

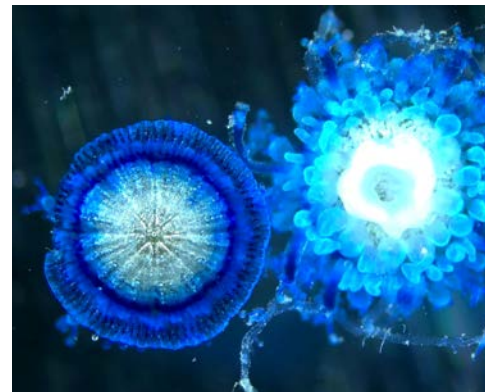


**CNR
ISMAR**
ISTITUTO
DI SCIENZE
MARINE

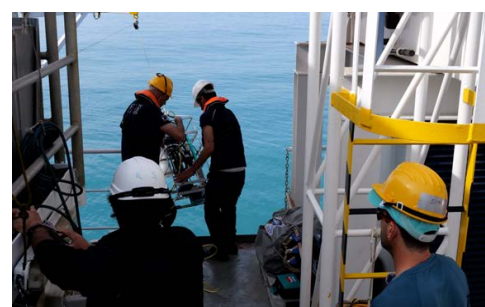
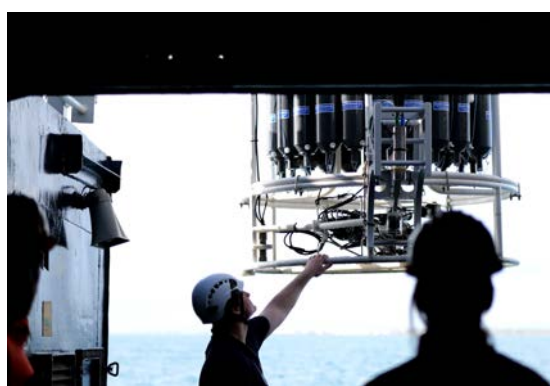
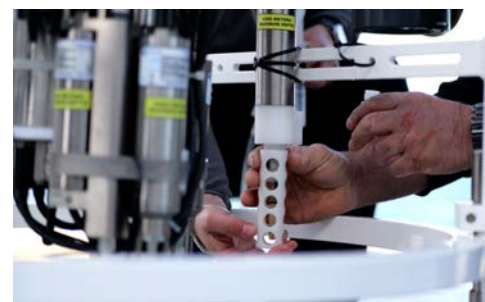
ANNUAL REPORT

**2025
2026**





“Marine research is the bridge between what we have yet to understand and what we must protect: a continuous commitment to exploring the oceans and safeguarding the future of our planet.”



Editing and Graphic Design by Patricia Sclafani and Laura Giordano, CNR-ISMAR

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Director's Message



It is my pleasure to present the second edition of the Annual Report of the Institute of Marine Sciences of the National Research Council of Italy (CNR-ISMAR). More than a summary of activities, this report reflects a period of significant development, transformation and collective effort across the Institute's scientific, technical and administrative community. I would therefore like to sincerely thank all colleagues who contributed to the work presented in these pages.

The period 2025–2026 marked an important phase for ISMAR. Major initiatives developed within the framework of the National Recovery and Resilience Plan (PNRR) strengthened infrastructures, observing systems, laboratories, digital capacities and collaborative networks across the Institute. At the same time, ISMAR expanded its activities in biodiversity research, marine observation, interoperable data systems and technological innovation, further reinforcing its contribution to national and European marine science.

Among the most significant developments were the consolidation of the Marine Data Center and the definition of a renewed data policy aimed at improving the accessibility, interoperability and long-term stewardship of scientific data. Important progress was also achieved within the National Biodiversity Future Center (NBFC), including the development of the Biodiversity Gateway network, which connects scientific research, digital innovation and public engagement across multiple territorial nodes.

An important milestone during the reporting period was the International Symposium on Transformative Ocean Science, held in Venice in March 2026. The Symposium brought together scientists, policymakers and institutional representatives from across Europe and beyond, creating an opportunity to reflect collectively on the future role of ocean science in addressing environmental, technological and societal challenges.

This phase of development also coincided with an important institutional transition within the National Research Council involving the reorganisation of marine research activities. The process encouraged broader reflection on ISMAR's mission, scientific identity and future strategic directions within a rapidly evolving ocean-science landscape.

Looking ahead, strengthening integrated observing systems, digital infrastructures, interdisciplinary collaboration and international partnerships will remain central priorities for the Institute, alongside continued investment in scientific innovation, training and support for early-career researchers.

I hope this report provides a clear overview of the activities, infrastructures, initiatives and collaborations that continue to shape the work of our scientific community.

Mario Sprovieri

Director, Institute of Marine Sciences (CNR-ISMAR)

Executive Summary

The period 2025–2026 marked a phase of consolidation and development for CNR-ISMAR. Across its distributed network, the Institute strengthened research infrastructures, observing systems, digital services, biodiversity initiatives, field operations and international scientific positioning.

The activities presented in this Report represent selected highlights from a broader framework of scientific, technical, operational and institutional work carried out across ISMAR's sites, platforms, laboratories and research communities.

1. Infrastructures, Observing Systems and Digital Capacity

A central driver of this period was the implementation of initiatives supported by the National Recovery and Resilience Plan (NRRP) the national recovery and resilience plan Plan (NRRP), also known in Italy as PNRR (Piano Nazionale di Ripresa e Resilienza) including ITINERIS, the National Biodiversity Future Center (NBFC), EMBRC and high-performance computing programmes. These investments contributed to the expansion of research infrastructures, observing systems and digital services across the Institute.

Among the most important developments were the consolidation of the Marine Data Center and the operational deployment of IT-IOOS, which provides a single federated access point to Italian marine and oceanographic data generated by research infrastructures, observing systems, and research platforms. The definition of a renewed data policy, further strengthened accessibility, interoperability and the long-term stewardship of scientific data, supporting the transition toward more

integrated and FAIR data management practices.

2. Biodiversity, Gateway Nodes and Territorial Development

Within the National Biodiversity Future Center, ISMAR contributed to the development of Biodiversity Gateway nodes in Venice, Palermo, Rome/Tevere, Naples and Lecce together with the digital Gateway platform. These initiatives improve access to biodiversity knowledge while connecting scientific research, digital innovation, education and public engagement.

The Institute also expanded its territorial and operational presence through the activation of the Livorno site (Tuscany) and the establishment of a new secondary site in Palermo (Sicily). These developments strengthen ISMAR's ability to support marine research, observation and collaboration across strategic coastal, insular and Mediterranean environments.

3. Competitive Research, Training and Field Activities

During the reporting period, ISMAR maintained strong scientific competitiveness, with numerous proposals submitted and several projects funded at national and international level. This reflects the vitality of the Institute's research community, despite the demanding implementation of large-scale national programmes.

Training and capacity-building activities also expanded, through advanced schools, technical training initiatives and the first Marine Geology Advanced School. Oceanographic campaigns, field missions and research-vessel activities continued to provide essential opportunities for observation, sampling, interdisciplinary collaboration and the training of early-career researchers.

4. European Positioning and Institutional Evolution

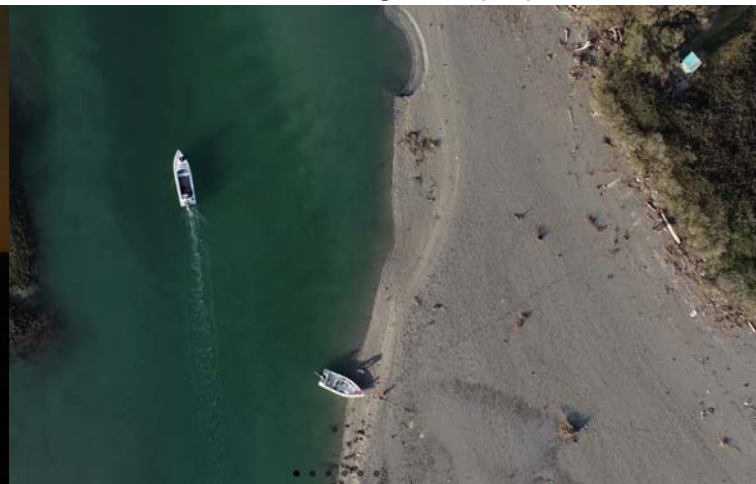
A major milestone was the International Symposium on Transformative Ocean Science, held in Venice in March 2026. Bringing together scientific, institutional and policy communities, the event contributed to discussions on the future of ocean research and innovation in Europe. Principle outputs, including a Policy Brief, Strategic Roadmap and White Paper, provide contributions to ongoing discussions on the Ocean Pact and future European ocean research priorities.

The period also coincided with an important institutional transition within the National Research Council, involving the proposed

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In 2025, ISMAR further strengthened its human capital and research infrastructures as part of a **strategic effort** to consolidate its positioning at the European level and enhance its contribution to EU research priorities.

Staff



48%

52%

65% 35%

Temporary
(51)

52% 48%
Permanent
(189)

240

Research
& Support

126

Associates (34), PhDs (37)
& Collaborators (55)



Total General Budget
30.436.493

Geography



1 Headquarter
(Venice)



7 + '2' Branch Research
Centres



1 Experimental Centre
(Pianosa)

Networking



70 Agreements and Collaborations



13 Research Infrastructures Participated



Labs

14

Sea
Laboratories



19 New Projects Launched



2.491 Research and Work Travels

Administration



2797 Payment Orders

260 Bank Transfers



177

Adjustments
for Increased
Revenue
and Expenses

170

Days
Onboard



12

Oceanographic
Campaigns

>60

Colleagues
Involved

PART I — STRATEGIC FRAMEWORK AND INSTITUTIONAL EVOLUTION

1. ISMAR in Transition: Strategy, Science and Institutional evolution

1.1 Ocean Science in Transition

Ocean science in Europe is entering a phase of significant change. Growing pressures linked to climate change, biodiversity loss, coastal vulnerability, technological innovation and marine governance are increasing the demand for integrated knowledge, sustained observing systems and science-informed decision-making.

Marine research institutions are now expected to work across disciplines, infrastructures and scales, connecting field observation, laboratory analysis, modelling, technological innovation and policy-relevant knowledge. At the same time, digital infrastructures, interoperable data systems, artificial intelligence and advanced modelling approaches are transforming how marine processes are observed, analysed and shared.

Within this evolving landscape, CNR-ISMAR contributes through a multidisciplinary scientific profile spanning physical and chemical oceanography, marine geology, biogeochemistry, marine biology, ecology and biodiversity research. Its activities are supported by distributed infrastructures, observing networks, laboratories, research vessels, digital platforms and field operations and numerical modelling across marine and coastal environments.

During 2025–2026, ISMAR further strengthened the integration of observing systems, modelling frameworks, digital services and interoperable data infrastructures through major national and European initiatives, including ITINERIS, the National Biodiversity Future Center (NBFC) and several European Research Infrastructures. These developments reinforced the Institute's contribution to the European ocean science landscape and provided the context for broader reflection on scientific priorities, institutional evolution and future directions.

Ocean Science in Europe: Key Directions

- Sustained ocean observing systems and long-term monitoring
- Biodiversity conservation and ecosystem resilience
- FAIR, interoperable and open marine data systems
- Digital Twins of the Ocean, AI and advanced modelling
- Climate adaptation and environmental intelligence
- Stronger science–policy interfaces
- Mission-oriented and interdisciplinary research

1.2 Mission and Scientific Identity

During 2025–2026, ISMAR further clarified its scientific identity within the broader reorganisation of the CNR marine research system. The updated mission, currently undergoing final institutional approval, reaffirms the Institute's role as a national reference point for marine research across ocean, coastal and transitional environments.

ISMAR's scientific profile is based on the integration of observation, experimentation, modelling, technological innovation and analysis. Its activities address physical, chemical, biological and geological processes, contributing to climate research, geodiversity and biodiversity conservation, environmental monitoring and the sustainable management of marine, coastal and transitional systems.

A central element of this identity is the ability to connect research infrastructures, observing systems, laboratories, technologies and interoperable digital platforms within an integrated Earth-Ocean system perspective. Increasing attention is devoted to FAIR and Open data practices, advanced digital approaches and emerging applications of artificial intelligence in marine science.

Alongside scientific research, ISMAR contributes to education, training, science communication, and dissemination, public engagement and international cooperation, strengthening links between scientific knowledge, environmental governance and societal needs.

ISMAR MISSION

The Institute of Marine Sciences of the National Research Council of Italy conducts fundamental and applied research in marine sciences to understand ocean processes and their interactions with the other components of the Earth system, across different spatial and temporal scales and in relation to climate variability.

Through observation, modelling, technological innovation and interdisciplinary research, ISMAR develops knowledge, systems and tools for the protection and sustainable management of the marine environment and its biodiversity.

The Institute aims to become a national and international reference point for knowledge and protection of oceans and coasts, contributing to the sustainable, inclusive and resilient management of marine environments.

THEMATIC RESEARCH AREAS

- Oceanographic, physical and biogeochemical processes across ocean, regional sea, coastal and transitional environments
- Interactions between the marine system and the atmosphere, cryosphere, geosphere and biosphere
- Recent and past climate variability and mechanisms of change
- Observing and modelling systems for monitoring, forecasting and risk assessment
- Geological evolution of oceanic, marine, coastal and transitional domains
- Ecological research on marine, coastal and transitional ecosystems, biodiversity and ecosystem functioning
- Innovative and emerging technologies, including Key Enabling Technologies, Digital Twins of the Ocean and Artificial Intelligence
- FAIR data systems and management of digital data and physical collections
- Knowledge transfer, ocean literacy, science-policy dialogue and science diplomacy

Retreat agenda. The retreat was held on 12–13 January 2026 through a hybrid format combining remote participation via Microsoft Teams with coordinated local gatherings at selected ISMAR sites. This approach reduced travel requirements and the number of simultaneous connections while maintaining interaction across the Institute's distributed network.

A central part of the Retreat focused on mapping each site's scientific positioning, technological assets, urgent societal questions, future development trajectories and opportunities for stronger internal synergy. Contributions highlighted the breadth of ISMAR's capacities, including observing systems, laboratories, modelling tools, digital infrastructures, autonomous platforms, long-term monitoring sites, research vessels, data services and specialised field activities.

Discussions addressed several cross-cutting scientific and organisational priorities, including integrated Earth-system approaches, biodiversity and ecosystem resilience, climate variability, artificial intelligence, Digital Twin Ocean perspectives, FAIR data, science–policy interfaces and the need to strengthen collaboration across infrastructures, disciplines and sites.

Beyond scientific priorities, the Retreat also provided an opportunity for reflection on institutional well-being and the everyday experience of working within a distributed research environment. These exchanges contributed to identifying opportunities for stronger cross-site collaboration, interdisciplinary and transdisciplinary integration, and organisational improvement.

The Retreat reinforced a central message for ISMAR's future development: scientific excellence and advanced infrastructures depend not only on individual capacities, but also on the Institute's ability to operate as a connected, collaborative and inclusive research community.

RETREAT AGENDA

Day I - January 12, 2026

- 9:15 Introduction to the retreat: agenda, working method, etc.
- 9:30 New structure of the 'Marine Institutes' of the CNR (F. Petraccini)
- 9:50 ISMAR 2025 presentation and Q&A (M. Sprovieri)
- 10:30 Working groups – an ISMAR project for the next 10 years
- 10:40 Work for groups of 15
- 11:45 Interaction among groups by Node, with presentation of group work (Node Plenary)
- 12:45 Rapporteurs and discussion (Institute Plenary)
- 13:45 Lunch
- 14:30 Working groups – a major ocean project for the future
- 14:40 Interaction among groups by Node, with presentation of group work (Node Plenary)
- 16:30 Presentation of the projects (8-10 min per project)
- 17:30 Discussion and end of day

Day II – January, 13 2026

- 9:00 Transdisciplinarity as an enabler of empowerment, skills and reskilling in the blue economy (S. Gruber)
- 10:00 Working groups – Well-being in the Institute. How we can work better
- 10:10 Interaction among groups by Node, with presentation of group work (Node Plenary)
- 12:45 Rapporteurs, discussion (Institute Plenary)
- 13:45 Lunch
- 14:30 A conversation with the governance of the CNR (Dr. P. Raimondi)
- 15:30 Building the future of ISMAR: people, contracts and opportunities and Q&A (C. Fanelli)
- 16:00 Moment of in-depth analysis with the administration (A. Graziani, E. D'Acunzo, A. Anzini)
- 16:30 Conclusions and end of retreat

Figure 2 — ISMAR Retreat 2026. Agenda of the two days and collaborative sessions.

PART II — INFRASTRUCTURES, OBSERVING SYSTEMS AND DIGITAL TRANSFORMATION

2. Observing Systems, Research Infrastructures and Digital Platforms

Research infrastructures and observing systems are among ISMAR's defining strengths. During 2025–2026, major investments linked to NRRP-ITINERIS, advances across European Research Infrastructures and the expansion of integrated monitoring capacities further reinforced this role.

A central development was the growing connection between observing systems, research platforms, laboratories, field operations and digital services. This integration is particularly visible in the Italian Integrated Ocean Observing System (IT-IOOS), which links distributed infrastructures and data streams within a more interoperable national framework.

Through these developments, ISMAR strengthened its contribution to long-term ocean observation, environmental monitoring, technological innovation and policy-relevant marine knowledge. The Institute also consolidated its role in the coordination of increasingly interconnected and service-oriented marine research systems at national and European level.

