



**Ifremer**

Annual Report

**2015**

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## A MESSAGE FROM THE CHAIRMAN

*France holds an important position in the maritime world. A pioneering nation in oceanographic research, France also has the second largest exclusive economic zone in the world, after that of the United States. In 2015, its sub-sea territory even grew by more than 500,000 km<sup>2</sup>, thanks to the outcome of the French Extraplac programme for continental shelf extension, led by Ifremer. This area holds considerable potential in terms of discoveries, innovations, growth and resources in fields such as energy, food, health and so on, where societal stakes are high.*

*The fact that the ocean was incorporated in the Paris Agreement adopted by COP21, also shows that both its integrity and essential role in the climate were acknowledged.*

*In a context marked by global change, it is vital to increase our knowledge in marine science, so that we can benefit from the wealth of potential resources in a sustainable manner. To do so, Ifremer is developing an integrated approach for better understanding of the oceans and their resources. The original nature of the Institute lies in the combination of a wide range of missions, approaches and skill sets. This is Ifremer's strength and what made it possible in 2015 to deliver the scientific, technological, technical and expert assessment results described in this report.*

*The year 2015 was full of achievements putting our Institute's scientific policy into practice. These included the positive evaluation of the technical units by four inspection committees, setting up the UMR IHPE and Marbec joint research units in Languedoc-Roussillon, developing a joint unit project in French Guiana, bringing a new UMR project (future LOPS) on oceanography to fruition and obtaining recognition of a research infrastructure on the coast and of a planned infrastructure of test tank facilities.*

*In the field of informing public policy-making, our work aiming to clarify cooperation and partnerships with public-sector authorities and the professional sectors involved continued. I believe that this will help make the full interest of having Ifremer better focus and enhance its action by preparing policies of the future better understood.*

*2015 was also the year when the decision was taken by the Board of directors to transfer our Headquarters to the Ifremer campus at Plouzané, Brittany. It will now be a question of implementing it, being particularly attentive to what will become of our staff.*

*Finally, some sweeping work efforts will consolidate the Institute's position, chiefly the renovation of the budget and accounting management system or those engaged to use the ocean research fleet to best advantage through transparent and optimised management. Ifremer's role, in the field of marine science and technology, is to translate the current social issues into research issues, then deliver the analyses and results which can be the basis for a rational approach to the marine environment. This is what must guide our action, and seeing the work accomplished in 2015, I am convinced that our Institute's team will fully rise to the challenge.*

*François JACQ  
Chairman and Chief Executive Officer*

# IFREMER FACT SHEET

## Background

The French marine research institute Ifremer came into being when two worlds met. The first is related to the field of fisheries and mariculture and was originally the Maritime fisheries technical service created in the second half of the 19<sup>th</sup> century. Following on from this service, the Maritime fisheries scientific and technical service (OSTPM) created by the Finance Act on 31 December 1918 took on new missions including sanitary inspections of shellfish

and canned food manufacturing. The establishment became the Maritime fisheries scientific and technical institute (ISTPM) in 1953.

The second is linked to the rise of oceanography and harks back to the development of over a century of measurements and cruises to explore the oceans. After World War II, a Committee was set up for ocean exploitation which gave rise, through the 3 January 1967 law, to the National centre for exploita-

tion of the oceans (Cnexo), giving a significant place to technology.

Ifremer was created on 5 June 1984 with the merging of ISTPM and Cnexo.

Ifremer is a public institute of industrial and commercial nature, placed under the joint supervision of the Ministry of Higher education and Research and the Ministry of the Environment, Energy and the Sea.

## Missions

As set out in the decree enacting its creation, **Ifremer has the remit to conduct and promote basic and applied research and establish expert assessment reports and action for technological and industrial developments** intended to:

- know about, assess, and valuably utilise ocean resources in view of their sustainable use,
- improve methods for monitoring, forecasting trends, protecting and enhancing marine and coastal environments;
- foster social and economic development of the maritime world.

The marine environment is subjected to numerous types of pressure: high demand for raw materials and seafood, growing populations along coastal zones, increasingly pervasive pollutants

and waste and growing development of uses of the sea. Within this context, understanding the impact that global change, especially climate change, has on the oceans is a major challenge.

Ifremer is thus confronted with many scientific and technical issues, with growing social demand in the field of food safety, transitioning energy sources, environmental protection and respect for biodiversity, as well as in the realm of sharing and disseminating knowledge.

As an integrated research institute in marine science, Ifremer contributes to the national system for research and innovation as well as to the European research area, by producing:

- fundamental knowledge in a systemic approach enabling a better grasp of the processes governing ecosystems and

- understand the changes affecting them;
- more finalised results to answer questions raised by society, based on its observation, monitoring and expert assessment capacities, and to give policy-makers support for managing the marine environment and its resources;
- outcomes and technologies contributing to economic development in the framework of a balanced partnership with various economic players, including industrial firms.

To meet these objectives, **Ifremer has worked with its supervising ministries to construct the 2014-2017 State-Ifremer objectives contract, which is part of its 2020 strategic plan.** The strategy is linked up to French and European scientific priorities and fits into major international research programmes.

# 1,464

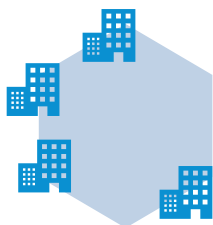
PEOPLE



including 595 engineers/researchers

# 450

scientific articles published in 2015 and indexed by the Web of Science



# 5

CENTRES

(Atlantic, Brittany, English Channel-North Sea, Mediterranean, Pacific)

# 20

COASTAL LOCATIONS



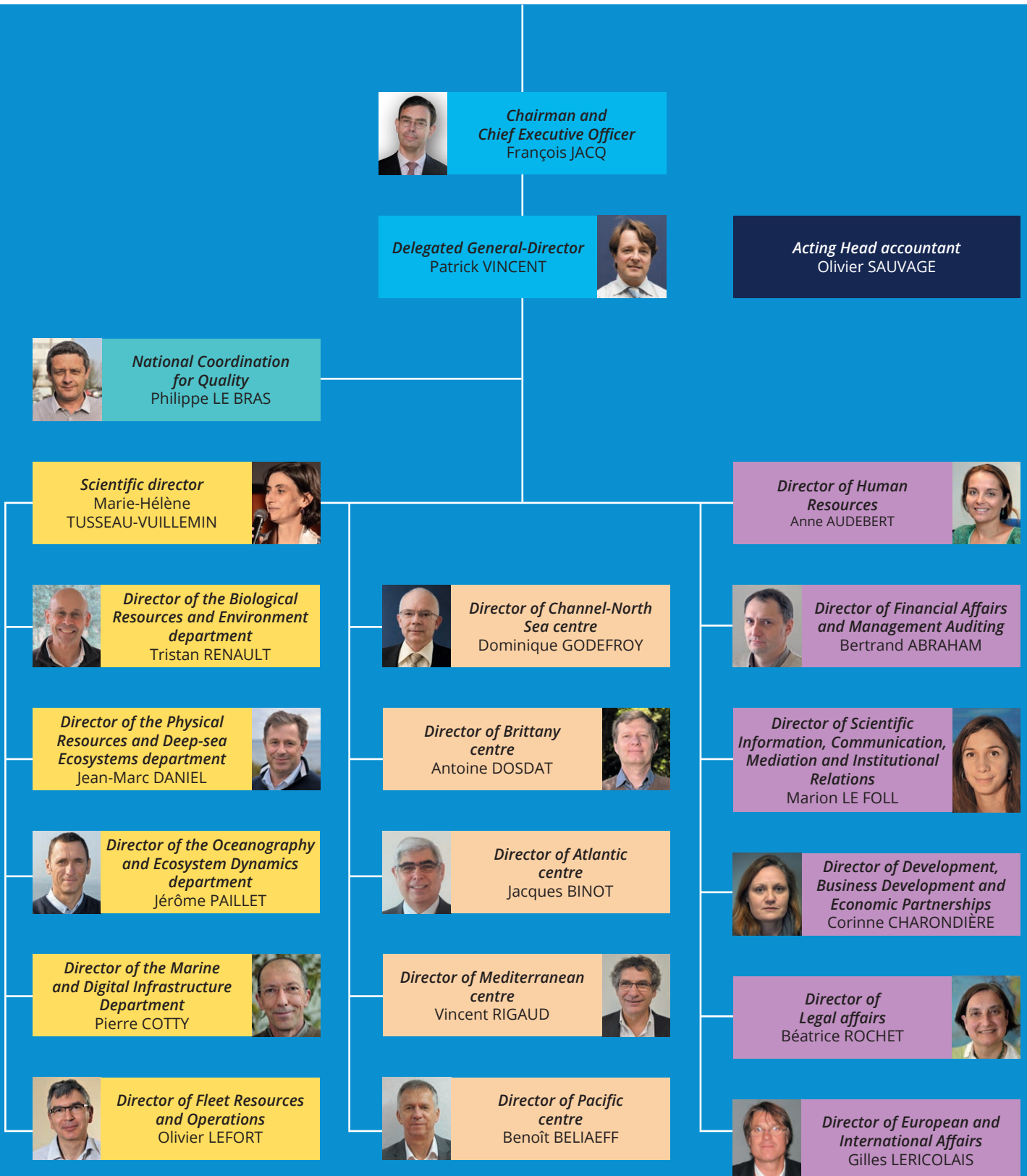
BUDGET approximately

# 210 M€

IN 2015

## Organisation

The scientific component is made up of scientific management, four departments uniting scientific and technical staff and the Fleet resources and operations division. Support for research is provided through six functional divisions (human resources, finances, legal affairs, business development, communications, international and European affairs) and the accounts department.





# DEVELOPING AN INTEGRATED APPROACH TO THE OCEANS AND THEIR RESOURCES

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# Understanding marine environment dynamics

Observing and understanding the marine environment's dynamics is a major orientation for Ifremer's endeavours, responding to various stakes for society:

- assess the influence climate change has on the ocean and the role the ocean plays in the climate;
- understand ocean-atmosphere interactions with the perspective of improving oceanographic, meteorological and climate forecasts;
- and learn to assess good environmental status of coastal ecosystems by knowing how to distinguish between their natural variability and the impacts of human activities.

Research conducted at Ifremer particularly deals with understanding physical, biogeochemical or biological processes than can be appraised using new techniques for ocean observation and modelling, or a combination of the two. In physical oceanography, research studies focus on the dynamics of the world ocean, especially the Atlantic Ocean and Mediterranean Sea, as well as the ocean mixed layer and its interactions with the atmosphere and ice. In the coastal realm, they also focus on characterising the impacts of anthropogenic activities on the marine environ-

ment: chemical contamination, eutrophication, deteriorating or restoring benthic habitats, the influence of inputs on plankton composition and especially on toxic phytoplankton, modifications in sedimentary dynamics and so on.

Several advances and publications were 2015 milestones. A few of them are presented in this chapter: an overview study based on various data sources, supplying new information about ocean heat transport in the North Atlantic; the Amazon River plume described thanks to new satellite data; completion of the European EMoSEM project working to assess eutrophication management measures on the scale of the Atlantic seafloor; initial results from a study on changes in the distribution of benthic macrofauna in the English Channel over the past fifty years; an analysis of phytoplankton composition on nineteen *Réphy* monitoring network sites since 1995, revealing significant changes; and finally, observing and modelling the invasion by a ctenophore from the East coast of America, *Mnemiopsis leidyi*, in the English Channel and North Sea.

## Support for managing environmental quality of marine waters in Europe

For the Marine Strategy Framework Directive (MSFD), achieving Good Environmental Status of marine waters depends on reducing the phenomenon of eutrophication (algal blooms due to excess nutrients, best known for green algae washed up on beaches) which will require lowering nitrate and phosphate inputs from rivers. Aiming to determine how best to reduce inputs, river by river, Ifremer took part from 2013 to 2015 in the European EMoSEM project bringing together Belgium, France and Portugal. Through an environmental modelling approach, scientists determined the nitrate

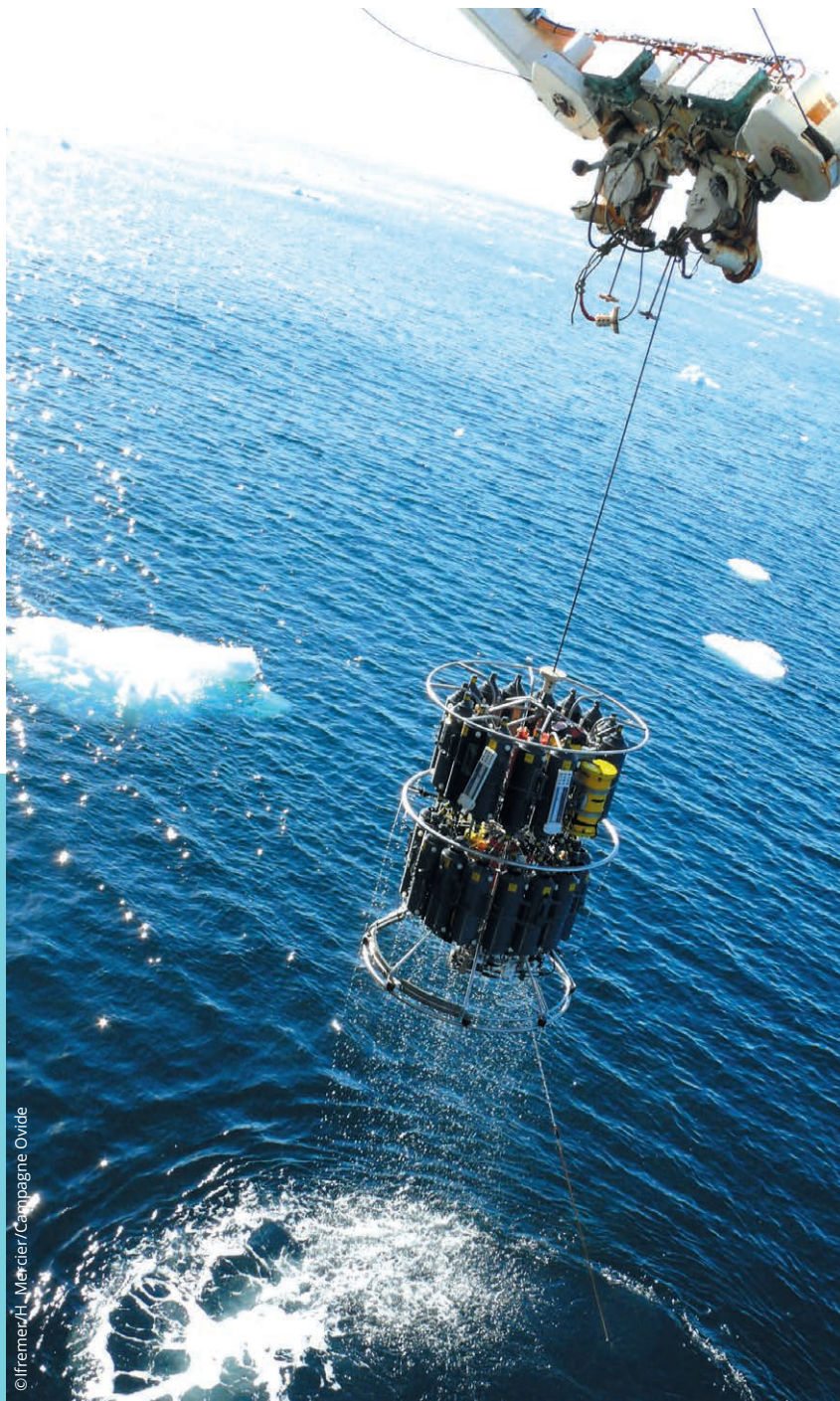
and phosphate levels not to be exceeded for 174 main rivers of Western Europe.

By coupling various models for watershed catchments and the coastal sea, the researchers compared the main variables of the pelagic ecosystem for over a decade, in several situations, i.e. the contemporary situation with current nutrient input levels, a theoretical pristine situation with only natural inputs and no anthropogenic influence and three more-or-less stringent nutrient reduction scenarios. The scenarios which correspond to a more extensive implementation of the Nitrates Directive or to more responsible farming practices do not manage to notably reduce coastal eutrophication. On the other hand,

the scenario for radical reorganisation of the agro-food system (conversion to local organic farming and changing dietary practices, e.g. demitarian diet) yields considerable results in terms of reducing surplus nitrogen, and in turn results in significant improvement of marine eutrophication status.

Furthermore, a relationship has been shown between planktonic chlorophyll (indicator of environmental status) and the nitrate-phosphate combination which is effectively bioavailable at sea. By targeting two possible levels of chlorophyll enabling "good marine environmental status" to be achieved, the recommended optimal river load reductions for each group of rivers could be established.





Deploying a CTD sonde during an Ovide cruise near Greenland.

© Ifremer/H. Mercier/Campagne Ovide

## Variability of the Meridional Overturning Circulation in the North Atlantic

The North Atlantic plays an essential role in climate regulation by transporting heat from the equatorial regions northwards to high latitudes and by contributing to the deep sea seques-

tration of part of the CO<sub>2</sub> generated by human activity. This is due to the existence of Meridional Overturning Circulation (MOC) which transports warm surface water northward and cold deep water southward. The two limbs are interconnected by the water masses sinking from the surface layers to the deep ocean in the Greenland

and Labrador Seas. Climate projections foresee that the MOC will lose about 25% of its intensity by 2100 compared to that of the last century, with repercussions on the sequestration of anthropogenic carbon dioxide and heat redistribution. Therefore, measuring MOC transport and how it evolves has become a priority for oceanographers. Since 2002, the Ovide research cruises conducted every two years between Greenland and Portugal, have made it possible to develop a method to ensure monthly monitoring of the MOC's amplitude. Using satellite altimetry and hydrographic data acquired *in situ* from 1993 to 2010, it was demonstrated that the mean intensity of the MOC index was 18 Sv (million m<sup>3</sup>/s) showing greater variability over quasi-decadal time scales. The analysis also highlighted a drop of  $2.5 \pm 1.4$  Sv in the MOC's intensity since 1993. This information is compatible with climate projections, however it is not possible to determine whether the signal is directly linked to anthropogenic forcing.

Mercier H. et al., 2015. *Progress in Oceanography*

## Amazon plume study using satellite remote sensing

Fresh water flowing into the ocean at the mouths of large rivers significantly modifies the physical, optical and biochemical characteristics of ocean surface waters. This mixing of fresh water and sea water creates a plume of low salinity surface water generally rich in sediments and organic matter which accumulate as riverine waters flow through land areas.

New surface salinity measurements performed using SMOS satellite data since 2010 have made it possible to regularly monitor the extent of plumes from the largest tropical rivers on earth (Amazon, Orinoco, Congo and

Mississippi). A study made by Ifremer's spatial oceanography laboratory combined data obtained via SMOS and high resolution optical observations improved the characterisation of the seasonal cycle of the Amazon River plume, whose annual discharge represents approximately 15% of global riverine inputs of fresh water into the oceans.

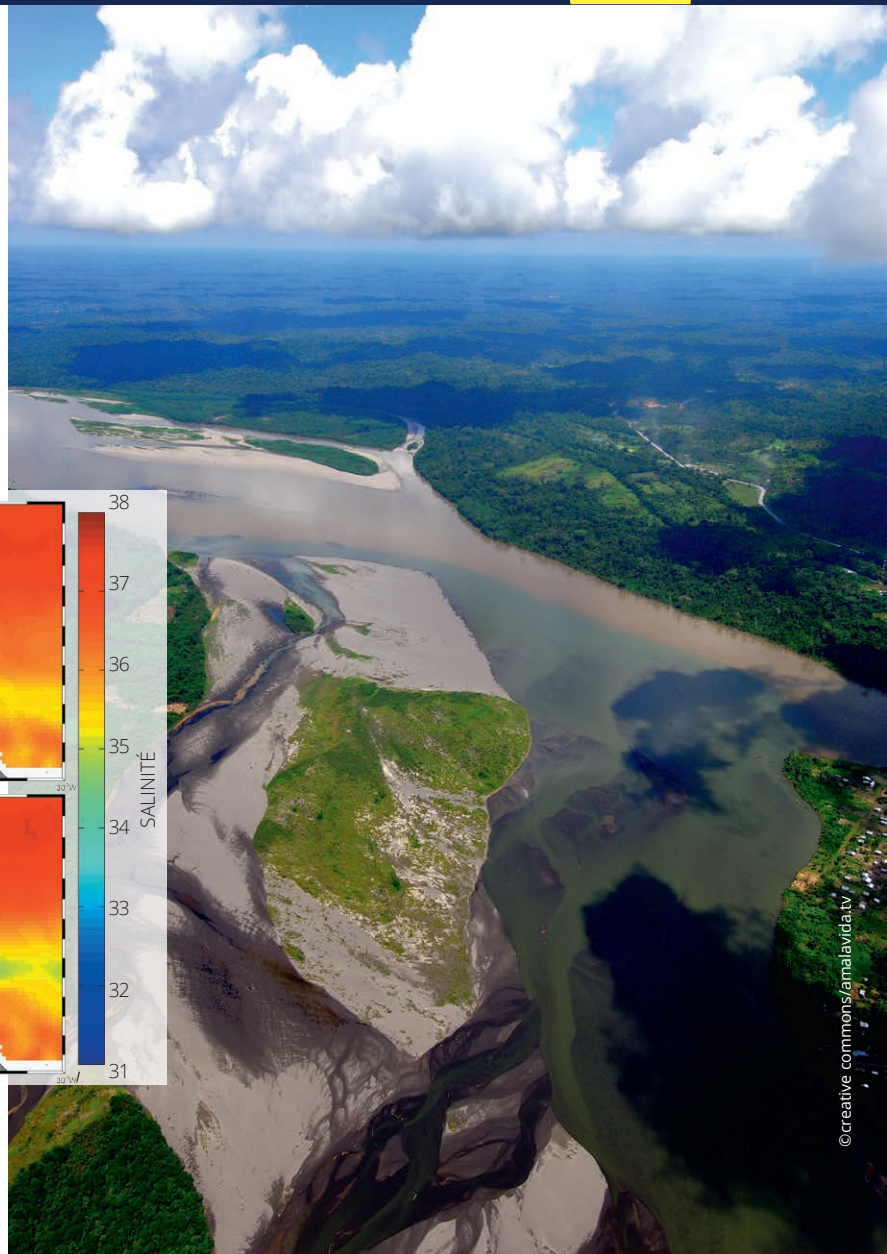
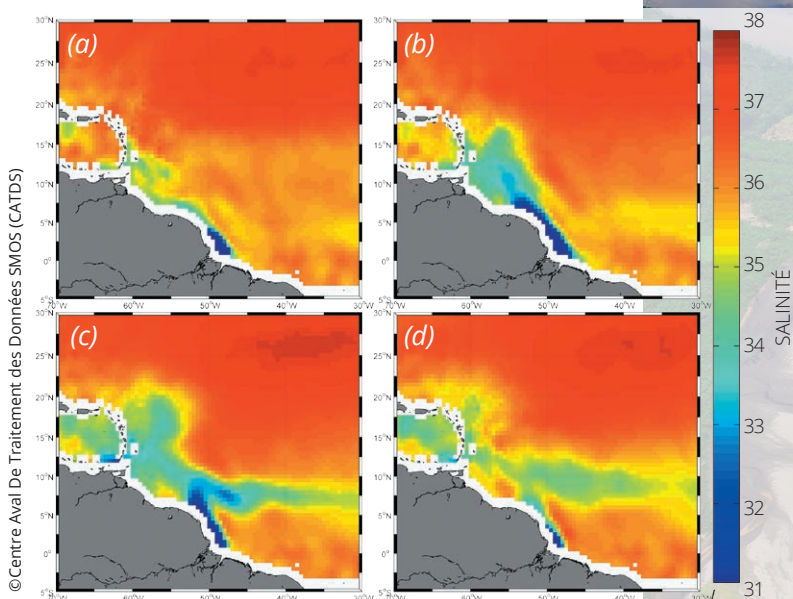
The plume of the Amazon can thus be detected thousands of kilometres from shore, and its extent varies under the influence of river discharge (and therefore of seasons), ocean currents in the area and the intensity of trade winds.

