30 other centres of all scientific disciplines, the ICM is the first and only marine research centre to attain this distinction. This achievement gave a definitive boost to further advance the transformation of the institute and to consolidate our position as an international benchmark in marine research and a social guarantor of the values of sustainability and planetary awareness.

The Severo Ochoa Centre of Excellence accreditation comes together with one million euros in annual funding until 2023, which has allowed a strategic plan to be implemented with two pillars: reinforcing key operational areas to increase our research impact, and bolstering our scientific strategy. The former was materialized through the creation of the Research Support Office, which functions as a hinge mechanism between the research groups and the administrative staff. It provides support for project management, dissemination and outreach, career

development, improving the work environment, talent attraction and knowledge transfer. The institutional scientific strategy pillar has been strengthened through competitive calls that follow the principles of transparency, young talent development, implementation of equality measures and creation of scientific synergies. These calls have allowed us to significantly increase our capacity to attract external talent and retain young talent, reinforce key strategic research lines and improve our core facilities.

In addition to the direct economic benefits and the prestige associated with the Severo Ochoa accreditation, this new work dynamics has strengthened the ICM's institutional representation in various areas of great international importance. Among the most significant achievements is our involvement in the UN Decade of Ocean Science for Sustainable Development (2021–2030), in which the ICM leads and coordinates the Ocean Cities programme, which aims to promote more resilient coastal cities and make the relationship of their citizens with the ocean more sustainable. In addition, the ICM has also submitted its candidacy to become the collaborating centre for the Mediterranean region within the Ocean Decade.

In the local arena, the ICM is closely working with the Barcelona City Council to deploy



Figure 2. View of one of the inner courtyards that hosted activities of the 2021 City and Science Biennial. Source: ICM-CSIC.

initiatives to facilitate the interaction between science and society while raising citizens' awareness of the planetary boundaries, the need for sustainability and the current climate emergency. The Barcelona Mar de Ciència project and our leading role in the 2021 City and Science Biennial are clear examples of this societal commitment.

A shared vision

In addition to these institutional achievements, the ICM has been bolstered through the many scientific individual and collective achievements. These include the coordination of several projects within the Horizon 2020 programme, the attainment of the first European Research Council Advanced Grant, a continued increase in high-impact publications, and many awards and recognitions granted to members of the institution.

The current outlook thus seems quite favourable for the growth of the ICM, but it also entails significant risks in an unstable political context and a complex and changing socio-economic dynamics. The consolidation of the ICM

as a major player on the local and international stage will require it to step up its continual transformation in order to maintain and further improve its training capacity and innovative research excellence and respond effectively to its growing social and environmental commitment. We believe that this dual challenge, which will only be achievable through a collective effort, must guide the ICM's decisions and actions in the near future.

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DOI: <https://doi.org/10.20350/digitalCSIC/14049>