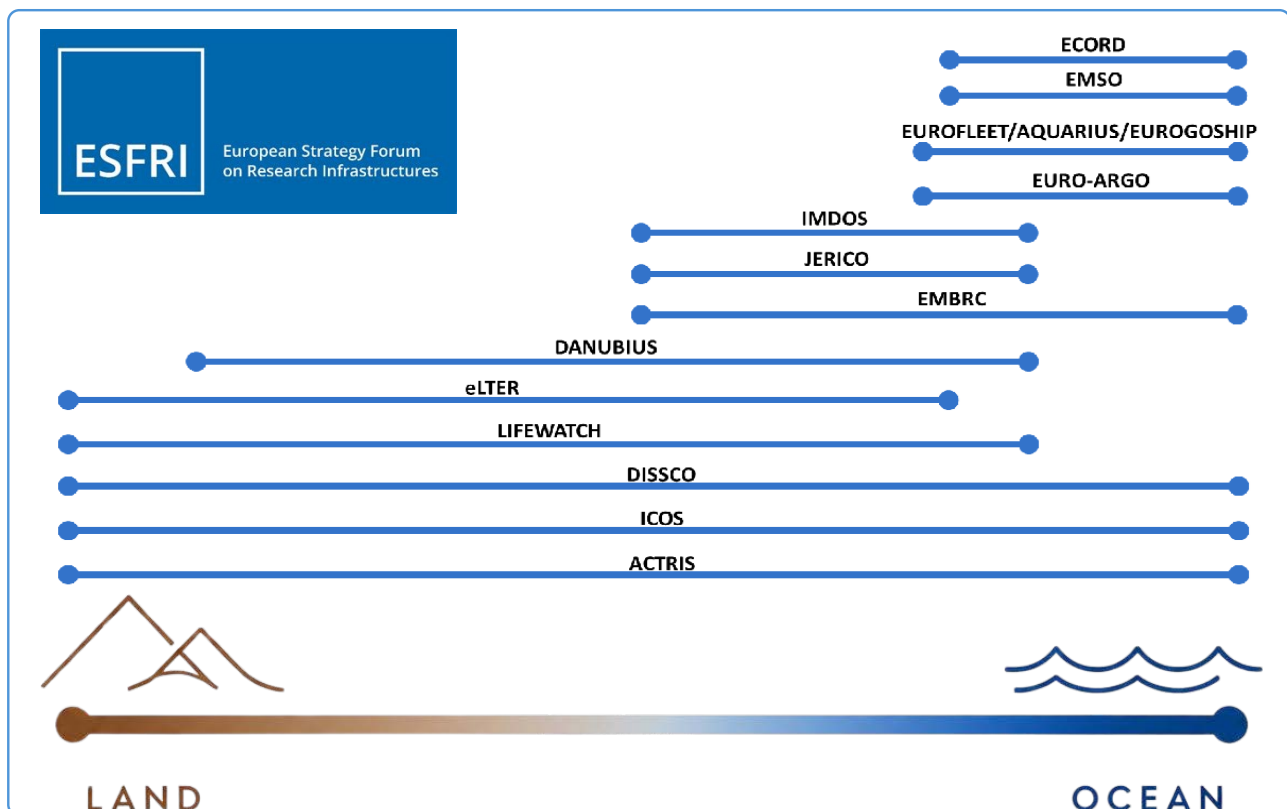


Figure 3 — ISMAR's research infrastructure landscape across environmental domains. In 2025 ISMAR participated in 13 RIs with a total coverage of land-ocean and transitional domains.

ISMAR - Infrastructure Ecosystem

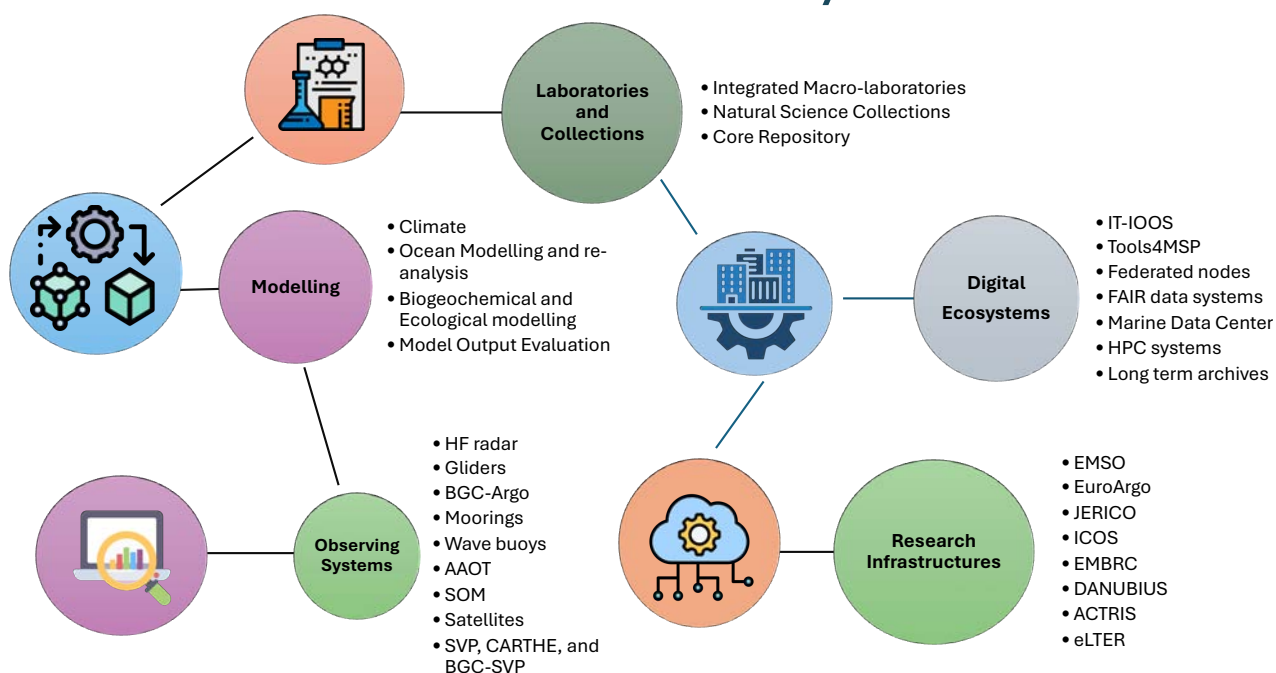


Figure 4 — ISMAR Infrastructure Ecosystem. ISMAR’s research activities are supported by an integrated ecosystem of observing systems, European research infrastructures, research platforms, laboratories, collections and digital services connecting field observation, analysis, modelling, data management and long-term marine monitoring.

2.1 Ocean Observation and Multi-Platform Systems

During 2025–2026, ISMAR strengthened its contribution to marine observation through an expanding system of platforms, infrastructures and monitoring activities spanning riverine, lagoonal, coastal, open-ocean and deep-sea environments.

A central development was the consolidation of the CNR-ISMAR Marine Observing System (SOM), which underwent a decisive phase of expansion in 2025. Supported primarily through NRRP–ITINERIS and RAISE investments, SOM evolved from a predominantly ocean-focused observational network into an integrated land–sea continuum observing system, encompassing riverine, transitional, coastal, shelf, open-ocean and deep-sea environments.

This expansion was achieved through the deployment of new observing stations, the renewal of sensor payloads, the strengthening of autonomous platforms and the integration of advanced multi-sensor systems. New and upgraded assets included riverine stations in the Isonzo and Tagliamento basins of Northern Italy, real-time Venice Lagoon CTD, hydrodynamic and turbidity networks, a Po River radiometric station, coastal monitoring stations, imaging-based observing nodes and upgraded offshore platforms.

Autonomous and high-frequency observing capacity also increased substantially. BGC-Argo floats, gliders, autonomous surface vehicles, drifters, wave buoys and HF radar systems contributed to more persistent, adaptive and spatially extensive observation of physical, biogeochemical and

ecological processes. The HF radar network expanded to seven operational stations, including new coverage in the Gulf of Salerno, delivering hourly surface current fields over approximately 12,000 km².

These developments increased SOM's spatial and thematic coverage, improved the continuity and quality of long-term time series, and strengthened alignment with European and global observing priorities, including the Essential Ocean Variables, Essential Climate Variables and Essential Biodiversity Variables frameworks. They also reinforced the role of SOM as a strategic national infrastructure supporting scientific research, operational oceanography, satellite validation, environmental monitoring, forecasting and policy-relevant applications.

SOM in 2025–2026

- 7 HF radar stations
- approximately 12,000 km² covered
- strengthened BGC-Argo and glider activities
- autonomous surface vehicles, drifters and wave buoys
- upgraded observing stations and sensor payloads

SOM 2025 — Key Advances

- transition toward a land–sea continuum observing system
- new riverine, lagoonal, coastal and transitional observing stations
- upgraded AAOT, PALOMA, Lampedusa and offshore platforms
- seven HF radar stations covering approximately 12,000 km²
- strengthened BGC-Argo, glider, ASV, drifter and wave-buoy activities
- real-time Venice Lagoon CTD, ADCP and turbidity networks
- stronger integration with IT-IOOS and European observing frameworks



Autonomous observing capacity also continued to grow. In 2025, the CNR–JERICO glider fleet supported coordinated field activities in the Ligurian Sea, including AMBOW25, EYES ON GLIDERS and TrialCap, demonstrating the capacity of autonomous platforms to observe physical and biogeochemical dynamics from the continental shelf to the open sea.

At the same time, ISMAR continued contributing to major European Research Infrastructures, including EMSO, EuroArgo, JERICO, ICOS and EuroFleets, reinforcing Italy's participation in coordinated ocean observation systems and long-term environmental monitoring at European and international scale.

Within EMSO, ISMAR contributed to long-term deep-sea and water-column observations in the Mediterranean, particularly through activities linked to the Sicily Channel observing system and associated national investments in oceanographic instrumentation. In EuroArgo, the Institute expanded Mediterranean biogeochemical observation capacities through the deployment of new BGC-Argo floats and participation in the Horizon Europe EuroArgo ONE initiative supporting the global OneArgo vision. Progress within JERICO reinforced ISMAR's contribution to European coastal observation through activities linked to the ESFRI 2026 Roadmap process, innovation in coastal observing technologies and integrated coastal monitoring capacities. Through ICOS, ISMAR continued contributing to European marine carbon observation through ship-based measurements and coordinated carbon-monitoring activities linked to broader international observing initiatives. A major institutional milestone was the establishment of EuroFleets AISBL, providing a long-term framework for European research-vessel coordination and collaborative marine infrastructure development at European scale.

Operational observing capacity was further reinforced through the installation of the P1 deep-sea mooring in the Sicily Channel near Pantelleria. The mooring supports long-term observation of water-mass exchanges between the western and eastern Mediterranean, while improving logistical sustainability and operational robustness within the Sicily Channel observing system. Complementing these in situ observing activities, ISMAR also advanced remote-sensing methodologies through major updates to ocean-colour retrieval algorithms. In particular, an improved version of the CIAO code was developed for the retrieval of surface chlorophyll in the Arctic region.

Additional activities in 2025 reinforced ISMAR's contribution to international ocean observing coordination and climate-monitoring frameworks. The Institute contributed to the successful conclusion of the Horizon 2020 EuroGO-SHIP project, supporting European coordination of repeat hydrography, best practices, data management and integration within the global GO-SHIP programme. ISMAR also hosted the WMO–GCOS Essential Climate Variables Rationalization Task Team meeting at its Venice headquarters, bringing together international experts involved in revising the Essential Climate Variables framework supporting the Global Climate Observing System. Finally, ISMAR provided major contributions to Copernicus and European and national space agency programmes through participation and leadership in data provision, evaluation/analysis and key roles in remote sensing Mission Advisory Groups.

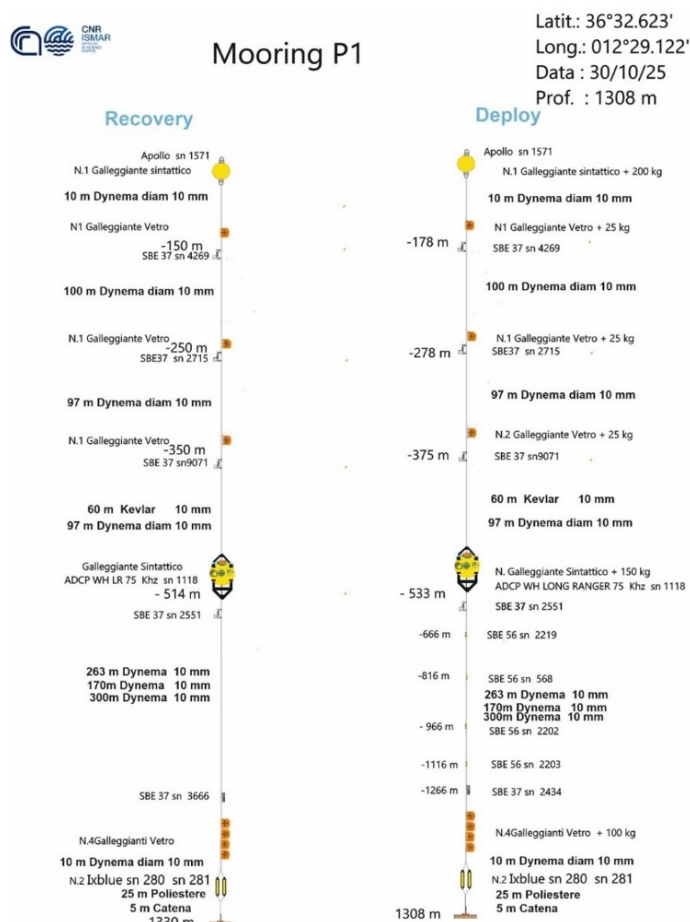
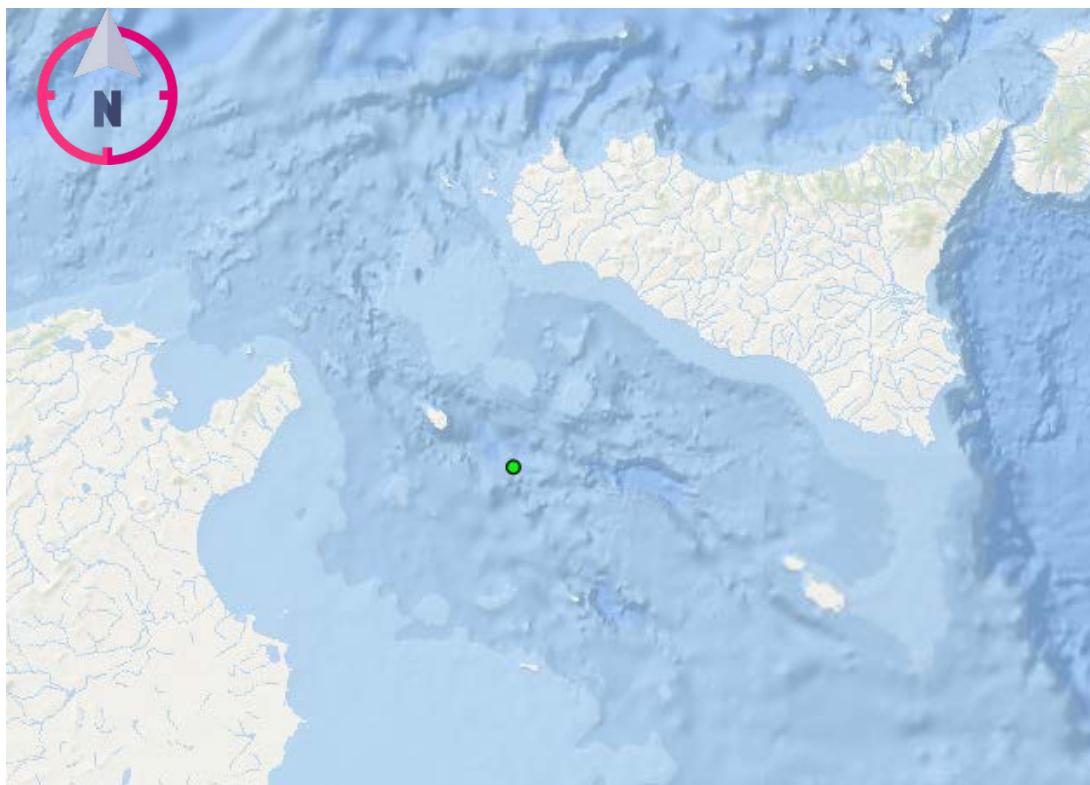


Figure 5 — P1 deep-sea mooring in the Sicily Channel. The P1 mooring near Pantelleria supports long-term observation of water-mass exchanges between the western and eastern Mediterranean.

SPOTLIGHT



Gaia Blu: Italy's Flagship Marine Research Infrastructure

Gaia Blu continues to serve as a flagship national research infrastructure supporting multidisciplinary marine science, technological innovation and long-term observing capacity. During the reporting period, strategic planning for the vessel was further strengthened through newly developed research guidelines identifying priority areas for future campaigns, ranging from climate processes, paleoclimate and marine geohazards to biodiversity, pollution, underwater cultural heritage and ocean science capacity-building.

During 2025, Gaia Blu also underwent significant instrumentation upgrades within the framework of the ITINERIS project. New onboard systems included a FerryBox platform for continuous surface measurements, advanced radiometers, LIDAR instrumentation, Eco-Triplet bio-optical sensors and upgraded calibration systems. These developments substantially enhanced the vessel's capacity to support integrated, high-resolution and multidisciplinary marine observations linked to national and European research infrastructures.

Beyond its role as a research vessel, Gaia Blu increasingly operates as an enabling platform for marine infrastructures, supporting the deployment, maintenance and upgrading of observatories, moorings and monitoring systems, while also serving as a testbed for emerging technologies, autonomous systems and evolving digital approaches. This reinforces the vessel's role not only as an expedition platform, but as a strategic component of Italy's marine research infrastructure ecosystem.



Strategic Campaign Priorities



Marine geohazards and deep Earth processes



Ocean biodiversity and pollution



Underwater cultural heritage



Future ocean science capabilities

2.2 Oceanographic Campaigns

Oceanographic campaigns are central to ISMAR's scientific activity, providing observations, samples and operational experience across coastal, shelf, open-ocean and deep-sea environments. Closely connected to the Institute's observing systems, research infrastructures and vessel-based activities, these campaigns support interdisciplinary research in oceanography, marine geology, biogeochemistry, biodiversity, ecosystem dynamics and climate-related processes.

During 2025–2026, ISMAR coordinated and contributed to campaigns combining in situ measurements, advanced sampling techniques, acoustic surveys, hydrographic observations, autonomous and ship-based instrumentation, and near-real-time data acquisition. Activities conducted aboard the R/V *Gaia Blu* and other research vessels supported Mediterranean observing programmes, infrastructure maintenance, process studies, habitat mapping, biodiversity and ecosystem research, model validation, training activities and the testing of new instrumentation developed within national research infrastructure initiatives.

The **MARSiCo-2025** campaigns contributed to the maintenance and strengthening of long-term observing infrastructures in the Mediterranean. The spring cruise focused on the urgent servicing of key moorings in the Corsica and Sicily Channels and the western Ionian Sea, combined with repeat hydrographic sections and the testing of new ITINERIS instrumentation and real-time data transmission systems. The autumn cruise continued infrastructure maintenance and hydrographic surveys, while also supporting AQUARIUS transnational access activities and consolidating near-real-time oceanographic data acquisition and transmission.