*Fournier S. et al., 2015. Journal of Geophysical Research-Oceans*

**Amazon**  
**15%**  
of global riverine  
inputs of fresh water  
into the oceans



Mean seasonal cycle in ocean surface salinity in the area of the Amazon River plume measured from space using the SMOS satellite (Fournier et al., 2015) in the months from: a) January to March, b) April to June, c) July to September and d) October to December.



# INTERVIEW

## Bertrand CHAPRON

*lfremer, head of the Laboratory of spatial oceanography*

### **Why does the Laboratory of spatial oceanography focus on sea surface salinity, and that from the Amazon in particular?**

*The Laboratory was associated with the first surface salinity measurements made from space and has been working on both metrology physics and on developing inversion algorithms for measured signals. In addition to its crucial influence in biosphere-ocean-atmosphere couplings, the Amazon River and its plume are characterised by very strong surface salinity gradients which are clearly marked over a very large extent. This makes the Amazon an ideal site for our studies.*

### **What instruments are deployed and how accurate are they?**

*From space, the sensors most sensitive to variations in surface salinity are antennas which passively measure the brightness temperatures at the surface, at a wave length of about 20 cm. At this wave length, there is almost no atmospheric opacity and data are measured whatever the conditions, regardless of cloudiness and precipitation. The European SMOS, Soil Moisture and Ocean Salinity project is based on technology which crosses a hundred small receivers angled differently to obtain a broad field of view with good spatial resolution, mak-*

*ing a swath of some 600 km with a resolution of 30 km. After correction and inversion, the accuracy obtained makes it possible to detect variations of about 0.05 psu in surface salinity.*

### **Do SMOS measurements provide us with other information?**

*In situ measurements alone cannot cover the entire world ocean area. With SMOS, for the first time, the first global maps of surface salinity and its variations over time were obtained. Measuring the extent of plumes, ocean eddy signatures or the temporary presence of freshwater lenses at the surface are just a few examples of results which can only be supplied by satellite measurements. Moreover, albeit more by chance, SMOS offered a better approach to estimations of extreme winds in hurricanes.*

### **Will it be possible to go much further in measuring salinity using satellites?**

*It certainly will. There is still progress to be in terms of greater accuracy and, above all, in spatial-temporal resolution. However, efforts have already been made using current data in order to better combine both satellite and in situ observations and to move forward on details of interpretation or algorithm developments which had been initially neglected. SMOS now makes it possible to have*

*surface salinity data over several years, which is vital in studying seasonal and interannual variability, supplementing other variables such as surface temperature, sea level elevation, wind pressure and precipitation. Finally, with these new surface salinity measurements, more exploratory studies are underway to determine geochemical properties and their dynamics over space and time, more specifically to better determine the inorganic carbon cycle.*



## Invasion of gelatinous plankton (ctenophores) in the English Channel and North Sea

In recent decades, unusual proliferations of gelatinous zooplankton have been reported in various places worldwide, including along French coasts. This is the case, for instance, of the sea walnut *Mnemiopsis leidyi*, a ctenophore which comes from the East coast of the American continent. This predator is related to jellyfish. It was seen for the first time in 2005 in Le Havre harbour and has since been observed on a regular basis in the Bay of Seine and along French coasts of the North Sea. It can withstand a wide range of salinity and temperature, very low concentrations of oxygen and long periods of fasting, meaning that the great ecological tolerance of this species enables it to overcome difficult conditions, endure transport via ships' ballast tanks and establish itself successfully in new surroundings. Observations made during winter cruises in the southern North Sea showed that *M. leidyi* populations could survive harsh winters, in water whose temperature was sometimes lower than 2°C. The results obtained by combining a habitat model and a particle tracking model allowed over-



© F. Chevallier/Laboratoire de biologie marine/le de Tathou

The sea walnut *Mnemiopsis leidyi* (7-cm long individual)

wintering areas along the South-east coasts of the North Sea and its estuaries to be identified. Individuals are hermaphrodites which can reach sexual maturity in two weeks and produce nearly 10,000 eggs per day. The species has few predators on European coasts of the Atlantic Sea, so can proliferate quickly. Seeing the harmful impacts the invasion of this gelatinous plankton had on fisheries ecology and econom-

ics in the Black Sea and the Caspian Sea during the years from 1980-2000, its possible population boom and the consequences on an already disturbed environment in the English Channel and North Sea are a major cause for ecological concern.

Antajan E. et al., 2014. *Aquatic Invasions*  
David C. et al., 2015. *Biological Invasions*

## Changes in phytoplankton biodiversity

Human activities and climate variations have an influence on the life cycle of phytoplankton species. These so-called abiotic factors, such as temperature, irradiance, salinity and nutrients, and therefore, riverine inputs, shape the diversity of marine phytoplankton communities by altering the number of species, their abundance and their succession over time.

The data collected over the years by observation systems enable us to evaluate variations in the abundance and composition of marine/coastal phytoplankton. In France, the *Réphy* monitoring network has inventoried some 180 species, identified from 78,000 samples taken over twenty years on the scale of the three seafronts of metropolitan France.

The analyses were carried out in the context of a PhD thesis and led to specifying the favourable environmental conditions for the appearance and development of each taxon and thus characterising the ecological niche of a taxon (or at best, of a species). The way the phytoplankton community's structure has evolved over the past twenty years and on nineteen monitoring sites on metropolitan French coasts, was then studied. Statistical analyses highlighted a variation in phytoplankton diversity characterised by changes in species composition over the long term and, in some zones, an increase in the abundance of potentially toxic taxa like *Pseudo-nitzschia* and *Alexandrium*. These structural changes differed depending on the geographical areas taken into

©lfremer/O. Dugornay



Toxic phytoplankton *Pseudo-nitzschia* sp. (approximately 20 µm)

consideration and, generally speaking, did not indicate a drop in biodiversity over the two decades. Further, more detailed observation of these communities will be necessary to assess whether the observed changes persist over time, to specify their causes and to determine their consequences for the ecosystems.

Hernández-Fariñas T. et al., 2015.  
*Estuarine, Coastal and Shelf Science*

## Does warming of English Channel waters have an impact on benthic fauna?

Due to global warming, the mean temperature in the English Channel has risen regularly. Modelling of bottom water temperatures in the Channel over the period from 1985-2011 showed the warming of the waters would range from between 0.1 and 0.4°C per decade, depending on the sector, which is rather fast compared to the world average. Although the consequences of the water's warming for the pelagic compartment (plankton and fish) or for benthic organisms on the foreshore are beginning to be well documented, those on benthic fauna (fauna associated with the seabed) are still poorly known for the most part.

In 2012, the North Brittany environment resources laboratory (Dinard) and the Biological station in Roscoff (Pierre & Marie Curie University/CNRS) launched the Benthoclim programme. Its objectives were to use ocean research cruise data to update knowledge acquired in the 1970s on the distribution of benthic fauna in the Western Channel, in order to monitor changes in their distribution limits in response to the rise in seawater temperature and to model the distribution of a few species between now and the end of the century.

The initial results have shown, with a few exceptions, relative stability in the distribution of mollusc, echinoderm and crustacean species. For the fifty-one most common species, an average displace-

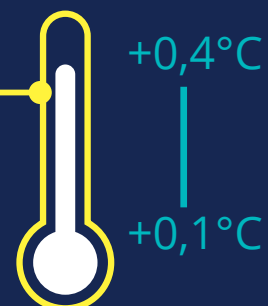
ment of 5.5 km to the east of the distribution barycentre was observed. This stability is in contrast to the extension in the sector of species with an affinity for warm temperate waters, belonging to a range of groups (zooplankton, intertidal benthic invertebrates and macroalgae and fish). However, a few species such as whelk, whose area of distribution has shrunk, show changes in their distribution which may be due to thermal aspects. These changes might be the first signs of more marked effects from water warming. On the contrary, the abundance and the occurrence of many species have dropped sharply. Integrating spatialised data of fishing efforts will deliver a more comprehensive interpretation of these decreases and an assessment of the respective role played by climate and by fisheries.



© Ifremer/O. Dugornay

A whelk (*Buccinum undatum*)

**1985-2011**  
in the English Channel, the warming of water could increase, depending on the sectors, by between 0.1 and 0.4°C per decade



# Studying marine ecosystems

Supporting the sustainable development of fisheries and aquaculture and finding better valuable uses for marine biological resources thanks to their exceptional diversity, in particular through innovative biotechnologies, are major challenges for Ifremer.

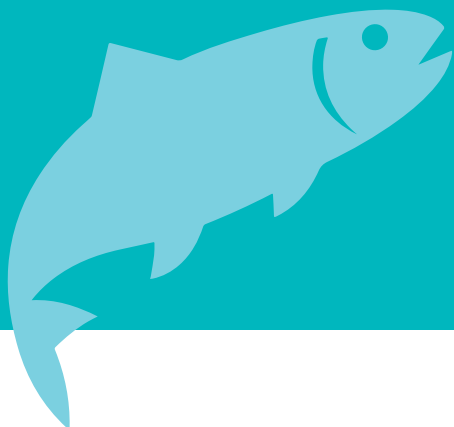
The growing importance of environmental changes requires that their interactions with developing human activities (exploitation of living resources, contaminant discharges, various developments, especially in coastal zones) be studied. In this context, Ifremer is continuing the monitoring and research studies which are indispensable for acquiring knowledge about the marine environment and the species which live there and for developing and implementing strategies to preserve biodiversity and manage uses of maritime areas.

Our Institute's multidisciplinary skills sets are particularly beneficial in federating an approach which links the need to support public policy-making in various ways and to strive towards sustainable exploitation of fisheries resources whilst protecting the habitats. This makes Ifremer a major stakeholder in the ecosystem-based fisheries approach. The studies conducted aim to develop our knowledge about current and potential pressures affecting the marine environment and its living resources, in order to assess management strategies in the framework of the Common Fisheries Policy (CFP) by comparing species plasticity, ecosystem trends and fishing fleet capacity.

Ifremer is also developing monitoring and research studies to support French shellfish farming. Research underway is principally targeting understanding the complex relationships between hosts, pathogenic agents and the environment. The past few years in the shellfish farming sector have been characterised by massive mortality phenomena affecting various farmed species. For instance, *Crassostrea gigas* cupped oyster production has been confronted since 2008 with mortality episodes reaching 80% of the spat stage over the entire coast of metropolitan France. The progress achieved should help us better understand these phenomena.

The Institute also conducts studies about the ecological approach to fishfarming production systems and the development of integrated aquaculture systems, to understand the processes by which reared animals can adapt to feed containing plant-based substitutes and the selection of individuals with high metabolic plasticity and better feed efficiency.

Ifremer also works in the field of creating utilisations and value from marine molecules, with applications in human or animal health and applications in environmental biotechnology. The marine environment represents 70% of the biosphere, but only 300,000 species have been inventoried out of the 1.8 million species currently known to be on Earth (for an estimated 10 to 100 million in all). These poorly known resources are a potential source of new molecules in coming decades.



## Limiting the impacts of bottom trawling and associated ecosystems

The European Benthis (2012-2017) project's objective is to better understand the effects of trawling on the seabed and on the related marine ecosystems. Alternative techniques or management approaches can minimise undesirable consequences while ensuring the economic and social viability of targeted fisheries. In the framework of this project involving over thirty partners from twelve countries, Ifremer is conducting a study mainly focused on *Nephrops* prawn fisheries in the Bay of Biscay.

By developing a fisheries data analysis method which takes particular account of the technical characteristics of the gear used, the footprint of fisheries on marine habitats on the scale of Europe could be better quantified and mapped. When compared to a hydrodynamic model (Mangae 2500), these maps are especially useful in accurately assessing the share of fishery activity impacting sedimentary flows, on the Bay of Biscay scale. These maps provide an essential medium for understanding fisheries strategies and

their effects and for proposing effective management alternatives.

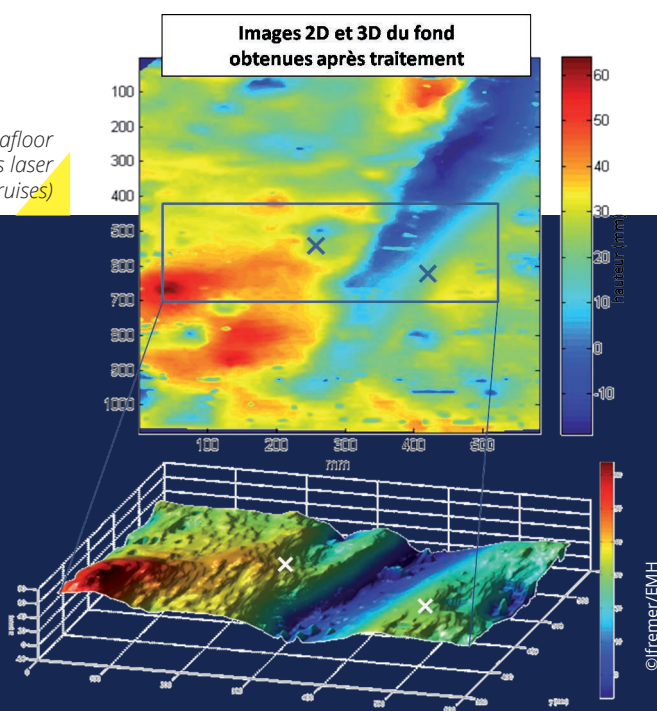
In order to better comprehend how fisheries-induced modifications are exerted on marine communities, the studies particularly analyse the affected species or ecological functions. The ecological compartments studied range from species living on the seabed to seabirds, taking into account fisheries discards that the latter feed on. This study is based on a series of data from fisheries research cruises, dedicated surveys (Febbe 1 & 2) and the marine observation network (Obsmer).

Sea trials are performed in cooperation with professional fishermen. In addition, representatives from fisheries professions, NGOs and the French State are invited each year to attend a presentation of progress made and to discuss project orientations.

Under usual operating conditions, bottom trawl doors impact habitats by scraping and ploughing the substrate and putting a fraction of the impacted sediments into suspension. To attempt to reduce these impacts, so-called Jump-

er trawl doors were designed and tested in the framework of the regional *Opti-pêche* project and the European Degree project in 2007 and 2008. The Jumper concept is based on the shape of the lower part of the door and the special position of its centre of gravity. These arrangements allow self-regulated adjustment of the door's contact with the seabed through a shoe which is smaller than that of a conventional trawl door or otter board. These innovative doors were recently improved in the frame of the Jumper project (co-financed by *France Filière Pêche*, 2013-2015) to make them more operational. Trials in Ifremer's Lorient station test tank and numerical modelling of the doors' dynamics provided guidance for design choices. They were also tested aboard different professional trawlers. These trials have shown that the trawl doors clearly reduce the resuspension of sediment and the seabed surface area impacted. In addition, they can potentially reduce fuel consumption. The Morgère component manufacturer in Saint-Malo has been a partner in the project since the first prototype was tested.

Footprint (2D and 3D) generated on the seafloor by a trawl door, measured using the Pagure sled's laser microphotography system (Febbe cruises)



## Fate and impacts of microplastics in marine ecosystems

Plastics have been accumulating in our oceans for several decades. More specifically, microplastics (plastic particles smaller than five millimeters) made up of highly stable persistent materials are omnipresent in every ocean compartment: in the water column, where their density gives them good buoyancy; in sediments, which hold quantities sometimes greater than those in the water column and finally, in living organisms. They have been observed to be present in several species which can passively or actively ingest these microscopic particles, particularly at the base of the food chain (plankton, filter feeders and fish larvae).

Effects of ingesting microplastics have been assessed using various models of living organisms, whether fish or filter feeders. Furthermore, the role played by microalgae in the transport of mi-

croplastics from the ocean surface to the deep layers and potentially to sediments has been studied (Micro project, Interreg 2 Seas involving the UMR Lermar joint research unit). These studies show firstly that ingestion of plastic microparticles by fish larvae is harmful for their survival and secondly that when these microplastics adhere to aggregates of microalgae it greatly increases their speed of sedimentation.

The results obtained in European seabass indicate that ingestion of polyethylene microplastics (2-40  $\mu\text{m}$ ) is detrimental to their survival. The mechanisms which are responsible for this impact at a sensitive stage remain to be defined, however the initial results based on studying the expression of genes of interest suggest a phenomenon of toxicity.

In order to understand the fate of microplastics in contact with phytoplankton, a system of continuous sedimentation cylinders was used to simulate

the sinking of aggregates through a layer of microplastic-rich water. Three types of aggregates were formed using cultures of two unicellular algae species: *Chaetoceros neogracile* and *Rhodomonas salina*. The cylinders were then connected to a continuous flow of seawater containing polyethylene microbeads measuring 2  $\mu\text{m}$  in diameter. Adding these microbeads to the three types of aggregates led to a significant increase in their sinking rate from a few millimetres to several metres per day. These results demonstrate that marine aggregates can modify the vertical distribution of microplastics by speeding up the rate at which they sink through different ocean layers. The organic matter which settles into sediment, also called "marine snow", makes up the first link in several pelagic and benthic food chains. The marine fauna which depends on it for food could ingest significant amounts of microplastics and be impacted in the same way as the fish and mollusc species in coastal waters.

## Digital fish science board instrument

Under the aegis of the European Union, Ifremer is the major national stakeholder in acquisition, recording and dissemination of fisheries data (DCF-Data Collection Framework). It is contributing in this way to creating a European fisheries observation network. In this context, each year the Institute performs ocean research cruises, specifically including trawling

operations during which thousands of measurements are taken on samples of fish and other marine species. Indeed, the size of individuals is a basic biological parameter for research studies and scientific assessments on the biology of exploited marine populations. Seeing the time devoted to taking these measurements, the accuracy expected and the working conditions at sea, Ifremer (Ecology and models applied to fishery resources unit) was looking for an auto-

mated solution for collecting this data. The choice made amongst the electronic fish science boards (to measure fish) on the market was for the 10MF1 model from the American firm Big Fin Scientific. Following different tests run at fish auctions, Ifremer made proposals to the supplier, who developed a new, more sophisticated model, called the DFS/2 digital fish study board, now available in their catalogue. This fish board is used along with the waterproof MioCARE® touch-screen tablet which offers the potential for further developments with a GPS antenna, barcode reader and RFID (radio-frequency identification) reader.

The digital fish science board used in conjunction with a touch-screen tablet is the solution currently being deployed on all Ifremer's fisheries resource cruises and by teams in charge of fish auction observations.

Tests are currently underway to supplement these tools with a bluetooth calliper rule connected to a touchscreen tablet, to electronically measure species other than fish, such as shrimp, Norway lobster (*Nephrops norvegicus*) prawn, etc.

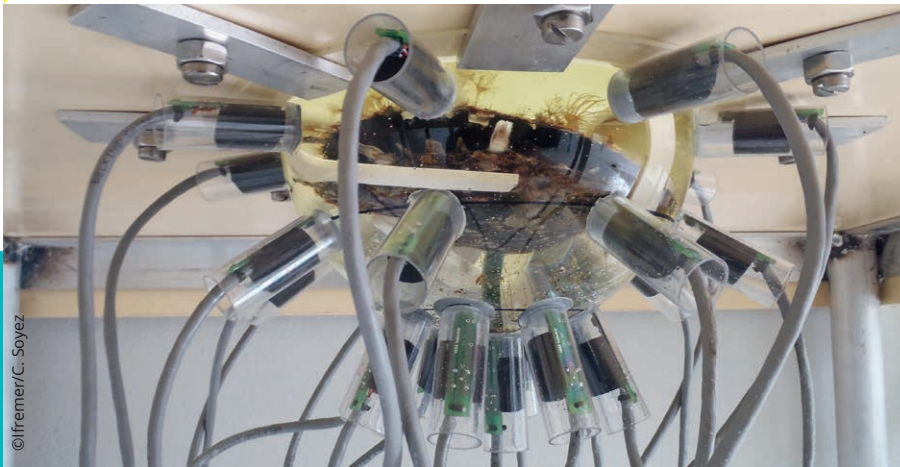


Measuring fish sizes using digital fish science board





Cultured pearls from French Polynesia



A specially developed magnetometer to quantify the rotational movement of a pearl being formed in the pearl sac

## Rotation of pearls during formation, observed using an innovative experimental system

A study published in July 2015 in *Royal Society Open Science* was carried out in the framework of collaboration between Ifremer's Pacific centre and several partners, in particular the *Véga Industrie* firm and the University of French Polynesia, showed that a pearl moves in rotation during its formation within the tissues of a pearl oyster. The scientists utilised a magnetometer system using a magnetic field to supply experimental evidence.

The sometimes perfectly spherical shape of pearls intuitively suggested that during its formation, the nucleus, around which the pearl is formed, undergoes a circular movement. Due

to the difficulty of observing this in the tissues of a living animal, it was hard to prove until now. Therefore, the formation of cultured pearls was scrutinized from outside of the animal, by recording magnetic field variations created by magnetic nuclei inserted in *Pinctada margaritifera* pearl oysters. After a four-week period in the lagoon, required to ensure that the pearl sac structure in which the pearl will form was in place, these oysters were put inside a Plexiglas globe attached to the bottom of an aquarium and equipped with ultra-sensitive magnetometers. This enabled the nucleus rotation to be measured every half-second.

