



*Ifremer's strategic  
plan for 2020.  
Summary report*

  
**Ifremer**

*Ifremer  
reveals  
the oceans*

# IFREMER, A MAJOR PLAYER FOR MARINE RESEARCH IN CHANGING GLOBAL, EUROPEAN AND NATIONAL ENVIRONMENTS

## FOREWORD

When Ifremer, the French research institute for exploitation of the sea, drew up its strategic plan in 2008 entitled "Contribution to a national marine science research strategy for 2020", it did not anticipate that it would become a national strategy for research and innovation, further complemented by a strand concerning overseas France.

Since then, numerous events, in which Ifremer has often played a major role, have justified an updating of its strategic plan:

- the launch and adoption of the "Healthy and productive seas and oceans" joint programming initiative (JPI Oceans);
- creation of a joint service unit for the coordinated management of the French oceanographic fleet, with significant results as of 2011;
- alliances created between research institutions and universities which Ifremer takes part in, particularly that of the AllEnvi national alliance for environmental research, whose roadmap is intended to prefigure what France hopes to sponsor in the European framework, or that of the Ancre national alliance for energy research, which has contributed to determining the R&D studies to be conducted to ensure



France's energy transition and give the country a industrial value chain;

- the autonomy of universities and the Investments for the future programme, both bringing new dynamics in terms of scientific partnerships;
- new stakeholders and players arriving on the scene, for instance, following the reform for devolution of State services for coasts and sea, as well as the Agency for marine protected areas.

Therefore, it was deemed essential for Ifremer to re-examine its strengths and assets in order to better prepare its contract with its supervisory line ministries. There is a triple objective for the Institute here.

- To remain, thanks to its teams' talents, the reference-setting institution it has become in the European research area and maintain the position it holds in marine sciences worldwide.
- To prepare proposals for public authorities so that the 2014-2017 contract will enable it to keep its integrated nature and maintain the continuity between research, expert assessment and monitoring.
- To provide its teams, in the context of a tight budget, with the perspective, outlook and legibility they need to work yet more efficiently and effectively.

Ifremer will no doubt have to construct a new model, by growing the number of its HDR (research supervision) accreditations and supervised PhD theses, and endeavouring to better target and measure its added value. This accrued value can be scientific, economic - seeing Ifremer's status as a public establishment of industrial and commercial nature (EPIC) - or democratic, contributing to better share with fellow citizens and policy makers alike, the scope of the challenges for applied marine research in today's world.



## AN AMBITION ADAPTED TO NEW OPPORTUNITIES IN EUROPE

On the European scale, Ifremer is reasserting its ambition to pursue studies on various themes developed since the 2008 strategic plan, with the launch of JPI Oceans, in which the Institute is strongly involved, the reform of the Common Fisheries Policy (CFP) underway, in particular with the creation of the European maritime and fisheries fund (EMFF), and the preparation of the Horizon 2020 programme.

The situation of the institutes which are its traditional partners in Europe is also clearly evolving

with respect to their macroeconomic and budgetary contexts. The increased importance of marine sciences and technologies in Germany, particularly benefiting the IFM-Geomar institute, can be noted.

In this context, Ifremer's ambition is to help give the scientific community the means it needs for research and expert assessment missions, which implies renewal and upgrading of the national scientific fleet, 60% of whose potential is supported by the Institute alone.

## COMMON ISSUES OF INTERNATIONAL SCOPE

Seeing the prospects for new resources, growth and jobs which oceans and seas can offer, the marine geosciences and knowledge about deep-sea environments are increasingly sought and requested. Whereas States are focusing on a long-term "blue growth" strategy aiming to support the entire marine and maritime sector, the international scientific committee is emphasising the threat of irreversible damage which mankind is causing to the oceans. Therefore, marine research must propose solutions to protect the environment and for rational utilisation of resources and energy.

In June 2012, at the United Nations Rio+20 Conference on sustainable development, the international community mobilised to promote the management and preservation of the oceans. On 12<sup>th</sup> August 2012, during the Yeosu International Conference in the Republic of Korea, the United Nations Oceans Compact Initiative was launched, with the aim of improving the UN system's coordination and supplying a framework which will facilitate the rapid achievement of the goal set, i.e.: "Healthy Oceans for Prosperity".

## THE DRIVE FOR MULTIDISCIPLINARY INTEGRATION

As a key player in the field, Ifremer's strategic orientations should help provide vital answers for knowledge of seas and oceans with respect to issues which are shared worldwide. These priorities represent a move toward greater multidisciplinary integration around societal challenges: global change and its consequences on the environment, knowledge and protection of biodiversity, the integrated ecosystem-based approach and sustainable procurement of non-energy and non-agricultural raw materials.



Also in 2012, the first report was published on the implementation of the Integrated Maritime Policy (IMP) which highlights Europe's will to better integrate the maritime economy in the Europe 2020 strategy for growth and employment. This strategy was defined in order to improve world governance of the seas and oceans. It provides the best safeguard to protect European economic, ecological and social interests in the maritime realm and should enable the European Union to exert greater influence in international discussions.

## STRENGTHENING EUROPEAN COOPERATION

In its funding programme for research and innovation called "Horizon 2020" (2014-2020), the European Union reaffirms its orientation towards practical implementation of the concepts of sustainable development and the ecosystem-based approach (fisheries, use of resources and coastal areas, new energy sources, pollution and food safety) already highlighted in FP7 R&D.

This programme will focus resources on three priorities: scientific excellence, industrial lea-



dership and societal challenges listed in the Europe 2020 strategy. This will be accompanied by innovative thinking on how to organise research whilst adopting an ambitious approach to optimising how public funding is used for research and development. Ten joint programming initiatives aiming for greater European cooperation in public research programmes have been approved to date by the EU, including JPI Oceans, of which Ifremer is a promoter.

## IN-DEPTH RESTRUCTURING OF RESEARCH

On both national and European levels, the research scene is undergoing major changes. Funding agencies play an increased role in the frame of European projects of excellence and research networks (ERA-Nets, etc.). In the field of monitoring and surveillance, new framework directives for coastal development, environmental and consumer protection will culminate on the same horizon as the strategic plan. Completing the European Research Area (ERA) also requires developing researcher mobility in Europe and abroad, on a more open and more competitive domestic market.



## IFREMER, A LEADING PLAYER IN MARINE SCIENCES IN EUROPE

Thus, the Europeanisation of marine research has grown with the structuring of research and the developing of finalised programmes, the greater role of coordination and co-programmation bodies (Marine Board, Eurogoos, ICES, etc.), better coordination in the use of infrastructures and facilities, the stronger European and international regulatory context for monitoring and surveillance and so on. As a key marine sciences organisation in Europe, Ifremer is continuing to be a driving force in implementing European programmes: taking part in JPI Oceans; in the Food4Future Knowledge and Innovation Community (KIC) related to bio-economics; the proposal to create a KIC on marine resources, multilateral cooperation including the G3 (Ifremer, NOCS and Géomar), etc.

Thanks to the good balance between its three conventional functions as an agency of means, an agency ensuring missions and a research operator, Ifremer covers all marine science and technology disciplines, manages the scientific fleet and performs environmental assessment and monitoring missions, while remaining in the fore of European marine research.

A recent estimation of French participation in EU-funded research programmes from 2007 to 2010 highlighted the coherence of Ifremer's strategic plan scientific themes and their inter-linking within these various programmes.

## A STRONG INTERNATIONAL POSITION

The world environment has been marked by rivalries emerging between the main centres of development, in a context where economies are energy-dependent. In terms of marine resource exploration and exploitation, these stakes will lead to major strategic consequences, with territorialisation of maritime areas which were previously freely accessible. With its overseas areas, France enjoys the second largest maritime area in the world, a fundamental asset in terms of ocean research. In order to maintain and strengthen its scientific excellence and its competitiveness, Ifremer must set its efforts and endeavours in an international dimension.

## PARTICIPATION IN MAJOR INTERNATIONAL SCIENTIFIC PROGRAMMES

By their very nature, some research activities (oceanography and climate, geosciences, fisheries) are conducted in the framework of international programmes, in which Ifremer participates on a selective basis, by acting as secretary general, through scientific partnerships or by work done to support development. Scientific collaboration should also be developed in Overseas France with Australia or Brazil.

The Institute aims to be in the lead in certain disciplines, like observation and deep-sea resource exploration techniques, or mastery of databases, which means establishing targeted strategic partnerships and taking an active part in large international scientific programmes with high added value. Ifremer will pursue its cooperation efforts with industrialised and emerging countries, while consolidating its position in the Mediterranean area.



## COOPERATION WITH COUNTRIES IN THE MEDITERRANEAN ZONE, A PRIORITY FOR EUROPE

The political and economic specificities of the countries on the shores of the Mediterranean, their relative vulnerability with respect to environmental stakes, their involvement and organisation regarding scientific issues lead the Institute to build its collaborative work with respect to its theme-based and geographical priorities, as in the international Mistrals programme studying how marine ecosystems respond to human activities and climate change.