The **ITINERIS-EYES** cruise, carried out in July 2025, represented a key component of the national ITINERIS research infrastructure initiative. It integrated physical, biogeochemical and ecosystem observations, contributing to the development and testing of innovative observational strategies and strengthening Italy's capacity for sustained and interoperable marine observations. The cruise also included ship-based training activities combining online modules with hands-on experience aboard the R/V *Gaia Blu*.

The **PAGES** cruise, carried out in April 2026 within the JPI Oceans **Science for GES** action and the related PAGES project, extended previous integrated, process-based surveys investigating biodiversity patterns in relation to oceanographic dynamics. Using trophic-web modelling, environmental DNA analyses and adaptive sampling guided by satellite remote sensing, the campaign targeted dynamic features such as upwelling systems, coastal fronts, jets and filaments. Its aim was to examine how physical processes influence phytoplankton diversity and trophic-web dynamics, contributing to more holistic approaches for assessing marine ecosystem health and Good Environmental Status in European seas.

Other campaigns highlighted the role of field operations as platforms for ecosystem research, habitat assessment and interdisciplinary training. **POSEIDON-SEED**, for example, investigated the ecological role of the Marsili and Palinuro seamounts in the southern Tyrrhenian Sea, combining acoustic mapping, water-column profiling, biological sampling and molecular analyses to study pelagic trophic webs and biodiversity from microbial communities to large predators.

ISMAR also contributed to international hydrographic observation through the **GO-SHIP METEOR M216 expedition** in January–February 2026. The Institute was involved in CTD operations, salinity sampling, vessel-mounted and lowered ADCP measurements, and environmental DNA sampling.

Beyond their scientific objectives, oceanographic expeditions support education and training, infrastructure operations, and interdisciplinary collaborations. They provide opportunities for early-career researchers and students to gain first-hand experience of fieldwork, advanced instrumentation, data acquisition, and integrated observational methodologies.

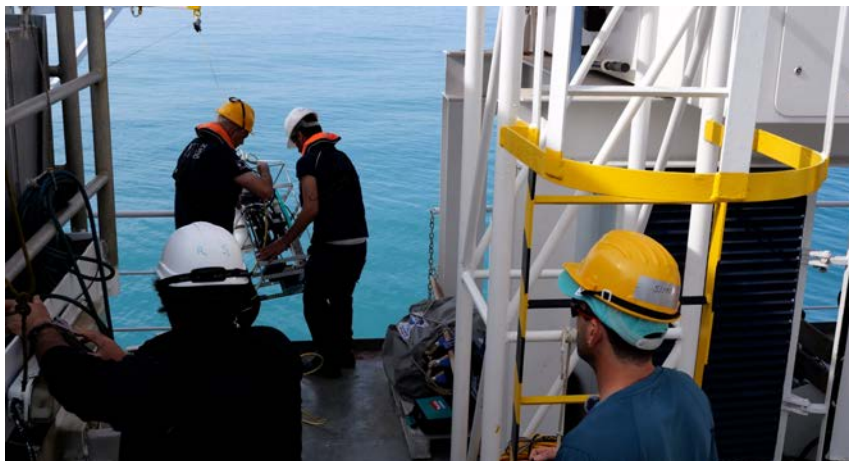
Looking ahead, planned future missions of the R/V *Gaia Blu*, including activities in the Red Sea from 2027 onward, will further expand ISMAR's observational capacities and reinforce its role within international marine research networks.

POSEIDON-SEED: Exploring Seamount Ecosystems in the Southern Tyrrhenian Sea

The POSEIDON-SEED cruise investigated the ecological role of the Marsili and Palinuro seamounts, two key submarine structures in the southern Tyrrhenian Sea. By combining acoustic mapping, water-column profiling, biological sampling and molecular analyses, the campaign examined how these environments influence pelagic biodiversity, trophic-web structure and the distribution of organisms from microbial communities to large predators.

The cruise brought together CNR-ISMAR, CNR-IAS and the Stazione Zoologica Anton Dohrn in a multidisciplinary effort linking oceanography, ecology, biogeochemistry and marine biodiversity research. Activities included acoustic surveys of scattering layers and fish aggregations, CTD and ADCP profiling, Bongo and Manta net sampling, eDNA metabarcoding, stable isotope analysis and microbial-community studies.

Beyond its scientific objectives, POSEIDON-SEED also supported NBFC activities, two Biodiversity PhD projects and the testing of ITINERIS instrumentation, reinforcing the role of oceanographic campaigns as platforms for research, training and technological development.



SPOTLIGHT - Oceanographic Campaigns 2025

During 2025, ISMAR coordinated and participated in multidisciplinary oceanographic campaigns across the Mediterranean Sea, supporting biodiversity research, climate observation, ecosystem assessment, infrastructure maintenance and integrated marine monitoring.

MARSiCo-2025-1

Mediterranean Sea | March 2025

Spring expedition aboard R/V Gaia Blu focused on servicing key moorings in the Corsica and Sicily Channels and the western Ionian Sea, repeat hydrographic sections, ITINERIS instrumentation testing and real-time data transmission.

SPIN-Gela 2025

Southern Tyrrhenian Sea | April 2026

Testing of Best Practices for the Study of the Potential Interaction between Offshore Activities and Natural Hazards

POSEIDON-SEED

Central-southern Tyrrhenian Sea | June 2025

Pelagic ecosystem characterisation in the area influenced by the Marsili and Palinuro submarine volcanoes, combining acoustic data, CTD profiles and water, zooplankton and pleuston sampling for biodiversity and food-web analyses.

ITINERIS-EYES

Western Mediterranean | July 2025

Integrated physical, biogeochemical and ecosystem observations supporting innovative observational strategies, interoperable marine research infrastructures and ship-based training activities.

WOMBlue

Mediterranean Sea | August 2025

Deep-sea science and ship-based training initiative supporting early-career women scientists from developing countries aboard R/V Gaia Blu.

INSIDE

Central Tyrrhenian Sea | August 2025

Unravelling the lithosphere-asthenosphere system of the Tyrrhenian back arc basin geophysical data Integration and geodynamic modelling

DEMETRA

Central-southern Tyrrhenian Sea | September 2025

ROV-assisted survey and ecological assessment of deep-water habitats (0–1,000 m) in the Gulf of Naples, targeting cold-water coral communities and monitoring the colonization of previously deployed 3D-printed artificial ecoreefs.

BIODREAM

Southern Adriatic Sea | October 2026

Monitoring, exploring and sampling the cold-water coral habitats of the Bari Canyon

CARG25

Central Adriatic Sea | October 2026

CARG25 cruise was dedicated to the acquisition of geophysical data and the collection of seabed samples and cores to characterize the seafloor geology for two Sheets for the Italian Geological Chart.

MARSiCo-2025-2

Mediterranean Sea | October 2025

Autumn expedition dedicated to continued maintenance of observing infrastructures, hydrographic surveys, AQUARIUS transnational access activities and near-real-time oceanographic data acquisition.

CHART-25

Northern Tyrrhenian Sea | December 2025

Cartographic characterization of depositional bodies and morphological/tectonic features to reconstruct the geological and morphological setting of the continental margin and its Plio-Quaternary evolution.

BRIDGES

Northern Tyrrhenian Sea | December 2025 – January 2026

Reconstruct the palaeo-geographic configuration of the former land bridge between southeastern numerous proxy records.



UPCOMING

BioGeoLin2026

Linosa | September 2026

ROV-assisted survey of benthic environments around Linosa, focusing on coralligenous formations, habitat-forming species and priority habitats relevant to maritime spatial planning for the future Marine Protected Area. Previous research documented a highly diverse seabed ecosystem, including gorgonians, black corals and other species of conservation interest. Recent work has also identified a distinctive coralligenous morphotype occurring at depths of approximately 80–100 m on sedimentary substrates rich in biogenic components, particularly rhodoliths. The campaign will contribute to improving knowledge of habitat distribution, ecological value and environmental vulnerability around Linosa.

GO-SHIP METEOR M216

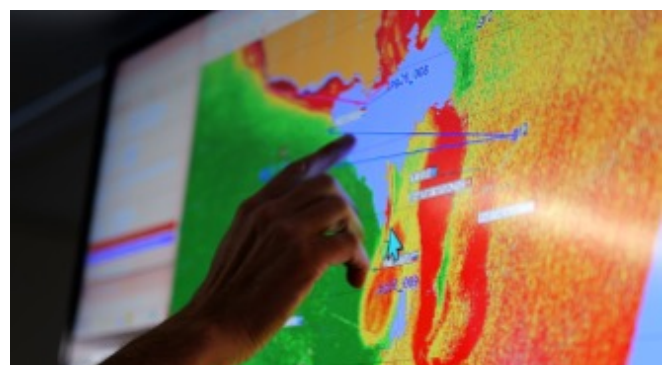
Mediterranean Sea | January–February 2026

International repeat hydrography expedition with ISMAR contribution to CTD operations, salinity sampling, ADCP measurements and eDNA sampling.

PAGES

Mediterranean Sea | April 2026

Expedition dedicated to defining a framework for more effective and holistic evaluation of marine ecosystem health, improving the capacity to assess and maintain the Good Environmental Status of European seas within the context of ocean dynamics.



2.3 Environmental Infrastructures across the Land-Sea Continuum

Important advances during 2025–2026 were also achieved through infrastructures addressing atmosphere–ocean interactions, river–sea system science and long-term ecosystem observation, particularly within **ACTRIS**, **DANUBIUS-ERIC** and **eLTER**. Together, these initiatives reinforced ISMAR’s contribution to integrated environmental observation and cross-domain research linking climate, biodiversity, sustainability and environmental monitoring.

Within **ACTRIS**, ISMAR strengthened activities related to advanced atmospheric observation, instrumentation and service provision, while expanding connections between in situ observations and Earth Observation applications. A notable development was the extension of **ACTRIS** activities into the marine domain through innovative lidar applications during the **ITINERIS-EYES** campaign, reinforcing synergies between atmospheric and oceanographic infrastructures.

A major milestone during the reporting period was the operational establishment of **DANUBIUS-ERIC**. ISMAR contributed through national coordination activities, modelling leadership and the development of the Po Delta–North Adriatic Supersite as a strategic living laboratory for transitional environments. Activities further strengthened integrated observation and modelling approaches across river–sea systems, including advances in FAIR data access and distributed environmental observation capability.

Progress within **eLTER** reinforced Italy’s contribution to long-term ecosystem observation through upgraded monitoring capacities, methodological harmonisation and service development at both national and European level.

Remote sensing within the **Copernicus** Marine framework also contributed to addressing land-sea interactions through the implementation of high resolution (i.e. 300 m horizontal resolution) ocean color satellite imagery over the European coastal regions, complementing the ultra-high resolution SST products developed in the preceding years.

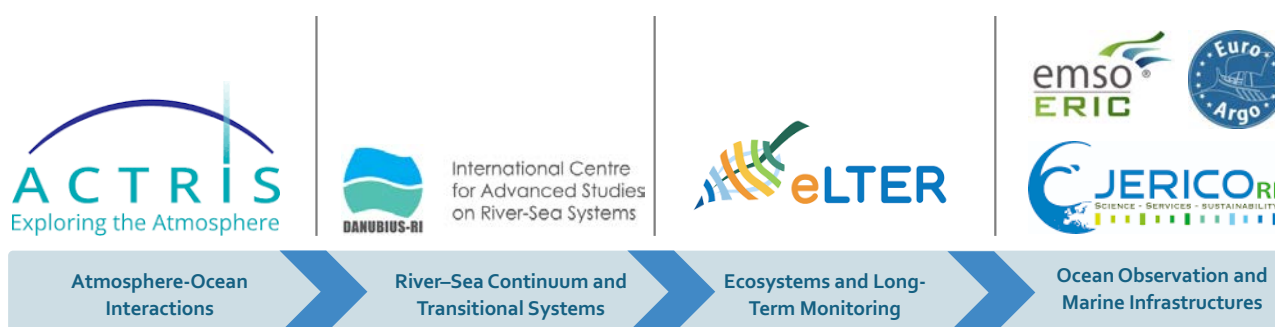


Figure 6 — Integrated environmental observation across domains - ACTRIS, DANUBIUS-ERIC eLTER and JERICO connect atmospheric, river–sea, ecosystem and long-term environmental observation capacities, complementing ISMAR’s ocean-observing systems and strengthening cross-domain research across the land–sea continuum.

2.4 Biodiversity Infrastructures, Laboratories and Scientific Collections

During 2025–2026, ISMAR strengthened infrastructures supporting marine biodiversity observation, advanced analytical capacities and long-term preservation of scientific collections. Developments across European research infrastructures, laboratory systems and scientific collections reinforced the Institute's capacity to connect field observation, laboratory analysis, specimen management and interoperable data systems.

Through **EMBRC**, ISMAR strengthened its contribution to European marine biodiversity observation, including activities connected to EMOBON and upgrades to research and analytical capacities at the Venice and Naples sites. These developments supported biological observation, marine bioresources research and innovation-oriented services.

Within **DiSSCo**, the activation of the Italian node marked an important step in consolidating Italy's contribution to Europe's distributed scientific collections infrastructure. ISMAR contributed to activities supporting the integration of marine and environmental collections and the development of interoperable specimen-based data services.

Progress within **IMDOS** further reinforced ISMAR's role in emerging international coordination systems dedicated to marine debris observation, harmonised monitoring approaches and policy-relevant environmental data integration.

The **ISMAR Integrated Laboratory Platform** represents a major scientific and technological asset, bringing together instrumentation, facilities and analytical capacities across chemical, physical, biological and geological domains. New equipment acquired through NRRP projects significantly strengthened the Institute's analytical capabilities and reinforced its role as a national reference point for advanced marine and environmental analyses.

To support the coordinated management of this distributed system, ISMAR developed an integrated laboratory framework organised into macro-laboratories across multiple sites. Dedicated management structures and harmonised operational procedures improve coordination, accessibility and traceability for both internal and external users.

Complementing the laboratory platform, ISMAR's scientific collections represent a unique research heritage developed through decades of marine geological research. Since 1968, the Institute has collected and preserved geological samples from Mediterranean and extra-Mediterranean environments, including sediment cores, dredge and grab samples, rock specimens, paleontological materials and processed samples.

To strengthen accessibility and long-term management of this heritage, ISMAR is implementing a Sample Policy inspired by international scientific best practices and supported by updated digital tools, including the ISMAR WebGIS Seamap Explorer and related metadata platforms that provide information on sample location, availability and subsampling activities.



Figure 7 — RIs biodiversity data integration.

3. Data Management, Digital Innovation and Interoperability

During 2025–2026, the expansion of ISMAR’s observing systems and research infrastructures was accompanied by major progress in the digital capacities needed to validate, integrate and share scientific data.

Developments included federated marine data systems, interoperable services, near-real-time data access and digital tools supporting environmental analysis, spatial planning and integrated observation. Together, these advances strengthened the connection between infrastructures, data stewardship and scientific services across the Institute.

A major driver of this evolution was the development of the Italian Integrated Ocean Observing System (**IT-IOOS**) within the NRRP-funded ITINERIS project. Designed as a federated digital architecture connecting distributed infrastructures and heterogeneous datasets, IT-IOOS strengthened access to marine observations and reinforced Italy’s contribution to integrated ocean observation systems at national and European scale. It also provides a common entry point for discovering, accessing and reusing Italian marine and oceanographic data through harmonised metadata, interoperable services and FAIR data-management practices.

Digital Highlights 2025–2026

- *Renewed ISMAR data policy*
- *IT-IOOS operational as a federated marine data system and single access point to Italian marine and oceanographic data*
- *39 Essential Variables available through the IT-IOOS portal, including EOVS, EBVs and ECVs*
- *Near-real-time access to distributed observing data*
- *Federated nodes connecting ISMAR sites, infrastructures and data services*
- *Harmonised metadata, controlled vocabularies, quality-control procedures and persistent identifiers supporting data discovery and reuse*
- *Digital tools for environmental analysis, spatial planning and integrated observation*
- *Stronger focus on the long-term sustainability of digital services and of the IT-IOOS Hub beyond the NRRP period*

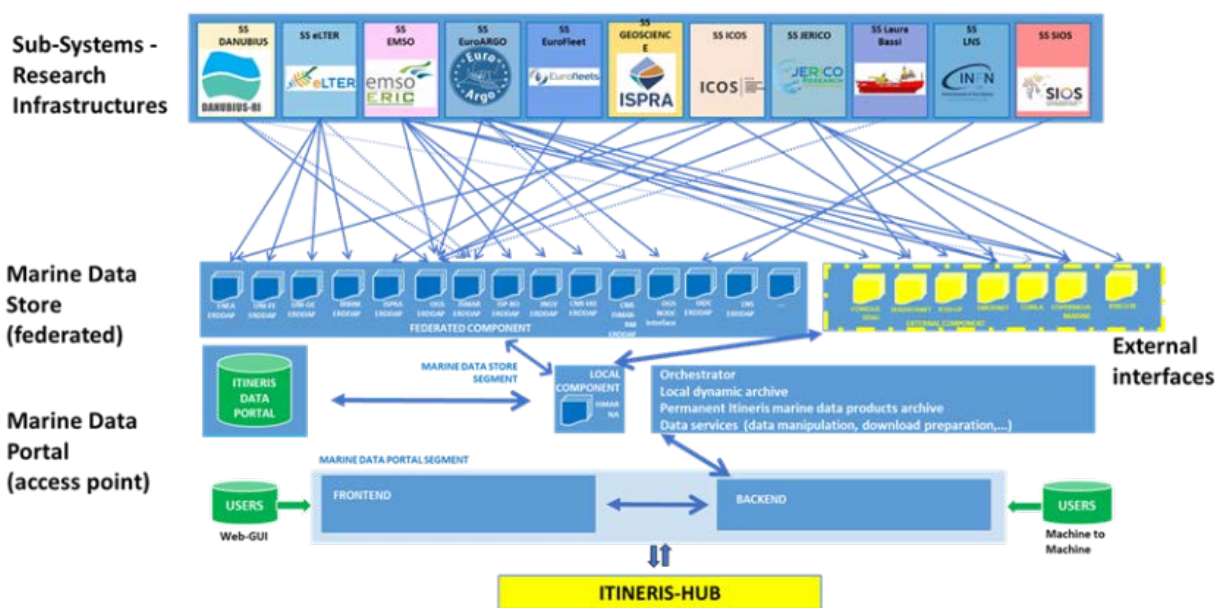


Figure 8 — Federated architecture of the Italian Integrated Ocean Observing System (IT-IOOS). Linking distributed nodes through a central hub for interoperable marine data services.