Mathematical processing of the data gave the speeds at which pearls rotated. For the first forty days, until the epithelial cells of the graft have developed, the pearl's movements are chaotic and

regularly interrupted by periods of immobility. Little by little, the movements become more permanent, however they still vary greatly in their intensity depending on the individual.

The mean angular speed of rotation was measured at 1.27 degrees per minute, corresponding to a complete turn in nearly five hours, with significant variations (with extreme values or outliers ranging from 3 h to 15 h). For twelve to eighteen months, throughout the pearl formation process, while the pearl-sac epithelium continues to produce nacre, the rotation is on-going.

Through this study, the biophysical and molecular details of the biomineralisation processes are better understood, however the processes by which nacre is produced are still unknown in part and further investigations on this are still underway.

Guéguen Y. et al., 2015. *Royal Society Open Science*



# INTERVIEW

**Michèle GOURMELON**

*Ifremer, Health, Environment and Microbiology laboratory,  
head of RiskManche project for France*



*farming and represents a significant health hazard. Indeed, these microorganisms can be found in shellfish and implicated in infectious diseases and foodborne illness outbreaks (FIO) when contaminated molluscs are consumed.*

*The project enabled better estimation of the agents which cause foodborne and other infections and which are present in recreational waters and in shellfish, to model faecal contamination in a catchment and finally to develop ways of informing and communicating about risks to the relevant managers or users.*

*In France, the prevalence of enteric and marine bacteria potentially pathogenic for humans and of noroviruses was assessed each month, from February 2013 to January 2015 in shellfish from three shellfish farming areas (one located in Brittany and two in Normandy). This was also done for enteric bacteria in the waters of the catchments upstream.*

## **What is the RiskManche project's objective?**

*RiskManche is an interregional project on the scale of Europe (Interreg IVA), conducted in partnership with a dozen French and English organisations, in particular the University of Brighton which coordinated the project. RiskManche focuses on risk management of catchments and coasts for risks for human health and environment, on both sides of the English Channel.*

*The presence of microorganisms (viruses and bacteria) in coastal zones from faecal or marine sources which are potentially pathogenic for humans is a concern for shellfish*

## **Can the sources of contamination of shellfish or seawater be determined?**

*The E. coli faecal contamination indicator used in the regulations does not enable the source of environmental contamination to be identified, since it is present in both human faeces and animal faeces. Alternative methods such as Microbial Source Tracking (MST) can not only distinguish between the sources of contamination (human or animal) but also differentiate between species of animals. These methods are based on searching for microbial or chemical targets which are present*

*in the intestinal tracts of people or animals and in faecal effluents.*

*We looked for the bacteria and chemical compounds associated with humans, pigs and cattle, i.e. bacteroidales (developing their markers in the laboratory beforehand) and faecal stanols. "Mixed" contamination was observed in catchment waters with the detection of markers associated with cattle and less often of markers associated with contamination by humans or pigs. Further developments are still needed to apply these MST methods to shellfish.*

## **Which of the bacteria and viruses detected are dangerous for human health?**

*First of all, we looked for the potentially pathogenic enteric microorganisms coming from excrements and effluents from human or animal sources in both water and shellfish. Although salmonella and potentially pathogenic strains of E. coli were rarely isolated in shellfish, some bacteria responsible for zoonoses (Campylobacter spp.) were isolated in over 25% of shellfish and 59% of water samples from catchments, with a majority of bacterial strains coming from poultry, pigs and cattle in water from streams and others from seabirds in shellfish.*

*Noroviruses (which cause gastroenteritis) were detected in 19% of the 184 batches of shellfish analysed, mainly during periods of epidemics. Finally, marine bacteria like Vibrio parahaemolyticus, V. vulnificus and V. cholerae were detected in shellfish (oysters, mussels and cockles) and at*

sea when the water temperature exceeded 15°C. These results indicated possible contamination of the coast by a wide variety of microorganisms from different sources.

### What are the main project outputs?

The project made it possible to create a collection of strains from the natural environment: salmonella, *Campylobacter* spp., pathogenic *E.*

*coli* and potentially pathogenic *Vibrio* spp. for human health and to store water and shellfish samples for future analyses. It also yielded elements about the microbial contamination of shellfish which help us better appreciate risks related to the presence in the environment of microorganisms which are potentially dangerous for humans. Next, it is planned to use high-throughput sequencing to identify on the genetic level the microbial communities

present in shellfish and the genome of some strains of *E. coli* or *Vibrio* spp. bacteria recently isolated on French and English sites. And lastly, the final conference organised in Brest in December 2015 provided the opportunity to present the project results to an audience of those interested by the health quality of shellfish farming and recreational waters.



Culturing of microalgae produced through the *Facteur 4* improvement programme under controlled conditions



Strain of *Tisochrysis lutea* which enables lipid vesicles to be observed

### Microalgae with higher lipid content

The potential for microalgae is now well established in numerous sectors and investments are booming in the microalgae supply chain. Exploiting them has developed recently and most of the algal strains currently being cultivated are not very different from those which have been isolated in the natural environment. As for the advances made in the field of agriculture, obtaining "improved" strains of microalgae should help make phytoplankton production and yields more economically profitable.

With its Laboratory of algal physiology and biotechnology (PBA), Ifremer is one of the pioneers in this research theme though its involvement in the Shamash (2006-2010) and *Facteur 4* (2012-2016) ANR projects. The general objective of these projects consisted in developing and optimising tools and methodologies to improve microalgal strains, particularly with respect to certain desired properties (like lipid content). During the Shamash project, initial selection tools were developed. The improvement programme made it possible to obtain a marine microalgae strain *Tisochrysis lutea* displaying lipid productivity which is twice as high as that of the original strain.

During the *Facteur 4* project new improvement methods were developed utilising novel approaches based on random mutagenesis, flow cytometric cell sorting and genetic selection. In particular, these studies yielded a strain which accumulates four times the amount of lipids that the native strain does.

In future, Ifremer will continue to invest its efforts in this path of research, in order to propose improvement methods for a broader spectrum of microalgae applications.

# Exploring and understanding the resources of the seafloor

The ocean covers slightly more than 70% of the surface of planet Earth and the better part of it has never been explored. The economic downturn we've been experiencing since 2008 has not weakened the environmental demands and expectations for controlling the exploitation of mineral and energy resources in the deep sea. On the contrary, the context of climate change rather urges us to take advantage of this slowdown to step up research efforts to learn more about this environment, develop tools to measure the impacts of industrial activity under these extreme conditions and to limit the related risks. In terms of resources, against a backdrop of transitioning energy sources, this also means developing the technologies which will enable us to best utilise the sources of renewable energy that the ocean can supply.

To meet these requirements, Ifremer is conducting research and innovation studies with four orientations: deepen knowledge about geology, geophysics and geochemistry of the deep ocean, especially on

the margins and mid-Atlantic ridges; discover the mechanisms which maintain biodiversity in these environments and identify the related ecosystem services; develop appropriate tools to measure physical, chemical and biological parameters in harsh environments which are demanding on equipment; and contribute to innovations for marine renewable energy sources.

From performing geochemical assessments on the Congo River deep-sea fan to supporting the tidal energy development of a small-to-medium-sized enterprise, as well as studying the hazards associated with destabilised gas hydrates in the Black Sea, Ifremer's studies in this field are varied. The 2015 milestones presented in this chapter also offer a brief overview of the various forms of funding mobilised for these research studies (public funds, H2020, public/private partnerships) and typical forms of cooperation engaged to complete them successfully.

## Millennial-scale fluctuations of the European Ice Sheet at the end of the last glacial and global impacts

Understanding the mechanisms of past climates provides a sound basis for understanding climate changes underway and for modelling their future trends. Using deep-sea sediment cores, collected in the northern Bay of Biscay on several research cruises, the fluctuations of the European ice sheet during its last major advance (between 35,000 and 22,000 years ago) then during its retreat and disappearance (over the past 22,000 years) were recently inventoried with previously unmatched accuracy.

This paleoclimate reconstruction is based on three major points: fine-scale surveying of the geochemical fingerprint of sedimentary deposits at the mouth of the Channel river, which no longer exists today, linking the ice sheet, extending from the north of Ireland to the north of Russia, to the Bay of Biscay over the last million years; identifying sources around the Baltic Sea and the British Isles, where some of the products from glacial erosion are still visible; and building a high resolution stratigraphic framework. As well as proposing an entirely new and continuous reconstruction of European glacial oscillations, these results have made it possible for the first time to compare highly detailed (millennial resolution)

marine paleoclimate knowledge with very patchy terrestrial knowledge. Paradoxically, major ice recessions have been described during extreme cold peaks (Heinrich events), and this profoundly challenges our previous understanding of past atmosphere-ocean-cryosphere\* interactions.

\*surface area of the Earth where water is present in solid form (ice caps, etc.).

Toucanne S. et al., 2015. *Quaternary Science Reviews*

## An amazing ecosystem 5,000 metres deep, fed by Congo River inflow

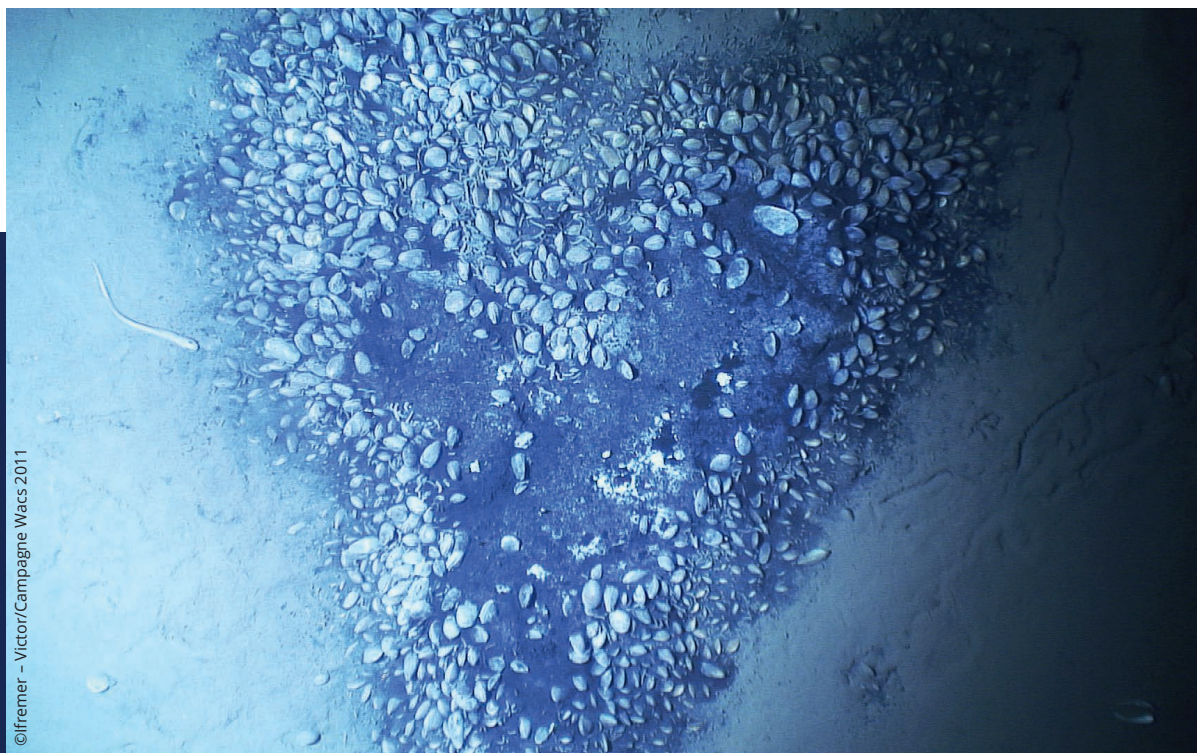
In the tropical South Atlantic, the terminal lobes of the Congo deep-sea fan, located at a depth of 5,000 m and a distance of 800 km from African shores, have the specificity of receiving frequent deposits which are rich in fresh organic matter. These deposits are generated by sediments directly discharged by the Congo River into the submarine canyon linked to its mouth and which are then carried to the lobes by turbidity currents. Thus, in spite of its abyssal depths, this area of lobes has characteristics which are similar to those in coastal delta zones, for instance in terms of organic carbon content and the frequency of sedimentary inputs. These conditions are exceptional at such depths, and foster the development of special microbial and fauna communities, in particular, based on chemosynthesis comparable to that of cold seeps or hydrothermal vents, creating a zone of high biodiversity in the deep sea. The ANR's multi-

disciplinary "Congolobe" project bringing together geologists, geochemists, microbiologists and benthic ecologists from the laboratory of climate and environmental sciences (UMR-CNRS, CEA, University of Versailles), from Pierre & Marie Curie University (UPMC) and from Ifremer is aiming to make the connection between the type and magnitude of organic matter inputs from the Congo river and these exceptional ecosystems discovered in 2000 and then explored and studied in 2011 during two cruises with the remote-operated *Victor 6000* vehicle.

The entire zone shows sedimentary macrofauna densities which are six to seven times higher than expected and an abnormally high oxygen demand at these depths. All the conditions are met for the development of biological communities like those in pockmark zones of fluid and methane-rich gas emissions located further downstream on the margin. Habitats formed by microbial mats or bivalves living in symbiosis with bacteria sporadically develop due to the presence of sulphides in concentrations

which are favourable for their growth. These sulphides come from the high inputs of iron oxides coming from the Congo River. A microbiological study of the communities revealed that not only archaeobacteria and various anaerobic bacteria were present, but there were also specific bacterial communities oxidizing methane under aerobic conditions. Lastly, the presence of microbial lines which are characteristic of the terrestrial environment found at a depth of 5,000 m raises questions about the functioning of the ecosystem mainly controlled by the availability of methane, sulphide and iron.

Thanks to a joint analysis of geochemical and biological data, hypotheses have been put forward about how chemosynthetic habitats evolve. However, questions remain about the conditions under which these habitats are established and persist in an extremely unstable sedimentary environment, with sedimentation rates reaching 10 cm/year.



©Ifremer - Victor/Campagne Wacs 2011

Clusters of vesicomyid bivalves on the site of the Congo River deep-sea fan's terminal lobes in the Gulf of Guinea (Atlantic Ocean)

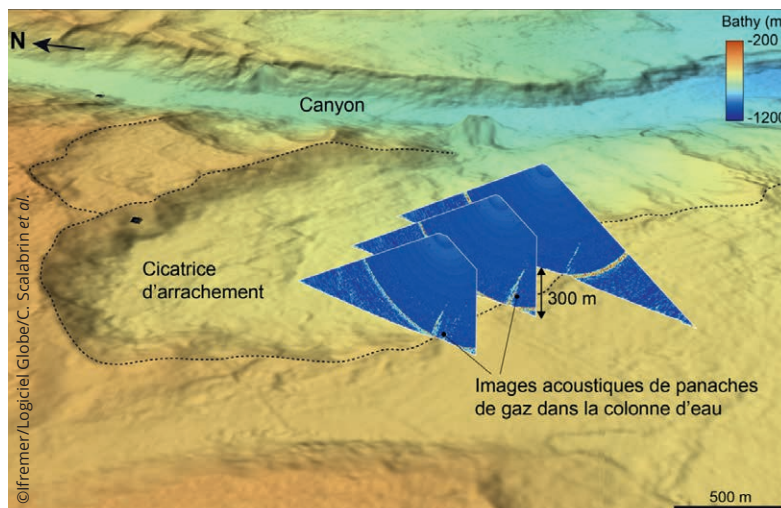
## Gas hydrates and seafloors in the Black Sea

Gas hydrates are water molecules which form a cage around molecules of gases, like methane. In nature, they are stable under certain conditions of temperature and pressure and have the particularity of storing gas in a highly concentrated form. Warming of the water and/or a drop in pressure can cause the hydrates to be destabilised and thus release methane. This makes the sediment fragile and under some conditions causes submarine landslides. Methane is also a powerful greenhouse gas and its discharge into the atmosphere contributes to raising the global temperature.

In September 2015, the Ghass oceanographic cruise studied gas hydrates and free gas and the role they play in sedimentary deformations and destabilisation of seafloors in the Black Sea. The cruise was conducted by Ifremer and associated with the European Midas project, rallying German (Geomar), Romanian (GeoEcoMar), Norwegian (NGI) and Spanish (University of Barcelona) research scientists. It made acoustic acquisitions in the water column and seismic acquisitions of the seabed and then took samples in them, aboard RV *Pourquoi pas?*. Some sites showed the presence of methane hydrates in marine surface sediments, which was a first in this zone located offshore from the city

of Constanta, Romania. Specific analyses are underway to analyse the chronostratigraphic context of the study zone in order to address the chronology of the processes involved: sedimentary destabilisation, expelling of gas, formation of gas hydrates.

Quantifying the saturation in gas and in hydrates and the dynamics of gas/hydrate systems are also being studied. Integrating the data should establish whether there is a proven link between their presence and the gravity instabilities and deformations observed during the cruise.



3D image of seafloor, of part of the zone prospected during the Ghass cruise, showing landslide scars around an underwater canyon. Acoustic images of the water column reveal gas seep activity around the edges of one of the landslide scars.



A core sample taken in the Romanian sector of the Black Sea during the Ghass mission, showing the presence of gas hydrates for the first time (at centre)

## Modelling the effects of tsunamis in the Atlantic and the English Channel

Financed in the framework of the Investments for the future programme (PIA) and sponsored by the CEA in cooperation with Ifremer, EDF, BRGM and SHOM, the Tandem project (ANR project, 2014-2017) is devoted to assessing the effects of tsunamis around the French coasts of the Atlantic and

the Western English Channel. In order to assess the coastal impact, this project is performing numerical modelling to generate and propagate tsunamis and identifying and characterising the sources or causes of tsunamis due to either earthquakes or submarine landslides. A key point of the project lies in identifying past and potential slides and quantifying the mechanical behaviour of the geological layers involved. How the slipped volume evolves in the

seconds or minutes after the landslide is triggered will effectively determine the risk of a tsunami occurring. With this objective, the Gitan cruise was organised aboard RV *Pourquoi pas?* in the Bay of Biscay. The mapping, seismic and coring results will make it possible to quantify sub-sea gravity flows, model tsunamigenic waves on the French Atlantic coasts and evaluate the possible impact close to coastal civilian nuclear facilities.

# INTERVIEW

## Stéphanie DUPRÉ

*Ifremer, Geological hazards and sedimentary dynamics laboratory, chief scientist on the Gazcogne2 oceanographic cruise*

### **Hadn't the continental shelf of the Bay of Biscay already been "scrutinized" before your cruise?**

*Yes indeed, but in spite of numerous studies in the zone, no fluid indicator had been detected up until then. It is only very recently, thanks to acoustic surveys acquired on fisheries resource cruises that the first fluid emissions in the water column had been discovered.*

### **What means were used to make these observations?**

*It was acoustic imaging of the seafloor and the water column, acquired with a multibeam echosounder that enabled us to identify more than 3,000 fluid seeps. Gas bubbles from the seabed, which sometimes reach the water-atmosphere interface, were sampled under in situ conditions with the Pegaz*

*system deployed by the Victor 6000 underwater vehicle.*

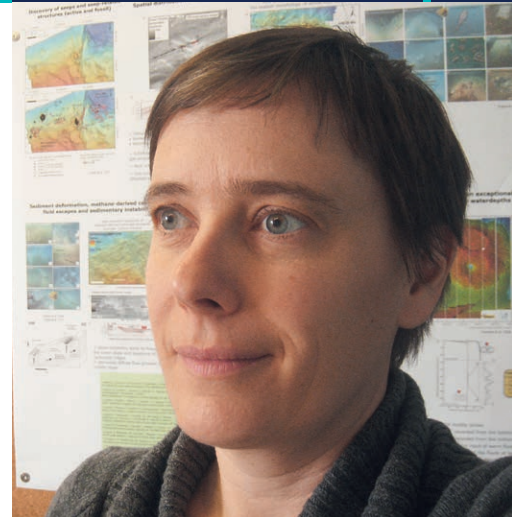
### **Are these fluid and gas emissions associated with a particular ecosystem?**

*In spite of the favourable chemical conditions, the fauna directly linked to microbial chemosynthesis is very limited there. However, microbial activity is clearly present with microbial assemblages which are characteristic of so-called cold seeps. The abundance of sessile and mobile fauna (sponges, fish, etc.) is most certainly favoured by the substrates and available nutrients.*

### **Are these fluid emissions due to seismic movements?**

*No, not at all, these emissions are linked to the tectonic-sedimentary architecture of the Aquitaine margin. However, the spatial-temporal*

*variability of the fluid expelled at the seabed depending on seismic cycles is a subject that we are studying in the framework of the Marmara Sea study site.*



### **Discovery of a vast biogenic methane fluid system on the Aquitaine shelf**

The Pamela project is a partnership-based multidisciplinary research project with the Total company, several universities (Rennes, UBO, UPMC), CNRS and Ifpen focusing on the evolution of passive margins (transitional zones between the con-

tinental crust and the ocean crust where there is no subduction).

In this framework, two oceanographic cruises, Gazcogne1 aboard ocean research vessel *Le Suroît* and Gazcogne2 aboard RV *Pourquoi pas?* were conducted on the Aquitaine continental margin. They discovered a fluid system associated with biogenic methane emissions

which extends over 200 km<sup>2</sup> on the edge of the Aquitaine shelf. This gaseous venting is associated on the seabed with authigenic (formed in sediment on site) carbonate seamounts created by anaerobic oxidation of methane. Scientists are investigating how this special and unique fluid system came into being, has evolved and been preserved over time.

## Interactions between waves, sediments, fauna and structures

Ifremer is a partner in the European H2020 programme's Hydralab+ project gathering the major stakeholders for hydrodynamics in Europe in a consortium to study complex interactions between environmental elements (waves, wind and currents), sediments, structures and ice, especially the rise in mean sea level and evolving swell characteristics. There are five Hydralab projects which have various strands: collaborative Joint Research Actions, training and education, dissemination of knowledge, drawing up standards or recommendations and managing transnational access to test facilities.

Several Ifremer units take part in the collaborative Complex research action. In semi-sheltered coastal environments (bays and estuaries), there is strong interaction between benthic fauna development and sedimentary dynamics. The so-called "ecosystem engineer species" are benthic populations which modify the depositing of suspended matter by biofiltration and contribute to increasing these deposits. In return, the hydrodynamics and sedimentary dynamics directly modify the benthic fauna or benthos. However, it remains difficult to study the complexity of these processes in nature, so experimental devices which reproduce natural environmental conditions within a controlled, enclosed, small-scale environment can be used to analyse

interactions between benthic fauna and the dynamics of sandy-muddy sediments under the influence of currents and waves. Working along with *Cedre*, high-frequency hydrodynamic, turbidity and turbulence measurements will enable the key processes controlling sedimentary dynamics in the presence of benthic fauna to be quantified and 3D hydro-biosedimentary numerical models to be parametrized.