# AN INTEGRATED RESEARCH STRATEGY



**“Asserting itself by excellence in research through a balanced partnership with universities and research bodies”**

On the national level, Ifremer has engaged partnerships both with universities and research bodies (CNRS, IRD and others) and with socio-economic stakeholders in the maritime realm. The Institute is heavily involved in LabEx Mer, and will pursue this dynamic growth by

supporting the LabEx policy for enhanced international reach, in order to grow its own visibility and attractiveness.

**“Making public-private partnership a component of the Ifremer model”**

One of Ifremer’s ambitions is to make its scientific research outcomes and technological developments utilisable and to disseminate them to socio-economic stakeholders. Lasting conditions for creating value must be brought together by reinforcing the process to raise scientific teams’ awareness about developing and growing economic value, detecting high potential pathways, legal protection, maturation, industrialisation and transferring of knowledge and technologies towards the private sector.

As an integrated marine science institute, Ifremer produces scientific knowledge and know-how which have economic and social value, thus supporting sustainable use of marine ecosystem goods and services in the context of global change. An integrated research strategy built around strong objectives

**“Contributing to public policies with high added scientific value”**

Ifremer is aiming to refocus on its activities with high added scientific value by transferring tried-and-tested monitoring protocols and assignments to other stakeholders, notably in the private sector.

**“Driving finalised and systematic research which is rooted in expert assessment and observation capacities”**

Ifremer’s ambition is to drive finalised research, firstly by making it part of the local and regional scientific fabric and secondly by ensuring it benefits from progress achieved in more upstream research in thematic laboratories. To do so, the Institute must give preference to missions for expert assessments which are in keeping with its economic model and directly linked to its objectives of sustainable use of marine resources.

**“Contributing to develop valuable uses of scientific assets and the socio-economic development of Overseas France”**

Seeing the potential that the regions and territories of Overseas France hold in terms of research, Ifremer has set itself the goal of pursuing its activities of observation, monitoring and surveillance, providing expert opinions and assessments to support public policies and participating in developing current and emerging local value chains, whilst endeavouring to provide support which remains strictly scientific in nature.

Thus the Institute’s priorities are to:

- strengthen research and draw greater benefit from the scientific added value brought by overseas environments, particularly in the fields of environment and biodiversity;
- develop scientific cooperation with neighbouring countries in the area and thus contribute to the integration of French ROM-COM overseas regions and local authorities in their regional and international surroundings.
- promote, within alliances and especially AllEnvi, structuring partnerships with French scientific institutions and universities involved in Overseas France areas.



## REVIEWED AND READJUSTED SCIENTIFIC ORIENTATIONS

Ifremer has updated and structured its strategic vision for 2020, into nine orientations which were defined in connection to national and European strategic priorities, whilst highlighting the importance of cross-cutting concepts (transfers, biodiversity, the structuring role of habitats). The institute accompanied this approach with a study of best practices in organisations in France’s three large European partner countries in terms of marine research (the United Kingdom, Germany and Italy).

- 1 • Learn about ocean dynamics to supplement the diagnosis of global change and anticipate changes in the coastal domain
- 2 • Characterise marine biodiversity to better protect it
- 3 • Develop enhanced value and use of biological resources through biotechnologies and bioprospection
- 4 • Support pathways for sustainable development of fisheries and aquaculture confronted by global change
- 5 • Explore the seafloors and identify the conditions for exploiting mineral and energy resources
- 6 • Understand how ecosystems function and develop tools to serve the good environmental status of coastal seas

- 7 • Contribute to implementing a national and European strategy for marine databases
- 8 • Optimise Ifremer’s fleet, keystone of the French oceanographic fleet large-scale research infrastructure
- 9 • Promote shared capacity for technological innovation

The two main principles resulting from collective thought and discussion within the Institute have guided the updating of this strategic plan.

On one hand, Ifremer wants to reassert its will to refocus its activities on its core business, generating added value in scientific, economic and democratic terms, whilst further specifying its role with respect to its academic, public-sector or economic partners.

On the other, in a difficult economic context combined with growing pressure on raw materials and other marine-based resources, Ifremer wants to guarantee a systemic approach aiming at sustainable fisheries and aquaculture (orientation 4), exploration of seafloors and the conditions under which mineral and energy resources are exploited (orientation 5).

# LEARN ABOUT OCEAN DYNAMICS TO SUPPLEMENT THE DIAGNOSIS OF GLOBAL CHANGE **AND ANTICIPATE CHANGES IN THE COASTAL DOMAIN**

01

Observing and quantifying the climate changes underway in oceans' physical, geochemical and biological components. Specifying the ocean's role in the Earth's climate

## CONTEXT AND STAKES

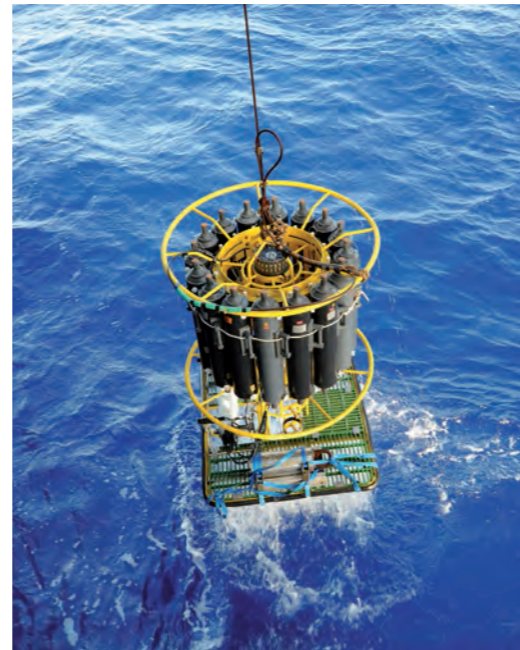
Climate change is at the fore of concerns for public opinion and policy makers. The prospective foresight study conducted by the CNRS-INSU's Ocean Atmosphere community, in the framework of defining strategies of adaptation to climate change, established that society expects that research should be clearly focused on decadal forecasts (30 years) on the regional scale for the ocean-atmosphere system.

The economic stakes related to assessing the impact of climate change on coastal regions at small spatial scales, associated with strong human pressures, will undergo significant developments in coming years, entailing the need to set up local models which are capable of estimating variations in coastal marine environmental components.

Some activities, such as exploiting renewable energy sources, create new requirements for knowledge, as does the phenomenon of population concentration on coasts. Coastal regions are also those most vulnerable to global change,

involving numerous issues ranging from water management to the fate of contaminants.

The outcome of the Prévimer project, which supplies observations and real-time forecasts to the broadest possible public, will also set the direction for the future of coastal oceanography. These tools for observation and modelling developed by Ifremer provide structure for activities of research, expert assessment and monitoring of the coastal zones.



Recent events (cyclone Xynthia, green tides in Brittany, pollution in the Gulf of Mexico, contamination by Fukushima, and so on) have borne out the relevance of actions engaged by Ifremer in ocean analysis and forecasting, from offshore to inshore, as well as in managing and predicting risks related to physical, biological or biochemical environments alike.

The three major challenges Ifremer has defined in this field thus remain highly topical: the Institute's participation in the international effort to diagnosis climate change and understand the mechanisms underpinning it, the high-resolution ocean and finally, inshore and offshore ocean exchanges.

The knowledge and tools produced by this research will be used in regional climate modelling and operational oceanography.



## OBJECTIVES AND STRATEGY

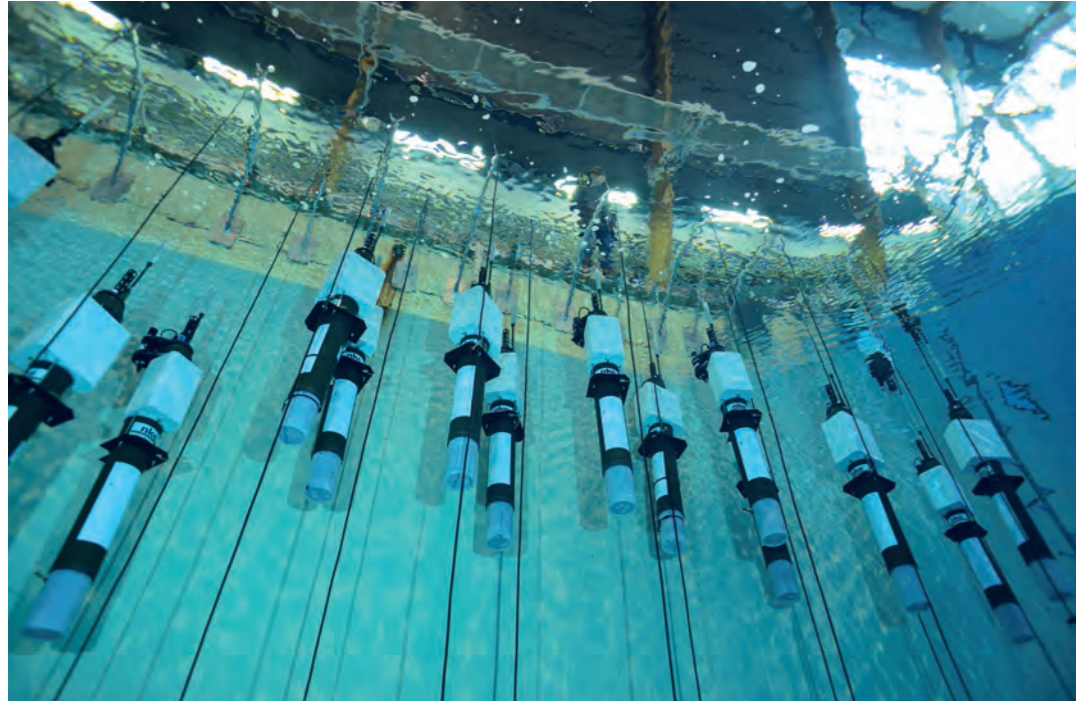
**“Rising to the scientific challenge of decadal forecasting by improving knowledge about the mechanisms of variability”**