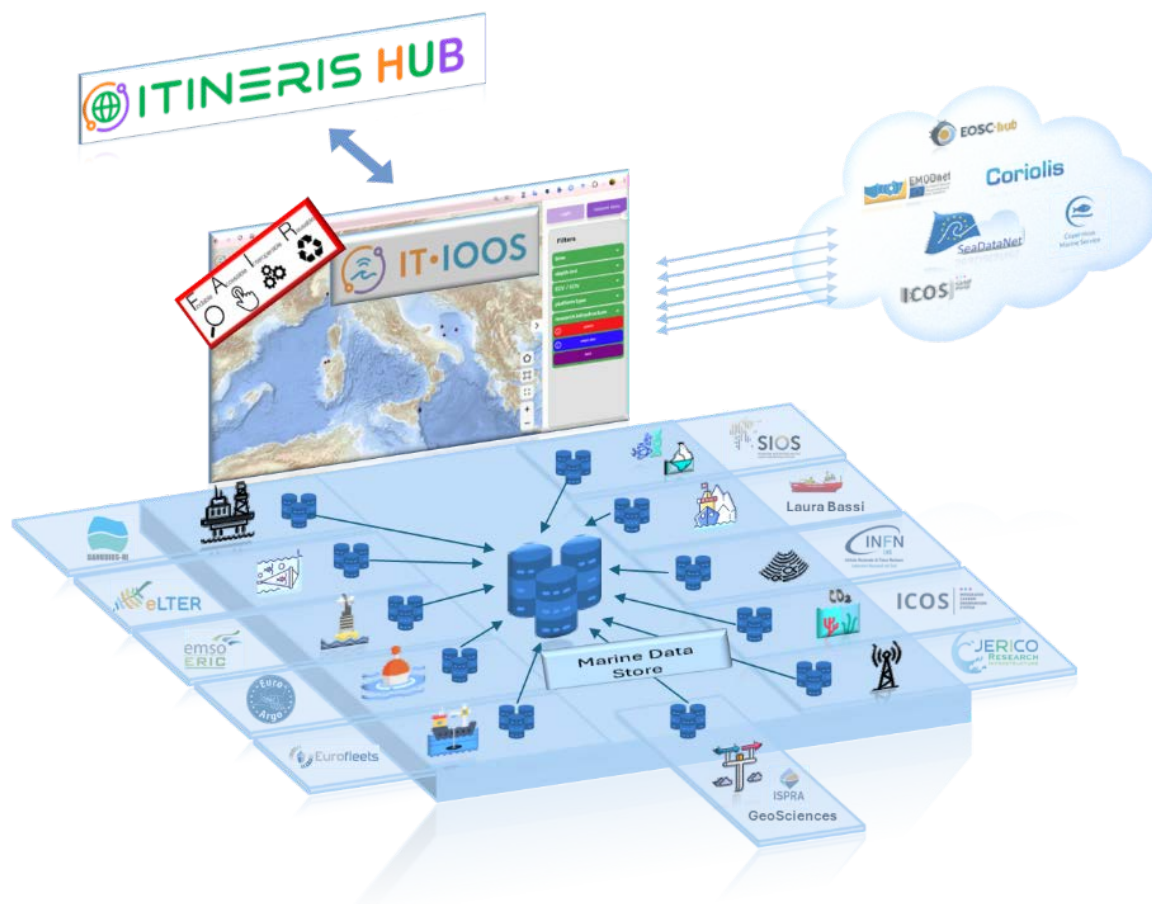


Figure 9 — IT-IOOS system architecture and Hub components. The figure presents the federated architecture of IT-IOOS, with a detailed view of the IT-IOOS Hub comprising the Marine Data Store and the IT-IOOS portal.

3.1 Data Policy, FAIR Principles and Open Science

A major development during the reporting period was the revision of ISMAR's data policy, strengthening provisions for the management, recovery and accessibility of both current and legacy datasets. This reinforced the Institute's commitment to FAIR data practices, open science and the long-term value of scientific data produced across its research activities.

In parallel, ISMAR advanced a broader institutional initiative aimed at consolidating its federated marine data infrastructure. This work supports digital services, data stewardship and operational continuity across distributed infrastructures, observing systems and research platforms.

Particular attention was devoted to sustainability beyond the NRRP period, including institutional support for federated nodes, technical expertise and the continuity of evolving digital services.

Data strategy in focus

- FAIR and open data
- legacy dataset recovery
- federated infrastructures
- interoperable services
- long-term sustainability



3.2 IT-IOOS and Federated Marine Data Systems

A major milestone during 2025–2026 was the operational consolidation of IT-IOOS as a federated national hub integrating services and data streams from distributed infrastructures and observing systems. Built on open-source technologies and conceived as a scalable “system of systems,” IT-IOOS strengthens access to heterogeneous marine datasets, observing platforms and interoperable digital services through a single federated access point.

The platform supports catalogue services, metadata stewardship and persistent identification mechanisms, improving the discoverability, traceability and long-term reuse of distributed datasets. A key element of this approach is metadata harmonisation: IT-IOOS aligns existing RI metadata structures with the ITINERIS metadata model through mapping and conversion procedures, using shared standards, controlled vocabularies, and interoperable services while preserving RI-specific data systems.

Particularly significant was the development of federated dissemination nodes and production units across multiple ISMAR sites, together with the integration of near-real-time observational data from coastal observatories, HF radar systems, oceanographic campaigns and R/V Gaia Blu operations.

SOM data streams from fixed, mobile and autonomous platforms are increasingly integrated into IT-IOOS and related European data systems through harmonised metadata, quality-control procedures and real-time or delayed-mode distribution services. This includes observations from coastal and offshore stations, HF radar systems, gliders, BGC-Argo floats, wave buoys, drifters, research-vessel operations and long-term monitoring sites.

The distributed architecture of the system, combining federated nodes with a central catalogue hub, represents an important model for resilient and scalable marine data infrastructures at national and European level and reinforces Italy's contribution to GOOS, EOOS, and emerging European marine data systems.

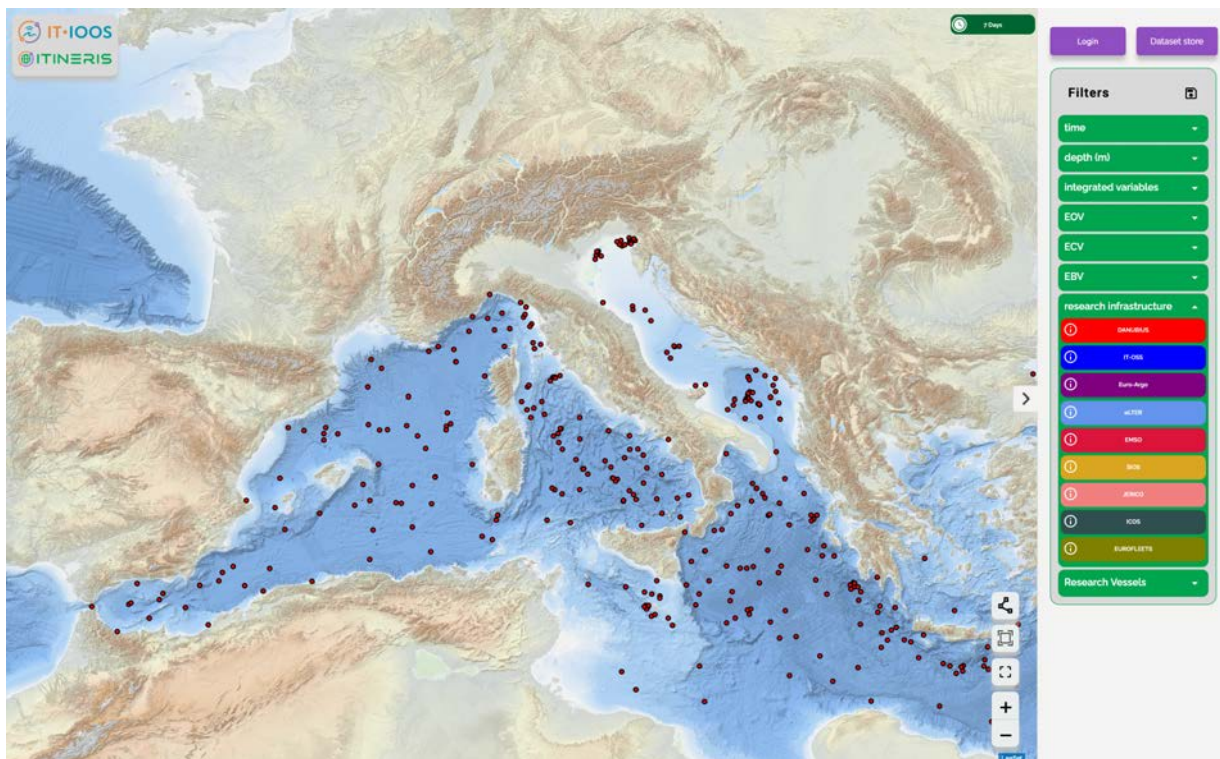


Figure 10 — IT-IOOS portal (<https://it-ioos.eu>). Data services across research infrastructures, including JERICO HF radar and *Gaia Blu* navigation data.

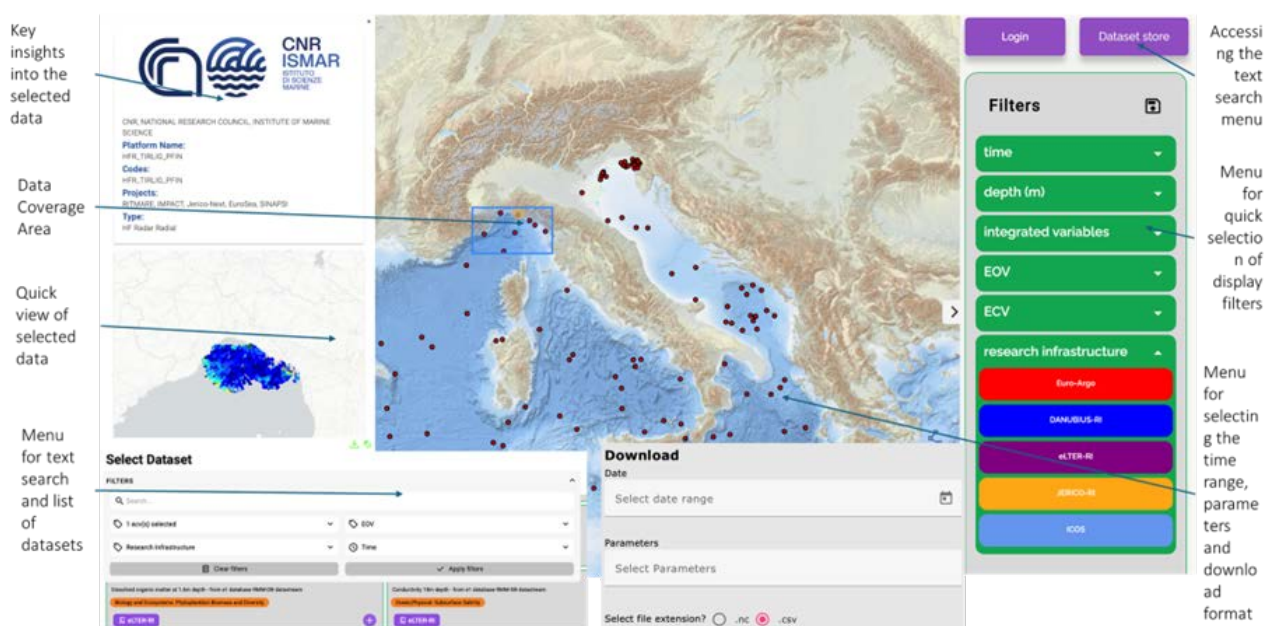


Figure 11 — IT-IOOS portal. Federated access and integrated visualization of marine observations and products across research infrastructures.

3.3 Digital Services, Spatial Platforms and Integrated Observation

During 2025–2026, ISMAR further expanded digital services and interoperable tools supporting marine observation and modelling, ecosystem assessment, spatial planning and environmental decision-making. These developments improved access to heterogeneous datasets while strengthening analytical capacities and user-oriented digital environments.

A major area of progress was the continued development of the **Tools4MSP** geoplatform, including its deployment on the CINECA Galileo HPC infrastructure and the expansion of its knowledge catalogue. By 2025, the platform hosted approximately 900 layers, 90 maps, 40 geostories and seven dashboards supporting spatial analysis, visualisation and participatory planning activities.

Tools4MSP is progressively evolving toward applications aligned with emerging Digital Twin of the Ocean approaches. Its services support exploratory scenario analysis for maritime spatial planning and ecosystem-based management, integrating scientific knowledge, modelling outputs and decision-support functionalities within interactive digital environments.

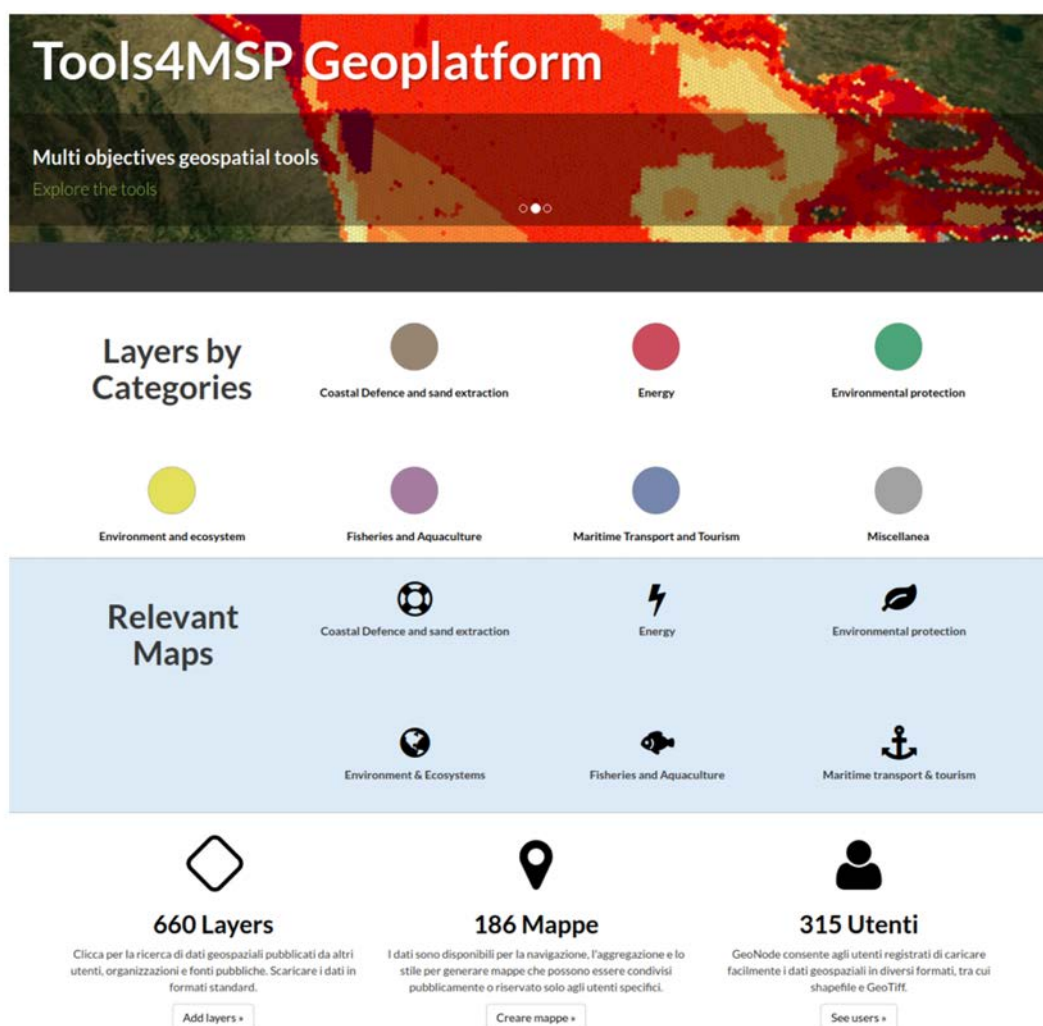


Figure 12 — Tools4MSP Geoplatform. Digital services and interoperable tools supporting marine observation and modelling, ecosystem assessment, spatial planning and environmental decision-making.

Additional progress was achieved through open-source service environments and near-real-time dissemination systems supporting access to distributed marine observations collected across infrastructures and monitoring systems. These services also support the transition from individual observing platforms toward integrated digital workflows, where data acquisition, quality control, metadata management, visualisation and dissemination are increasingly treated as connected components of the same research infrastructure. In this context, ISMAR also played a key role in supporting the expansion and validation of remote-sensing and model-output data collections.

Innovation is also reflected in the evolving technological ecosystem of R/V Gaia Blu, where advanced sensors, autonomous systems and digital methodologies are increasingly integrated into long-term scientific and operational activities.