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*Complex : Cross Disciplinary Observations of Morphodynamics and Protective Structures, Linked to Ecology and Extreme Events.*  
<http://www.hydralab.eu/>

## Ocean thermal energy

In tropical seas, the difference between temperature in surface water and that in deep water is utilised to produce direct current. The seawater temperature can reach over 25°C at the surface, whereas at a depth of nearly 1,000 m, it can be about 5°C.

The Marlin project proposed by DCNS, Ifremer and *France Énergies Marines* was selected by the French Agency for the environment and energy management (Ademe). It is supported by the regional councils of Martinique, Pays de la Loire and Reunion Island. Two key aspects of the Ocean Thermal Energy Conversion (OTEC) value chain are dealt with in the

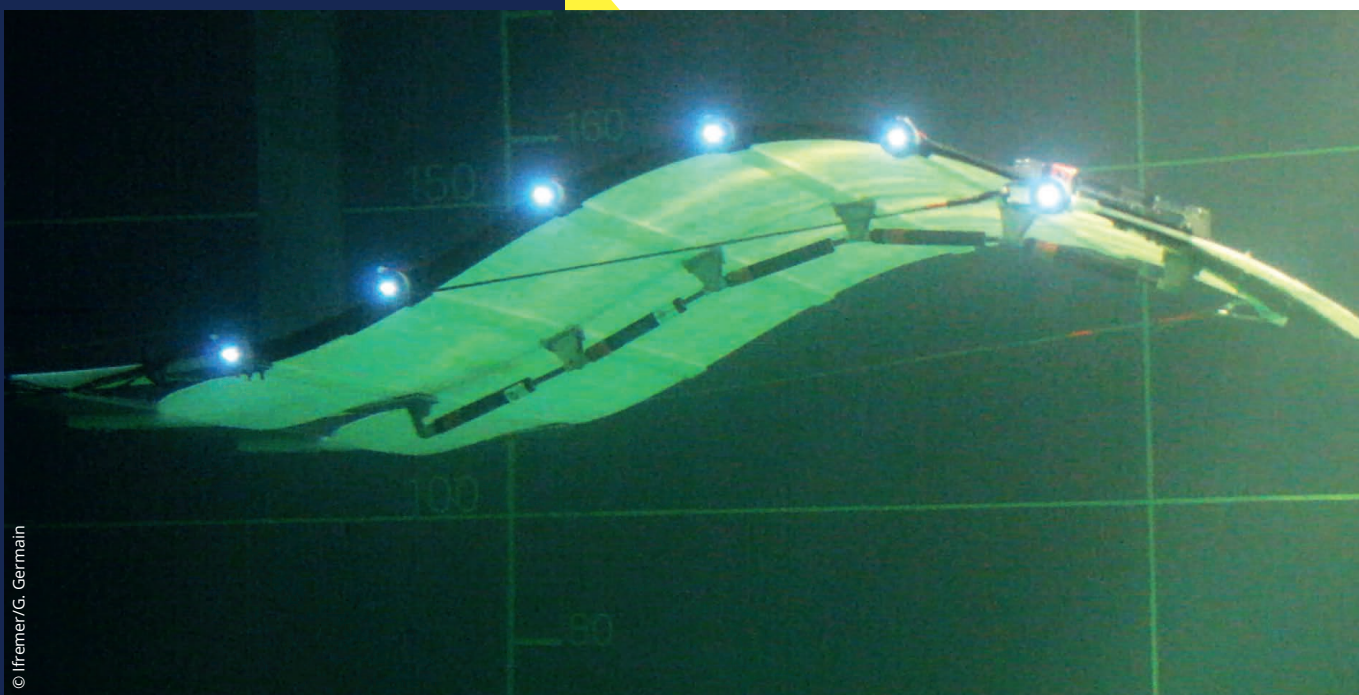
project, i.e. designing and eventually replacing certain elements in the heat exchanger system and sustaining their performance over time through the appropriate means to combat biofouling (choosing appropriate materials, using chlorine or ozone, etc.). At Ifremer, the project was conducted by the technological research and development unit (RDT) to study the behaviour and durability of materials used for the water pipe and experimental hydrodynamics studies in order to qualify models for its hydro-structural behaviour. In addition, studies were made on anti-fouling and devices to steer the installation of a test bench at Ifremer's site in Martinique for the heat exchangers of a cold water intake pipe whose cost was in line with the

profitability targets and which could last for twenty-five years.

Studies focused on finding materials with potential for use as components of the cold water pipe, on standards to comply with in carrying out mechanical trials, on compatibility with Ifremer's equipment and facilities, on the durability of submerged material and on the resistance of a material used alone or produced by assembling several polymers. These studies were used to draw up a plan for material qualification jointly established by DCNS and Ifremer. A list of requirements for designing the exchangers test bench was also drawn up, for the bench to be installed on the Ifremer site in Martinique.



*Trials of the EEL undulating membrane in the test tank at Ifremer's Channel-North Sea centre*



## **The EEL tidal energy converter using an undulating membrane**

The partnership set up between the EEL Energy start-up and Ifremer made it possible to validate an innovative technique to harness energy from marine currents. The EEL concept of a tidal converter using an undulating membrane is based on the use of distributed converters to recover the energy from the deformation of a pre-stressed membrane set into motion by the action of currents. The system's behaviour was studied on two model scales of device. At a scale of 1:20, the action of the energy converters is simulated by using double acting hydraulic jacks, enabling a given absorption to be imposed. At a scale of 1:6, the real converters can be used.

The complementarity of these two scales enabled different models (analytical and numerical) developed in the framework of a PhD thesis to be correlated. The approaches were compared in terms of stress, amplitudes and frequency of movements depending on the current velocity.



# Coordinating scientific policy

Although Ifremer holds numerous disciplines, skills and expertise in-house, the producing of knowledge and its research activities are deliberately envisaged in partnership with research bodies and universities. These partnerships are implemented in international

and national frameworks and also take the form of actions in favour of PhD students and an active site policy. Our Institute also enjoys the support of its scientific committee, providing guidance for its action.

## Site policy

In 2015, seventeen projects were selected and financed in the framework of a call for scientific and technological projects. This initiative was launched by the scientific management (DS) in 2014 with the aim of developing cooperation with various research or educational establishments on sites where our Institute is present, either through the joint research units (UMR) already in place or by bringing new cooperation to the fore. The sponsors of projects selected in 2014 were asked to provide feedback on their studies and results in June 2015.

The waves of assessments concluded that the UMR joint research units already set up should continue to develop. This will be the case for the Ocean physics laboratory (LPO) in the framework of "wave B" of assessments. Following an inter-organisation foresight study on physical oceanography in Brest, started by Ifremer and carried out over 2014 to 2015, the proposal for a new scope was effectively approved by the Scientific committee in March 2015. This meant that the Spatial oceanography laboratory (LOS) and the physicists from the Coastal environment dynamics unit (Dyneco) are joining LPO to form the UMR Physical and spatial oceanography laboratory (LOPS) joint research unit. The unit will document the ocean's status and variability, to better understand the physical and biogeochemical processes explaining ocean circulation, how pelagic ecosystems are structured and the surface states observed.

Two other UMR joint research units were created in 2015: Host-pathogen environment interactions (IHPE) and Marine biodiversity, exploitation and conservation (Marbec) in the Languedoc-Roussillon region. And lastly, CNRS, University of French Guiana and Ifremer will create a laboratory working on Amazon system interactions (Leisa), a joint service and research unit called USR n°3456 on 1<sup>st</sup> January 2016. Pooling overseas research efforts in this way is important.

Ifremer is a stakeholder in site policies led by its university partners, in particular in the framework of the Communities of universities and higher education

institutions (ComUE) on the one hand and IDEX or I-SITE projects on the other. The ComUE of the University of Brittany and Loire regions (UBL) is especially important in view of the four hundred research scientists located within its scope (two-thirds of Ifremer's employees). This number of its employees means that Ifremer is a member of this ComUE entity. The Institute is change of developing the future "Sea and coast" department. Furthermore, Ifremer will be a partner in the ComUE Nord, Normandy, *Aquitaine*, *Poitou-Charentes-Limousin-Centre*, *Languedoc-Roussillon* and Toulon organisations in the framework of specific agreements.

## Doctoral policy

PhD students are an integral part of Ifremer's research structure. In 2015, some one hundred-eighty PhD students were hosted by Ifremer; amongst other things, Ifremer allocated twenty-seven half-grants for PhD projects, to which can be added financing for PhD contracts obtained with 100% outside funding. This way of diversifying the means of financing is encouraged by the Institute.

Since 2013, Ifremer's scientific management has established an incentive action to promote international mobility for PhD students. This involves staying from one to three months in a laboratory abroad. This international mobility should be used as an opportunity for the PhD student and the supervisors to develop their network, create or strengthen international inter-university cooperation or to start preparing a post-doc stay. In February 2015, the Scientific management organised a day's event for PhD students who were mobile in 2014 to report on their experience. The feedback was highly positive, as told here by Taous SARAOU, who went to Finland thanks to this international mobility grant.

# INTERVIEW

## Taous SARAOU

PhD fellow

### What is the subject of your PhD thesis?

My thesis deals with the mechanisms of interactions between a bioprotective bacteria of interest for biopreservation of seafood products, called *Lactococcus piscium* (CNCM -I-4031 strain) and the pathogenic bacteria *Listeria monocytogenes*. I received a grant from the Ministry of Higher education and Research for my thesis work, which was carried out between the Microbial ecosystems and marine molecules for biotechnologies laboratory (EM3B) at Ifremer and the joint research unit UMR INRA-Oniris on food safety and microbiology.

### Tell us about your studies

I studied in Algeria, then specialised in fundamental and applied microbiology by doing my Master's degree at the University of Rennes-1 and an internship at INRA in Rennes.

### What do you think your research will contribute?

*Listeria monocytogenes* is an opportunistic pathogenic bacteria which can grow under extreme conditions of

pH and temperature, i.e. those found all along the food chain. It causes listeriosis which is a rare, but serious disease: in France, there are nearly three hundred cases each year (with mortality rates of 20 to 30%). Previous studies had highlighted the anti-listerial activity of a strain of the lactic bacteria *Lactococcus piscium*, to improve food quality and safety of products like smoked salmon or cooked prawns. My first observations showed that this mechanism of action is novel, since it is related neither to antimicrobial compounds being excreted nor to nutritional competition. Molecular tools are needed to elucidate these action mechanisms. Therefore, I worked on annotating *L. piscium*'s genome with support from the Génoscope platform and on analysing its proteome with the help of INRA's South-West Paris platform.

### Why did you choose to spend your study period in Finland?

The international mobility grant from Ifremer's Scientific Management enabled me to complement my research at the University of Helsinki's Food Hygiene & Environmental Health department. This laboratory is also



working on *Lactococcus piscium* and has expertise in genetic engineering, as well as using a recent method of RNA sequencing. So I learned to use this RNA extraction method on the *L. piscium* strain of interest for Ifremer, and then learned to process (bioinformatics and statistics) the sequencing data for this bacteria. Several scientific articles are being prepared jointly with Johanna BJÖKROTH's team and my two host laboratories. In 2016, I'd like to secure a post-doc position.

Saraoui T. et al., 2016.  
*Food and Microbiology.*





# INTERVIEW

**Patrick LANDAIS**

*New chairman of the Scientific committee*



Patrick LANDAIS has presided the Scientific committee since September 2015, following on from Pascale DELECLUSE. A geoscience engineer, holding a high-level PhD in geochemistry, during his career, Patrick LANDAIS has developed expertise on mineral and energy resources, as well as petroleum and environmental geochemistry and radioactive waste management. At the end of 2015, Patrick LANDAIS was appointed as deputy director for innovation and development at the National agency for radioactive waste management (Andra), having previously been the scientific director of BRGM.

## **What links are there between BRGM and Ifremer?**

Generally speaking, both are State-owned industrial and commercial

establishments (ÉPIC) with similar remit for research policy support in particular. Therefore, their institutional-level dialogue enables them to construct shared positions or to exchange experience. Scientists from BRGM and Ifremer have also been working together for a long time on projects and themes such as shore and coastal oceanography, data acquisition on continental margins, submarine mineral resources, geoscientific information systems or environmental metrology. At the outcome of a meeting held on some of these subjects in January 2015, it was deemed interesting for the two organisations to step up their cooperation, in particular on coastal issues.

## **The shore and coastal ecosystems are at the heart of Ifremer's scientific activities; how is this dealt with at BRGM?**

BRGM mainly focuses on anthropogenic risks in the context of climate change and works in cooperation with all stakeholders addressing this theme from various angles. For instance, Ifremer and BRGM organised a meeting in September 2015 on technological stakes and obstacles in terms of sedimentology, sedimentary dynamics and coastal hydrodynamics. The discussions helped us construct a common stance prior to the inter-organisation think tank organised by the CNRS Mission for interdisciplinarity on the coast and major future challenges in terms of instrumentation, observations and societal impacts.

## **Where does your own interest lie in Ifremer's Scientific committee?**

The Scientific committee (SC) is an independent organ, made up of outside experts in the various research fields at Ifremer. The Institute asks the SC for opinions and recommendations on its scientific strategy, its priorities and its developments. Because I am not an expert in Ifremer's themes (except for geosciences), I can step back and gain perspective on the technical issues addressed, by relying on the committee's members. Furthermore, having held positions as a UMR joint research unit director and as scientific director for two public-sector institutions, I can understand the strategic stakes for Ifremer.

The committee meeting in September was devoted to the assessment of the technology units; the work done by the inspection committees, in which different SC members took part, helped identify the challenges for the technology units and issue recommendations.

## **You have taken on new duties; can you tell us more about them?**

I have just become the deputy director for innovation and development at Andra, where I have previously held positions as Scientific director and R&D director. I'll specifically be in charge of the Agency's innovation, strategy and preparing the next contract of objectives.



# DESIGNING AND MANAGING INNOVATIVE INFRASTRUCTURES

Ifremer makes a significant contribution to developing and operating French and European marine research infrastructures and facilities. Thus, the French oceanographic fleet and the Euro-Argo ocean observation system, which Ifremer operates in part along with other national institutions, are Very Large Research Infrastructures (VLRI).

The research structures which are smaller in scope, but which also address important issues, are the research infrastructures (RI) approved by the Ministry in charge of Higher education and Research (national roadmap). They too, like the European Multidisciplinary Seafloor and water-column Observatory (EMSO), itself part of the EU framework (infrastructures roadmap), receive significant Ifremer support.

As of 2016, Ifremer and CNRS INSU will be in charge of coordinating a new RI called Ilico, which was approved by the Ministry of Research's VLRI steering

committee in December 2015. Ilico will federate eight services and observation networks and its remit will be to ensure that the observations made in shore and coastal environments respond to social stakes and related scientific questions, bring together and facilitate the multidisciplinary network of these eight "building blocks" and guarantee the interoperability and quality of the observations they produce.

The future Ocean data cluster (involving Ifremer marine databases) will also be one of four components in the RI project for Earth system observation data clusters, working with the French research alliance for the environment (AllEnvi).

Finally, hydrodynamic test tanks are contributing to a grouping for Marine renewable energies which is currently a research infrastructure project on the national roadmap of the Ministry in charge of Research.

## The French oceanographic fleet (VLRI)

In August 2014, the General inspectorate for national education and research (IGAENR) was entrusted with a study mission to evaluate the results obtained by the UMS Fleet joint research unit over the past four years and to recommend management and utilisation scenarios to improve the fleet's deployment. While awaiting its conclusions, in early 2015, UMS Fleet was extended, as is, for a two year period, with its complementary organisations: two national commissions (CNFH for the offshore fleet and CNFC

for the inshore fleet) and the Strategic and scientific orientation committee for the French oceanographic fleet (COSS). The committee is now chaired by Catherine JEANDEL (CNRS/LEGOS) and a new session was held in April 2015.

The IGAENR's report (June 2015) supplied a comprehensive review of the situation, documenting the progress made and making suggestions to improve governance and optimise the operation of the fleet. It will be up to the Ministry in charge

of Research to determine what follow-up is required.

Ifremer worked with the French Navy to define the conditions for renewing the agreement for operating RV *Beau-temps-Beaupré* and RV *Pourquoi pas?* which reached its term. A new agreement related to the operation of these two vessels for a three-year period was signed in June 2015.

## Technological foresight for the oceanographic fleet

In order to assess the fleet's future requirements, Ifremer organised, in cooperation with CNRS, a technological foresight seminar for the oceanographic fleet, open to all users of the VLRI fleet infrastructure in May 2015 in Paris. Some ninety-five scientists, users and

engineers were able to share their views on scientific requirements and what is made possible by technology in terms of the fleet. Presentations mainly focused on the functions/performances already made available by the fleet's scientific equipment (sonar systems, coring, seismics, underwater vehicles, information systems, databasing and data dissemination) and gathered scientists' expecta-

tions in the five to ten year time-frame, in the fields of marine geosciences, physical oceanography, deep-sea environment, fisheries resources, marine ecosystems, biodiversity and biogeochemistry. The seminar identified medium- and long-term actions/projects to be proposed in order to improve the performance of vessels and vehicles.



Research vessels Pourquoi pas? and Beautemps-Beaupré (in background) in the Bay of Brest

## Genavir EIG

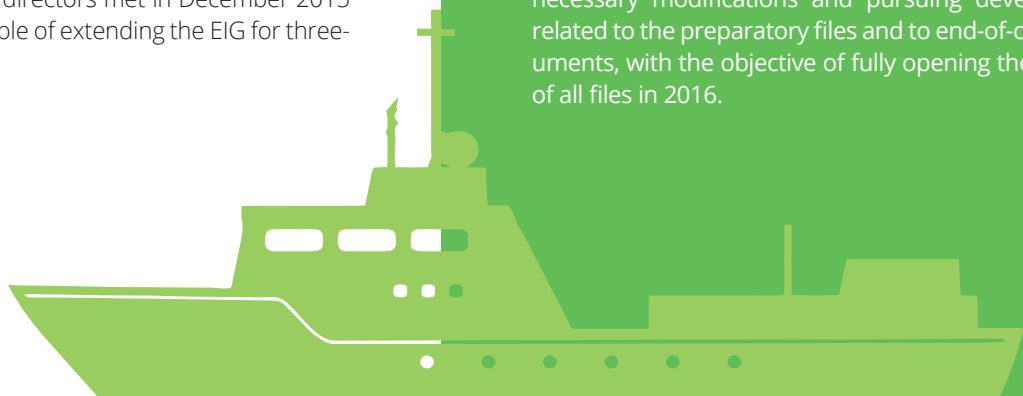
Since the Genavir Economic Interest Grouping (EIG) was to reach its term in August 2016, in 2015 Ifremer began an audit of its economic and organisational performance and of whether the EIG formula is adequate for fleet management. The audit showed that the legal scheme consisting in entrusting an EIG with vessels, vehicles and equipment of State-owned research institutions remains relevant, but that avenues for progress have been identified. Ifremer's Board of directors met in December 2015 and voted for the principle of extending the EIG for three-and-a-half years.

## European Research Vessel Operators

Olivier QUEDEC (Ifremer) was appointed as chairman of the group of European Research Vessel Operators (ERVO) for two years. Until now, the organisation has enabled the different national stakeholders to discuss their naval facilities programmes and share technical information. In keeping with the recommendations concerning the coordination of European regional fleets in the framework of the Eurofleets 2 project facilitated by Ifremer, a proposal was endorsed that ERVO get organised to promote actions such as exchanging ship and/or vehicle time on the maritime region scale.

## A new system for planning and managing ocean research cruises

The first module of the system allowing proposals for sea-going cruises to be entered and documents to be uploaded on line was opened in June 2015 for the call for sea-going cruise proposals starting in 2017. The special support set up guaranteed that all files could be submitted on time. The project team took account of the assessment made along with the users of this initial, partial opening. They are now moving forward with the necessary modifications and pursuing developments related to the preparatory files and to end-of-cruise documents, with the objective of fully opening the entering of all files in 2016.



## On line: ocean research cruises associated with scientific publications

In the framework of enhancing the value of oceanographic cruises, La Pérouse library (BLP), the Marine and Digital Infrastructure department and UMS Fleet worked together in setting up identification of each ocean research cruise by a Digital Object Identifier (DOI) so that a cruise can be linked, not only to the data acquired during it, but also to all contingent publications. A Landing Page is generated and published for each of the public-sector cruises indexed in the Sismar marine data centre's cruise catalogue. This Landing Page becomes the official cruise page, giving a succinct view of all the information supplied by the different systems.

## Controlling the risks related to sources of underwater noise

In 2015, Ifremer worked on controlling the risks associated with the use of noise sources, especially seismics, by optimising its mitigation protocol for seismic emissions. This "code of good conduct" provides that for each seismic survey, an analysis of noise risks be run and that measures to protect marine fauna be taken, depending on the characteristics of the seismic sources used, migration seasons and any existing regulations in the Exclusive Economic Zones (EEZ) which are crossed. The work will also require actions to maintain a Passive Acoustic Monitoring (PAM) system in operational condition and optimise its deployment at sea, along with a technology watch to rapidly propose a higher-performance system, particularly in terms of identifying and locating marine mammals.

## New seismic equipment

Following a European call for tender to progressively renew the seismic equipment, the Sercel company was selected. The budgets allocated for 2014 and 2015 will make it possible to finance the first two phases: a 600 m seismic streamer (high resolution seismics), a 4,500 m seismic streamer (multi-channel seismics) and the installations needed for deployment on board.

Two cruises for sea trials validated the new equipment, as well as the data-processing chains. The equipment was deployed during two scientific cruises in September 2015, called Tecta and Ghass. The initial results are highly satisfactory (noise levels lower than those obtained with former equipment, good behaviour of the seismic streamer).

In parallel, 3D seismic equipment is being purchased and a trial cruise is slated for early 2016.

## New optical mapping techniques

The visual reconstitution of seafloors using optical images has reached a level of performance and maturity hitherto unmatched. The fast algorithms run on a graphics processing unit now enable 3D reconstruction with georeferencing and scaling of the seabed. In the sub-sea domain, photogrammetry techniques are employed by processing sets of several thousand images from a single structure-from-motion sensor, with significant pre-processing steps to compensate for artificial lighting artefacts and colour attenuation depending on the distance from the scene. The resolution of the 3D model obtained is the size of a pixel and can reach a scale in millimetres, giving an overall assessment of a site as well as quantitative and statistical surface analyses.