The possibility of decadal forecasting of the climate system relies on data acquisition and analysis and modelling. Through its involvement in many partnerships, Ifremer contributes to observing ocean climate variability on the global scale (ARGO) and in the North and South Atlantic (Ovide, Samoc). Its research particularly focuses

on thermohaline circulation and on the MOC (its meridional overturning circulation cell), which are relevant indicators of climate change.

**“Better appraising ocean dynamics and scale interactions”**

Satellite observation of the oceans and very high-resolution ocean modelling have revealed small-scale, very high-energy phenomena at the sea surface which have an influence on the global matter and heat budgets in the ocean.



Ifremer is associated in work done by LabEx Mer on ways to improve climate and ocean forecasting models based on studying the interactions between the various scales and understanding the mechanisms of anthropogenic carbon uptake in the ocean.

The Institute is also actively involved in the inter-organisation body called Coriolis (in situ oceanographic data centre), in order to organise and optimise France's long-term contributions to the Global Ocean Observation System (GOOS) needed for operational oceanography and ocean and climate research.

**“Preparing the evolution of the international ARGO array while maintaining Ifremer’s commitments in French and European contributions”**

Coupling of biogeochemical cycles with the physical ocean is clearly recognised as a major research theme. The success of the Equipex NAOS project will make it possible to extend physical measuring capabilities beyond depths of 2,000 metres and give access to measurements of biogeochemical parameters from sensors installed on the new-generation ARGO profiling floats.

**“Improving understanding of exchanges between the ocean and the atmosphere”**

As a leader in observation and quantitative analysis of small spatial scales, thanks to its partnerships with CNES, ESA and NASA, as well as with Jamstec - which secures access to the Earth Simulator supercomputer - Ifremer organises its studies by implementing synergy between the interpretation of very high-resolution satellite observations, instrumentation developments, analysis of in situ measurements and modelling of ocean-atmosphere interactions.

New Earth observation missions have been scheduled, such as SMOS (surface salinity), SWOT (very high-resolution ocean topography) and CFOSAT (ocean surface wind and waves), as well as missions operated in the framework of the European GMES programme with the ESA's "Sentinels" satellites.

**“Ensuring long-term and reinforced monitoring facilities in the coastal zone”**

Coastal oceanography aims to improve the existing in situ observation and measurement systems, to consolidate Ovide's status as environmental research observation (ORE) and to extend the Coriolis project to the coastal domain.

**“Developing metrics to assess quality of simulations adapted to coastal environments”**

Ifremer's scientific committee recommends that a network of instrumentation be set up in the plumes of the four large rivers of metropolitan France to measure transport of nutrients and characterise the food chain (Fronce project).

**“Constructing coupling tools to enable a move to smaller scales between different models”**

The European Copernicus (GMES) programme aims to develop operational services to make information related to environmental and safety management available.



# KNOW, CHARACTERISE MARINE BIODIVERSITY TO BETTER PROTECT IT

02

Analysing and understanding the role played by biodiversity in the functioning and resilience of marine and coastal ecosystems where ecosystem services are produced. Developing capabilities to predict its evolution, taking account of legal, economic and social stakes and providing support for policy-makers

## CONTEXT AND STAKES

The issue of maintaining all biodiversity and exploiting it sustainably is a priority worldwide. Updating of strategies in this field on international, European and French scales is a major challenge for Ifremer.

In France, the Institute is directly associated with implementing the national strategy to create and manage marine protected areas, which was revised in 2011, the national biodiversity strategy (SNB) and the territorial strategy for Overseas France (Stratom).

Ifremer's participation in the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) set up by the United Nations in 2011 improves the rate of representation of French scientific expertise in international bodies.

This issue is even more cogent on the European level with FR7 initiatives such as the Biodiversity knowledge project (KNEU), the definition of a European 2020 strategy in response to the Convention on Biological Diversity (CBD) objectives, or the BEST calls for projects to preserve biodiversity in overseas territories, launched by the European Commission in 2011.

Ifremer must also rise to the challenge of putting EU framework directives objectives to recover good environmental status (GES) into application, especially that of the Marine Strategy Framework Directive (MSFD).

On the national level, research has evolved towards greater structuring through the creation of AllEnvi and that of the French foundation for research on biodiversity (FRB), itself at the origin of the Centre for synthesis and analysis on biodiversity (Cesab). Finally, the Ecoscope platform approved by AllEnvi as a long-term system of observation and experimentation for environmental research (Soere) in 2011, is taking part in coordinating biodiversity research observatories.

The cross-cutting nature of biodiversity requires that the major research players work in coordination. For example, the joint research unit UMR Amure, created by Ifremer and the Centre for marine law and economics at the University of western Brittany (UBO), leads the thought and discussion process on assessing ecosystem services and biodiversity economics. The UMR unit will play a leading role in mobilising and developing a research community in Europe.

Ifremer also has numerous strengths in terms of expertise and organisation to implement the strategic priorities defined in the field of biodiversity research: establishments located in strongly contrasting environments, interactions between thematic laboratories and coastal stations, multidisciplinary teams relevant to an ecosystem-based approach, as well as state-of-the-art technological capabilities.

## OBJECTIVES AND STRATEGY

### “Organising and developing research on functional biodiversity”

Research on microalgal ecology mainly focuses on toxic blooms and the forecasting of bloom episodes. Real-time observation combined with modelling remains the approach used by the international SCOR-IOC Geohab programme.

But the increasing frequency and the consequences of these phenomena, particularly in acute crisis situations, as well as phytoplankton's contribution to anthropogenic global climate changes, justify both setting up sound scientific coordination and integrating “research - expert assessment - dissemination”.



Development of molecular and immunological methods to identify taxa and a move towards modelling will be implemented to grow this expertise to support public policy makers, along with designing biosensors and diagnostic tests (DNA biochips) to be used for toxic algae monitoring.

### “Identifying the ecosystem services produced by marine and coastal biodiversity by developing methodologies for economic assessment of biodiversity”

Biological diversity holds a central position in the economic analysis of ecosystem services. Implementing social and economic evaluation is linked to growing demand from public environmental policies, in order to choose measures to be applied.

### “Modelling marine biodiversity in complex systems and including representation of uses”

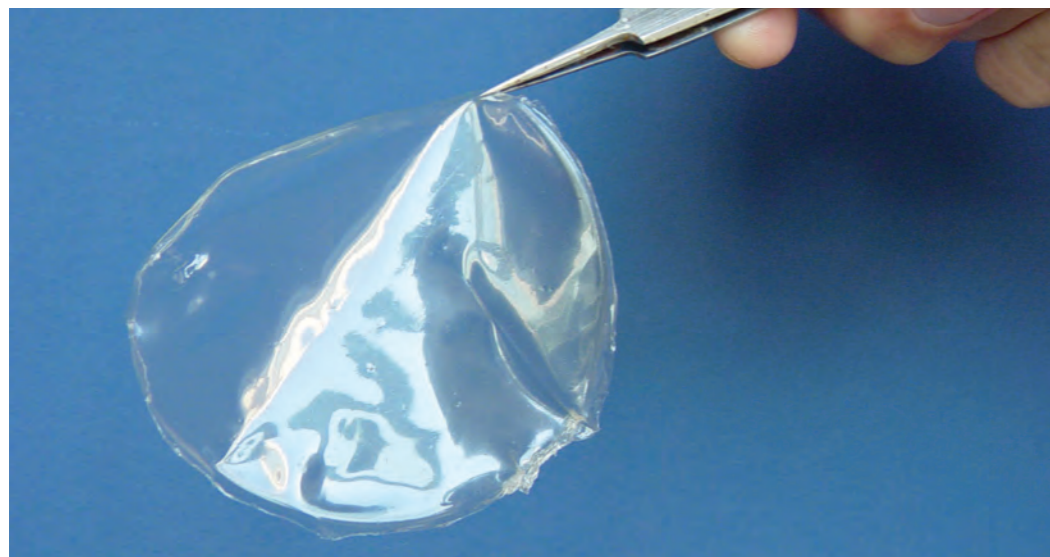
Ifremer's priority is to lead the reflection about assessment of ecosystem services and the economics of biodiversity, and to develop research projects aiming to define and apply conceptual and methodological frameworks. These approaches will lead to drawing up scenarios of how biodiversity could evolve, contributing to the running of the IPBES scientific platform.