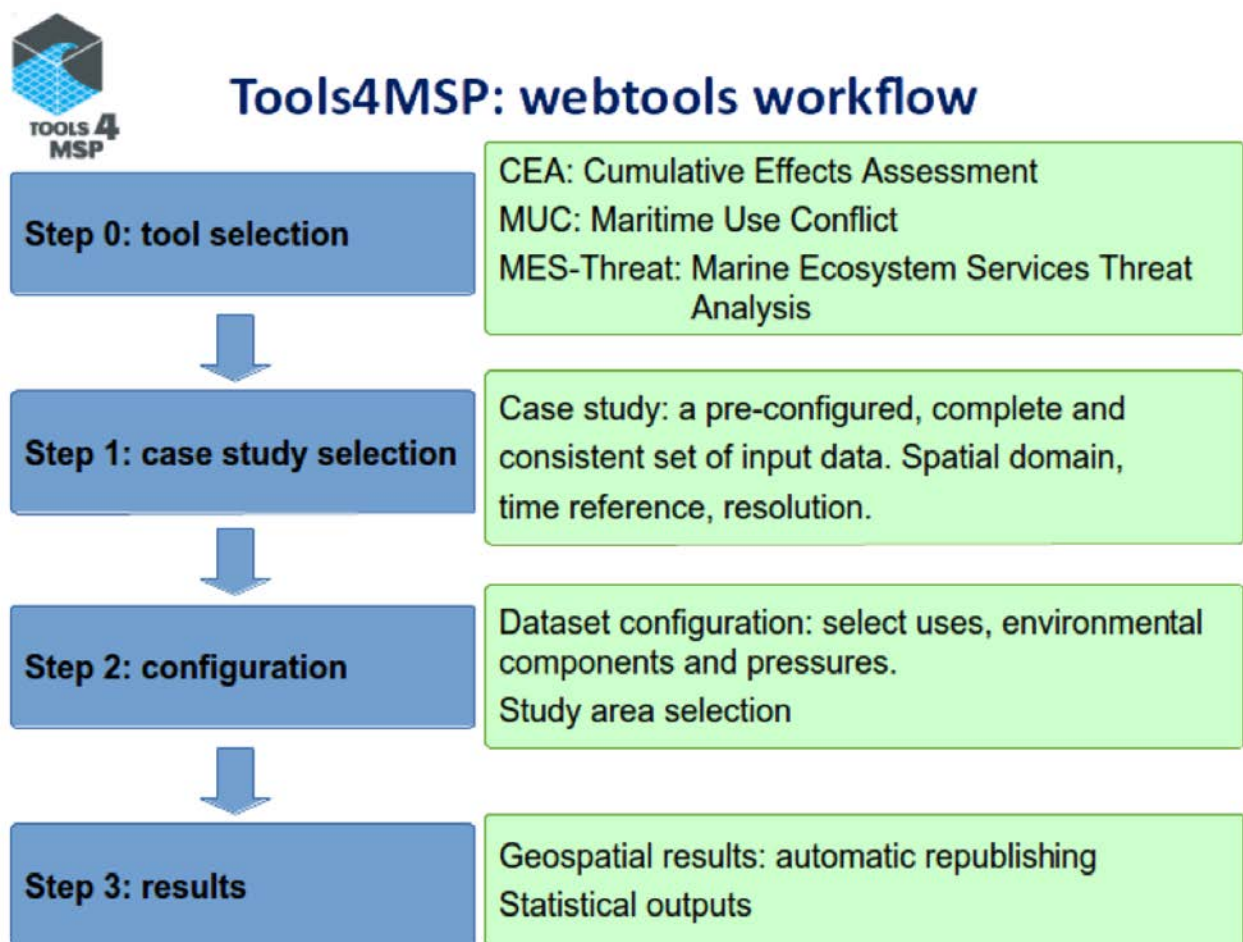


Figure 12 — Tools4MSP and Webtools workflow. Workflow; participatory planning interface; to produce geospatial results and statistical outputs.

PART III— SCIENCE IN ACTION: PROGRAMMES, RESEARCH AND STRATEGIC INITIATIVES

4. Biodiversity Research and Strategic National Initiatives

During 2025–2026, biodiversity research emerged as one of ISMAR’s major areas of development, supported by national investments, new digital infrastructures, advanced mapping technologies and stronger links between scientific research, environmental management and public engagement.

Within this framework, the **National Biodiversity Future Center (NBFC)** played a central role. ISMAR contributed to the development of tools and infrastructures for marine biodiversity observation, habitat mapping, data integration and science-based support for conservation, restoration and maritime spatial planning.

4.1 National Biodiversity Future Center: Marine Biodiversity Data and Mapping

Within the National Biodiversity Future Center, ISMAR contributed to activities connecting biodiversity observation, habitat mapping, marine monitoring, environmental data infrastructures and decision-support tools for conservation and management.

A major contribution developed within **NBFC Spoke 1** was the **Marine Spatial Data Infrastructure (MSDI)**, designed to harmonise fragmented knowledge on Italian marine and coastal biodiversity and integrate it into a shared digital environment. Built according to **FAIR** principles and aligned with international standards, the **MSDI** supports the storage, organisation, visualisation and sharing of heterogeneous biodiversity information.

Operationalised through the **Italian Marine Biodiversity Geoportal**, the infrastructure provides access to thematic layers, metadata catalogues and visualisation tools for scientists, policymakers and stakeholders. It integrates diverse data types, including spatial data, images, videos, time series and inventories, drawing on scientific publications, cartography, monitoring activities and public databases.

The **Geoportal** currently hosts more than 60 thematic layers at national scale, organised around key categories including pilot sites, monitoring activities, protection and conservation actions, human uses, biodiversity, geodiversity and environmental variables. A dedicated metadata system supports data traceability, interoperability and long-term reuse.

Associated dashboard tools further improve the accessibility and usability of marine biodiversity data, allowing users to explore pilot sites, mapping activities and study and monitoring programmes through charts, indicators and interactive visualisations. These tools provide a foundation for ecological assessment, gap analysis, biodiversity-oriented management and maritime spatial planning.

Technological innovation was also strengthened through new habitat-mapping capacities developed within **NBFC Spoke 1**. The acquisition of a Kongsberg 2040p mkII multibeam echo sounder, designed for integration with the **OpenSWAP** autonomous surface vehicle, represents

an important advance for high-resolution coastal and shallow-water surveys. This system improves access to littoral and very shallow environments, reduces operational constraints and supports more frequent, flexible and detailed mapping of habitats that are difficult to survey using larger research vessels.

Together, the **MSDI, Marine Biodiversity Geoportal, dashboard tools and new autonomous mapping capacities** strengthen ISMAR's contribution to marine biodiversity knowledge, monitoring and management, while supporting the broader NBFC objective of translating scientific data into operational resources for conservation, restoration and sustainable planning.

Geoportal and Biodiversity Dashboards

The Italian Marine Biodiversity Geoportal integrates spatial data, monitoring activities, habitat mapping, environmental variables and biodiversity observations within a FAIR-compliant framework. Associated dashboards and visualisation tools allow users to explore pilot sites, indicators, mapping activities and monitoring information through accessible interfaces for researchers, policymakers, environmental managers and public users.



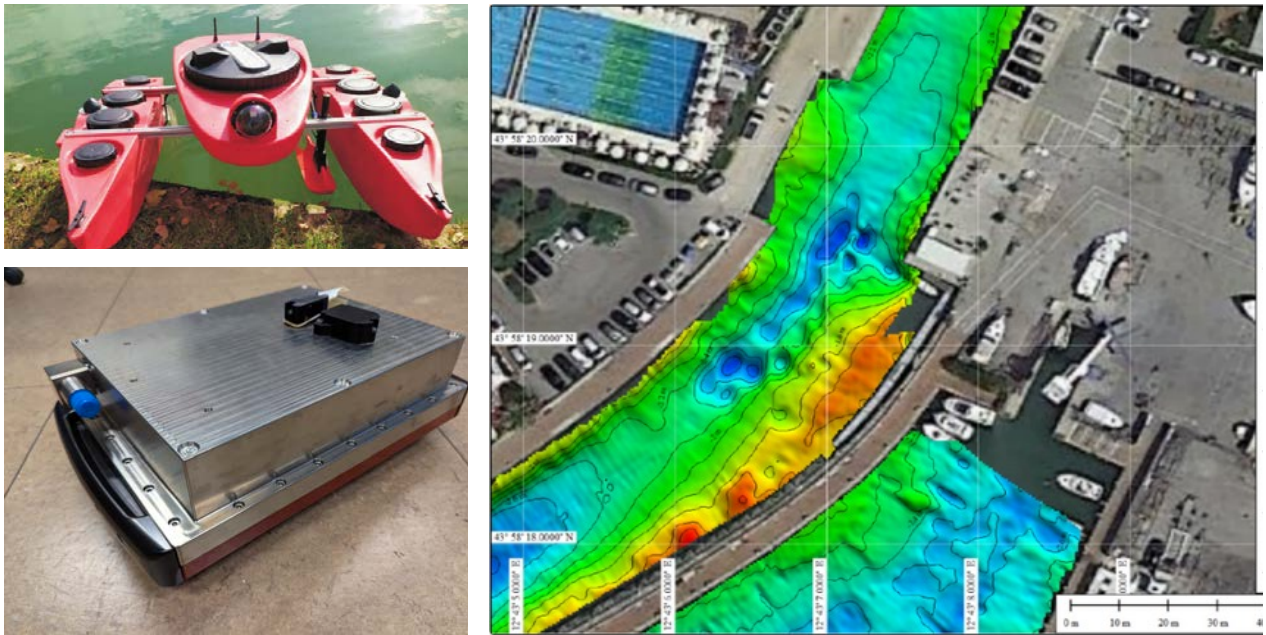


Figure 13 — OpenSWAP and multibeam habitat-mapping system. The integration of autonomous surface vehicles and high-resolution multibeam technologies supports flexible habitat mapping in coastal and shallow-water environments.

4.2 Biodiversity Gateway: Connecting Research, Digital Tools and Society

The Biodiversity Gateway represents one of the main interfaces through which NBFC biodiversity research is made accessible beyond the scientific community. Conceived as both a digital platform and a distributed network of territorial nodes, it connects scientific knowledge, digital tools, education, innovation and public engagement within a shared national framework.



During 2025–2026, the Gateway moved from implementation toward operational readiness. The physical network was consolidated through the activation of territorial nodes, while the digital platform was expanded with new editorial content, interactive services and tools designed to make biodiversity knowledge easier to access, explore and reuse.

The digital portal was substantially enriched through the expansion of its Experiences and Actions sections, the introduction of filtering tools in the Biodiversity

Solutions and Biodiversity Experiences areas, a redesigned digital-services catalogue, and an interactive network map connecting users with the physical Gateway nodes. These developments strengthened the platform's role as a national access point for biodiversity knowledge, data-driven tools and science communication.

In parallel, the physical network developed as a set of place-based nodes linking biodiversity research with territorial contexts. Venice, Palermo, Naples and Rome/Tevere became operational or entered full activation during the reporting period, each with a specific ecological, cultural and institutional profile.

Within Chapter 4, the Gateway is presented primarily as part of the NBFC biodiversity infrastructure: a bridge between research outputs, digital platforms, territorial nodes and society. Its educational, citizen-science and public-engagement activities are addressed in greater detail in Chapter 8.



Figure 14 — Biodiversity Gateway digital platform and territorial nodes. The Biodiversity Gateway combines a national digital portal with a distributed network of territorial nodes, connecting biodiversity research, digital services and public-facing spaces across Italy.

4.3 MSP4BIODIVERSITY: Biodiversity-Sensitive Maritime Spatial Planning

MSP4BIODIVERSITY is an NBFC activity coordinated by CNR-ISMAR to support the integration of biodiversity conservation and restoration into the Italian Maritime Spatial Planning process. It develops science-based and policy-relevant tools for assessing how marine planning choices can affect biodiversity, ecosystems and sustainable blue-economy development.

During 2025, the activity completed the design and implementation of an integrated methodology for the co-development of maritime spatial planning and management scenarios up to 2040. These scenarios were designed to explore options for strengthening biodiversity protection while considering governance, environmental, social, cultural and economic dimensions.

The methodology was applied in three pilot regions: the Northern Adriatic, the Strait of Sicily and the Ligurian Sea–Northern Tyrrhenian region. Across these areas, multidisciplinary teams developed models and analytical modules addressing cumulative environmental impacts, underwater noise propagation, fisheries dynamics, climate refugia, ecosystem services, socio-economic implications and legal and governance aspects.

A distinctive element of MSP4BIODIVERSITY was its participatory approach. Scenario results were presented and discussed through three dedicated stakeholder workshops, enabling multidimensional “what-if” analyses and supporting dialogue between scientific expertise, planning needs and management priorities.

By linking biodiversity data, spatial modelling, participatory processes and policy needs, MSP4BIODIVERSITY represents a concrete example of science-policy work within NBFC. It shows how marine research can support biodiversity-sensitive planning, ecosystem-based management and more sustainable governance of Italian marine spaces.

MSP4BIODIVERSITY in Numbers

- 3 PILOT REGIONS
- 6 STAKEHOLDER SCENARIOS UP TO 2040
- 10 ASSESSMENT DIMENSIONS
- 3 STAKEHOLDER WORKSHOPS
- MULTIDISCIPLINARY MODELLING AND PLANNING TOOLS





Figure 15 — MSP4BIODIVERSITY pilot regions and planning tools. The activity applied biodiversity-sensitive scenario analysis to the Northern Adriatic, Strait of Sicily and Ligurian Sea–Northern Tyrrhenian region, integrating spatial modelling, ecological assessment and stakeholder dialogue.

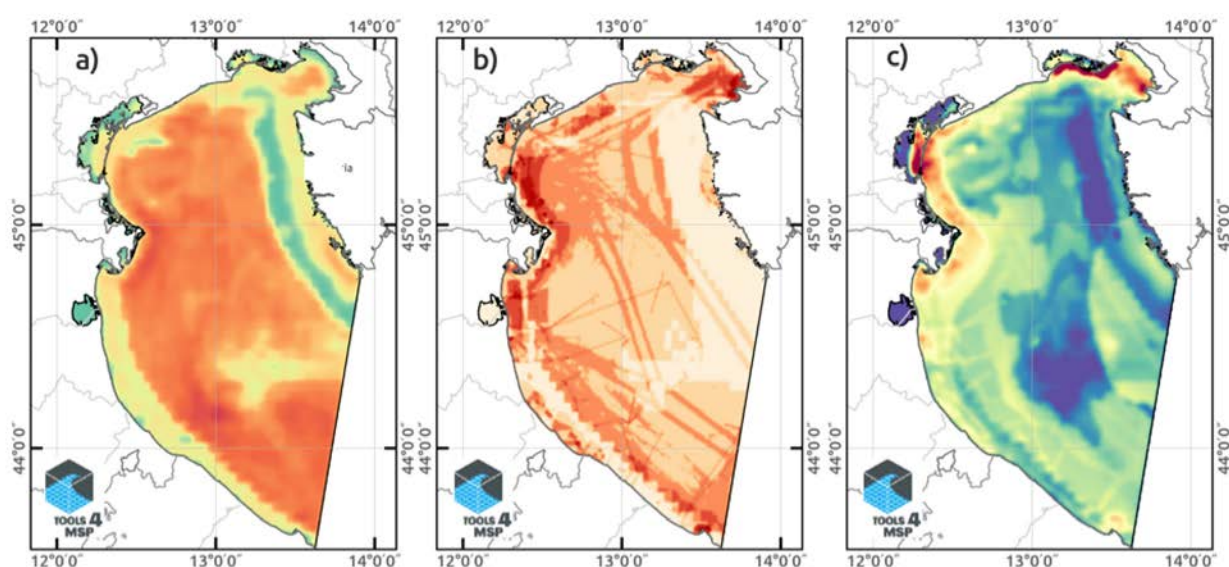


Figure 16 — From biodiversity data to planning scenarios. MSP4BIODIVERSITY links biodiversity information, cumulative impact analysis, ecosystem services, fisheries dynamics, climate refugia and governance considerations within a participatory maritime spatial planning framework.

5. Strategic Research Initiatives and Emerging Scientific Directions

During 2025–2026, ISMAR continued to develop research initiatives that connect marine observation, biodiversity, climate science, modelling, digital technologies and environmental governance. These activities reflect the Institute’s capacity to mobilise infrastructures, scientific expertise and interdisciplinary collaborations within competitive national and international research frameworks.

This chapter highlights selected projects and emerging research directions that illustrate how ISMAR’s scientific activities are expanding across new methods, applications and thematic areas — from inclusive biodiversity conservation and high-performance computing to intelligent marine monitoring, spatial planning, cultural heritage and transformative approaches to ocean science.

5.1 Competitive Projects and Strategic Initiatives

During 2025–2026, ISMAR participated in a wide range of competitive projects and strategic initiatives addressing biodiversity conservation, climate modelling, high-performance computing, artificial intelligence, marine observation, spatial planning and interdisciplinary ocean science.

This section highlights selected initiatives that illustrate the breadth of ISMAR’s scientific engagement and its capacity to connect research infrastructures, modelling tools, field observations, digital platforms and policy-relevant applications.

PROJECTS HIGHLIGHTS

INTRASEAM — Integrating Sex in Sustainable Ocean Management and Observing Systems for Biodiversity Conservation of the Mediterranean Sea

INTRASEAM is a five-year FIS Advanced Grant funded by the Italian Ministry of University and Research through the Italian Fund for Science, with a budget of €1.76 million. The project develops innovative approaches to sustainable ocean management by integrating sex-specific biological processes into biodiversity conservation, observing systems and climate-smart planning.

The project combines sex-specific policy analysis, habitat and niche modelling, marine spatial prioritisation and cumulative-effects assessment to support more effective conservation and management strategies. Tested in the Northern Mediterranean Sea, with particular reference to Italian Maritime Spatial Planning initiatives, INTRASEAM connects scientific analysis, policy

engagement, capacity building and interoperable data services within the Italian National Biodiversity Gateway.

INSPIRI — Imaginative Narratives and Scenarios for Inspiring Restoration and Innovation for European Seas and Water Systems

Launched in 2025, INSPIRI is a Horizon Europe Mission Ocean project focused on developing imaginative narratives, visions and scenarios for biodiversity restoration, zero pollution and carbon neutrality across European seas and water systems. The project runs from September 2025 to August 2028 and uses creative participatory methods to support more ambitious and inclusive approaches to sustainable futures for EU waters.

Through case studies across the Mission Lighthouse regions, INSPIRI will co-create visions of desirable futures for ocean and water systems, develop modelling and back-casting scenarios, and support regional Transformation Labs involving decision-

makers, policymakers, experts and stakeholders. CNR co-leads WP4, “Actioning visions through policy,” with the University of Santiago de Compostela and contributes to the Mediterranean case study.

ICSC Spoke 4 — Earth and Climate

Within the National Centre for High-Performance Computing, Big Data and Quantum Computing, ISMAR contributed to Spoke 4 — Earth and Climate through advanced modelling, data assimilation and high-performance computing applications for marine and climate research.

Activities included the development of deep-learning approaches for simulating sea-surface temperature diurnal variability in Mediterranean coupled ocean–atmosphere models, carried out in collaboration with FBK. ISMAR also produced MESMAR-R, a coupled Mediterranean regional reanalysis covering 1993–2024 and representing one of the first regional-scale products combining an Earth-system model with data assimilation.

Additional work advanced coupled atmosphere–ocean–wave modelling systems and the design of finite-element solvers for coastal applications targeting modern HPC architectures, adaptive meshes and high-resolution bathymetric datasets.