## "Acoustic" mapping

A report on measurement techniques and the processing of seafloor backscatter measurements using multibeam echosounders was published by the *ad hoc* working group and presented at the GeoHab 2015 symposium (Salvador, Brazil). The document compiles the ef-

forts of twenty authors from seventeen organisations representing research, government and the market sectors of eight countries. Intended for a broad audience of scientists, engineers and operators using sonar backscatter data, it covers the basics of imaging, the requirements and expectations of various players, the procedure to estimate

seafloor backscatter by sonar and best practices for data acquisition and processing methods.

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Lurton X., Lamarche G. (eds.), 2015. *Backscatter measurements by seafloor-mapping sonars. Guidelines and recommendations. A collective report by members of the GeoHab Backscatter Working Group*



## HROV *Ariane*, a new underwater vehicle

The HROV\* *Ariane*'s launch ceremony was held at Ifremer's Mediterranean centre in La Seyne-sur-Mer on 23 April 2015, with officials, partners and teams from the Centre in attendance. The programme for the vehicle's technical validation then continued with two sea trial cruises during which *Ariane* made eighteen dives, logging over sixty hours on the bottom at depths reaching 2,000 m. Technically speaking, the majority of the system functions were commissioned. The active management of the fibre optic cable using a shipboard reel attained a level of robustness to match the demanding nature of the scarped seafloors explored. Innovative functions for navigation on sharp slopes, based on the perception of complex reliefs, produced data which

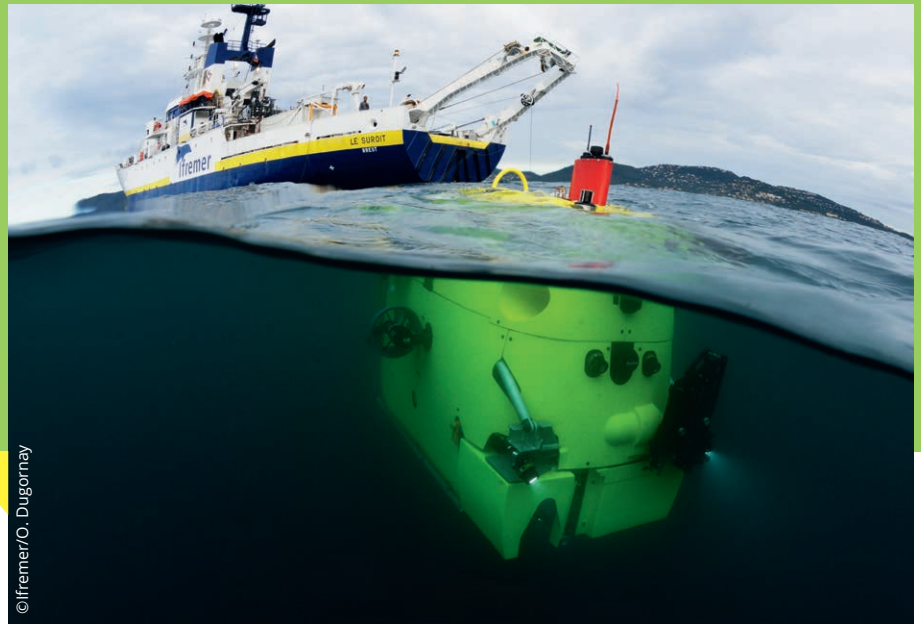
can be used to characterise performance in canyon-type environments.

However, the technical validation process for the vehicle was interrupted in July when its lithium-ion batteries overheated and damaged the HROV. A task group was set up for feedback on this unexpected event, bringing together experts on embedded power sources and system security from Ifremer, DGA and the HROV project's industrial part-

ner. The time required for rebuilding it and running new testing cruises will postpone its arrival in the operational fleet to beyond late 2016.

Concurrently, an industrial variant of the patented HROV *Ariane* concept is being studied in the framework of a service provision contract on behalf of a company working in the offshore field.

\*Hybrid Remotely Operated Vehicle



The HROV *Ariane* at stern of RV *Suroît*

©Ifremer/O. Dugornay

## Examples of ocean research cruises

### Polyplac2 (off the Tuamotu Archipelago)

Mapping of the natural extension of the continental shelf (beyond the 200 nautical mile zone) offshore from the Tuamotu Archipelago was done during this cruise, which was the second Extraplac project cruise aboard RV *L'Atalante* in French Polynesia. Eight days of acoustic data were acquired in the zone and dredging operations were performed to collect samples. Both will be used to prepare the dossier for the outer limits of the continental shelf in French Polynesia. The cruise was led by Ifremer, with SHOM's participation.

### Shomcal (New Caledonia)

Meticulous planning for this cruise made it possible to safely engage RV *L'Atalante* in zones which are still uncharted. The cruise made it possible to open a new recommended sea way in the north Caledonian Grand lagoon, between Ile Pott (Belep islands) and Grand Passage and two new recommended sea ways inside the Bampton reefs (Chesterfield islands). The cruise also improved knowledge about the bathymetry around Bampton reefs and made it possible to extend the sea lane in the Havannah Passage south of Grande-Terre.

### Storm (Southern Ocean)

The Southern Ocean is the main artery of geochemical exchanges between the Pacific and Indian oceans, not only in water masses, but also for deep sea marine organisms linked to hydrothermal vents and under the oceanic lithosphere. The Pacific upper mantle appears to migrate westward, encroaching on the Indian upper mantle. The Storm (South Tasmania Ocean Ridge and Mantle) project is studying the dynamics of the earth's mantle in this zone and prospecting to discover new hydrothermal vents. The Storm cruise, aboard RV *L'Atalante* was able to map and sample the seafloor on the axis of the South-East Indian Ridge between 128°E and the transform fault at 140°E, and to make a map of the complex transform system at 140°E (George V transform fault). *In situ* measurements in the water column were used to highlight zones of hydrothermal activity.

OCEAN-GOING FLEET

NATIONAL COMMISSION

351 DAYS

POURQUOI PAS ?



**MOMARSAT M. CANNAT, CNRS-IPGP**  
Atlantic Ocean, study on Lucky Strike site on Mid-Atlantic Ridge

**GHASS N. SULTAN, IFREMER**  
Black Sea, gas hydrates

**GITAN S. TOUCANNE, IFREMER**  
Bay of Biscay, potential effects of tsunamis

L'ATALANTE



**OUTPACE T. MOUTIN, MOI**  
Western Pacific Ocean, biogeochemistry and biodiversity

**VESPA M. PATRIAT, IFREMER**  
Western Pacific Ocean, geophysical study of volcanic arcs

**CARACALHIS L. BEAUFORT, CEREGE**  
West Indies, geology

**STORM A. BRIAIS, CNRS**  
Indian Ocean, geosciences in the Southern Ocean

**CASSIOPÉE F. MARIN, IRD**  
Western Pacific Ocean, study of deep currents

**TECTA J. COLLOT, IFREMER/SGNC**  
Western Pacific Ocean, acquisition of seismic data

THALASSA



**PIRATA B. BOURLES, IRD**  
Atlantic Ocean, study on climate variability

**RREX V. THIERRY, IFREMER**  
Atlantic Ocean, physical oceanography

LE SUROÏT



**MOOSE P. TESTOR, LOCEAN**  
Mediterranean Sea, physical oceanography

OCEAN-GOING FLEET

COOPERATION BETWEEN RESEARCH AND INDUSTRY

45 DAYS

POURQUOI PAS ?



**MOZ 4 S. JORRY, IFREMER**  
Indian Ocean, sedimentary system of Mozambique Channel

L'ATALANTE



**AFFK N. ELLOUZ, IFP**  
West Indies, core sampling

# RESEARCH CRUISES

## OCEAN-GOING FLEET

## OFFSHORE CRUISES OF PUBLIC INTEREST

163  
DAYS

L'ATALANTE



**POLYPLAC**, B. LOUBRIEU, IFREMER  
Pacific Ocean, bathymetric surveys / Extraplac project

**NODULE**, L. MENOT, IFREMER  
Pacific Ocean, bathymetric surveys,  
France/IBS contract

THALASSA



**IBTS 15**, Y. VERIN, IFREMER  
Atlantic Ocean, Eastern English Channel, North Sea, fisheries resource assessment

**PELGAS 15**, M. DORAY, IFREMER  
Bay of Biscay, fisheries resource assessment

**EVHOE 15**, M. SALAUN, IFREMER  
Bay of Biscay, Celtic Sea, fisheries resource assessment

## OCEAN-GOING FLEET

## FRENCH NAVY-IFREMER PARTNERSHIP

145  
DAYS

POURQUOI PAS ?



**SHOPROTEVSMED**, SHOM  
Atlantic Ocean, physical oceanography

**SHOMAN**, SHOM  
Atlantic Ocean, hydrography

L'ATALANTE



**SHOMPOL**, SHOM  
Pacific Ocean, hydrography cruise

**SHOMCAL**, SHOM  
Pacific Ocean, hydrography cruise

LE SUROÏT



**SHOM BAMBI**, SHOM  
Mediterranean Sea, hydrography cruise

OCEAN-GOING FLEET

INSHORE CRUISE OF PUBLIC INTEREST

23  
DAYS



THALASSA

CGFS F. COPPIN, IFREMER  
Eastern English Channel,  
resource assessment

OCEAN-GOING FLEET

TECHNICAL TRIALS MISSIONS

63  
DAYS



POURQUOI PAS ?

ESSPENCAR L. DUSSUD, IFREMER  
Atlantic Ocean, technological trials for long core sampling

ESSISM1 A. PACAULT, IFREMER  
Atlantic Ocean, seismic trials

ESSPEN50 L. DUSSUD, IFREMER  
Mediterranean Sea, testing Penfeld penetrometer at 50 metres

ESSPENCARROVSYS L. DUSSUD, IFREMER  
Atlantic Ocean and Mediterranean Sea, Testing HR seismics,  
Penfeld penetrometer and SYSIF



L'ATALANTE

ESS-SMT A. PACAULT, IFREMER  
Pacific Ocean, testing new streamer of heavy seismics equipment SIS 1

ESS-SMF/K E. NEDELEC, GENAVIR  
Pacific Ocean, MBES -K multibeam  
echosounder trials



THALASSA

TVMARPORT H. FLOCH, IFREMER  
English Channel-Atlantic, testing positioning  
system of MARPORT trawl



LE SUROÏT

ESSHROV-02 P. SIMEONI, IFREMER  
Mediterranean Sea, HROV technical qualification trials

ESS/SISM A. PACAULT, IFREMER  
Atlantic Ocean, seismics trials in the framework  
of plan to renew seismic equipment

# RESEARCH CRUISES

## COASTAL FLEET

## INSHORE CRUISES OF PUBLIC INTEREST

138  
DAYS

**THALIA**  
**COMOR45** E. FOUCHER, IFREMER  
Bay of Seine, fisheries and stock assessments



**COSB** S. FIFAS, IFREMER  
Bay of Saint-Brieuc, fisheries and stock assessments



**L'EUROPE**

**DCE4-01 et 02** B. ANDRAL, IFREMER  
Mediterranean Sea, WFD

**PELMED15** J.L. BIGOT, IFREMER  
Mediterranean Sea, fisheries and stock assessments

**MEDITS15** A. JADAUT, IFREMER  
Mediterranean Sea, Fisheries and stock assessments

**DCE4-02** B. ANDRAL, IFREMER  
Mediterranean Sea, WFD

## COASTAL FLEET

## TECHNICAL TRIALS MISSIONS

44  
DAYS

**THALIA**  
**ESSTECH-15-TH** H. LOSSOUARN, IFREMER  
Bay of Brest, technology sub-bottom profiler



**HALIOTIS**

**ESSTECH-15-HA** H. LOSSOUARN, GENAVIR  
Brest, technical trials

**TEST PIEZZO/ RECUP PIEZZO** A. EHRHOLD, IFREMER  
Atlantic, piezometer



**L'EUROPE**

**ESSTECH-15-GEN-EU** H. LOSSOUARN, GENAVIR  
Toulon, technical trials

**DIVACOUB-HROV** M. DROGOU, IFREMER  
Toulon, technology / acoustic tests

**ESSTECH-15-IFR-EU**  
Brest, technical trials

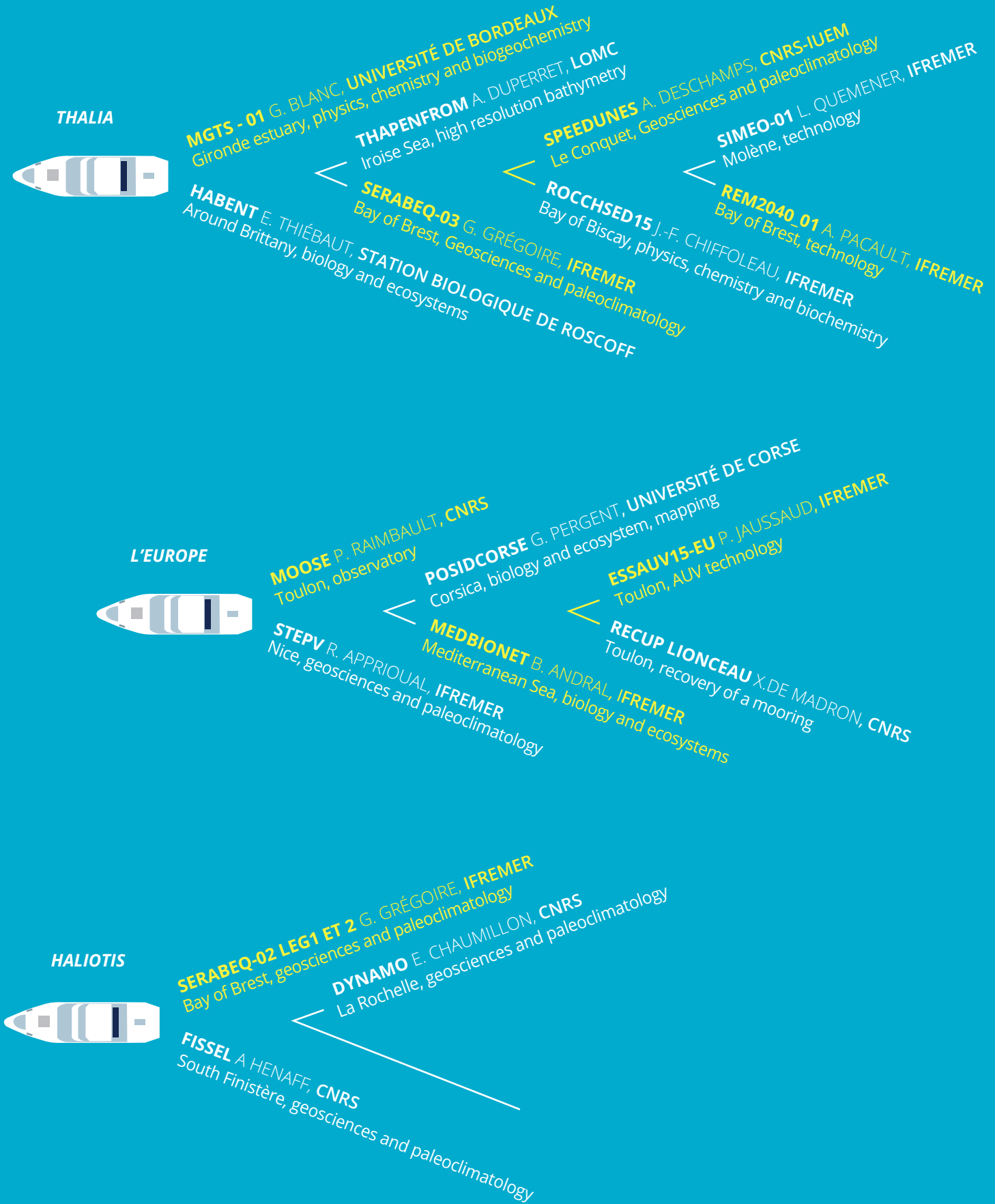
**ESSHROV** E. RAUGEL, IFREMER  
Toulon, technology HROV trials

A. PACAULT, IFREMER

COASTAL FLEET

NATIONAL COASTAL FLEET COMMISSION

**296**  
DAYS



# RESEARCH CRUISES

**TV RECUP** N. LE DANTEC, IFREMER  
English Channel, current meter technology

**CHALKWAVE** F. PAQUET, BRGM  
English Channel, geosciences and paleoclimatology, seismics

**CAMELIA-III** C. BRACH-PAPA, IFREMER  
Loire estuary and Southern Brittany, physics, chemistry and biochemistry

**CARMOLIT -SIMEO2 2015** L. QUEMENER, IFREMER  
Bay of Vilaine and Molène, technology

**MERCAUX** F. PAQUET, BRGM  
English Channel, geological mapping

**NURSE15** A. BRIND'AMOUR, IFREMER  
Bay of Vilaine, fisheries resources and stock assessments

**MGTS** G. BLANC, UNIVERSITÉ DE BORDEAUX  
Gironde estuary and coastal zone, physics, chemistry and biochemistry

**REM2040\_02** A. PACAULT, IFREMER  
Bay of Brest, technology, sub-bottom profiler

## COASTAL FLEET

## COOPERATION BETWEEN RESEARCH AND INDUSTRY

14  
DAYS

THALIA



**VOLT** R. SILVA JACINTO, IFREMER  
Bay of Biscay, bathymetry, mooring, coring

L'EUROPE



**COM OPTIC** P. LÉON, IFREMER  
Mediterranean Sea, optical modem testing

HALIOTIS



**MOZA** G. JOUET, IFREMER  
Mozambique, Haliotis aboard  
Pourquoi pas?

## Euro-Argo (VLRI)

Euro-Argo is the European contribution to the international Argo array consisting of 3,000 profiling floats which measure temperature and salinity from the surface to depths of 2,000 metres over all the world's oceans.

The setting up of a European legal structure in 2014 called the European Research Infrastructure Consortium (ERIC) for *in situ* observation of the oceans was a major step in optimising, preserving and consolidating European contributions to the Argo array.

Establishing the Euro-Argo ERIC and the JCOMMOPS centre at Ifremer's Brittany centre in Brest was made tangible by the inauguration of their new premises, as a side-event of the 5<sup>th</sup> Euro-Argo Users meeting and the meeting of the international Argo coordination group organised there, thus gathering over one hundred scientists from the world over in Brest.

Testing of Arvor floats in Ifremer's Brittany centre test tank



©Ifremer/S. Lesbats

### Ifremer secures the coordination of the "Copernicus *in situ* TAC" service

Carrying on from the MyOcean project in the 7<sup>th</sup> European framework programme, the Copernicus *in situ* TAC (Thematic Assembly Centre) is a service for *in situ* observation data of the global ocean and of European seas on the regional scale. The aim of the service is to collect and produce physical and biogeochemical data in real-time and in batch mode and it is coordinated by Ifremer. It is an integrated component of the Copernicus Marine Service (European marine environment monitoring service) coordinated by Mercator Ocean. The consortium has sixteen partners, all major stakeholders in managing *in situ* data for the needs of operational oceanography in Europe, and is already providing the requested service. It will further develop this service to improve both the catalogue and the quality of products and services and thus better meet users' requirements.

### Mocca (Monitoring the Ocean and Climate Change with Argo)

By financing 150 floats, the Mocca project reinforces the European contribution to the global Argo array, in order to improve the coverage of European seas and extend both real-time and batch processing centres. Ifremer's contribution to the project involves processing the data from part of the Mocca fleet and ensuring their dissemination via the global Argo centre.



# Marine databases

## Seanoe, publishing and citing scientific data sets: <http://www.seanoe.org>

Seanoe is a new solution for publishing scientific marine environmental data, created by Sismer, Ifremer's data centre. Seanoe enables scientists to publish freely accessible data sets and to cite them in articles in a reliable and lasting way. It could be part of the national effort to set up a facility for coordinated management of observation data, more specifically, in the Ocean cluster.

As a subset of Archimer (Ifremer's open-access archives), Seanoe makes it easy to publish research data free of charge. It is open to the entire international scientific community working in the marine research field. Each data set published by Seanoe has its own DOI (Digital Object Identifier). Thus Seanoe offers a solution in response to journals which request that the data used in an article be accessible on line (such as *Plos One*). This makes it an alternative for national communities which until now had to turn to foreign centres to publish their data. The data

published by Seanoe can be utilised in compliance with the terms of the Creative Commons licence. It is possible to place an embargo on a set of data for up to two years. Publishing a data set in Seanoe also provides a linkage with other information systems: those related to French ocean research cruises, thematic databases and directories of people and their publications.

*An example: Lefebvre A., 2015, Marel Carnot data and metadata from Coriolis Data Centre. <http://dx.doi.org/10.17882/39754>*

## The data.ifremer.fr portal




Through its scientific and observation activities, Ifremer collects and enhances a large number of highly varied data (physical, chemical, biological measurements, observations, mapping, etc.). They are archived in a wide range of databases, which reduces their visibility and their

accessibility. To remedy this, Ifremer has created a single portal to access these marine data. The new portal shows the different types of data available, which can be filtered using many criteria, making searches easier and more efficient.

Finally, because science has the duty to be accessible to everyone, there are also

educational contents about marine data, explaining "What is a marine datum?" "How are data acquired?" "What computer processing is applied to data?" This year, an addition has been made to the "Submit data" section of the data.ifremer.fr portal with a new data compiling interface called Seanoe.