# DEVELOP ENHANCED VALUE AND USE OF BIOLOGICAL RESOURCES THROUGH BIOTECHNOLOGIES AND BIOPROSPECTION

03

Collecting, isolating and characterising marine microorganisms. Improving value enhancement of the entire exploited marine biomass, particularly by-products. Controlling its production or supply for the characterisation of biomolecules of industrial interest in the fields of food, health, environment and energy



## CONTEXT AND STAKES

Only a tiny fraction of the micro-organisms living in extreme ecosystems has been inventoried and an even smaller fraction of these can be cultured (less than 1%). These unknown and untapped marine biological resources may well be the main reservoir of new high added value molecules in coming decades.

Less than 50% of commercially-used marine species are directly utilised by humans, the rest is often considered as waste or by-products and should be valorised. Trends in European regulations require that appropriate solutions targeting zero-discharge be sought.

A European foresight study published by the European Science Foundation in 2010 indicated that blue biotechnologies will make a significant contribution in responding to major societal stakes on the 2020 horizon.



- **Dwindling marine food resources.**  
In view of the general awareness about environmental and over-exploitation issues, there is an urgent need to increase the valuable development of the entire biomass utilised.

- **Reducing energy consumption and greenhouse-gas emissions.**  
Microalgae can help trap CO<sub>2</sub>, and enzymes, including those from ocean hydrothermal vents, can supply catalytic biosynthesis solutions as alternatives to chemical processes currently used.

- **Environmental compliance by treating pollution from farming, sea or industry.**

- **Changing legislation on chemical products (European REACH directive).**

This awareness has led to the will of industrial firms to propose, by 2030, between 20 and 30% of products from natural sources. This means that in the next few decades, the percentage of biodegradable polymers produced by biotechnologies could reach from 15 to 20% of the world market for polymers from petrochemical production.

Creating value from biotechnologies: responding to five major concerns

- **Scarcity and higher prices of raw materials and fossil energy sources.**  
Marine plant biomasses produced by photosynthesis could be a solution to produce energy or raw materials for industry (fine chemicals, pharmaceuticals).



## OBJECTIVES AND STRATEGY

The principal goals identified by the coordination of three European networks (Marine Genomics Europe, MarBef and EurOceans) and by the 2010 European foresight study concern bioprospection for novel microorganisms and exploiting biodiversity by developing culturing techniques and valorising biological and renewable energy resources.

To rise to these challenges, Ifremer has extensive means to explore marine environments, as well as know-how in controlled culturing and bioconversion of marine resources.

Coordination of various disciplines (ecophysiology, biochemistry, molecular biology, bioinformatics, taxonomy, and so on) which are indissociable from a systemic approach in biotech research will also have to be set up.

In order to reinforce and develop these various fields of excellence, Ifremer has drawn up its strategic priorities.

### “Step up research on various aspects of genomics (metagenomics, proteomics, metabolomics)”

Developing genomics tools to identify genetic resources and to inventory species, along with setting up national and regional technical platforms, considerably speeds up the acquisition of the knowledge base needed for biotechnology.

### “Develop strain collections in the framework of European biological resource centres”

Collecting micro-organisms relies on setting up a procedure for their systematic collection during cruises, ensuring they are consistent with means and metiers (fishing gear, grounds, etc.).

### “Pool Ifremer’s strengths in the field of marine bacteria”

Research on related molecules (thermostable enzymes, metabolites and biopolymers) will be ramped up for applications in the fields of health and environment.



### “Develop, improve and transfer conversion bioprocesses which can optimise sustainable use of resources”

This involves, in partnership with INRA, implementing modern tools for identification, screening, conversion and analysis of molecular biosynthesis based on the species studied.

### “Pursue and broaden research for exploiting and deriving value from novel molecules from species endemic to New Caledonia”

### “Develop biosensors to monitor coastal systems”

This objective corresponds to a strong European orientation (The Ocean of tomorrow programme) and involves developing biosensors to check contaminant and toxin levels in the marine environment (working with the CEA).

### “Maintain and strengthen collaborative work with French and European institutes and universities, as well as with industrial firms for R&D”

# SUPPORT PATHWAYS FOR SUSTAINABLE DEVELOPMENT OF FISHERIES AND AQUACULTURE **CONFRONTED BY GLOBAL CHANGE**

04

Making fisheries and aquaculture research and expertise part of the rationale to protect the functionalities of biodiversity and sustainable use of ecological services for economic and social purposes, in the dual context of global change and rising demand for seafood products



## CONTEXT AND STAKES

Evaluated every ten years, the Common Fisheries Policy (CFP) has been reformed with the priority of bringing fisheries stocks exploitation back to and keeping it at levels enabling maximum sustainable yield to be achieved by 2015. One of the new CFP's ambitions is to become consistent with the Marine Strategy Framework Directive (MSFD).

The European strategy for sustainable development of aquaculture also supports these guidelines, with European Union funding being allocated to R&D projects and the development by Member States of planning systems for uses of maritime areas which incorporate the strategic importance of aquaculture.

In the fisheries assessment field, Ifremer's capabilities will be confronted with expectations raised by the renewal of European environmental and fisheries policies. These regulatory changes will lead to the ramping up of modelling related to assessment and management procedures,

as well as the implementation of reliable tools and rules for decision-making which can be used with smaller amounts of data.

Drawing up scenarios for the development of fisheries and aquaculture is also highly dependent on knowledge and on anticipating the effects of global change on marine ecosystems.

Since 2008, the French oyster-farming value chain has been hit by sudden and massive mortality events affecting Pacific cupped oyster spat. Putting a protection plan into practice is subject to understanding resistance mechanisms in spat, in the framework of partnership-based research led by Ifremer.

Being linked to food safety, creating wealth and maintaining jobs, the research stakes here are both socio-economic and environmental in nature. Therefore, the prime objective, in the framework of a systemic approach, is to identify the determining factors of development pathways in fisheries and aquaculture (global change, market mechanisms, etc.) and elucidate the combined effects of the numerous, multi-scalar phenomena which alter these pathways.

## OBJECTIVES AND STRATEGY

In view of the regulations and reforms underway, it seems necessary to reinforce some research and expert assessment priorities and define new strategies within an appropriate partnership-based framework. Due to the interactions and socio-economic context, working more closely with the professional sector will be further increased in the framework of jointly-operated projects. Ifremer is also pursuing its commitment to research and support for aquaculture development in Overseas France.

### GENETICS AND AQUACULTURE

The short-term priority is to understand the mechanisms of atypical mortality episodes affecting Pacific cupped oysters (*C. gigas*) so that measures can be put into place to prevent outbreaks, raise alerts and combat these pathogenic organisms. They comprise identifying and characterising the virulence of pathogenic organisms, elucidating host-environment-pathogens interactions and modelling the outbreaks and persistence of pathogens.

Outcomes will be applied to rebuild sources of larvae by genetic introgression. The approach will be grounded on modelling of the environmental dynamics in pearl farming areas. In French Polynesia, genetic selection will concern characteristics of nacre quality in pearl oysters.



In the medium term, genetic research will seek to understand the processes of species adaptation to global change.

### FISHERIES SCIENCE, AN ECOSYSTEM APPROACH

The individualisation of fishing rights, proposed in the review of the Common Fisheries Policy (CFP), raises many questions for research which Ifremer will have to answer. This firstly involves understanding the effects of governance on catch dynamics using multi-criteria approaches, as well as identifying the consequences of choices concerning conservation and exploitation on fisheries fleet economic models.

In order to better understand the impacts of anthropogenic pressures on populations, appraise the mechanisms of response and adaptation and elucidate the processes involved in the fate of various families of contaminants, Ifremer has organised its actions around five main themes:

- intensifying research on habitats: identification, spatial distribution of populations, migration and connectivity phenomena;
- understanding the processes linking spatial-temporal population dynamics with intra-population diversity (plastic, physiological or genetic components);
- distinguishing between confounding processes and factors in biological processes and the environmental factors truly involved in interactions between the organism and its habitat, the aim being to generalise the experimental approach;
- incorporating results on the ecosystem impact of persistent contaminants in the modelling of populations and food webs. Extending this study to different families of contaminants and fish species studied;
- studying the effects of contaminants on the behaviour of organisms in a medium-term outlook, in order to appraise individual vulnerability and its incidence on the scale of populations ("multi-stress" approach).