RAISE — Robotics and AI for Socio-economic Empowerment

Within RAISE, ISMAR contributed to intelligent marine monitoring, AI-assisted environmental analysis and operational forecasting through activities developed under Spoke 3 — Environmental Protection and Care and Spoke 4 — Smart and Sustainable Ports.

Under Spoke 3, ISMAR coordinated work on advanced technological platforms for sea monitoring and forecasting, including the SmartOb-RAISE multi-parametric

observatory, passive acoustic monitoring systems, automated imaging tools for detecting gelatinous macrozooplankton and predators in mussel farms, adaptive sampling technologies and AI-assisted environmental reconstruction.

Under Spoke 4, ISMAR contributed to smart and sustainable port applications, including met-ocean nowcasting and forecasting, HF radar integration, high-resolution data assimilation, Search and Rescue proof-of-concept chains and low-cost drifter development for port and coastal environments.

Tools4MSP — Geospatial Tools for Maritime Spatial Planning

Tools4MSP continued to support advanced spatial analysis, ecosystem-based planning and marine environmental management through open-source geospatial tools. The software supports cumulative effects assessment, maritime use conflict analysis and marine ecosystem-services threat analysis, and can be used both as a stand-alone library and as a GeoNode plugin with graphical user-interface functionalities.

Because Tools4MSP has already been discussed in Chapter 3 as part of ISMAR’s digital services and spatial platforms, it should remain concise here as a project highlight linking digital innovation, maritime spatial planning and environmental decision support.

MarDepend — Reconstructing Maritime Dependencies in Antiquity

Launched in 2025, MarDepend — *Maritime Dependencies in Antiquity* — is a Horizon Europe ERC Consolidator project led by the University of Trier, with CNR as second beneficiary. The project investigates how maritime conditions shaped trade, power relations and conflict in the ancient

Mediterranean, with particular focus on Syracuse between the fifth and fourth centuries BCE.

ISMAR and ISAC contribute to the reconstruction of historical meteo-marine conditions, including winds, waves and currents influencing ancient navigation. With a CNR budget of €400,000 within a total project budget of approximately €1.95 million, MarDepend illustrates how oceanographic and climatological modelling can support interdisciplinary research in maritime history, archaeology and cultural heritage.

Copernicus — Marine Observations, Climate Services and Modelling

Within the European Copernicus initiative, ISMAR contributed to the Copernicus Marine and Climate Change services through the provision, evaluation and quality control of remote-sensing datasets, model outputs and reanalysis products. Activities included work on sea-surface temperature, salinity and ocean-colour products, as well as contributions to data evaluation, validation and service development.

These activities build on ISMAR's expertise in high-performance computing, advanced modelling and emerging digital methodologies, including machine-learning-assisted approaches, hybrid physical modelling and the development of high-resolution data products.

RISCHiA-Re — Monitoring Coastal and Submarine Instabilities for Hazard Assessment

Coordinated by CNR-ISMAR within the NRRP RETURN partnership, RISCHiA-Re investigates slope instability in nearshore and shallow marine environments, with the aim of supporting hazard assessment, risk prevention and coastal-management strategies. The project combines high-resolution satellite data, geomatics, acoustic and sonar-system design, landslide-event databases, UAV photogrammetry and MT-InSAR analysis to monitor morphological changes in shallow seabeds and rocky coastal cliffs. Developed with ISMAR Naples, ISMAR Bologna, Planetek Italia and Leonardo Sistemi Integrati, it links geosciences, engineering and remote sensing to improve understanding of coastal and submarine gravitational instabilities.

Piano AZA-RER — Applied planning and institutional support

Through an institutional agreement with the Emilia-Romagna Region, ISMAR contributes to the development of the Regional Plan for Areas Allocated to Aquaculture in marine waters off the regional coast. The Piano AZA-RER activity supports spatial planning for aquaculture, linking environmental knowledge, marine uses and regional management needs. The agreement runs from January 2025 to December 2026, with a total budget of €223,100 and an ISMAR budget of €43,500.

SPOTLIGHT - Emerging Direction — Tropical Environments and Mediterranean Futures

ISMAR has promoted the establishment of a Departmental Working Group dedicated to tropical environments, with the aim of strengthening the connection between scientific research, operational applications and international cooperation. The initiative responds to the need to translate scientific knowledge into effective practices for the protection of natural and cultural heritage in a context of rapid climate change.

Tropical environments are approached as strategic laboratories for anticipating future scenarios that may become increasingly relevant to the Mediterranean, including biodiversity change, coastal vulnerability, ecosystem resilience and climate-related pressures. The initiative is being developed through international collaborations involving academic institutions, research bodies and local stakeholders.

In Egypt, relationships with Galala University and the presence of an operational base at Gorgonia Beach Resort in the Red Sea support the development of joint activities in research, training and technology transfer. Planned actions include studies on marine biodiversity, coastal dynamics and habitat mapping, as well as training initiatives for researchers, resource managers, hospitality facilities and local communities.

A distinctive feature of the initiative is the integration of environmental research with sustainable development, including the involvement of the tourism sector and models of sustainable hospitality. Collaboration with international partners, including CIHEAM Bari, further supports knowledge exchange and capacity building across Mediterranean and tropical contexts.

Future developments include planned oceanographic campaigns in the Red Sea with the CNR research vessel *Gaia Blu* from 2027 onward, offering opportunities to integrate observations, experimentation and advanced modelling in a comparative perspective between tropical and Mediterranean marine systems.



5.2 Goal Oriented Units and Interdisciplinary Collaboration

The Goal-Oriented Units (GOUs) were introduced as a mechanism to encourage interdisciplinary interaction across ISMAR's distributed research community. Developed through two funded calls, the GOUs brought together researchers from different sites/units and scientific domains around topics of strategic relevance to marine sciences.

During 2025–2026, an internal review of the GOUs highlighted their strengths as well as the need for adaptation. The GOUs have helped foster dialogue among colleagues working on related topics, encouraged cross-site collaboration and facilitated the development of project ideas, workshops and new scientific directions, including activities involving communities beyond the Institute.

At the same time, existing workloads and the demands of project-related activities have at times hampered the continuity and feasibility of planned actions, many of which had been designed with ambitious objectives. For this reason, the GOU framework is being reviewed to strengthen its role as a practical and flexible tool for interdisciplinary collaboration within a highly diverse Institute, while reducing the risk of excessive fragmentation.

Within this evolving framework, four new or renewed GOUs are highlighted below.

DTO — Digital Twin Ocean Approaches

The DTO GOU is being established as ISMAR's pilot group supporting the implementation of Digital Twin Ocean solutions within the EDITO digital infrastructure. The initiative aims to strengthen ISMAR's capacity to contribute to the responsible development and use of DTOs in research contexts and evidence-based decision-making.

During 2025, an ISMAR team participated in the EDITO-Model Lab Hackathon, engaging with platform applications and custom services linked to themes such as marine protected areas, biodiversity conservation, zero-carbon shipping routes and zero-pollution pathways.

The GOU is developing as a community-of-practice framework connecting several thematic and territorial demonstrators, including saltwater intrusion management in the Po Delta, multi-hazard assessment in the Volturno River coastal plain, the Gulf of Naples, Smart Bay La Spezia, the Northern Adriatic Sea and coastal areas in Tuscany. These activities build on ISMAR's capacities in

observing systems, modelling, digital platforms and spatial analysis.

impACTS — Active and Inclusive Participation for Citizen Science in the Marine Environment

The impACTS GOU focuses on inclusive citizen science in marine environments, with particular attention to physical and experiential accessibility in public-engagement activities. The group brings together 19 researchers across botany, zoology, palaeontology, geology, oceanography, science communication and ICT, while also engaging stakeholders active in the marine sector and in the field of inclusiveness.

During 2025, the GOU promoted the establishment of an ISMAR citizen-science network to connect researchers interested in participatory approaches and strengthen collaboration across the Institute. Training activities included seminars on citizen science principles and project design, supporting the development of shared methodological foundations for future initiatives.

The group also advanced the design of inclusive citizen-science case studies through brainstorming and stakeholder-oriented planning. Two pilot directions were identified: island bio-geodiversity and coastal litter monitoring. These activities aim to support marine monitoring through inclusive public engagement and the development of protocols, materials and living-lab approaches adapted to specific contexts.

Mediterranean Paleooceanography — Circulation and Global Teleconnections

The Mediterranean Paleooceanography GOU promotes interdisciplinary collaboration in paleoceanography, integrating geology, biology, oceanography, modelling and genomics. Its aim is to strengthen understanding of Mediterranean ocean dynamics and their connections with climate variability, marine biota resilience and biogeochemical cycles from deep time to the present.

The GOU was established after preparatory mapping and networking activities carried out in 2024 and 2025 to identify paleoceanographic expertise within ISMAR and potential synergies with Italian and international research institutions. Key priorities include integrating paleoceanographic archives with modern observations and climate models, identifying strategic Mediterranean areas and time windows, supporting collaborative projects and oceanographic cruises, and exploring innovative methodologies such as paleogenomics and artificial intelligence.

During 2025, activities included preparatory meetings in April and May, an in-person GOU meeting in Bologna in November, scientific planning for PRIN and GEONEXT proposals, and discussions on future R/V Gaia Blu campaigns. Additional work addressed links with international initiatives such as TREC and TIMES, the development of AI-based techniques for microfossil identification, and student training activities in paleoceanography, paleobiodiversity and seabed exploration.

GeM — Gender and Sex Dimensions in Marine Research

The GeM GOU focuses on the integration of gender-related aspects and biological sex into marine research, with particular attention to how these dimensions can inform research questions, modelling approaches and environmental assessment. Building on developments in fields such as medicine, ecology and artificial intelligence, the group promotes reflection on how gender- and sex-based perspectives can contribute to innovation in marine biology and source-to-sea research.

The GOU brought together 16 researchers from different institutes to discuss intersectional, gender- and sex-based approaches within source-to-sea models. Starting from participants' ongoing research activities, discussions addressed sources and exposure pathways, factors regulating sex ratios, and the integration of different disciplinary competences as a basis for future modelling analyses.

The collaboration also contributed to the development of themes included in the proposal **FOCUS - Adaptive responses of small-scale fisheries to joint climate-pollution scenarios: a computational One Health framework**. The proposal explores the socio-economic potential of small-scale fisheries while laying the groundwork for integrating a One Health perspective into modelling approaches. The connection with the FISIR-funded project "INTRASEAM" represents further opportunities for the development of the GOU.

6. Transformative Ocean Science Symposium

6.1 Venice 2026: A Forum for Transformative Ocean Science

Held from 24 to 27 March 2026 in Venice, the International Symposium on Transformative Ocean Science represented a major contribution to European discussions on the future of ocean research and innovation. Conceived as a forum at the science–policy interface, the Symposium explored how ocean science must evolve to respond to increasingly complex environmental, technological, societal and governance challenges.

Bringing together approximately 300 participants from 23 countries — including scientists, policymakers, institutional representatives and stakeholders — the Symposium created an interdisciplinary space for dialogue and strategic reflection.

Over four days, discussions addressed ocean observing systems, biodiversity, artificial intelligence, ethics, marine governance, innovation and the future positioning of ocean science within European policy frameworks, including the Ocean Pact and future EU research strategies



Figure 17 — Participation in the International Symposium on Transformative Ocean Science. Overview of countries, institutions and organisational representation.

6.2 Scientific Dialogue and European Priorities

The programme featured an international line-up of keynote speakers, institutional representatives and scientific leaders contributing perspectives from across marine science, policy and research governance.

During the first three days, keynote contributions from leading figures including James Morrison, Sabrina Speich, Margaret Leinen, Claire Jolly, Annalisa Bracco, Martin Visbeck, Chris Bowler and Ricardo Serrão Santos helped frame discussions around scientific ambition, societal relevance and emerging frontiers in ocean research.

The fourth day expanded the dialogue through a high-level plenary session and thematic roundtables involving European institutions, marine research organisations and policy actors. Contributions from Sir Tim Hunt, Pascal Lamy and Geneviève Pons were accompanied by participation from senior representatives of DG RTD, DG MARE and leading European research centres.

Discussions addressed the evolving relationship between ocean science, marine governance and European strategic frameworks, with particular attention to the Ocean Pact, future Ocean Research and Innovation strategies, and the role of scientific knowledge in supporting evidence-based marine policy.



Keynote Speakers and Invited Contributions

Day I — Future Ocean Science

James Morrison — European Commission, DG Research and Innovation
Sabrina Speich — ENS-PSL / Laboratoire de Météorologie Dynamique
Margaret Leinen — Scripps Institution of Oceanography, UC San Diego

Day II — AI, Ethics, Foresight and Education

Annalisa Bracco — Georgia Institute of Technology / CMCC
Matthias Kaiser — University of Bergen
Silje Granum Carson — Norwegian University of Science and Technology
Claire Jolly — OECD Ocean Economy Programme
Deirdre Brophy — Atlantic Technological University
Evy Copejans — Marine science education

Day III — Observation, Exploration, Biodiversity and Culture

Paula Bontempi — University of Rhode Island
Martin Visbeck — OceanQuest
Jean-Marc Daniel — IFREMER
Chris Bowler — Institut de Biologie de l'École Normale Supérieure
Ricardo Serrão Santos — Institute OKEANOS, University of the Azores

Day IV — Transformative Ocean Science: Reflections and Recommendations

Sir Tim Hunt — Nobel Prize in Physiology or Medicine 2001
Pascal Lamy — Chair, EU Mission "Restore our Ocean and Waters"
Geneviève Pons — Europe Jacques Delors



Institutional Roundtables and Strategic Dialogue

Roundtable 1 — Stakeholder perspectives

CNRS-INSU, DTU Aqua, HCMR, NTNU Ocean and Coast, GeoEcoMar, METU, ICMAN-CSIC, IEO

Roundtable 2 — European and international ocean networks

European Marine Board, Ocean Exploration Cooperative Institute, EurOcean, EuroMarine, JPI Oceans, SEA-EU / University of Malta

Roundtable 3 — From the Ocean Pact to the Ocean R&I Strategy and the Ocean Act

European Commission DG RTD, European Commission DG MARE, GEOMAR, National Oceanography Centre, IFREMER, CNR-DSSTTA

6.3 Working Groups and Participatory Process

A defining feature of the Symposium was its participatory, working-group-based format. Six interdisciplinary working groups provided spaces for dialogue, co-design and collective reflection, enabling participants to identify challenges, priorities and possible directions for transformative ocean science.

The working groups addressed different but interconnected dimensions of ocean transformation, from observing systems, biodiversity and digital technologies to ethics, governance, education and societal engagement. Their discussions helped connect scientific perspectives with institutional, policy and stakeholder needs.

Several recurring messages emerged across the groups, including the need for:

- sustained and integrated ocean observing systems;
- stronger connections between science, policy and society;
- transdisciplinarity and inclusion as conditions for meaningful transformation;
- responsible use of digital technologies, including artificial intelligence and Digital Twins of the Ocean;
- more ambitious, impact-driven approaches to ocean science.

A central message emerging from the discussions was that ***transformation must become a method, not only a goal***. This principle shaped both the working-group process and the development of the Symposium outputs, reflecting a broader shift toward more integrated, inclusive and action-oriented approaches to ocean science and governance.



Figure 18 — Working groups in session. The Symposium’s working-group format created spaces for interdisciplinary dialogue, co-design and collective reflection on the future of transformative ocean science.

6.4 From Discussion to Action

The Symposium was conceived not only as a space for scientific dialogue, but also as a contribution to ongoing European strategic processes related to the Ocean Pact and the future EU Ocean Research and Innovation Strategy.

Outcomes from the working groups, plenary discussions and institutional roundtables were consolidated into a set of documents intended to support future scientific, institutional and policy developments at European level. These include the Symposium Policy Brief, the Strategic Roadmap and the White Paper.

The Policy Brief, *Transformative Ocean Science for the Ocean Pact*, was finalised and shared with the European marine science and policy community¹. It translates the main messages emerging from the Symposium into a concise set of recommendations addressing the future role of ocean science, research infrastructures, science–policy interfaces, responsible innovation and public engagement.

More broadly, the Symposium helped strengthen connections between marine research communities, European institutions and policy-oriented initiatives, reinforcing the role of science as a strategic component of future ocean governance and long-term sustainability planning.

¹ SPROVIERI, M., GISSI, E., SCHROEDER, K., & the Venice Symposium 2026 Scientific Community. (2026). *Transformative Ocean Science for the Ocean Pact* [Policy Brief]. International Symposium on Transformative Ocean Science, Venezia, Italy. Zenodo. <https://doi.org/10.5281/zenodo.20176785>



INTERNATIONAL SYMPOSIUM
Transformative Ocean Science

POLICY BRIEF - International Symposium on Transformative Ocean Science, Venice 2026

Transformative Ocean Science for the Ocean Pact

Scientific priorities for the EU Ocean Research and Innovation Strategy

300+ scientists · 23 countries · Venice, 24–27 March 2026

*A creative and inclusive forum bringing together
science and policy to shape the future of Europe
ocean research and innovation.*

Strategic Messages Emerging from the Policy Brief

- reposition ocean science more firmly within society and policy frameworks;
- promote transformation as a structural method, not only a long-term objective;
- strengthen inclusion, transdisciplinarity and equitable access to knowledge;
- reinforce long-term and integrated ocean observing systems as strategic infrastructures;
- strengthen science–policy interfaces and support for research infrastructures and innovation pipelines;
- promote responsible use of artificial intelligence and digital technologies;
- expand investment in ocean literacy, communication and public engagement.

6.5 A Shared Experience and a Continuing Process

Beyond its formal outputs, the Symposium was also experienced as a space for open, high-level and constructive exchange among scientific, institutional and policy communities. The working-group format, the diversity of perspectives and the intensity of the programme contributed to a strong sense of shared purpose around the future of ocean science.

Venice provided a particularly meaningful setting for these discussions. As both a historic maritime hub and a climate-vulnerable city, it offered a powerful context for reflecting on ocean science, sustainability, governance and responsibility.

The Symposium is intended to represent the first step in an ongoing process, with the ambition of establishing a recurring international forum dedicated to transformative ocean science. A second edition is currently under consideration for 2028.

Building on the momentum generated in Venice, ISMAR will continue working with European and international partners to advance more integrated, inclusive and forward-looking approaches to ocean research, sustainability and marine governance.