-  Data centres with
-  defective link at time of snapshot
-  Data centres with link OK

Data centres involved in the SeaDataNet 2 project, as seen by the Monitoring Portal  
Two centres for France: Ifremer and SHOM



# INTERVIEW

**Michèle FICHAUT**

*Ifremer, Marine scientific information systems service,  
SeaDataNet2 project coordinator*



*SeaDataNet2, both coordinated by Ifremer, set up a Pan-European data infrastructure to facilitate access to oceanographic data acquired by riparian countries around European seas, by bringing together forty-six data centres in thirty-four countries participating in the project. The project's second phase aimed to consolidate the infrastructure created during the first project by making it more robust and more interoperable and by adding new types of data, like those for biology. In other words, it had to become bigger, faster and better.*

## **What major progress has been made?**

*The number of networked centres and that of data available have doubled during the second phase of the project. As of now, data from one hundred and two centres connected to the SeaDataNet system can be accessed ([www.seadatanet.org/Data-Access](http://www.seadatanet.org/Data-Access)). In all nearly 1.8 million stations, time series or tracks, collected by over five hundred laboratories, have been described in the infrastructure and 87% of the data can be freely accessed without restrictions. For the remaining 13%, the description is accessible and the data may be made available after negotiating with the suppliers. The infrastructure is utilised by many partners in other European initiatives like EMODnet, GeoSeas, etc.*

*The infrastructure has been made much more robust through the setting up of a control system which sends out alerts in the case of mal-*

*function. Updating (creating or modifying) information in catalogues or directories can now be automated by implementing ISO-19139 and Inspire standardised metadata harvesting systems. This system is already operational in four connected centres, including Ifremer, and the infrastructure's aim is to increase this number in coming years.*

## **What makes SeaDataNet data's interoperability possible?**

*In particular, SeaDataNet contains data from oceanographic cruises or collected by ships of opportunity, and those from mostly coastal monitoring systems or from stand-alone sensors (such as drifting floats, for instance). The data correspond to various themes (physics, chemistry, geosciences and biology). All data are processed and described using the common procedures, software and vocabulary created by the project and used by numerous other European, as well as American and Australian, initiatives. They are distributed in the standardised formats defined by the project.*

*SeaDataNet is an infrastructure whose data sources are spread over several sites or distributed (and shared by networking): the data remain in the interconnected data centres and only their (metadata) descriptions are archived in centralised catalogues. When a user logs on to SeaDataNet to download data of interest, the system will search in the different data centres for the data corresponding to the search*

*You coordinated, on behalf of Ifremer, the European SeaDataNet project from 2011 to 2015, the second phase of this project for marine data coming from research institutes and data centres in the North East Atlantic, the Arctic Ocean, the North Sea, Baltic Sea, Mediterranean Sea and Black Sea.*

## **What does this project involve?**

*SeaDataNet must ensure that data are archived and conserved, to guarantee that they can be re-utilised in new investigations or research. The projects under the FP6 Framework Programme for technological research and development, i.e. SeaDataNet and under FP7, i.e.*

criteria, and make them available to the user in an identical, standardised format, whatever the location they come from.

### Are other developments slated?

The infrastructure is operational, but must constantly adapt to new tech-

nologies in order to stay competitive. Data collection methods are also changing and producing increasingly large volumes, as well as new types, of data. So the systems have to be adapted to take account of these developments. In addition, new services must be provided for data producers and users (feedback on data use, networking of users utilising the

same data, etc.). A third phase of the project will thus be needed to rise to these new challenges, which is why SeaDataNet will submit a bid in 2016 for the European call for proposals concerning research infrastructures for "advanced communities".

## Onshore test facilities and infrastructures

### Measurement and analytical equipment

The system comprises a dedicated process called "Operate, maintain, develop experimental equipment and control measurement devices". Its end-purpose is to acquire experimental results by deploying, making available and developing reliable experimental facilities and equipment, complying with hygiene and safety rules, standards in effect and professional ethics. Amongst the most important actions achieved in 2015, we can mention:

- Large-scale work continued to inventory measurement and analysis devices, working with the laboratories and services and has now covered 90% of the Institute's instruments.
- Sixty-four metrology correspondents were identified to carry out this task.
- Result indicators implemented make it possible to assess the performance

and efficiency of processes and detect any problems.

- The relevant platforms are the technological testing infrastructures: hyperbaric (Brest and Toulon) or flume tanks (Brest, Boulogne-sur-Mer and Lorient), aquaculture facilities (Argenton, Palavas-les-Flots, Brest and Bouin) and the ICP-MS (inductively coupled plasma mass spectrometer) instrument platform in Brest.

- In 2015, effort was focused on better compliance with hygiene and safety rules and current standards for the areas used to rear larvae and experiment on tropical species at Palavas-les-Flots; improving hygiene and safety in experimental pathology labs and processing the seawater at the inlet of the mollusc nursery in La Tremblade.

Pacific cupped oyster breeding laboratory at the Ifremer Argenton station



©Ifremer/B. Petton

# ACTING WITHIN THE FRAMEWORK OF EUROPEAN AND INTERNATIONAL PARTNERSHIPS

Internationally speaking, 2015 was a year marked by growing awareness of how important oceans are. The stakes for the ocean and for coastal areas were highlighted in particular during COP 21, but also during the Unesco World Oceans Day, whose theme this year was "Healthy Oceans, Healthy Planet". Its approach aims to make 8 June the occasion to inform people about better management of the oceans and their resources. Karmenu VELLA, European Commissioner for the Environment, Maritime Affairs and Fisheries, took the opportunity presented by COP21 to emphasise the role that Europe must play in order to maintain good health of marine ecosystems and to combat climate change. In 2015, the 1<sup>st</sup> conference organised by the Joint Programming Initiative for the oceans (JPI Oceans), called: **Joining Forces Towards Healthy and Productive Seas and Oceans**, presented

the Strategic Research and Innovation Agenda (SRIA) for healthy and productive oceans.

Ifremer participated in all these actions through its place within the Intergovernmental Oceanographic Commission (IOC), its involvement in the Ocean Climate platform and its role representing AllEnvi within JPI Oceans.

Our Institute also pursued its commitment to European construction and significantly invested in several Horizon 2020 marine research projects with a satisfactory rate of success.

2015 was also a year when important bilateral agreements were signed, with Japan (FRA), Canada (MPO) and the United States (NOAA).

## Promising outcomes of European calls for proposals

The results of the first 2014 and 2015 calls from the European Commission's H2020 Framework Programme for Research and Innovation were both foreseen - seeing the financial scope of the programme - and uncertain - seeing the significant changes made with respect to the previous FP7.

In this highly specific context requiring special mobilisation of support services, Ifremer achieved satisfactory results which were even better than the annual

mean of those obtained during FP7. The final results from the 2014 call available as of February 2015 were:

- forty projects submitted (for an average of twenty-nine during FP7);
- thirteen projects selected (one of them coordinated by Ifremer);
- 7.4 million euros of accrued income for Ifremer, up from the mean annual figure of 4.1 million euros during FP7.

The European projects to which Ifremer is a contributor fit into the French national research strategy (SNR) published in 2015 by the Ministry in charge of Research.

To make its strategic objectives part of the European research area approach, Ifremer is present in numerous European networks. Ifremer also takes an active part in the International Council for the Exploration of the Sea (ICES) and is an active member of fora like Clora, EfarO and EurOcean, which it also vice-chairs. Our Institute also contributes to the European Marine Board's analyses (especially "Delving deeper" for deep sea exploration) for which Ifremer holds a vice-chairmanship.

*Clora: (French) club of associated research organisations - EfarO: the European Fisheries and Aquaculture Research Organisation association of research institute directors - EurOcean: the European centre for information on marine science and technology*



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Signing of the Memorandum of Understanding between Ifremer and FRA. From left to right: François JACQ, Chairman and Managing Director of Ifremer and Masanori MIYAHARA, President of the FRA

### Strategic cooperation with Asia

One 2015 development was Ifremer's stronger cooperation with the Japanese Fisheries Research Agency (FRA), the institute of reference for fisheries resource

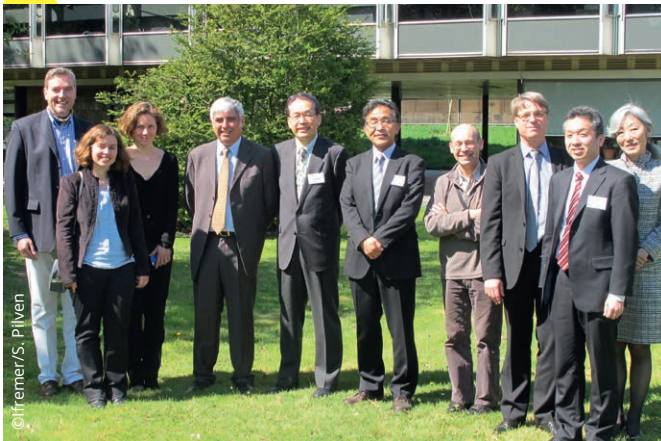
and aquaculture research. Both relying on previous partnerships (on toxic phytoplankton and aquatic animal diseases in particular) and identifying new fields of cooperation, Ifremer and FRA decided to bring their research activities closer by signing a Memorandum of Understand-

ing (MoU) on 14 April 2015, which should give rise to joint research programmes. The first studies began as of November 2015, along with participation by Ifremer research scientists in the 16<sup>th</sup> Japanese-French Symposium organised by the two Japanese-French oceanographic societies in Tohoku and Tokyo.

Cooperation with Ifremer's historic partner in Japan, Jamstec (Japan Agency for Marine Earth Science and Technology) was also quite fruitful. We can also note the hosting of an employee on secondment at Ifremer and the organising of a Franco-Japanese seminar on the impact of mineral resource exploitation on deep-sea ecosystems in Tokyo in June 2015.

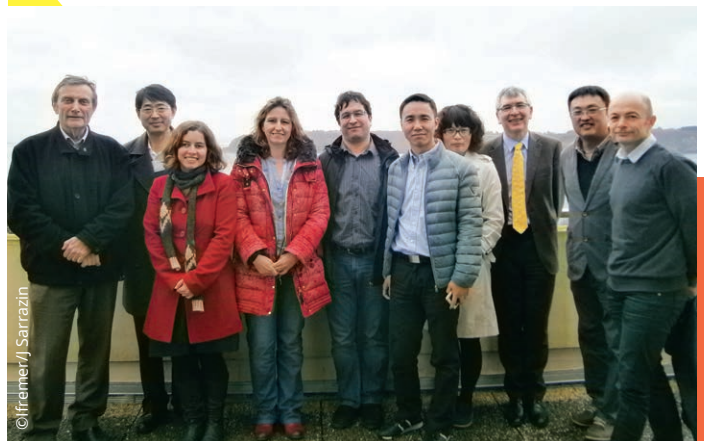
A series of new scientific cooperation projects with China was launched and a delegation from the new "Sanya Institute of Deep-Sea Science and Engineering" (of the Chinese Academy of Sciences) was welcomed at Ifremer's Brittany centre in March 2015, focusing on technological and scientific challenges related to studying deep-sea ecosystems.

FRA delegation's visit to Ifremer's Atlantic centre



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Welcoming the delegation of the new Chinese Sanya Institute of Deep-Sea Science and Engineering to the Brittany centre



©Ifremer/J. Sarrazin



## New collaborative work with Canada

Ifremer's cooperation with Canada mainly manifests itself through its agreement with the Department of Fisheries and Oceans (DFO) in place since 1990. The Ifremer-DFO joint committee decided in 2015 to update the legal framework of cooperation whilst taking account of new projects and opportunities for teams to work together. Within the new cooperation framework is an agreement from the International Research Group (GDR) in the field of fisheries and aquaculture (GDRI Rechaglo), entitled: "Responses to the global population change and fisheries and aquaculture communities and their habitats, 2015-2019" and an agreement on operational oceanography linking the specific needs of the Canadian Ministry with the products and services generated by Mercator Ocean.

## Strengthening partnerships with Oceania

Scientific cooperation between France and New Zealand, backed up by a symposium led by the New Zealand and French ministries of Research, has provided support for Ifremer's cooperation projects with our New Zealand partners on a wide range of subjects: marine geosciences, acoustic technologies, deep-sea environment, coastal environment and ecotoxicology, marine biodiversity, aquaculture and mollusc diseases, biotechnologies and marine resources, and fisheries science. Specific working meetings held alongside this event with the National Institute of Water and Atmospheric Research (NIWA), GNS Science (geology, geophysics and nuclear science) Cawthron Institute and Environmental Science and Research (ESR) were an opportunity to make an initial assessment of the partnerships underway.

## Mediterranean cooperation: scientific policy and maritime economy

Ifremer took part in work coordinated by the European Commission to draw up a new Strategic Research and Innovation Agenda for the Mediterranean Sea, approved by six Member States on 16 October 2015 in Venice. It identifies three actions for research and innovation:

- knowledge about ecosystems, marine dynamics and risks;
- identifying key economic fields and related research and innovation requirements;
- innovative technologies.

In the framework of the bilateral agreement signed at the Franco-Italian summit organised in France in February 2015, the Italian National institute of geophysics and volcanology (INGV) and Ifremer decided to strengthen their cooperation in developing and operating autonomous seafloor observatory stations in order to better understand the coupling of submarine fluids and seismicity.

In 2015, Ifremer also reinforced its partnerships with countries on the southern shores of the Mediterranean.

A Franco-Moroccan partnership financed by the European Union was conducted between March and October 2015 in the

form of a French expert analysis, which Ifremer took part in, to enhance the capacities of the National agency for the development of aquaculture in Morocco (ANDA).

The dialogue between Ifremer and the Tunisian Institute of marine sciences and technologies (INSTM) grew with the visit of the INSTM delegation led by its general director Hechmi MISSAOU and will lead to a framework agreement for cooperation being signed by the two institutes.

**40**  
Projects submitted



**13**  
H2020  
projects  
selected

# INTERVIEW

## Dr. Peter HEFFERNAN

Marine Institute, Ireland

Peter HEFFERNAN is the chief executive of the Marine Institute, Ireland's national agency for marine research (with a staff of 200 and an annual budget of approximately 45 million euros, in County Galway). He oversaw the delivery of two multi-purpose research vessels, the Celtic Voyager and Celtic Explorer. During the Irish presidency of the European Union in 2013, Peter HEFFERNAN worked for the creation of Aorac, the Atlantic Ocean Research Alliance Coordination, with the signing of the Galway Statement in May 2013 to promote trans-Atlantic scientific cooperation between Canada, the EU and the USA. Peter HEFFERNAN is the coordinator of the Horizon 2020 Aorac Support Action.

### **How do you consider the Marine Institute-Ifremer collaboration within the context of the European marine research area?**

The Marine Institute and Ifremer both participate in a number of EU fora – the European Marine Board, JPI Oceans and EurOcean. In addition, both entities collaborate closely on EU projects, particularly in the domain of large distributed marine infrastructure. These projects include Eurofleets2, Jerico-Next, EMSO and EMSO-Dev (European Multidisciplinary Seafloor and water-column Observatory) and the Euro-Argo

ERIC. Both agencies are also involved in the AtlantOS and Aorac H2020 projects.

### **How could you define this collaboration in the context of the Atlantic Ocean Research Alliance (Galway Statement)?**

The Marine Institute is once more partnered with Ifremer in the context of the EC H2020-funded Coordination and Support Action Aorac coordinated by the Marine Institute. The Atlantic Ocean Research Alliance is striving to promote an Atlantic Ocean Cooperation between EU, Canada and the United States. A key aspect of this endeavour is underpinning and enabling the Research Alliance by sharing access to marine research infrastructures. Ultimately the aim is to intelligently cooperate to increase our knowledge of the Atlantic Ocean and its dynamic systems.

### **How do you imagine the international framework for performing transatlantic marine research in the future?**

The Marine Institute anticipates that there will be many opportunities for future international frameworks which build on the Galway Statement on Atlantic Ocean Cooperation. The success of AtlantOS and Aorac will be a fundamental building block for identifying opportunities in the ma-



rine domain which will extend from the Southern Atlantic right through to the Arctic. Projects funded under the final H2020 work programme (2018-2019) could form an integral part of this.

Aorac-SA project: [www.atlanticresource.org](http://www.atlanticresource.org)

# PROVIDING SUPPORT FOR PUBLIC POLICIES

In 2015, France strengthened its maritime sovereignty by extending the limits of its continental shelf by more than 500,000 km<sup>2</sup> in the framework of the Extraplac project led by Ifremer. This is a good illustration of how Ifremer's informs policy-making and invests its role as expert for the French State.

Progress was also made in 2015 in defining the Institute's position along the continuum of research, monitoring and expert assessments. In agreement with the Directorate general for food (DGAL, Ministry of Agriculture, Agrifood and Forestry), Ifremer's role will evolve towards assisting the contracting authority in two networks working for health and food safety: controlling shellfish microbiology (*REMI*) and monitoring phytoplankton and phycotoxins (*Réphy*). In the medium term, Ifremer will no longer be an operator for sampling and analyses, since these are not strategic activities for research.

Our Institute also clarified the role it wants to play in the field of environmental monitoring. Several meetings held with the managers of river agencies, the water and biodiversity department (DEB, Ministry of the Environment, Energy and the Sea) and the Nation-

al office for water and aquatic environments (Onema) gave opportunities to collectively consider how continuing support can be provided for the authorities, particularly in cases of blooms of macroalgae (green tides) and blooms of opportunistic planktonic algae.

In the field of fisheries resources, Ifremer worked with the maritime fisheries and aquaculture directorate (DPMA) to define how the Institute will contribute to the implementation of the fisheries data collection obligation under the new EU Common Fisheries Policy (CFP) regulations. Furthermore, in compliance with a commitment made in the 2014-2017 objectives contract, the transfer from Ifremer to the DPMA to supervise landings sampling has begun. Ifremer will continue to supply support and assistance to the contracting authority.

Lastly, our Institute further asserted its scientific support for the Marine Strategy Framework Directive (MSFD), by agreeing to take on several scientific (co) leadership roles for the monitoring of Good Environmental Status and implementation of the monitoring programme.

## France's undersea domain grows by over 500,000 km<sup>2</sup>: Extraplac programme

In 2015, France extended its undersea territorial domain by 579,000 km<sup>2</sup>, i.e. approximately the surface area of metropolitan France. Four orders published in the *Official journal* on 25 September 2015 officially set the new limits of the continental shelf off Martinique, Guadeloupe, French Guiana, New Caledonia and the Kerguelen islands. This extension increases France's rights to seafloor and sub-seafloor resources beyond the 200 nautical mile zone.

The applications for extension of the continental shelf are submitted to the special UN Commission on the Limits of the Continental Shelf (CLPC). An extension can be claimed providing that the seabed meets the criteria of natural extension and geological and morphological continuity from the land-mass.

To draw up extension claim applications in compliance with these criteria, in 2002 France set up a dedicated national programme for the French continental shelf called Extraplac, coordinated by an inter-ministerial steering committee reporting to the Secretariat general for the Sea.

Ifremer led the scientific project group, in close collaboration with SHOM, Ifpen and IPEV. The claims currently being examined concern French Polynesia in the Pacific Ocean and the Crozet archipelago, Reunion Island and Saint-Paul and Amsterdam islands in the Indian Ocean. All the steps taken are based on studies previously carried out at sea in order to specify the geological characteristics of the sub-sea environments in question.



## Europe 2020 strategy and European funding: developing fisheries and aquaculture while protecting resources and marine biodiversity

To rise to the major challenges facing the European Union, in 2010 its Member States adopted the Europe 2020 Strategy for smart, sustainable and inclusive growth. All European policies take part in this strategy and receive a budget determined by the 28 Member States for seven years. Within this framework, the European Maritime and Fisheries Fund (EMFF) is the funding strand for the Common Fisheries Policy and the Integrated Maritime Policy. Its management is delegated to the Member States.

For France, the fund has resources amounting to 588 million euros for the period from 2014-2020. It is distributed over six sectors: sustainable development of fisheries, aquaculture and the coastal areas which depend on these activities (€369M), data collection (€66M), fisheries control and enforcement (€56M), compensation for additional costs in outermost regions due to their distance (€86.45M), storage aid (€4.7M) and integrated maritime policy (€5.3M). It is expected that the actual implementation of the fund for France will be effective in 2016.

For fisheries data collection, the major objectives are focused on resource assessment, evaluating the level of fisheries and their impact on resources and ecosystems, as well as the socio-economic assessment of fisheries.

As the main partner of the French directorate (DPMA) in this field, Ifremer has especially mobilised its efforts on the theme of fisheries data collection for scientific assessment purposes (Data collection framework) and CFP implementation. Ifremer is also directly concerned by other measures supported by this fund, such as partnerships between scientists and fishermen, supporting innovation in fisheries and aquaculture,

reducing the impact of fisheries on the marine environment and adapting fisheries for species protection, protecting and restoring biodiversity and marine ecosystems, energy efficiency and mitigation of climate change.

In 2015, the Institute worked alongside the DPMA to prepare the future 2017-2020 data collection programme, to best match it to the new CFP orientations, based on prior experience acquired. Amongst other things, a series of tests was performed during fisheries resource cruises to ensure that the aspects of MSFD monitoring programme are as fully integrated as possible.



Fishing harbour in front of Ifremer's Channel-North Sea centre in Boulogne-sur-Mer

## Ifremer and the European Union's environmental integrated maritime policy

In 2015, the teams ensuring the scientific steering of the MSFD were reorganised and expanded for six themes (commercial species, fish and cephalopods, eutrophication, contaminants, marine litter and pelagic habitats).

### Good Environmental Status

The scientific and technical coordination of the MSFD's implementation is jointly ensured by the Agency for marine protected areas (AMP) and Ifremer. In 2015, as the scientific coordinator for "Good Environmental Status", Ifremer monitored the methodological devel-

opments of MSFD descriptors for each theme. Our Institute provided scientific assistance to the DEB in national and international task groups working on the subject. In particular, Ifremer took part in the work on the intermediate assessment of Oskar (North East Atlantic), for the updating of the QSR2010 (Quality Status Report). This assessment will be

in part the forerunner of the 2018 revision of the initial assessment of Good Environmental Status of marine waters and of the environmental impact of human activities on them, drawn up for each of the four marine sub-regions of metropolitan France in 2012.

## The monitoring programme

This programme was finalised, then approved by the coordinating prefecture authorities (regional prefects and maritime prefects) in June 2015. With the aim of strengthening the current monitoring systems to better meet the stakes of the MSFD, significant work was accomplished for the pooling of fisheries research cruises. It led to a costed proposal presented in late 2015 to the Ministry in charge of the Environment for monitoring (marine litter, contaminants and food webs) to be incorporated in the fisheries resource cruises conducted by Ifremer.

## Ifremer's changing role in observation and monitoring systems for coastal and marine water quality

Seeing the numerous fields in which Ifremer acts and the growing number of requests it receives, it has become necessary to clarify our Institute's positioning with respect to environmental monitoring systems, particularly in the context of evolving maritime policies and studies related to the Framework Directives for Water (WFD) and the Maritime Strategy (MSFD).

The initial reflection process was about the WFD monitoring system in metropolitan France, organising bilateral meetings between the Institute's general management and its Water agency counterparts. In November, it was concluded by a summing-up meeting where the director of Onema and all Agency directors were present.

An analysis of the monitoring set-ups devoted to chemical and environmental status identified the activities to maintain and those where the Institute should preferably refocus its role on supplying assistance to the contracting authority. The stakeholders who could directly take charge of some monitoring activities were identified, depending on their capability to guarantee the continuity and quality of the support for public authorities, and to both keep and release the data.