# EXPLORE THE SEAFLOORS AND IDENTIFY, BY ECOSYSTEMIC APPROACH AND IN A CONTEXT OF SUSTAINABLE DEVELOPMENT, **THE CONDITIONS FOR EXPLOITING MINERAL AND ENERGY RESOURCES**

05

Mobilising expertise in geosciences, biology, chemistry and technology to improve the multidisciplinary knowledge base for the ocean, in order to meet new challenges of the deep sea and contribute to the sustainable development of marine renewable energy sources

## CONTEXT AND STAKES

The scientific stakes related to marine mineral and energy resources are mainly focused on knowledge about deep seafloors and the processes of formation of these deposits, on the environmental impact that mining or exploiting them will have - including on climate change, on natural and induced risks and hazards of seabed instability and on developing efficient exploration and production systems.

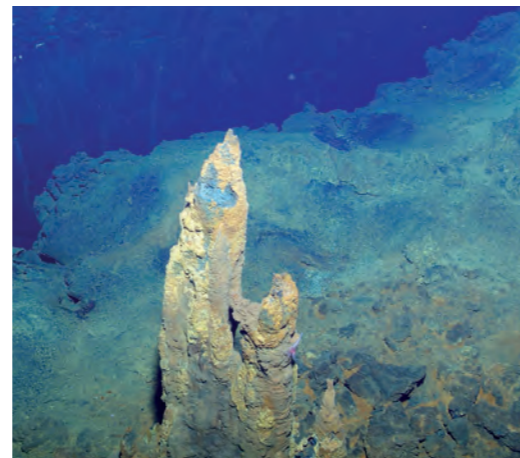
Prospecting and exploiting "extreme oil" at increasingly great depths already represent 30% of current production. This research will grow even more thanks to new knowledge about margin structures and sedimentary processes.

The Cimer interministerial committee for the sea meeting on 2 December 2013 highlighted France's will to promote the exploitation of deep seafloors. Ifremer is one of the actors of the national strategy in the field, whose foundations are based on close cooperation between research and industry, in order to position research in geology and ecology, technology and French industry in the field of deep mineral resources.

Selected in the framework of the Investments for the future programme, the calling of the IEED institute of excellence for carbon-free en-

ergy France Énergies marines is to achieve the French objective of installing 6,000 MW in marine renewable energies (MRE) between now and 2020, by counting on all of the supply chains (fixed and floating offshore wind turbines, wave energy, tidal stream energy and ocean thermal energy conversion).

Seeing the worldwide tensions affecting the supply of base metals and precious metals used in new technologies and green energy, identifying potential mineral resources (hydrothermal sulphides, cobalt-rich ferromanganese crusts and polymetallic nodules) and drawing up the requisites for their sustainable exploitation have led to renewed explorations, against a backdrop of regulation of international waters. Upon Ifremer's



**"Observing and understanding the dynamics of interacting processes in the deep sea"**

initiative, a foresight study was conducted in 2010, on France's and Europe's needs for marine mineral resources by the 2030 horizon.

Furthermore, the International Seabed Authority issued a permit to France in July 2012, with Ifremer's support, for hydrothermal sulphide exploration in international waters.

## OBJECTIVES AND STRATEGY

Ifremer benefits from extensive scientific expertise in this field and its research studies are built upon a systemic approach applied to the economic, geopolitical and legal context. This includes understanding the mechanisms by which resources and related ecosystem services were formed, as well as analysing natural and environmental risks and hazards. This research depends on developing technologies for multi-scalar exploration and seafloor observation (EMSO large-scale RI, Eric EMSO).

The Carnot-Ifremer Edrome institute (for exploration and sustainable utilisation of mineral and energy resources from the ocean) secured new labelling approval for the period from 2011-2015.

Ifremer's studies will contribute to building a knowledge base on the dynamics of interactions between fluids, lithosphere, hydrosphere and biosphere, taking systematic or even long-term observations as a basis, and thus to appraising variability over time and space.

One of LabEx Mer's orientations involves geobiological interactions in extreme environments, whilst another line of research focuses on transfers of matter between land and ocean, from coastal areas to the abyssal plains.

On questions of sedimentary basins and deep offshore oil, studies are aiming to develop conceptual models of how margins were constructed and modelling of sedimentary deposits and natural hazards related to gas hydrates.

The processes of metalliferous deposit formation in the deep sea are also an important research theme.

In the field of deep biodiversity, actions are intended to describe the biodiversity of deep sea ecosystems and the interactions between biological communities and their habitat by interdisciplinary multiscale approaches, from the ecosystem to the molecule.

It is indeed essential to understand the structure of these ecosystems discovered recently, their role in the biosphere and anticipate their utmost resilience, before considering the use of resources associated with them.

**"Developing new technologies for site exploration, assessment and studies"**

Achieving better scientific understanding of geological and biological processes on a local scale requires both sampling and high-resolution data acquisition near the seabed, available thanks to constant development of equipment and facilities (underwater vehicles and instrumentation).

**"Developing marine renewable energies"**

Working in liaison with the France Énergies marines national platform, Ifremer intends to strengthen its standing as a prime player in R&D both nationally and internationally and encourage public-private partnerships in three essential fields: environmental knowledge and how structures respond (foundations and interactions with the environment), knowledge about the environmental and societal impacts of MRE conversion devices and arrays, and technological innovation, through participation in energy converter device demonstration projects and their development.

# UNDERSTAND HOW ECOSYSTEMS FUNCTION AND DEVELOP TOOLS TO SERVE THE GOOD ENVIRONMENTAL STATUS OF COASTAL SEAS

06

Promoting innovative research, based on monitoring, to better assess the environmental status of marine ecosystems, understand how they respond to pressures and provide support for public policies on the environment, health and fisheries. Helping anticipate changes in regulatory frameworks and developing the monitoring system for surveillance

## CONTEXT AND STAKES

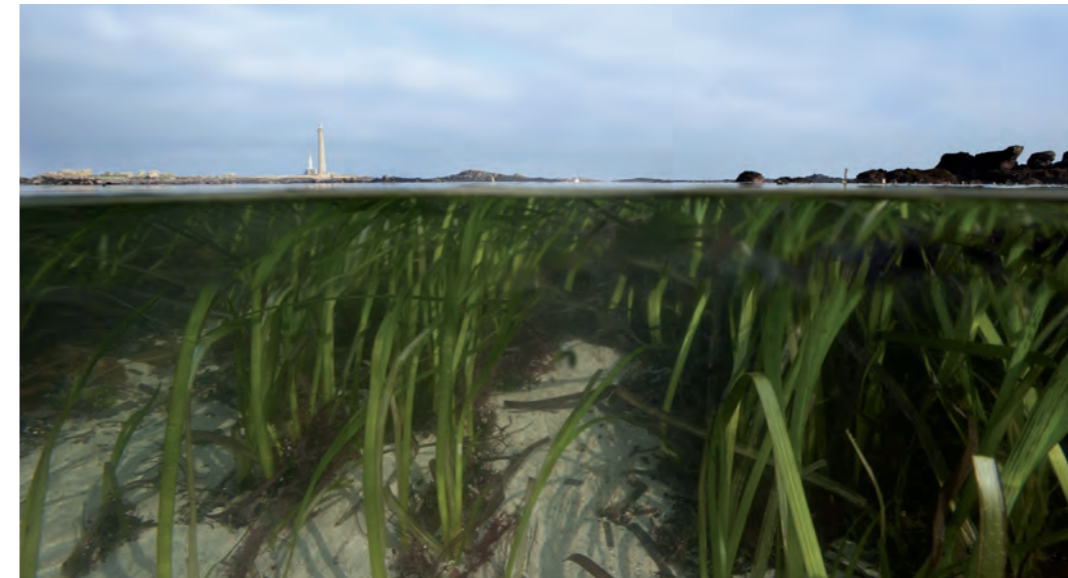
France has defined a national strategy for the sea and coasts which is in phase both with European policies and with the conventions for regional seas (Ospar). Its implementation requires new knowledge with a strong operational component directed at collecting data, informing the indicators (state of ecosystems, resources, changes and developments) and drawing up effective management measures.

Ifremer's contribution is awaited to enable an ambitious monitoring programme, imposed by the MSFD on the scale of marine subregions, to be set up as of 2014. This directive raises numerous questions and presupposes that environmental status objectives be defined and that tools, assessment methods and measures to control anthropogenic pressures be developed. It also gives rise to European programmes that Ifremer will take part in.

These public policies are based on a monitoring system which can ensure progression towards good status of the marine environment and enable managers of maritime areas to be informed. Designing, implementing and updating this system involve a comprehensive approach (physics, biogeochemistry, benthic and pelagic ecology) in order to better understand the dynamics of ma-

rine ecosystems, along with the effect of natural and anthropogenic forcings.

The national 2012–2020 strategy for research infrastructures promotes the networking of long-term observation and experimentation systems (Soere) and the developing of databases in European and international frameworks (GMES-Geoss). AllEnvi leads to structuring of institutional approaches and facilitating the sharing of means. Other bodies also promote this work to coordinate observation, like the INSU special commissions ("Ocean, atmosphere and climate" and "Continental surfaces and interfaces").