The full programme, including presentations and recorded talks, is provided in the Appendix. Additional information and materials are available through the official Symposium website².



Figure 19 — Participants of the International Symposium on Transformative Ocean Science. Gathered at the Arsenal, Venice, 24–27 March 2026.

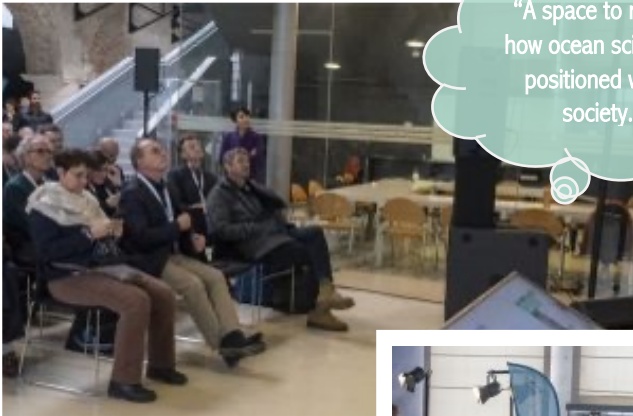
² [International Symposium ProgrammeMedia.pdf](#)
[Symposium website](#)



“Transformation must become a method, not only a goal.”



“Transdisciplinarity is a moral obligation.”



“A space to rethink how ocean science is positioned within society.”



PART IV — PARTNERSHIPS, INTERNATIONAL COOPERATION AND CAPACITY BUILDING

7. Partnerships and International Cooperation

During 2025–2026, ISMAR strengthened a set of strategic partnerships and international collaborations connecting marine science, Earth Observation, research infrastructures, technological innovation, training and policy-oriented research.

These collaborations ranged from formal institutional agreements and joint laboratories to scientific workshops, visiting programmes, European research networks and emerging cooperation with universities and international research centres. Together, they contributed to expanding ISMAR's capacity to develop shared methodologies, access complementary expertise and position its research activities within broader European and international frameworks.

7.1 Strategic Partnerships, Research Networks and Technological Cooperation

During 2025–2026, ISMAR consolidated dialogue with major European marine and environmental research institutions. A two-day meeting held at IFREMER headquarters in Brest involved researchers from several ISMAR sites and explored opportunities for collaboration in areas including research infrastructures, data management, research-vessel operations, fisheries, aquaculture and future joint initiatives. Additional workshops with CNRS and GEOMAR were prepared around topics ranging from marine geology to ocean observation, reflecting a broader effort to structure long-term cooperation with leading European partners.

New technological partnerships were also developed. A formal agreement was prepared with the Sant'Anna School of Advanced Studies to support joint activities in marine robotics, sensor technologies and autonomous systems. Following an initial kick-off meeting, three potential project lines were identified for development within future regional and European funding opportunities, with the aim of strengthening the value chain from scientific knowledge to marine technologies.

International collaboration also expanded through targeted scientific initiatives. The CNR–ISMAR / MIT seed project **SeaX-Venice** focuses on sea-level extremes in the Venice Lagoon, combining CNR's long tide-gauge records with MIT expertise in ocean–atmosphere dynamics and modelling. The project aims to separate, quantify and attribute key components of sea-level variability and extremes, providing information relevant to MOSE operations and Venice climate-adaptation planning.

ISMAR's participation in international research networks continued to support cooperation on ocean observation, biodiversity, climate adaptation and environmental governance. Within **CLIMASERVATION**, an I-Link network funded by the Spanish Ministry of Science and CSIC and coordinated by CSIC, ISMAR participates in an international collaboration involving researchers from Spain, Japan, the United States and Italy.

7.2 ESA–CNR ISMAR Joint Laboratory for Mediterranean Science and Technologies

A major strategic development during 2025 was the formalisation of the **ESA–CNR ISMAR Joint Laboratory for Mediterranean Science and Technologies** through a Memorandum of Intent with the European Space Agency. The Joint Laboratory was conceived as a long-term collaborative framework connecting space-based Earth Observation with marine research in the Mediterranean.

The Joint Laboratory will operate as a distributed centre of excellence co-located at ESA's ESRIN Science Hub in Frascati and ISMAR premises. Its activities focus on the development and validation of Earth Observation methods for Mediterranean marine systems, the integration of satellite and in situ observations, and the study of climate-driven extremes such as marine heatwaves, medicanes and coastal hazards.

The initiative also supports staff mobility, visiting scientist programmes, co-supervision of PhD candidates and early-career researchers, joint training activities, open-science events and the development of future collaborative research projects at national and European level. The Memorandum of Intent is effective through December 2028 and provides a flexible framework for cooperation without direct financial transfers between the parties.

ESA–CNR ISMAR Joint Laboratory: Areas of Cooperation

- Earth Observation and marine applications
- Climate variability and extreme-event analysis
- Integration of satellite and in situ observations
- AI and advanced digital methodologies
- Scientific mobility and visiting programmes
- Joint training and collaborative research activities



7.3 Mobility, Visiting Programmes and Collaborative Exchange

International mobility and collaborative exchange continued to support ISMAR's scientific environment during 2025–2026, particularly in areas connected to Earth Observation, satellite oceanography, artificial intelligence and data-driven marine science.

Several visiting scientist programmes were formalised in 2025 and are scheduled to begin in 2026. Prof. Fabricio S. C. Oliveira of the Federal University of Rio Grande was invited for a six-month sabbatical period at the Naples headquarters, focusing on the use of Earth Observation data to study ocean processes. Under the PolarCSIC "KryosLink" Connection Programme, PhD candidate Nicolas Werner Pelletier will carry out a three-month research stay at CNR-ISMAR in Naples, applying deep-learning methods to reconstruct Arctic hydrographic profiles from in situ, satellite and reanalysis data.

These exchanges reinforce ISMAR's role as both a host institution and an international partner, supporting methodological exchange, early-career researcher development and long-term scientific cooperation across marine and environmental research communities.

8. Outreach, Training and Knowledge Exchange

During 2025–2026, ISMAR developed a broad range of outreach, training and knowledge-exchange activities connecting scientific research with education, public engagement and international collaboration. These initiatives involved students, teachers, early-career researchers, institutions, stakeholders and broader audiences through specialised schools, workshops, field activities, citizen-science initiatives and collaborative programmes linked to biogeodiversity, ocean observation, climate research and marine technologies.

Many of these activities were closely connected to research infrastructures, observing systems and major national initiatives, helping to strengthen the relationship between scientific knowledge, training and society.



8.1 Biodiversity Gateway: Education, Public Engagement and Citizen Science

The Biodiversity Gateway represents one of ISMAR's most visible science–society initiatives within the National Biodiversity Future Center, functioning as an interface between biodiversity research, education, digital innovation and public engagement. While Chapter 4 presents the Gateway as part of the NBFC biodiversity infrastructure, this section focuses on its public-facing dimension: educational activities, citizen science, territorial nodes, digital communication tools and participatory experiences. During 2025–2026, the Gateway developed as both a digital platform and a physical network of territorial nodes, translating biodiversity research into accessible experiences for schools, teachers, citizens, cultural institutions, local communities and the wider public. Activities combined immersive installations, educational pathways, digital services, citizen-science initiatives, public events and interdisciplinary collaborations linking science, culture and environmental awareness. A defining feature of the initiative is the integration of place-based nodes, digital services, educational resources and participatory activities within a shared national framework. Together, these components contribute to strengthening biodiversity literacy, environmental awareness and interaction between scientific research and society.

8.2 Biodiversity Gateway Territorial Nodes

From Venice to Palermo, a living network

The physical gateways in Venice and Palermo coordinate a series of diffuse locations that, together with protected areas, represent the biodiversity network in the territory. A physical network that is intertwined with the Biodiversity Gateway, the portal that connects and enhances biodiversity information, manages its knowledge, and makes it usable and usable by all.



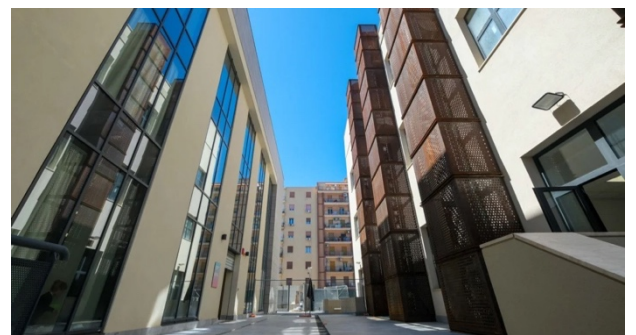
Venice Node - Palazzina Canonica | Venice Lagoon

A public-facing space linking lagoon biodiversity, cultural heritage, interactive installations and interdisciplinary science communication. The node hosts educational pathways, public events, guided visits and collaborative initiatives involving schools, cultural institutions and local stakeholders. Its inaugural events in March 2026 involved more than 140 institutional participants and over 300 members of the public.



Palermo Node - University of Palermo campus

Inaugurated in December 2025, the Palermo node represents one of the flagship hubs of the national network. It integrates immersive environments, simulation laboratories, digital installations and technology-transfer activities dedicated to biodiversity and sustainability, with public events and educational initiatives developed in collaboration with the University of Palermo, Le Vie dei Tesori and other institutional partners.



Rome/Tevere Node - *River and urban biodiversity*

The Rome/Tevere node extends the Gateway network to river and urban biodiversity, highlighting the ecological continuity between freshwater systems, coastal environments and the sea. Developed in collaboration with Marevivo, it supports public engagement, citizen participation and environmental awareness around the Tiber river system.



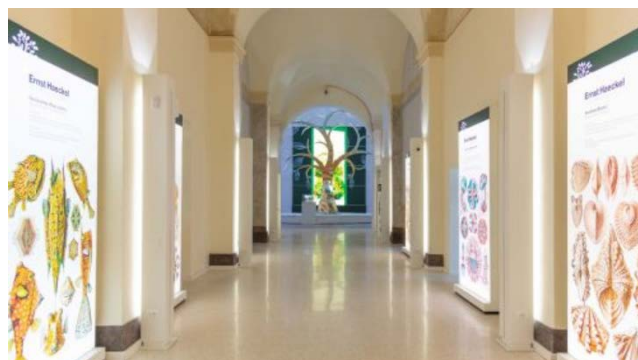
Naples Node - *Casina Pompeiana / Port of Naples*

Developed with the Stazione Zoologica Anton Dohrn and the Municipality of Naples, the Naples node combines immersive installations, digital narratives and educational activities dedicated to the marine biodiversity and geodiversity of the Gulf of Naples. Activities are distributed between the Casina Pompeiana in the Villa Comunale and the ISMAR multimedia area in the Port of Naples.



Lecce Node – *Demo Center Convitto Palmieri*

The Demo Center in Lecce Inaugurated in May 2026, is a new public space that aims to connect scientific research, in particular in the field of natural sciences and technologies applied to biodiversity, with citizens, institutions, the training system and the business world. Promoted by the CNR, as Biodiversity Gateway node involves the Puglia Region/Lecce Biblio-Museum Pole, the Province of Lecce, the University of Salento and the DHITECH High Tech Technological District.



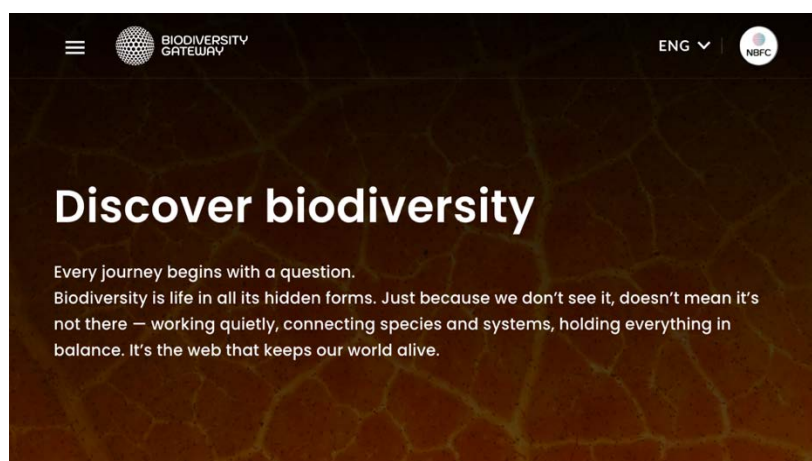
Biodiversity Gateway — Education and Engagement Highlights

- 40 schools, 80 classes and approximately 2,000 students involved in Venice Lagoon biodiversity education activities
- 8 schools, 16 classes and 400 students involved in “Gite biodiverse” with UNESCO
- 100 teachers involved in national training workshops in Venice and Naples
- 44 schools and 120 teachers engaged through the Ocean Schools programme
- 64 online courses funded on biodiversity statistics and analysis
- 66 AGESCI scout leaders involved in ScoutNaturalist training events
- Venice node inaugurated with more than 140 institutional participants and over 300 public participants
- Rome/Tevere node inaugurated with approximately 500 participants

8.3 The Digital Gateway

Alongside the physical network, the Biodiversity Gateway digital platform became a fully operational environment for biodiversity communication, knowledge sharing and public accessibility to scientific information.

During 2025–2026, the platform expanded its editorial and functional architecture through biodiversity narratives, educational resources, interactive experiences, digital services and maps connecting users with the national network of physical nodes. New developments included filtering tools, expanded biodiversity experiences, a redesigned digital-service catalogue and interactive resources designed for researchers, institutions, schools and broader audiences.



Education, Citizen Science and Public Participation

Gateway activities connected biodiversity research with schools, teachers, citizens, cultural institutions and local communities through a broad range of educational and participatory initiatives. These included biodiversity education pathways in the Venice Lagoon, Ocean Schools activities with UNESCO, Ocean Space and TBA21, teacher-training workshops, taxonomy initiatives, online courses, citizen-science activities and interdisciplinary science–art collaborations.

Public participation was further supported through initiatives such as ScoutNaturalist³, Nature Challenge, biodiversity festivals, public dialogues, family-oriented museum programmes and activities linked to ArSMar and the Venice Biennale. Together, these initiatives contributed to creating accessible and participatory experiences connecting biodiversity research with cultural production, education and civic engagement.



³ <https://www.inaturalist.org/projects/scoutnaturalist>

8.4 Advanced Schools and Technical Training

During 2025, ISMAR contributed to several advanced training initiatives designed for students, PhD candidates, postdoctoral researchers and early-career scientists. These activities combined theoretical teaching, practical exercises, field experience and interdisciplinary exchange, strengthening the connection between research infrastructures, ocean observation, marine geology, Earth Observation and ecosystem science.

The first edition of the **Marine Geology Advanced School: Deep-Sea Frontiers** was held at the ISMAR headquarters in Bologna from 27 to 31 January 2025. The School provided intensive training on geological processes in deep-sea environments through lectures and practical sessions coordinated by more than twenty national and international experts. Topics included abyssal environments, ocean ridges, sedimentary processes, marine bio-geological interactions in extreme environments and advanced exploration technologies.

The School hosted thirty early-career researchers and students from Europe and included a strong international capacity-building dimension through the **Women in Blue** initiative, developed in collaboration with the International Seabed Authority. This initiative supported the participation of ten young women scientists from Argentina, Bangladesh, Ghana, Kiribati, India, Mauritius, Nepal, Nigeria and Tonga. The programme was also linked to the **WOMBlue** oceanographic campaign carried out aboard the R/V *Gaia Blu* from 1 to 7 August 2025, extending the training pathway from classroom learning to ship-based field experience.

A second major initiative was the **Copernicus FRM4SOC-2025 Training in Above-Water Radiometry**, held in Venice from 6 to 20 July 2025 within the EUMETSAT FRM4SOC-2 project and supported by the European Commission Copernicus Programme and NASA. Hosted at San Servolo, CNR-ISMAR and the Acqua Alta Oceanographic Tower, the course involved 24 PhD students, postdoctoral researchers and early-career scientists from Europe, the United States, South America and Asia.

The training focused on fiducial reference measurements for satellite ocean-colour validation, combining expert lectures, field measurements, instrument intercomparison, hands-on work with Copernicus Sentinel-3 and NASA PACE data, and practical exercises using specialised processing and matchup-analysis tools. Participants also worked on group projects based on collected and processed data, reinforcing practical skills in Earth Observation, radiometric validation and ocean-colour data quality assessment.

The **Synergy Summer School: Complexity and Emergence in Marine Ecosystems** was held in Forio d'Ischia from 30 June to 4 July 2025. Jointly organised by CNR-ISMAR and the Stazione Zoologica Anton Dohrn within the framework of the NEREA Observatory and the Horizon 2020 AtlantECO project, the School focused on complexity and emergence in marine ecosystems and seascapes.

The five-day residential course combined theoretical lectures, interactive workshops and debates on the integration of ocean physics into theoretical ecology. The programme addressed complex systems theory, biophysical coupling, climate dynamics, advanced data analysis and niche modelling, providing advanced PhD students and postdoctoral researchers with conceptual and practical tools for studying pelagic ecosystems through interdisciplinary approaches.

Training highlights 2025

Marine Geology Advanced School

Bologna | 27–31 January 2025

Deep-sea geology, exploration technologies and Women in Blue capacity-building.

FRM₄SOC-2025

Venice / Acqua Alta Oceanographic Tower | 6–20 July 2025

Above-water radiometry and satellite ocean-colour validation.

Synergy Summer School

Forio d'Ischia | 30 June–4 July 2025

Complexity, emergence and ocean physics in marine ecosystems.



Figure 20 — Copernicus FRM₄SOC-2025 training. Participants combined lectures, field measurements and collaborative data analysis activities in Venice and at the Acqua Alta Oceanographic Tower.

The ISMAR Seminar Series continued during 2025–2026 as a regular platform for scientific exchange within the Institute and with the broader research community. Contributions from national and international researchers addressed topics spanning oceanography, climate processes, marine ecosystems, environmental monitoring, offshore impacts, continental-margin dynamics and modelling approaches.

The series supported interdisciplinary dialogue across ISMAR's distributed network, helping maintain a connected scientific environment and encouraging exchange among different research communities. Its accessible format, including recordings and seminar materials for selected events, further strengthened internal knowledge circulation and external visibility.

Further information on the seminar programme, including selected recordings and presentation materials, is available on the CNR-ISMAR website.