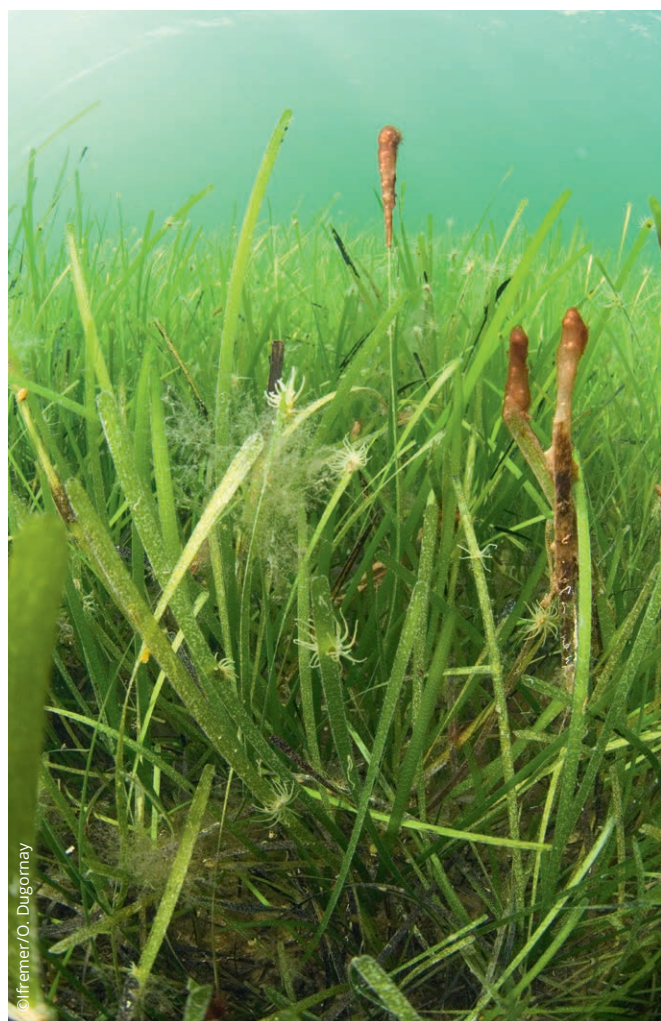
This work consolidated Ifremer's role in the *Réphy* (phytoplankton and phyco-

toxins, environmental status) and *Rocch* (chemical status) networks as well as in regional networks which back up and supplement these systems. Proposed developments mainly concern the benthic domain. Ifremer will continue its efforts in monitoring benthic invertebrates in soft substrates in the English Channel and East Atlantic and underwater zoster beds and macrophytes in lagoons. In the Mediterranean, soft sediment invertebrates, posidonia (flowering seagrasses) and macroalgae are already monitored respectively by Stareso, *Andromède Océanologie* and the Mediterranean institute of oceanology. In the English Channel and the Atlantic, the Seaweed technology and research centre (CEVA) was identified to coordinate the monitoring of macroalgae blooms (green tides) and the National museum of natural history (MNHN) could coordinate the monitoring of subtidal and intertidal macroalgae communities. However, these organisations must still agree to this.

It remains to translate these orientations into the administrative and financial realms, however, they do set the framework for Ifremer's future intervention. To facilitate the implementation of this organisational approach and make

## The programme of measures (decisions to be taken to foster good environmental status)

It is not within the remit of our Institute to contribute to programmes of measures. However, in connection with these programmes to support public policy-making, upon request from the directorate for water and biodiversity, Ifremer carried out a complementary study to harmonise the environmental objectives over the four marine sub-regions and link the indicators which can be used to judge the extent to which they are affected.



Posidonia meadow in the Thau lagoon

it totally operational in 2017, Ifremer has committed to ensuring the coordination of studies in 2016.

## Passive samplers, additional monitoring tools

Several projects have received support from public bodies (Rhone Mediterranean Corsica water agency, regional environment, development and housing directorates, the National office for water, Onema) and have tested three types of passive samplers (DGT for trace metals, SBSE for hydrophobic organic compounds and Pocis for polar or hydrophilic organic compounds).

Their potential for use as an additional tool to monitor marine water bodies, particularly in the framework of the WFD implementation and in connection with Aquaref's approach, was assessed.

Applications and large-scale developments were thus conducted in various environments (Mediterranean, Corsica, Reunion Island, Mayotte, French Guiana, Martinique) and under various conditions in the field (open sea, lagoons, ponds, marinas, harbour areas, reefs), which

secured entirely new data for the most part from over two hundred different coastal environments.

Since 2011, more than two hundred and fifty people (those in charge of setting up data acquisition surveys, consultancies, policy makers and managers in charge of setting up monitoring programmes) have been trained by Ifremer staff to implement the techniques related to these samplers in the coastal marine environment.



©Ifremer/J.-L. Gonzales

*Pocis (metal cage) and DGT (white plate) passive samplers submerged in the lagoon environment*

**197**   
**expert assessments**  
 made in 2015

## Sustainable management of marine granulates

After the strategy was drawn up for the sustainable management of terrestrial and marine granulates and quarry substances and materials, the Ministry of the Environment, Energy and the Sea mobilised a marine granulate working group (GTGM) to define a methodological guide for the sustainable management of marine granulates on the scale of seafronts.

The working group (made up of representatives from various marine granu-

late extraction stakeholders, maritime social-professional stakeholders, representatives of elected officials from coastal areas, scientific institutions, NGOs, state administration managers and devolved State services) was set up around a plenary group steering the work and four technical groups.

In the framework of its mission to inform public policy making, Ifremer has worked in two of the technical groups:

- the "criterion" group to take inventory of the state of knowledge about pressures and impacts from marine granulate extraction on the environment;

- the "resource" group to draw up a summary of knowledge about mineral resources and the stakes for exploiting them. The group relied in great part on the results from the Ifremer/Ministry of the Environment-marine granulates study (2005-2012).

A methodological guide was drafted for the drawing up of guidance documents for the sustainable management of marine granulates (DOGGM), whose publication is slated for 2016.

# CONTRIBUTING TO BLUE GROWTH

Marine sciences offer significant potential for innovations which can contribute to competitiveness and growth. The broad range of Ifremer's activity enables it to work in a variety of sectors, such as underwater systems, operational oceanography, marine biotechnologies, fisheries science, aquaculture, environmental monitoring, energy and mineral resources and so on.

Carrying on from the work engaged in 2014 to map Ifremer's property and assets, whether or not they have been utilised or developed for business to date, and to identify and characterise its high priority fields of activity, in 2015 our Institute created roadmaps for the requirements of the sectors and value chains in

question. Prospecting activities were also conducted in order to identify new partnerships. Meetings were held with Ifremer's existing partners with the aim of diversifying cooperation and bringing in new teams. There were also encounters organised with new targets (large corporations and SMEs) to initiate future collaborative work.

Our ambition is both to broaden the dissemination of our scientific results and technological developments towards stakeholders in social-economic realms and to help develop new French economic sectors and value chains by bringing our expertise and scientific facilities to industrial partners.

## Framework agreements and licences

An exclusive licence was granted to the Tecdron SME firm based in La Rochelle to manufacture and commercialise the know-how related to the SPEEdoo system for coastal water sampling, thanks to the collaborative work accomplished by the three Carnot institutes in the Captiven project. This small, lightweight and easy-to-transport drone can take water samples. It was perfected by two of Ifremer's research units: Dyneco (Coastal environmental dynamics) and RDT. SPEEdoo meets a specific need, i.e. to quickly and easily take seawater samples, up to 500 m from shore.

Several licencing agreements to share know-how for purposes of industrialisation were also signed with the NKE SME company. One is for Deep Arvor,

the profiling floats developed within the international Argo programme. The first of a new generation of deep-sea profiling floats, Deep Arvor can obtain data at depths reaching 3,500 m and meets the requirement of monitoring the deep ocean water masses which play a role in studying climate change. Deep Arvor was perfected by Ifremer in the framework of the Equipex NAOS (Novel Argo Observing System) project, the outcome of a strong partnership between Ifremer, UPMC (project co-sponsor), CNRS, UBO/

IUEM, SHOM and two private-sector firms: CLS for satellite telecommunications aspects and NKE in charge of industrialising and commercialising the floats.

The licence signed with NKE involves the transfer of know-how for Navloc beacons which can geolocate fishing vessels, for industrial and commercial end-uses. The project is part of a global one called Recopesca which is creating a network to measure fisheries activity and collect environmental data for scientific use.

## Patents

In the field of medicine, a European patent application was filed in September for a derivative of a marine native exopolysaccharide obtained using a process from a previous Ifremer patent. This glycosaminoglycan mimetic derivative has shown significant antimetastatic activity in preclinical models of metastases dissemination in bone. Its ability to inhibit tumour cell migration and invasion, as well as the development of pulmonary metastasis, was determined both *in vitro* and *in vivo*.

## Contract for collaboration

Ifremer and the Jouin Solution Plastique (JSP) company have jointly developed know-how in the field of developing photobioreactors to continuously produce microalgae in mollusc hatcheries. The

cooperation, which began in 2004 in the framework of a Cifre (industrial agreement for training through research) thesis with the University of Nantes, has enabled JSP to design and manufacture a high-performance model of photobioreactor for continuous production of

microalgae. An agreement was struck between JSP and Ifremer for the commercial utilisation of this photobioreactor. Simple and easy to use, it produces significant volumes of high-quality microalgae, from seawater or fresh water, using a nutrient solution, air and CO<sub>2</sub>.

# INTERVIEW

## Alexandre BESSON

Chief Technical Officer of the Alg&You start-up

*Winner of the 2030 Innovation Worldwide Challenge, Alg&You is a start-up company in Toulouse specialised in cultivating microalgae "at home". Its challenge is to make this sustainable foodstuff a food that people want to eat.*

### What are your expectations from your partnership with Ifremer?

*I had already worked with the PBA (algal physiology and biotechnology) laboratory at Ifremer's Atlantic centre on the Salinalgue project and the training I have in cultivating microalgae is thanks to the team there. To my mind, it is essential for us to be able to rely on their expertise and feedback in our work to optimise and ensure the safety of the culturing of our microalgae. Since our aim is to make growing microalgae accessible to everyone, working with experts on each one of the technological building blocks in our processes is the only way to rise to the challenge of democratising this technique!*

### You won the 2030 Innovation Worldwide Challenge, how are you going to exploit this success?

*With our ideas, we convinced several partners to follow us. Then, with*

*our partners, we convinced several public-sector funding entities to trust us. By winning phases 1 and 2 of this contest, we hope that our project now has credibility in the eyes of private-sector investors. We also want to take advantage of the media's showcasing this offer, to make microalgae for food more widely known in France. Our project is not just to create an enterprise, we want to promote the development of a new food value chain.*

### What are your targets in commercial terms?

*Alg&You is not just developing individual appliances to produce microalgae at home. We are also developing products made for restaurants and catering and for professionals in the health and wellness sector. Likewise, we've launched a consultancy service offer for industrial firms who want to recycle their waste to move towards a circular economy approach. The point that all our market segments have in common is the local production of edible microalgae. To learn more about our objectives in terms of sales, and society and the environment, you can consult our website ([www.alg-and-you.com](http://www.alg-and-you.com)) and join us on the social networks.*

### Have you got other projects to develop with Ifremer?

*Alg&You is positioned as a laboratory for innovations in the microalgae sector. Today we are mainly working on one microalga. How many of them still remain to be explored with Ifremer? Thousands...*



# Developing partnership-based research thanks to the Carnot Edrome Institute



The Ifremer-Edrome Carnot Institute for Sustainable exploration and exploitation of oceanic mineral and energy resources was created in 2006 and renewed in 2011 for a five-year period. In 2016, Ifremer will respond to the new Carnot call for proposals.

Research studies carried out within IC Ifremer Edrome focus on understanding the geological systems holding mineral and energy resources, including the characterisation of the associated ecosystems; developing tools for exploration, contributing to developing production systems including those specific to marine renewable energy sources, and even on regulating the utilisation of these resources and impacts on the environment.

The objective, through the Carnot approach, is to promote transfer of technologies, partnerships between public sector laboratories and companies and developing innovation.

In 2015, the IC Ifremer Edrome entity continued to participate in thematic value-enhancement Consortia of the Ancre and AllEnvi alliances, which gives it access to numerous studies (state of the art, market study, technology watch, academic stakeholders and key industrial firms) and thus consolidate its business development strategy. Training has been undertaken for the scientific teams, on raising awareness about intellectual property and about partnership-based research.

The Investments for the future project called Captiven (sensors and data for environmental quality of water and soil), conducted in association with the two other ICs, BRGM and Irstea, pursued its

objective to work collaboratively with businesses in the "environmental metrology sector" which can be SMEs, intermediate-sized firms or very small enterprises. Marketing and sales actions have been stepped up, as has the process of economic maturation.

Partnerships with other Carnot institute ICs (Cimat, BRGM, Cetim, Isifor, ARTS and Inria) and both national and international academic stakeholders also grew stronger in 2015. Additional funding from the Carnot programme made it possible to host foreign research scientists for periods of up to two years. Efforts continued to develop structuring partnerships over the medium- and long-term, with the aim of fostering joint research and development studies with industrial firms, like the research departments of oil (Total, Petrobras) or mining operators and with engineering firms or equipment manufacturers.

## Licence for the Salsa deep-ocean pump system

Salsa is an autonomous system to capture marine larvae at seabed depths reaching 4,000 m, developed and perfected by Ifremer's RDT unit. It was utilised at sea in the framework of the Momarsat 2015 cruise in April 2015. This led to the licensing of a Salsa (Serial Autonomous Larval Sampler) incubator prototype in 2015. The prototype makes it possible to observe the larvae of deep-sea organisms by recreating their natural conditions (pressure, temperature and chemical gradients).

The Salsa larval pump carries on from a Carnot project previously submitted by Ifremer. It involved improving a pump developed by the American firm McLane so that it could filter large quantities of water autonomously and thus collect larvae of marine organisms from the abyssal plain. The novelty of the system lies in the possibility of creating a time series by successively collecting several separate samples. An agreement was signed between Ifremer and McLane, who could utilise the know-how developed by Ifremer.

## A patent for a system to measure interstitial pressure in marine sediment

was filed by IC Ifremer Edrome, for France. It concerns protecting a new type of piezometer and the way it is deployed in sediment. Its innovative process for determining interstitial pressure was also protected in the filed patent.

## Collaborative work with IC BRGM

An IT tool to analyse data based on chemometric techniques was developed in 2015 in cooperation with IC BRGM. Analysing spectra using chemometrics can quantify organic compounds mixed in the water, such as BTEXs (benzene and its derivatives), which are on the WFD 2000/60/EC list of priority substances.

Moreau J., Rinnert E. 2015. *Analyst*.

# INTERVIEW

## Philippe MAGALDI et Jean-Luc LONGEROUCHE

GEPS Techno, SME

During COP21, the GEPS Techno young SME won the Pépites Tech contest, in the Smart energy systems category.

### Tell us about your innovations?

Geps Techno has developed an entire mix of solutions which can make the development of human activities at sea possible or easier. These innovations particularly concern floater stabilisation and power supply.

In terms of stabilisation, we base our work on the well-known principles of passive, Flume-type stabilisers which act as wave dampers for the boat's roll and we've introduced new designs that can incorporate cylinder-turbine-valve assemblages which act as power generators.

For energy generation, a system to harness wave energy was developed during the collaborative Pilote wave power project. It too is based on the same cylinder-turbine-valve system installed in a float divided into compartments. In July 2015, within the collaborative Pilote Hybride 4 Sources (PH4S) project, we commissioned and launched a hybrid power production solution combining, wind, hydraulic, photovoltaic and wave energy sources. Our objective is to

demonstrate that energy hybridisation is a high-performance response to the intermittent nature of these energy sources.

### What are the advantages in working with Ifremer?

For us, it is accessing the extraordinary experience gained over dozens of years during oceanographic cruises, in deployment of vehicles at sea or in terms of marine environmental measurements. It also lies in having access to high-performance test facilities, flume tank and hexapod system of course, but also the in situ test tank at Sainte-Anne-de-Portzic in the bay of Brest. Since November 2012, we have racked up over seven hundred days of sea trials for our prototypes. Finally, after the three programmes carried out jointly, it is always a pleasure for us to work with the Ifremer teams who passionate about the maritime realm.

### What are your ultimate objectives?

Our first objective for 2016 is commercial, setting up a network of sales agents who will enable us to roll out our international development. In R&D, our short-term objective is the IHES project. This col-

laborative project (2015-2018) with highly reputed partners, Ifremer of course, as well as STX, Blue Solutions, SNEF, ECN and ICAM, consists in developing a platform which is energy-autonomous and stabilised at 120 kW. The project is funded in the framework of the Investments for the future programme and is supported by the EMC2 and Pôle Mer Bretagne Atlantique competitiveness clusters.

In the medium term, based on the results from the IHES for intermediate power and from PH4S for hybridisation of energy sources, we will produce an initial prototype for the MLiner (moveable floating structure) concept that we hope to launch by 2020... And we're hoping to convince Ifremer to once again take part in the adventure!



©GEPS Techno

en 2015  
**10,746 k€**  
total income from contracts

**19** active licences  
**1** patent filed

**2** invention statements\*  
**2** Soleau envelopes\*  
**5** framework agreements with joint public/private sector labs



\*data from the PIA Captiven project, in addition to IC Ifremer Edrome objectives.

# DIALOGUE WITH SOCIETY

The subjects which Ifremer addresses are at the heart of many societal issues. Promoting scientific culture in marine sciences to broaden the debate with citizens is, *de facto*, one part of the Institute's remit. Throughout the year 2015, actions were undertaken to raise the public's awareness about the major stakes for the sea.

## The Climate's year

2015, the year of the COP21, was the opportunity for Ifremer to contribute to disseminating knowledge on the themes of ocean and climate. A photo exhibition whose theme was "the climate is changing and so is the ocean" was specially created for the occasion of COP21. It was displayed at the *Porte Dorée* aquarium in Paris, and on the railings of *Océanopolis* in Brest during the summer, and then on the railings of the *Arts & Métiers* museum in Paris. In twenty pictures, the exhibition shows the work of research scientists studying and observing the ocean, processing the data collected, and effects of global change on water bodies, on marine species and on the coast.

Prints from the exhibition in the form of a boxed set of postcards were distributed on a large scale during the COP21 branded events in which Ifremer actively participated: the Solutions COP21 show at the *Grand Palais* in the area called "Research rallying for climate action" coordinated by the Ministry in charge of Research, Research Day at Le Bourget, Climate Train stops and the Ocean & Climate forum organised by the Ocean and Climate platform in the Generations Climate Village at Le Bourget.

Ifremer joined the Ocean & Climate platform when it was launched two years ago. The platform has helped to promote the ocean theme and give it visibility in the Paris Agreement.

Prior to COP21, our Institute was also associated with the scientific web TV show called "*L'esprit sorcier*" to produce a complete educational package on the Ocean and Climate theme. A one-day event was organised on 30 October at the Ifremer Brittany centre. The highlights were two TV shows hosted by Fred COURANT which were broadcast live and then available on replay on line: one was a fun and educational game show aimed at children and young people; the other was a ninety-minute live TV talk show with the presence of several researchers from Ifremer and the polar explorer Jean-Louis ÉTIENNE.

Ifremer's Chairman was also invited to speak on the theme of the climate at the opening session of the Maritime economy congress in Marseille before more than 1,800 participants from the maritime economic realm.



## European Sea for Society project results

As a partner in the EU Sea for Society project since 2011, Ifremer contributed to the project's final phase by taking part in the Europe-wide consultations for citizens and experts organised in 2015. They enabled "barriers" to be identified and proposals to be made on six themes related to the ocean. Mobilisation activities were also conducted to inform citizens and stakeholders about the benefits and services to humans rendered by the sea and to make the Blue Society concept better known. This work has led to proposals for research and governance which have been submitted to Euro-MPs and the European Commission.



## Marine-related books published by éditions QUAE

Ifremer is one of the four founding bodies, along with Cirad, INRA and Irstea, of the Quae publishing house, now an acknowledged player in scientific and technical publication in France.

Thanks to collections like *Clés pour comprendre* (Keys to understanding) or *Carnets de Sciences* (Science log-books) the research community provides accessible and scientifically impeccable information to a readership of non-experts with curious minds.



## What's new on the web and social networks

Several novel operations were conducted in 2015 to supply dynamic and innovative internet content for marine science buffs.

For instance, in spring, Ifremer took part in MuseumWeek on Twitter. With nearly 2,000 museums in fifty-eight countries participating, this global Twitter operation aimed to popularise cultural institutions and make them known to a new audience. This year, the event was also open to scientific institutions.

In early November, a member of the communications team embarked on the Evhoe research cruise to supply articles and photos for a blog. This enabled the general public to discover daily life aboard RV *Thalassa* on a fisheries resource assessment cruise.

## "Voyages planétaires" in Nantes

A major exhibition called "*Voyages planétaires: sur la trajectoire d'une comète*" (Planetary travels: on the trail of a comet) organised by the Nantes Laboratory of Planetology and Geodynamics gave the local Nantes community an exceptional opportunity to rub shoulders with the world's leading specialists in planetology and science of the universe, jointly with a scientific conference bringing together over eight hundred international scientists. The exhibition, with free admission, received 21,000 visitors from 28 September to 4 October at the *Cité des congrès* conference centre in Nantes. Ifremer participated in the exhibition with a stand on Deep seafloors and a conference casting light on the abyssal plains.

## Two participatory science operations about plankton

Middle school students from the Ponant island schools network (Batz, Ushant, Molène and Sein islands), partners since 2014 in the Phenomer project of the participatory science programme led by Ifremer, presented a film, a radio broadcast report and drawings of plankton in a contest for young reporters on arts, science and the environment. The contest is sponsored by *Océanopolis*, and creates the opportunity to present works of Art and Science combined.

In the framework of the *Hermione* frigate's Great Voyage from 18 April to 10 August 2015, Ifremer engaged a partnership with the maritime high school in La Rochelle whose students sailed along with *Hermione* aboard the *K VIII* sailing boat during its voyage in the North Atlantic and along the coasts of the United States. The aim was to entrust them with a scientific assignment to collect marine plankton in order to form a collection of samples to be studied later by Ifremer and MNHN.



# ACCOMPANYING IFREMER ON THE MOVE

## Upgrading human resource management tools

The launch of the new HRAccess software suite is a major step in the context of implementing integrated enterprise resource planning (ERP) management software at Ifremer. The preparation for its deployment in 2013 and 2014 enabled Ifremer to successfully launch its new human resource ERP package as of the 1<sup>st</sup> January 2015.

In a project-based approach, the HR and IT teams in metropolitan and overseas France deployed this tool over the scope of administrative management (including employee absences) and the payroll. A portal for users has also been made available to all salaried employees. Thanks to improved interactivity, it allows HR managers to devote their time to tasks with higher added value. This facilitates and expedites the dissemination of human resource information and the dematerialisation of data flows.