Generally speaking, marine research will have to respond to new, emerging research themes related to the European Union's will to achieve and preserve the good status of marine ecosystems and resources.

## OBJECTIVES AND PRIORITIES

Ifremer's aim is to maintain its strategic position in developing the national monitoring system which should provide ongoing assessment of marine waters' ecological status. In this way, the Institute will help respond to national and European stakes, as well as the new challenges posed by the MSFD.

Nevertheless, it will be necessary to strengthen the links between research, monitoring and expert assessment activities, giving priority to actions with high added value: integrated expertise, drawing up of methods and indicators, defining standards, databasing and data interpretation.

Ifremer is also participating in developing coastal operational oceanography tools and related services geared towards research and towards the social and economic sphere (forecasts, alerts, crisis management, embedding small-scale models, drafting scenarios for trends and so on).

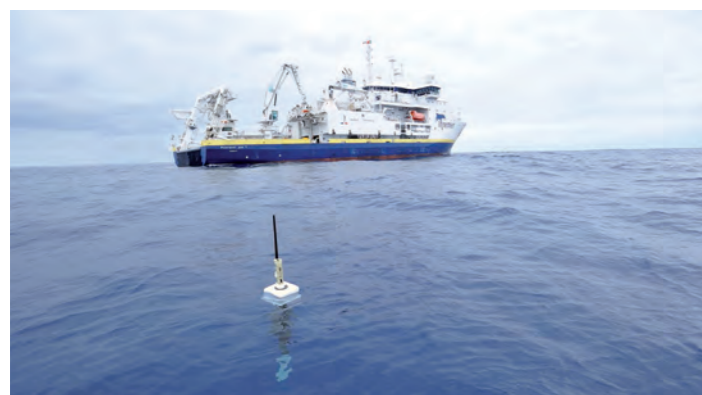
The pursuance of these studies and goals relies on implementing the following actions:

- consolidating theme-based clusters and reference laboratories combining research, expert assessment and monitoring support activities. Adapting and optimising the strategy for quality and laboratory accreditation;
- ramping up efforts on observatories to serve research issues and to meet societal expectations (in relation with AllEnvi);
- favouring a stance of assisting the contracting authority in the national monitoring system and continuing to transfer tasks with lower scientific added value to other stakeholders;
- developing numerical modelling of the coastal sea and coupling physics with biogeochemical and biological models by adding metrics which can be used to characterise the uncertainties and the validity of model outputs;
- contributing to setting up integrated "digital monitoring" combining field data, high frequency in situ instrumentation, satellite data and numerical modelling. Integrating new tools and technologies will make it possible to upgrade the configuration of existing networks and to optimise field work.

# CONTRIBUTE TO IMPLEMENTING A NATIONAL AND EUROPEAN STRATEGY FOR MARINE DATABASES

07

Protecting, managing and maintaining marine data over the long-term, in databases which can be accessed by all users, with the objective of supporting public decision-makers and underpinning research and management in the exclusive economic zone, in accordance with European directives



## CONTEXT AND STAKES

To successfully fulfil its missions for research and support to public policy makers and socio-economic players in the maritime realm, Ifremer has acquired sound expertise in the field of databasing and management of marine data. The quality of the services operated has made the Institute a globally recognised player.

In Europe, Ifremer coordinates the SeaDataNet digital research infrastructure, hosts one of two ARGO centres worldwide (automating marine observation) and manages databases in five major fields: ocean physics, geosciences, coastal environment, fisheries and biodiversity.

Databasing is facing contextual changes and developments which raise many challenges for Ifremer, with general trends tending to evolve towards increasingly distributed systems, together with growing service requirements and demands for access to data.

The increasing importance given to themes related to biodiversity is accompanied by high-performance tools linked to progress made in

molecular biology. This has resulted in a wide range of highly diverse data to be harmonised and managed.

The most integrated scientific approaches require creating large sets of consistent data of proven quality, sufficiently processed for direct use by multidisciplinary teams.

Recent regulatory developments of the MSFD and the Common Fisheries Policy have generated a rising need for data acquisition or indicator definitions, at a time when the European marine environmental data network Emodnet has expressed the will to harmonise data flows and exchanges with the European Commission.

By nature, environmental data should be widely disseminated. In this respect, the European Inspire Directive sets out obligations for data description and availability. In France, this policy to open up access has led to the creation of institutional distributed systems, like that of the water information system (SIEau) or the national sea and coast observatory (ONML).

The growing fluxes of digitized data, greater volumes of data to be archived, the multiplication of data acquisition in the form of images imply

that higher performance IT resources and more automated data management procedures are required, meaning that this field of work must evolve towards new practices and skill sets.

## OBJECTIVES AND STRATEGY

Marine databases are strategic infrastructures, just like large-scale facilities and supercomputing resources. Ifremer must consolidate its position in this field in order to contribute to the excellence of French marine research and to weigh in on the norms and standards decided on at the European level.

First and foremost, for Ifremer this means building services based on availability, continuity, quality and commitment, while focusing its efforts on its high-priority discipline fields.

The Institute is also working to develop tools to facilitate access to data and information stored and promoting the valuable utilisation of data in publications and scientific studies.

In technical terms, the objective is to continue the transition, already well underway, towards "open" standards, which will facilitate the interconnection of data systems and enable a given

basic datum to be used under various forms and via various portals.

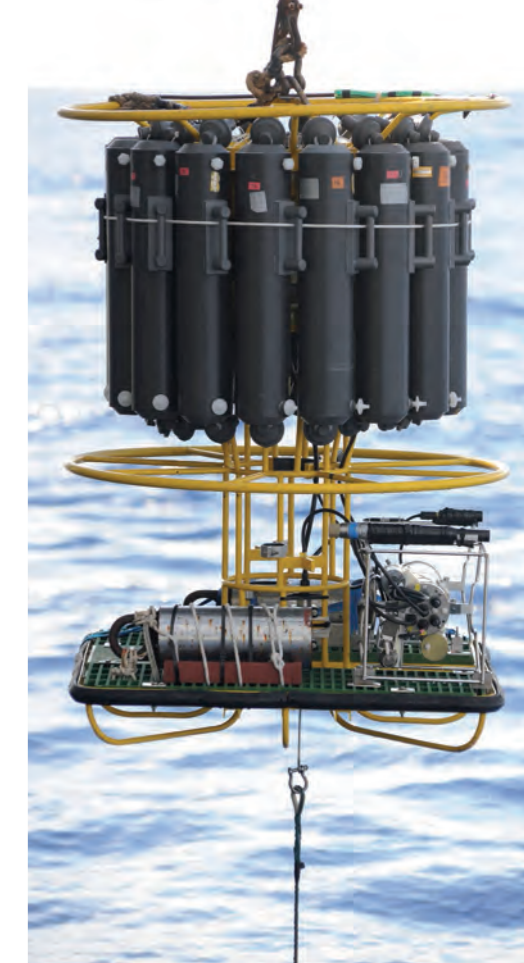
Carrying on from the actions undertaken for services rendered by information systems, the quality approach will have to be reinforced in order to characterise data services, ensure their security and protect the rights associated with this information.

Two priorities appear when updating these research orientations.

**“To strengthen national coordination of marine databases, as in major European projects (SeaDataNet, MyOcean, etc.)”**

**“To better integrate Ifremer’s marine databases within scientific observatories for the marine environment”**

This means consolidating their position as instruments to serve research, adjusting the thematic priorities for developing them depending on strategic reorientations - in particular, growing the biodiversity and bioinformatics component - and supporting their implementation and development through long-term funding and resources, limiting their dependence on project-based funding.



Technically speaking, the objective is to ensure that all marine data be converged towards a single point of access (portal) and to develop more didactic products to visualise them (maps, indicators, etc.) that are adapted to contractual requirements.

This strategy will be refined, working with AllEnvi partners. It will especially consist in clarifying the linkage between the scope of marine databases and Soere-labelled systems for observation and experimentation.

# OPTIMISE IFREMER'S FLEET, THE KEYSTONE OF THE FRENCH OCEANOGRAPHIC FLEET LARGE-SCALE RESEARCH INFRASTRUCTURE

08

Renewing and modernising the national scientific fleet, with the perspective of maintaining its multifunctional dimension and its technological edge, underpinning excellence in research. Consolidating partnerships and pursuing its European integration

## CONTEXT AND STAKES

The French oceanographic fleet is one of the most integrated fleets in the world. It is characterised by its multi-purpose functioning, made possible by its current scope, with vessels and underwater vehicles which are complementary in terms of size and functions. It is solicited for activities of scientific research, cooperation between research and industry and chartering, as well as for public service missions, with priority given to access for research cruises and scientific observations.

The sea-going oceanographic research facilities of Ifremer, CNRS, IPEV and IRD have been grouped together in the French Oceanographic Fleet large research infrastructure called TGIR FOF since 2008. In March 2011, a significant step in its governance was made with the creation of

the joint service unit called UMS FOF. The unit is in charge of coordinated management of the ocean research fleet (integrated scheduling, fleet development plan and investment policies).