ISMAR Seminar Series — Selected Topics 2025–2026

- Offshore Wind Farm Impacts On Phytoplankton
- Ocean-Wave Analysis Using The Swot Mission
- Marine Debris Transport And Oceanography
- Integrated Modelling For Ecology
- Continental-Margin Dynamics And Submarine Landslides
- Fisheries Replenishment Zones In Tanzania
- Mediterranean And Antarctic Zooplankton Ecology
- Deep-Sea Systems And Submarine Fans

8.5 Sea Hub (Polo del mare) in Venice

In March 2026, the Italian Navy, Ca' Foscari University of Venice, IUAV University of Venice and CNR-ISMAR signed a cooperation agreement establishing the Sea Hub (Polo del Mare), a multidisciplinary initiative dedicated to education, research and innovation related to the sea.

The initiative aims to strengthen collaboration among the partner institutions and to develop advanced educational and research programmes addressing the environmental, technological, economic and geopolitical dimensions of the maritime domain. By bringing together complementary expertise in higher education, scientific research and professional training, the Sea Hub seeks to enhance Venice's role as a centre for marine knowledge and innovation at national and European level.

Activities will address a broad range of themes, including marine and coastal environments, blue economy, maritime technologies, critical infrastructures, environmental sustainability, ocean governance and maritime security. Through integrated research, training and outreach activities, the initiative aims to promote interdisciplinary approaches to contemporary marine challenges while contributing to the sustainable use and protection of marine resources.

The partnership builds on the long-standing presence and expertise of the participating institutions in Venice, combining the Italian Navy's advanced maritime training, the academic programmes of Ca' Foscari and IUAV, and the marine-science research capacities of CNR-ISMAR.

SPOTLIGHT — Highly Specialized Educational Programs

The Italian Navy provides advanced education and training for its officers at the Maritime Military Studies Institute in Venice. Ca' Foscari University and IUAV University offer first-, second-, and third-cycle academic programs, while CNR-ISMAR conducts advanced research activities.



Figure 21 — Sea Hub (Polo del Mare). Partnership cooperation agreement on multidisciplinary education and research related to the sea (signed on March 11, 2026).

8.6 Science, Governance and the Venice Lagoon

Held in October 2025 and jointly promoted by ISPRA, CNR-ISMAR and CORILA, the workshop **Research Priorities and Operational Tools for Ecosystem-Based Management of the Venice Lagoon** brought together public institutions, universities, research organisations and stakeholder groups to discuss future priorities for lagoon management.

The two-day programme combined institutional dialogue and technical working groups focused on governance needs, environmental monitoring, ecosystem-based approaches and operational tools for the Venice Lagoon. Discussions addressed the integration of scientific knowledge, observational systems and management priorities, with the aim of strengthening the connection between research activities and decision-making processes.

The workshop provided an important opportunity to consolidate collaboration among scientific institutions, environmental authorities and territorial stakeholders involved in lagoon governance, conservation and long-term environmental planning.

Workshop highlights

- jointly promoted by ISPRA, CNR-ISMAR and CORILA
- held in October 2025
- approximately 100 participants
- two-day programme with institutional dialogue and technical working groups
- focus on ecosystem-based management of the Venice Lagoon
- integration of scientific knowledge, governance needs and operational tools

9. Institutional Development and Territorial Presence

During 2025–2026, ISMAR strengthened its organisational structure and territorial network in parallel with the expansion of scientific activities, infrastructures and national initiatives. The growth of observing systems, digital infrastructures and multidisciplinary research programmes required more coordinated administrative support, stronger local operational capacity and closer integration across the Institute’s distributed sites.

Rather than representing only an organisational adjustment, these developments reinforced the practical framework through which ISMAR supports research activities, field operations, infrastructures and collaborations across multiple marine, coastal and transitional environments.

9.1 Administrative Coordination across a Distributed Institute

During 2025, ISMAR’s administrative sector underwent a significant reorganisation aimed at improving operational coordination, harmonising procedures and strengthening support for the Institute’s distributed scientific network.

The reorganisation consolidated the administrative Service Units within a more integrated structure designed to combine central coordination with local operational support. While maintaining shared procedures and interfaces with the CNR central administration, the new framework also introduced designated administrative contacts at local sites, making support more direct and responsive for researchers, infrastructures and project activities.

This reorganisation helped improve operational continuity across the Institute and strengthened support for increasingly complex national and international projects, research infrastructures and collaborative activities.

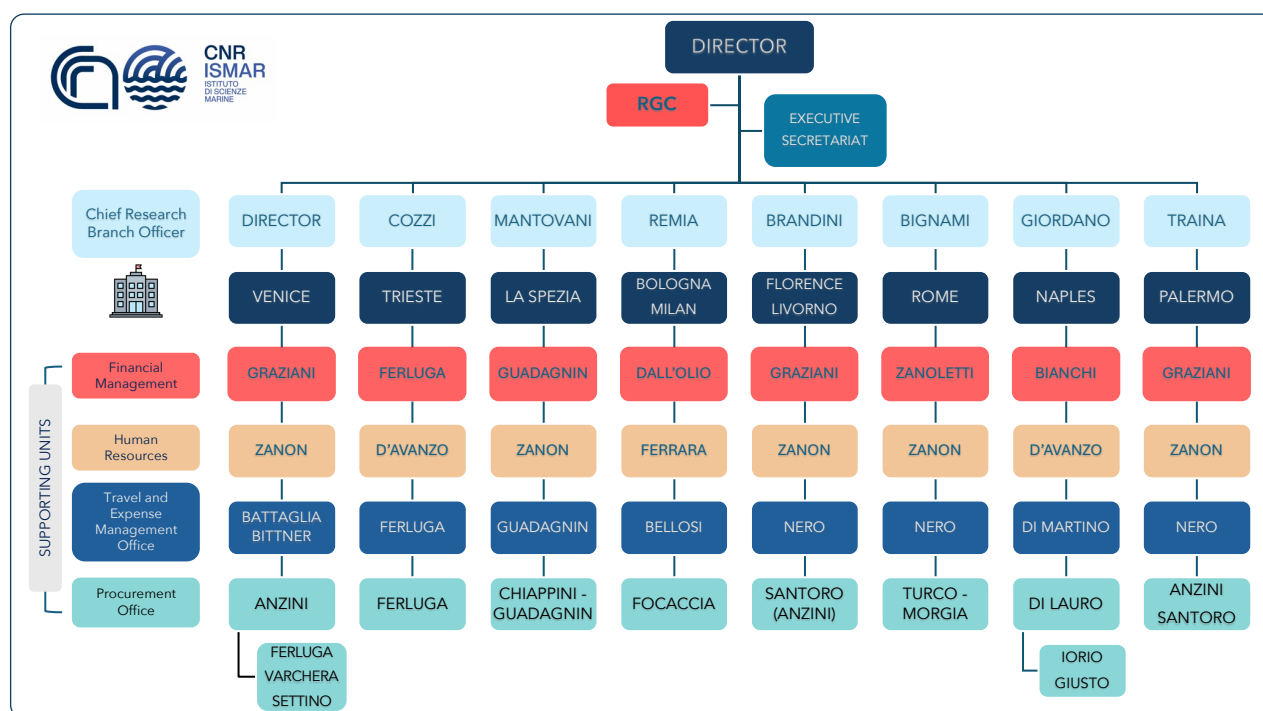
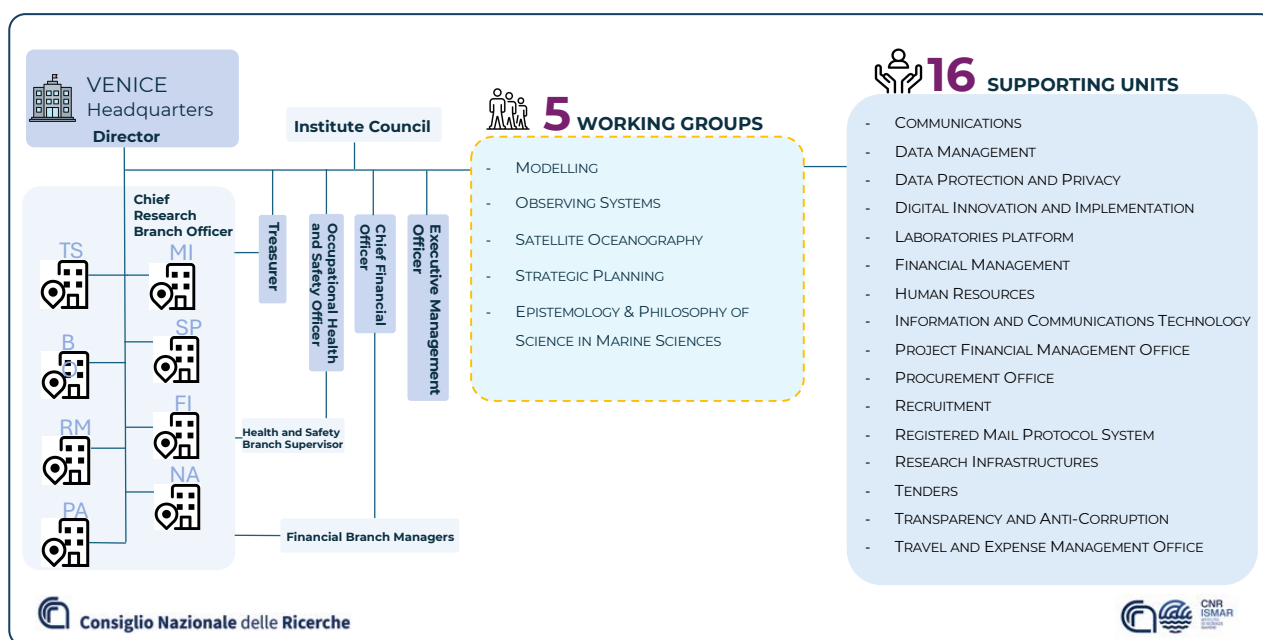


Figure 22 — Support Structure across ISMAR sites and Administrative Organisation.

9.2 Livorno, Palermo and Pianosa: Strengthening Operational Presence

During 2025–2026, ISMAR expanded and consolidated its operational presence across multiple regions of Italy, reinforcing its role as a distributed national marine research infrastructure active across diverse marine and coastal environments.

A major development during the reporting period was the activation and consolidation of the **Livorno site**, which strengthened ISMAR's presence in the Tyrrhenian basin. The site supports observational activities, logistical coordination and scientific operations linked to marine monitoring, oceanographic campaigns and regional collaborative initiatives. Its strategic location

also facilitates interaction with coastal and offshore infrastructures operating across the central Tyrrhenian region.

The establishment of the new **secondary site in Palermo** further reinforced ISMAR's scientific and operational presence in Sicily and the central Mediterranean. Located within the University of Palermo campus, the site supports research activities, collaboration with academic partners and Biodiversity Gateway initiatives connected to education, public engagement and marine biodiversity.

Scientific and operational activity was also strengthened in **Pianosa**, where field campaigns, environmental monitoring and interdisciplinary research contributed to consolidating ISMAR's role in insular and protected marine environments. Pianosa provides an important operational context for field-based scientific activities, logistical support and collaborative research linked to coastal ecosystems, biodiversity and marine observation.



Site highlights

Livorno Site

Supports observational activities, logistics and scientific operations in the Tyrrhenian basin, with strategic relevance for marine monitoring, oceanographic campaigns and regional collaboration.

Palermo Secondary Site

Strengthens ISMAR's presence in Sicily and the central Mediterranean, supporting research, academic collaboration and Biodiversity Gateway activities.

Pianosa Research Activities

Provides a field context for monitoring, campaigns and interdisciplinary research in insular and protected marine environments.

Figure 23 — ISMAR territorial network and operational sites.

10. Looking Ahead: 2026 and Beyond

The period covered by this report marks a phase of consolidation and transition for CNR ISMAR. Major national and European initiatives have strengthened the Institute's infrastructures, observing systems, laboratories, digital capacities, biodiversity initiatives and collaborative networks, creating new opportunities for integrated marine research.

Looking ahead, a central priority will be ensuring the long-term sustainability of the infrastructures, services and capacities developed through recent investments, including NRRP initiatives. This will require continued attention to operational continuity, technical expertise, data stewardship, quality-control procedures and the integration of distributed facilities and digital services across ISMAR's national network.

Scientific development will increasingly depend on the Institute's capacity to connect field observations, laboratory analysis, modelling, digital platforms, physical collections and international collaboration within coherent and interoperable research systems. Integrated observing systems, FAIR data infrastructures, biodiversity monitoring, advanced modelling, artificial intelligence and Digital Twin Ocean approaches will remain key areas of growth.

At the same time, ISMAR will continue strengthening research that addresses the marine system in connection with the broader Earth system, including atmosphere–ocean interactions, the river–sea continuum, environments ranging from coastal to open ocean systems, geological and biological processes, ecosystem functioning and climate variability across different spatial and temporal scales.

The Institute will also continue consolidating its role within European and international research frameworks linked to the Ocean Pact, future EU research priorities and the broader transition toward environmental intelligence, sustainability and evidence-based marine governance. Partnerships, mobility, training and science-policy dialogue will remain essential to this process, together with continued support for early-career researchers and new professional capacities for a sustainable blue economy.

The International Symposium on Transformative Ocean Science, held in Venice in March 2026, reinforced the importance of long-term scientific vision, sustained infrastructures and stronger connections between science, policy and society. Building on this direction, ISMAR will continue contributing to ocean science that is interdisciplinary, operationally grounded and responsive to environmental and societal needs.

The developments presented in this report show an Institute increasingly able to connect infrastructures, data systems, field activities, scientific expertise, technological innovation and partnerships. This capacity to work across scales, disciplines and territories will be central to ISMAR's contribution to future ocean science and to the sustainable, inclusive and resilient management of marine and coastal environments.

FUTURE PRIORITIES

- Long-term sustainability of infrastructures and digital services
- Integrated observing systems, FAIR data and interoperable platforms
- Biodiversity monitoring and environmental intelligence
- Advanced modelling, AI and Digital Twin Ocean approaches
- Cross-domain Earth-system research, from atmosphere–ocean interactions to river–sea continua
- Stronger science–policy interfaces and support for marine governance
- International cooperation, mobility and next-generation training

ANNEX – Ongoing Projects

EU Projects				
ACRONYM	TITLE	TOTAL BUDGET	ISMAR BUDGET	DURATION
INSPIRI - HORIZON-MISS-2024-OCEAN-01	Imaginative Narratives and Scenarios for Inspiring Restoration and Innovation for European Seas and Water Systems	2.995.413,75 €	191.531,25 €	2025-2027
LIFE24 - PRE-IT-LIFE MAPPER	Guidelines for MAPping, ProtEcting, and Restoring Marine Ecosystems	1.161.765,55 €	307.946,00 €	2023-2027
LIFE21-NAT-IT-LIFE DREAM	Deep Reef restoration And Litter removal in the Mediterranean sea-	3.184.462,00 €	684.443,90 €	2025-2028
Tools4CleanBANOS	HORIZON-MISS-2025-03			
Isla Bonita - HORIZON-MISS-2025-03	Beautiful Island: Supporting Managing Authorities to Restore the Oceans and Waters on Islands	17.656.553,67 €	516.875,00 €	2026-2030
COMEDI - HORIZON-CL4-2025-02	COPernicus Marine services with Enhanced Data assimilation and improved Interoperability	4.995.835,63 €	304.750,00 €	2026-2030
MarDepend ERC-2024-COG	Maritime Dependencies in Antiquity: how trade, geography and conflict are related. A maritime history and case study of Syracuse combining history, archaeology, oceanography, ships, economic theory	1.948.174,75 €	400.000,00 €	2025-2030
PREDDYCT ERC-2024-COG	Resolving and understanding the contributions of mesoscale eddies to climate prediction	1.998.903,00 €	99.853,75 €	2026-2030
OceanNexus HORIZON-CL6-2025-02	Assessing consequences in the cascading of climate Tipping in the ocean-Marine ecology-society connection	6.531.287,50 €	506.601,25 €	2026-2030
INTERREG Projects				
ACRONYM	TITLE	TOTAL BUDGET	ISMAR BUDGET	DURATION
JASON - PC IFM 2021-2027	A resilient and efficient cross-border area from Resource Perspective	4.693.331,09 €	309.270,00 €	2025-2029
EPIC - PC IFM 2021-2027	A plastic-free sea: A resilient and resource-efficient cross-border area	5.731.551,40 €	182.800,00 €	2024-2028
TENDER				
ACRONYM	TITLE	TOTAL BUDGET	ISMAR BUDGET	DURATION
ESA 4DMED	4-Dimensional datadriven reconstruction of the Mediterranean ecosystem for the study of biophysical interactions and their impact assessment	799.695,00 €	144.978,00 €	2024-2026
ECMWF C3S2_601	To prepare the next generation C3S ocean reanalysis system	1.198.654,00 €	254.686,00 €	2024-2026
CMEMS2 SST TAC	COPERNICUS MARINE – PRODUCTION - PROVISION OF OCEAN OBSERVATION PRODUCTS "Thematic Assembly Centers" provision of ocean colour observation products (OC-TAC) Lot. 3	4.499.999,00 €	1.215.018,00 €	2025-2028
CMEMS2 OCTAC	COPERNICUS MARINE – PRODUCTION - PROVISION OF OCEAN OBSERVATION PRODUCTS "Thematic Assembly Centers" Provision of Sea Surface Temperature Observation Products (SST-TAC) Lot. 4	2.399.994,00 €	691.500,00 €	2025-2028
ESA-MITHO	Multiple Threats on Ocean health	943.930,00 €	319.970,00 €	2023-2026
ESA-PHYTODIVERSA	Phytoplankton community diversity from Sentinels	1.000.000,00 €	200.000,00 €	2025-2028
ESA CARE Heat	CAREHeat: detection and threats of marine Heat waves	495.804,00 €	237.581,00 €	2023-2026
CMEMS2 INS-TAC	COPERNICUS MARINE – PRODUCTION - PROVISION OF OCEAN OBSERVATION PRODUCTS "Thematic Assembly Centers" Provision of Oceanic Observation Products (INS-TAC) Lot. 8	6.800.000,00 €	171.000,00 €	2024-2028
ECMWF C3S2 520	Quality Assurance for Datasets in the Climate Data Store	5.499.975,08 €	1.415.819,71 €	2023-2026
Other National & International				
ACRONYM	TITLE	TOTAL BUDGET	ISMAR BUDGET	DURATION
FIS 3 - INTRASEAM	INTEgRATING SEx in sustainable ocean mAnagement and observing systems for biodiversity conservation of the Mediterranean Sea	1.764.356,00 €	1.764.356,00 €	2026-2031