Concurrently, the main research stakes which are decisive for fleet use were clarified.

Within the Fleet large-scale Research Infrastructure, Ifremer is owner via the Genavir EIG of 4 of France's 5 ocean-going vessels, 3 of the 5 coastal vessels and all of the underwater vehicles and heavy equipment. The Institute ensured 84% of the 1,343 days of commissioning for ocean-going vessels of 35m LOA or more during the 2007-2012 period.

Although the decision to create the UMS French fleet joint service unit is an important one, it has come at a time of severe budgetary constraints, chronic under-financing of fleet operation and the urgent need to renew part of its vessels and large equipment. Therefore, a scenario for a renewal plan was submitted by the institutions which operate the Fleet large-scale research infrastructure to MESR in July 2012. It aims to keep investments to a reasonable level whilst conveying a national ambition kept intact in

terms of fleet capacity and performance. Ifremer will defend this scenario, as it guarantees the multi-purpose nature of the fleet that will ensure overall savings for the French State and confirms the importance of technological innovation required for research excellence.

Finally, indicative of the far ranging changes underway, two structuring institutional partnerships - developed within OFEG and with the Spanish oceanographic institute (IEO) - for the building and use of RV *Thalassa* - are in crisis or have disappeared due to lack of financing. The third partnership, set up with the French Navy for the construction and use of RVs *Pourquoi pas?* and *Beautemps-Beaupré* is continuing, with increasingly tight financial constraints.

## OBJECTIVES AND STRATEGY

The importance of an economic model in common with the large research infrastructure

An economic model must be reinvented to allow balanced programming of its activities and reduce cruise scheduling time. Seeing how funding of scientific-cruise projects is progressing both nationally (with the ANR) and on the European



level, this approach should be based on aligning the fleet's financing.

The Fleet large-scale research infrastructure will be built by making optimal use of its members' strengths, while constantly seeking effects of critical mass. Ifremer's ambitions are expressed through two strategic priorities

**"To be the operator of future deep-sea vessels and systems"**

The main strengths of Ifremer lie in the professionalism of its operations coordination teams, its engineering and its technological development capability, whether for integrating or developing its vessels and underwater systems or equipment or making them operational. The system is complemented by the relationship with Genavir currently being redefined in order to clarify roles and control costs - and the quality assurance approach.

**"Maintain partnerships and pursue European integration of the fleet"**

The absence of a legal structure for the UMS Fleet joint service unit prevents it from signing agreements with other operators. Thus opening the Fleet large-scale RI to national and European institutions relies almost exclusively on agreements or partnerships which were entered into by Ifremer more than fifteen years ago.

Stronger ties should be sought with the French Navy, which is confronted with the need to renew its three second-class hydrographic survey vessels.

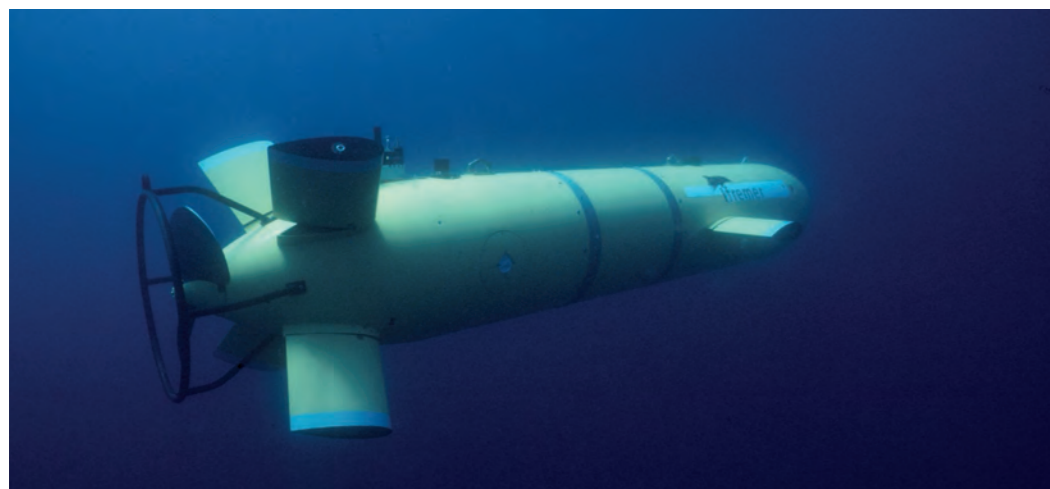
On the European level, Ifremer, coordinating two projects, Eurofleets1, then Eurofleets2 (2013-2017) and playing an important role within OFEG, will endeavour to reconcile these two approaches.



# PROMOTE SHARED CAPACITY FOR TECHNOLOGICAL INNOVATION

09

Integrating state-of-the-art technologies in metrics and operational systems. Proposing technological innovations to serve oceanographic research, exploration and exploitation of resources, and developing equipment and facilities which will be part of the development of large-scale Research Infrastructures.



## CONTEXT AND STAKES

The updating of Ifremer's strategic plan, in the field of research and technological innovation, takes new players and large-scale projects into account. These include the Carnot Ifremer-Edrome Institute's Captiven project (water and soil sensors for environmental quality data); EMSO-Esfri and Jerico (deep seafloor and coastal observatories); Eurofleets2 (standardised measurement tools and software for data acquisition, processing and databasing).

The Phoenix research grouping brings together French (CNRS and Ifremer) and German (AWI and Marum) institutes to perform studies in the field of underwater systems and related technologies (AUVs, HROVs and interoperability).

Lastly, the participation of keen citizens who care about their environment is increasingly solicited, to enrich and complement scientific assessment studies ("participatory science").

## OBJECTIVES AND STRATEGY

Research and technological innovation must meet new requirements related to observation, measuring and monitoring, with ever-higher performance in terms of accuracy, reliability, repeatability and sustainability as well as eco-design. This ambition is built upon well-defined objectives for Ifremer's actions in this field:



- pursuing technological developments in the Carnot Ifremer-Edrome institute framework and helping support both France énergies marines and the world of industry by proposing technological expert assessments, site studies and impact measurements;
- contributing to keeping a high level of service in terms of underwater equipment, vehicles and systems, for the benefit of the scientific community;
- promoting and developing observatories around NAOS and the European Euro-ARGO (open seas), EMSO (deep sea) and Jerico (coastal) projects, as well as the different measurement systems (buoys, profiling floats, seabed stations, gliders, surface drones, etc.);
- developing tools for *in situ* surveying and analysis of mineral resource deposits and helping to characterise sinks and reservoirs;
- anticipating new tools for monitoring and surveillance incorporating high-frequency *in situ* measurements, operational oceanography techniques and numerical modelling.

Ifremer gathers complementary expertise in disciplines which are essential in marine science and engineering science, enabling it to progress in mastery of data chains, from sensor to databasing, and in drawing up time series, thus meeting major challenges of the coming decade.



Priorities are set with respect to three fields of research.

#### **R&D FOR SENSORS AND MEASUREMENT SYSTEM TECHNOLOGIES**

A major effort is expected in terms of coastal and deep-sea chemical, biological and biogeochemical measurements, including the integration of new transducers, miniaturisation of measurement systems and data recovery, associated with lowering of costs. Measuring anthropogenic noise using passive acoustics also represents a future challenge for the MSFD.



The principal challenge will be to make biosensors to detect micro-organisms or trace molecules operational in five years' time, by integrating the so-called "-omics" techniques and nanotechnologies. Developing biopolymer materials for sensors for eco-design of measurement systems is being studied.

#### **COMPLEX SYSTEMS ENGINEERING**

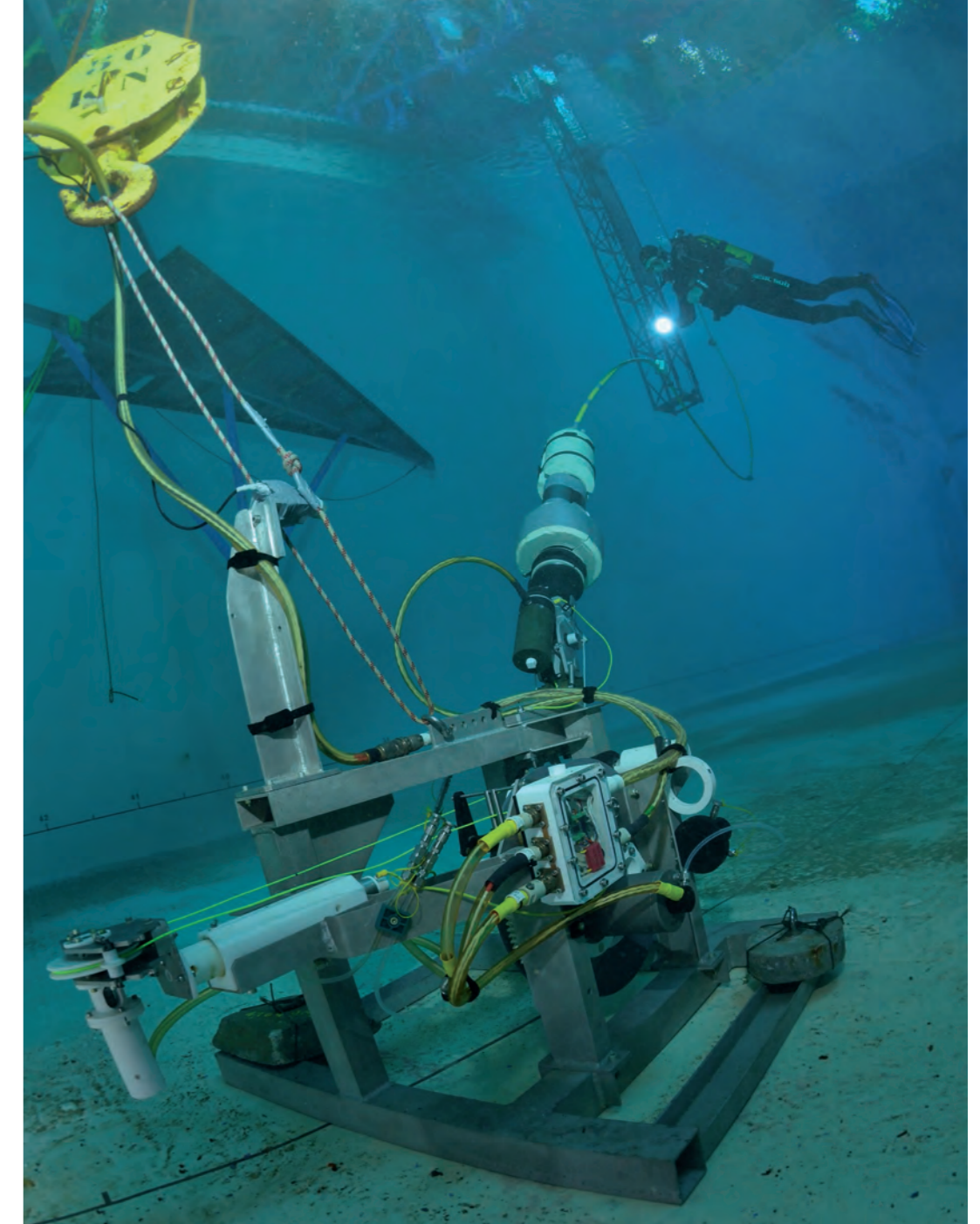
Ifremer integrates technologies for vehicles, underwater systems and observatories. By coordinating these complex projects, the Institute has acquired expertise which is practically unique in Europe. So, research is aimed at optimising these networks by developing or improving tools for strategic prospection, studying ecosystem functioning and developing marine energies.

Observation systems are producing more and more data. To optimise analysis time, information technology tools adapted to each instrument must be developed and new computing technology capabilities assessed.

#### **TECHNOLOGY CONTRIBUTING TO LARGE RESEARCH INFRASTRUCTURES**

Ifremer is actively engaged in three large scale research infrastructures (FOF, Euro-ARGO and EMSO) which are structuring orientations to be maintained, with the required service levels and quality, and which represent the following challenges to tackle:

- improve the power capacity of at least one of the coastal AUVs to dive to greater depths;
- commission HROV aboard inshore vessels;
- optimise the offshore fleet's tools by implementing new monitoring protocols and calibration methodologies;
- increase the inshore fleet's data acquisition capacity;
- finalise the software to help perform and process cruise data (Eurofleets);
- develop telepresence to reduce sea cruise costs;
- upgrade the seismic equipment (Sisdav project);
- develop new biochemical sensors and create profilers which can measurement physical parameters to depths reaching 3,500 metres (Equipex NAOS project);
- assess gliders' contribution to the ARGO network and to ocean modelling;
- increase long-term holding of fixed-point deep seafloor observatories.



# GLOSSAIRE

ANR	<i>Agence nationale de la recherche</i>
AWI	<i>Alfred Wegener Institut</i>
CEA	<i>Commissariat à l'énergie atomique et aux énergies alternatives</i>
CNES	<i>Centre national d'études spatiales</i>
CNRS	<i>Centre national de la recherche scientifique</i>
COM	French overseas local authorities
MSFD	Marine Strategy Framework Directive
ESA	European State Agency
FP R&D	Framework Programme Research & Development
GEOSS	Global Earth Observation System of Systems
GMES	Global Monitoring for Environment and Security
GOOS	Global Ocean Observing System
ICES	International Council for the Exploration of the Sea
IEED	<i>Institut d'excellence sur les énergies décarbonées</i>
IFM Geomar	<i>Institut für Meereswissenschaften an der Universität Kiel</i>
INRA	<i>Institut national de la recherche agronomique</i>
INSU	<i>Institut national des sciences de l'Univers</i>
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IRD	<i>Institut de recherche pour le développement</i>
JPI Océans	Joint Programming Initiative Oceans
NASA	National Aeronautics and Space Administration
ROM	French overseas regions
SCOR-IOC Geohab	international research programme on the Global Ecology and Oceanography of Harmful Algal Blooms
TGIR	Fleet large-scale research infrastructure

## CREDITS PHOTOS

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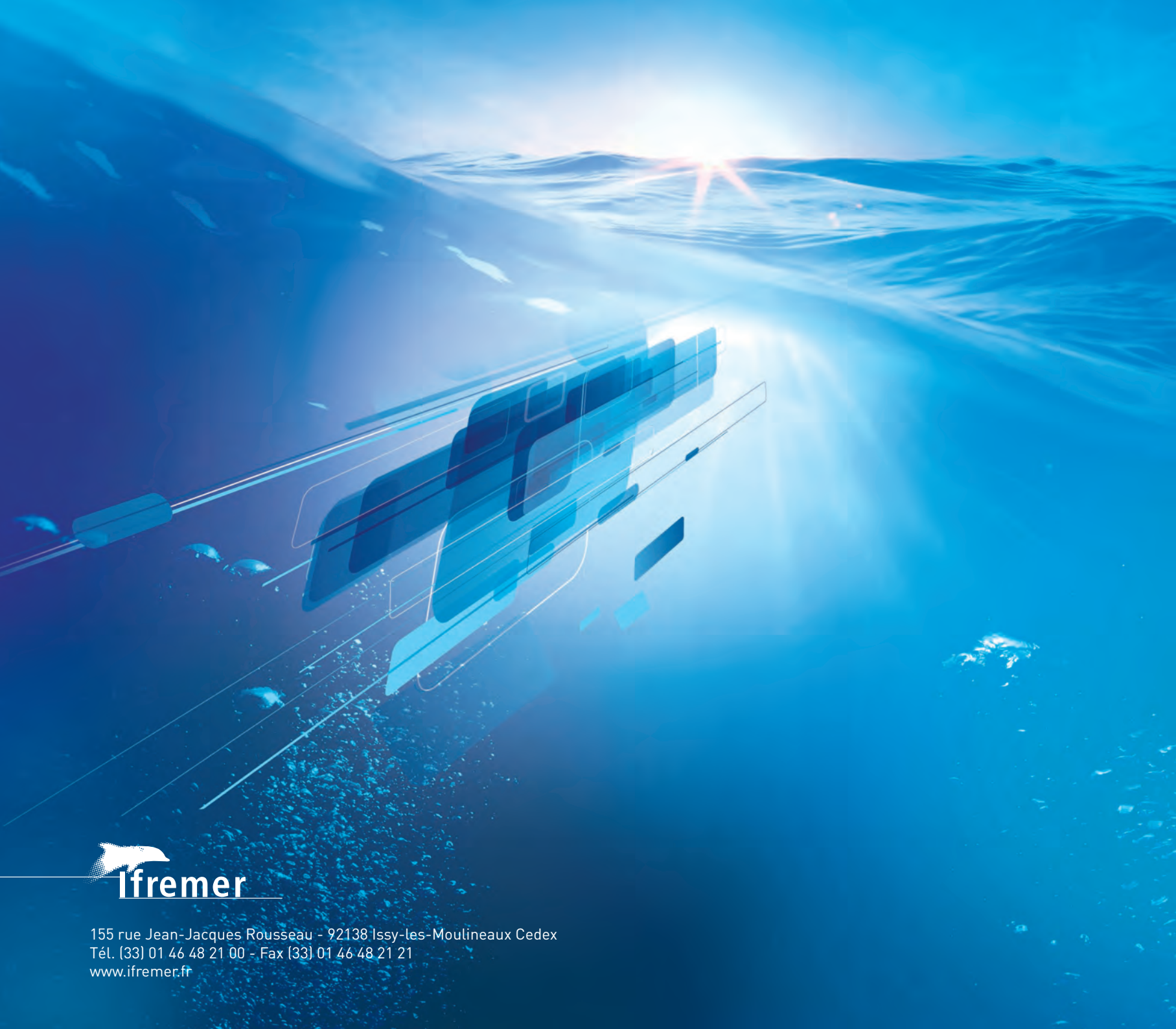
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