Preparatory work was undertaken to upgrade and modernise the training management tool, with complete deployment slated for 2016.

Along with deploying the initially planned functions, the need to make some compulsory changes also came to light. They involved the social contributions declaration made by French employers to the administration and the implementing of the new DSN personalised declaration which is an important measure in the government's radical simplification approach aiming to replace multiple filings (DMMO for labour force movements and other monthly or annual administrative declarations like DUC or DADS) by a single monthly declaration to a "one-stop shop" using standardised and dematerialised electronic data transfers.

These regulatory developments, along with their compulsory implementation as of 1<sup>st</sup> January 2016, led to developing the new standard within HRAccess. Following the test phase completed in late December 2015, the first DSN declaration was successfully produced in January 2016.

## Preparing the deployment of the new integrated management ERP software package

Development of version V1 of the SAP ERP resumed in October 2014 following a phase of reconfiguration of the work approach. It was successfully carried out to software package acceptance in late 2015. In order to secure the SAP developments and avoid getting into a future phase of overly complex maintenance, the new development method consisted in relying as much as possible on the "pre-configured" public sector SAP version from Sopra Steria and strictly limiting special developments.

In this context, the design work, which was based on a detailed description of the Institute's financial, budgetary and ac-

counting target processes, defined how Ifremer's business requirements could be modelled in the SAP software, described the management rules to be developed and defined the control parameters. An integrator ensured the parametrization and developments, which also took into account the various reference systems specific to our Institute (budget, analytical, procurement and income, accounting plan reference, etc.) which were collected and translated into the SAP model before being loaded into the software tool. The test, integration and acceptance phases have now made it possible to obtain a basic tool meeting the initial project objectives.

However, at the time when the public call for tender was published in 2012 and led to the selection of Sopra Steria as the integrator, the terms and conse-

quences of the Public sector budget and accounts management (GBCP) order were still unknown.

Analysing the new regulatory framework, which must be put into application by the Institute as of 1<sup>st</sup> January 2017, the need for stronger security for monetary flows, the need to simplify day-to-day management tasks for the users (employees and managers), improve steering possibilities and reinforce dematerialisation have led Ifremer to define the scope of a second V2 version. It is designed to complement the V1 version which will be put into operation in accordance with a newly adapted organisation of the budgetary and accounting sphere. This will be an important project for the Institute throughout the year 2016.

## Employer-union dialogue

The two collective agreements signed were milestones for the year 2015.

A new agreement on training was signed in December 2015 with the CFDT and CGT trade unions. It follows the 5 March 2014 law establishing a vocational training reform and a personal training account system, thus eliminating the former DIF individual training rights. The main objectives of Ifremer's training system are to maintain existing skill sets and acquire new ones, develop employees' professional qualifications and support employees' career path progression through training courses leading to qualifications and diplomas.

Attentive to the social protection of its salaried staff, Ifremer renewed the employees' Health costs scheme on 1<sup>st</sup> January 2015 and chose a new insurance firm. Over the year 2015, Ifremer carried out the actions required to bring the Health coverage into compliance with regulations concerning "responsible" contracts, in keeping with the 1<sup>st</sup> January 2016 deadline. The new guarantees and all of the conditions for additional social protection benefiting the Institute's salaried employees underwent negotiations for a collective agreement which was signed with the above-mentioned trade unions in December 2015.

## Transfer of headquarters to Brest: support measures for employees

After consulting the unions and staff representatives, Ifremer's Board of directors ruled on the 1<sup>st</sup> of October 2015 in favour of transferring the head offices to the Brittany centre in Plouzané (western France). The decision falls under the French government's project to promote the development of a world-class cluster on marine sciences and technologies in the region of Brittany. Aware of the decision's consequences for the salaried employees who work at headquarters, Ifremer's management and the supervisory ministries announced they would pursue the objective of ensuring that each one of them will have found a job solution by the date of the transfer.

Ifremer's management and the representative trade unions quickly engaged negotiations to agree on the method to be employed. This agreement was signed by workers and management in order to supervise and secure negotiations in coming months on specific support measures for the ensuing moves to come.

## Training

Training remains a vital component of Ifremer's attractiveness and is essential for developing its employees' skill sets. Ifremer thus wanted to significantly increase the number of young people recruited on combined work-study contracts in 2015. As of 1<sup>st</sup> October 2015, our Institute hosted forty-five people on vocational or apprenticeship contracts (nearly double the figure from 2014). Some two-thirds of these contracts involve scientific or technological training courses, at levels ranging from BTS higher technical certificate to Master's or Engineering degrees. Training for young people also involves supervising seventy-eight PhD students (under contract with Ifremer), thirty post-doc

fellows and twenty-four civilian service volunteers (VSC) on our sites in overseas France.

Likewise, Ifremer gives its employees the possibility of preparing lengthy training courses or those leading to degrees or qualifications. By the end of 2015, twenty-seven people were preparing or were going to prepare a diploma course or skills training in scientific (sixteen) or administrative (eleven) fields, for the most part in the framework of an approach to validate prior experience (VAE), enabling either credits toward a degree or a full diploma to be obtained.

The ten PhD theses in continuing education and the thirty accreditations to

supervise research (HDR), underway in late 2015, also contribute to developing both expertise and career perspectives.

Lastly, in the framework of its 2015 training plan, Ifremer developed cross-cutting training themes, specifically on project and team management. A new management training course was organised for employees who were recently appointed to a managerial position. In particular, it included themes of conflict management and preventing psychological and social risks, as well as strongly raising awareness about in-house systems for managing human resources, finances, hygiene and safety.

## Sustainable development

The Institute carried out a diagnosis of its sustainable development-social responsibility (SD-SR) approach during a day-long meeting and peer discussions on 9<sup>th</sup> January 2015 at the Brittany centre.

This peer discussion meeting (RPP) was scheduled and held in the framework of exchanges with the Public establishments and publicly-owned companies sustainable development club (emanating from the Ministry of the Environment, Energy and the Sea's General commission for sustainable development) which Ifremer belongs to.

The five peer-auditors, two of them from the General commission for sustainable development, two from *Banque de France* and one from the National Institute for the Industrial Environment

and Risks (Ineris) endeavoured to verify whether Ifremer took social responsibility for organizations into account in its internal functioning as well as in carrying out its missions and as an enterprise serving society and attentive to its stakeholders.

Following this diagnosis, the Institute was invited to take part in an ISO 26000 surveillance evaluation at *Banque de France* on 24 September, where one of the objectives according to the Afnor Certification auditor, was to assess how *Banque de France* influences its "sphere of influence" and helps engage other bodies in a Corporate Social Responsibility approach.

Along with this, an initial exercise was conducted to produce a diagnosis in the form of the in-house sustainable development - social responsibility 2014 re-

port in order to measure and evaluate the Institute's performance with respect to laws, rules, codes, standards and voluntary initiatives and to report on its involvement in terms of expectations related to sustainable development.

In compliance with its objectives contract, which identified Ifremer's need to strengthen and implement a programme of actions in eco-responsibility and sustainable development, and on the basis of the diagnoses mentioned, thought and discussion has begun in order to propose in-house governance SD-SR orientations and procedures. This is based on the Corporate Social Responsibility principles and guidelines for public institutions, the exemplary administration plan (PAE) approach and the nine challenges of the National strategy for sustainable development (SNDD).

## Ifremer's contribution to sustainable development through research

Thanks to the Bibliometrics service of the La Pérouse library (BLP), the Institute analyses the articles indexed by Thomson-Reuters (Web of Science) as well as expert advice and reports related to sustainable development concepts, in order to better evaluate the contribution of our teams and partners in this holistic approach. In 2014, nearly 16% of Ifremer's production, taking all types of documents into account (publications, reports, expert advice, book chapters, etc.), was linked to the theme of sustainable development. In the Web of Science alone, the proportion of articles associated with this theme has constantly grown since 2000, going from 6% to 21%.

## Quality

### Ifremer's ISO 9001 certification was successfully renewed.

To ensure the reliability and traceability of actions conducted, promote greater rigour in managing activities and project and guarantee our partners the exacting standards which drive our actions, Ifremer has had a quality system in place for four years now, covering all its activities and in application on all twenty-four of our Institute's sites.

The system is aiming to take care of malfunctions which can appear in daily operations and which have not been dealt with until now. It also gathers proposals to improve the way things function in-house and implements them in keeping with the principle of continuous improvement.

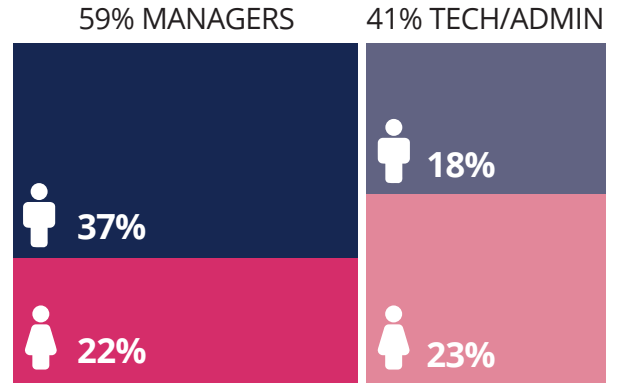
To validate its implementation, Ifremer's quality system was first audited in November 2012 by AFAQ-Afnor, which issued its ISO 9001 certification for a three-year period. Every year since that date, the organisation's auditors have come to audit all sites in metropolitan and overseas France. This was the case in November 2015 with the auditing of the sites of Cayenne, Nantes, Bouin, Toulon, Port-en-Bessin, Dinard and Issy-les-Moulineaux. At the outcome of the exercise, the certification was renewed for three years, beginning 25 November 2015.

## The Institute's workforce

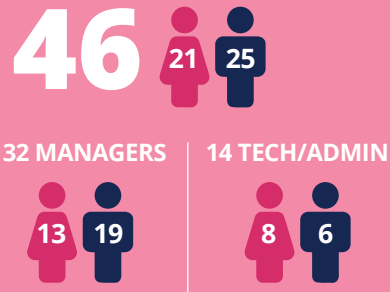
Ifremer's total work force as of 31 December 2015 was 1,464 salaried employees, including 171 on fixed-term contracts. The breakdown between managerial and technical staff is 59% managers and 41% technicians. Female staff make up 45% of the personnel, which is a slight increase from 2014. The proportion of women being hired has also risen. Thus, out of 46 recruitments in 2015, 46% were women and 70% of the newly hired employees were managers.

**1,464**   
**SALARIED EMPLOYEES**  
 including 171 with fixed-term contract

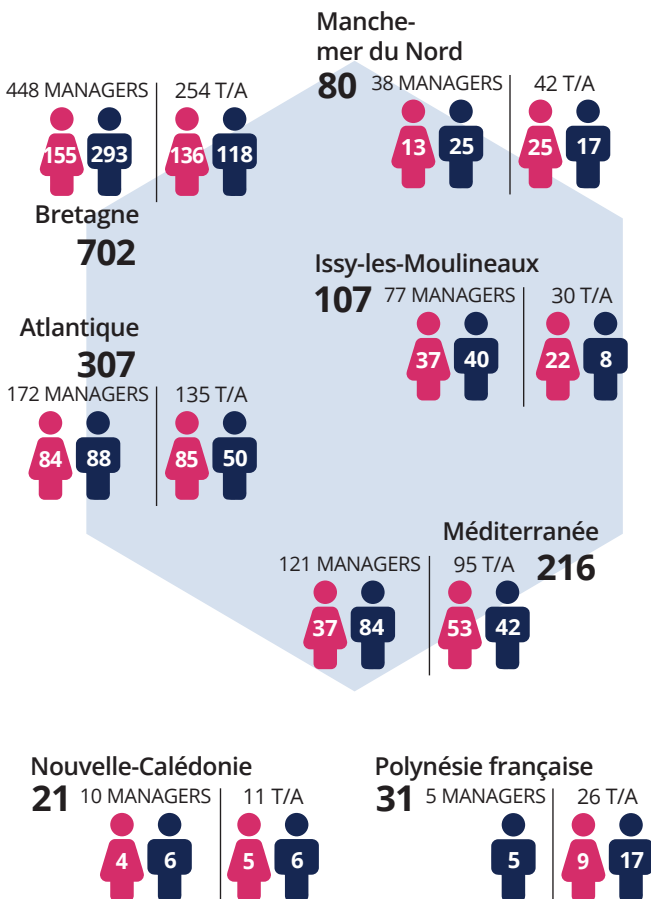
## BREAKDOWN OF MEN-WOMEN BY CATEGORY



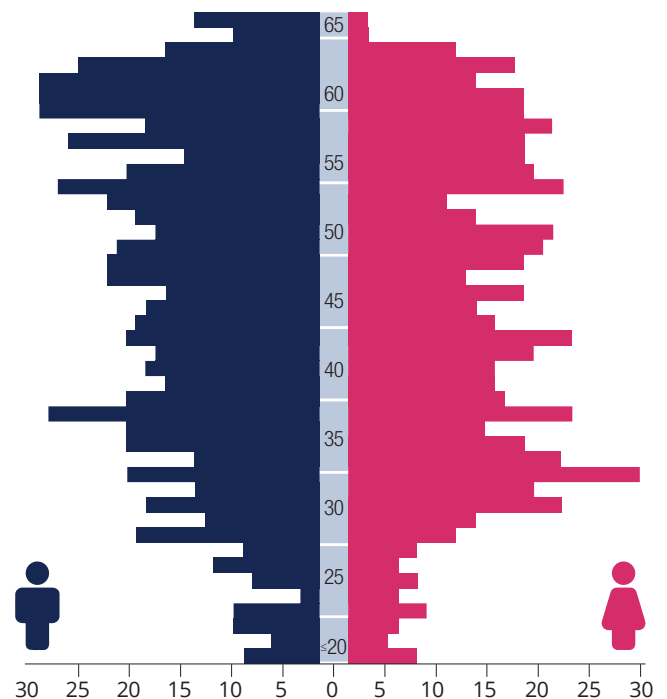
## RECRUITS (PERMANENT CONTRACTS) IN 2015



## BREAKDOWN OF LABOUR FORCE BY CENTRE



## AGE PYRAMID AS OF 31 DECEMBER 2015



# Budget and financial figures

## Financial year 2015

The 2015 budget performance features a positive profit-and-loss account balance of 14.22 million euros. Including internal transactions, this balance is the result of costs reaching 204.25 million euros for deferred revenues amounting to 218.48 million euros. The balance goes in part into the reserve fund earmarked for the transfer of the headquarters to Brest, to the amount of 0.95 million euros. Another part of it will be used to finance the facilities, equipment and investment operations conducted over the past year.

The difference between the resources mobilised externally by the Institute, which finance the equipment and investment operations, and the investment spending, effective as of 31 December 2015 reached -20.74 million euros (\*). Therefore, the 2015

financial year shows a consolidated loss of -6.52 million euros.

The conclusions which were drawn in the 2014 management report stressed that great caution should be exercised in appraising the 2014 results (+€2.64M). The performance of the 2015 budget has given full significance to the warnings expressed at the time. Indeed, 2015 ends with a loss, in spite of careful management and continuing control of spending, particularly that of operating expenses (so-called core expenditure).

A parallel could be drawn between the amount of -6.52 million euros and the fact that the income expected (€6.45M) under the European Maritime and Fisheries Fund (EMFF) agreement for the collection of data could not be paid, considering that, when all is said and done, the situation was linked to economic circumstances.

That would mean disregarding the other operations postponed during the financial year and, in particular, the decrease of the level of revenues expected, directly linked to partnerships with private-sector companies and especially the research and development divisions of oil companies (with the Exxon/DSF, Exxon/Ghass and Total/Moz3-5 programmes being cancelled or postponed).

In other words, even though our Institute benefited from the drop in crude-oil prices (in the context of managing its contract with Genavir), and has increasingly adopted a prudent management approach as the problematic nature of the context has unfolded, this has not been enough to alleviate the institution's difficulties in the long run, revealing that the pressure on resources with respect to the missions assigned remains unchanged over the medium term.

## Resources

In 2015, Ifremer's total assets amounted to 227.53 million euros, thus down by -2.96% from 2014 (€233.82M). Not including internal transactions, these resources reached 205.39 million euros, indicating

a decrease of -5.83 million euros (-2.76%) between 2014 (€211.02M) and 2015. The levels of subsidies for public service charges (SCSP) and of programme transfers were stable between the two financial years. However, contractual resources dropped by 8.92 million euros, i.e. by

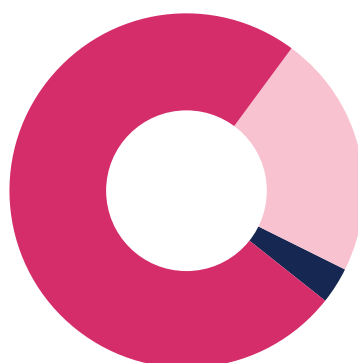
-16.36%. This means they went from 54.51 million euros in 2014 to 45.59 million euros in 2015.

The Institute drew on its reserves to the amount of €4.89M in 2015.

## Breakdown of resources (not including internal transactions)

### 2015 budget performance

- Subsidies for public charges
- Contractual resources
- Other resources



**205.39 M€  
resources  
not including internal  
transactions**

\* not including realizing the cash flow and own resources of the Institute

## Total resources of Ifremer (in euros)

Total resources	Performance 2014	Forecast* 2015	Performance 2015	Trend 2015 Forecast/Performance	
				in euros	%
<b>Available resources on SCSP subsidy grants for Public service charges, headings II and transfers headings VI</b>	153,981,217	153,447,942	153,197,627	-250,315	-0.2%
SCSP/ Heading III - <b>Programme 172 (ex187): Research in the field of environmental and resource management</b>	149,384,424	147,503,940	147,584,208	80,268	0.1%
TRANSFER/ Heading VI - <b>Programme 113: Landscapes, water and biodiversity</b>	150,000	1,020,000	870,000	-150,000	-
TRANSFER/ Heading VI - <b>Programme 205: Maritime safety and affairs, fisheries and aquaculture</b>	1,850,000	1,850,000	1,497,417	-352,583	-
TRANSFER/ Heading VI - <b>Programme 206: Food safety and health and hygiene quality</b>	2,485,791	3,000,000	3,172,000	172,000	-
SCSP/ Heading III - <b>Programme 172: Multidisciplinary scientific and technological research</b>	111,002	74,002	74,002	-	0.0
<b>Contractual resources</b>	54,515,483	54,507,838	45,594,237	-8,913,601	-16.4%
comprising Contractual resources (not including subsidies under programmes 113, 205 and 206)	51,149,119	52,329,871	42,622,235	-9,707,636	-
of which subsidies in addition to transfers / Headings VI	3,366,364	2,177,967	2,972,002	794,035	-
<b>Write-off of depreciations not related to internal transactions</b>	863,069	3,065,000	1,711,750	-1,353,250	-44.2%
Sums taken from Institute's working capital	1,860,830	-	4,886,616	4,886,616	-
<b>TOTAL RESOURCES AVAILABLE not including internal transactions</b>	211,220,599	211,020,780	205,390,230	-5,630,550	-2.7%
<b>Net book value of assets written off (internal transactions)</b>	58,451	300 000	274,581	-25,419	-8.5%
<b>Depreciation expenses (internal transactions)</b>	23,199,146	22,500,000	20,284,287	-2,215,713	-9.9%
<b>TOTAL RESOURCES AVAILABLE not including capitalised production costs</b>	234,478,196	233,820,780	225,949,098	-7,871,682	-3.4%
<b>Capitalised production costs</b>			1,583,525		
<b>TOTAL RESOURCES AVAILABLE</b>	234,478,196	233,820,780	227,532,623	-6,288,157	-2.7%

(\*) Amended budget n°2

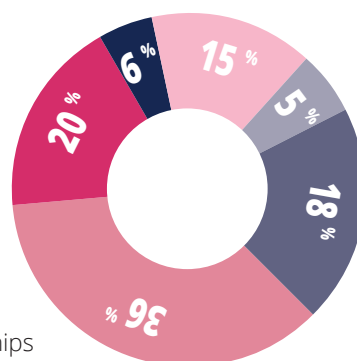
## Contractual operational resources broken down by source of funding (in euros)

Contractual resources	Performance 2014	Performance 2015	Trend 2014-2015	Forecast * 2015	Performance 2015	Trend 2015
Contributions from French State	4,996,047	6,180,008	1,183,961	5,681,299	6,180,008	498,709
French national research agency	2,048,292	2,076,849	28,557	2,724,623	2,076,849	-647,774
European Union bodies and international partnerships	12,522,456	7,045,602	-5,476,854	12,522,456	7,045,602	-5,883,784
Local and regional authorities and other public partnerships	11,311,866	14,352,298	3,040,432	12,617,644	14,352,298	1,734,654
Private partnership	15,073,013	7,925,302	-7,147,711	13,254,594	7,925,302	-5,329,292
Miscellaneous income	2,303,513	2,583,422	279,909	1,966,916	2,583,422	616,506
<b>Total</b>	<b>48,255,186</b>	<b>40 163 480</b>	<b>-8 091 704</b>	<b>49,174,462</b>	<b>40,163,480</b>	<b>-9,010,982</b>

(\*) Amended budget No.2

### Contractual operational resources broken down by source of funding 2015 budget performance

- French State
- ANR national research agency
- European Union and international organisations
- Local and regional authorities and other public partnerships
- Private partnerships
- Miscellaneous income



**40,16 M€  
contractual  
resources**



## Expenditure

With regard to these means, Ifremer's consolidated expenses for 2015 amounted to 225.87 million euros. Not including internal transactions, they reached 203.60 million euros (for a draft budget of 207.96 million euros adopted in the amending budget N°2).

Performance in 2015 was characterised by a decrease in staff costs (down by -€3.05M) and a drop in spending related to fleet scheduling (-€1.7M). The third item contributing to the overall decline in spending is related to the delay in constructing the Resource centre for marine samples and archives (Cream) on the Brest site, related to the unsuccessful call for tender.

2015 performance also features an increase in the cost of depreciations not covered: the amount due to recosting of the work for the headquarters remains set at 0.865 million euros; in addition to this is the cost of depreciations which have not been covered, in compliance with the application of new regulations and of the scheme for "earmarking of fixed assets".

## Total expenditure of Ifremer (in euros)

Total expenditure	Performance 2014	Forecast* 2015	Performance 2015	% of total expenditure performed	Trend Forecast/ Performance 2015		Trend 2014/2015	
					in euros	%	in euros	%
Payroll expenses (Ifremer)	109,207,998	109,663,344	106,612,407	52.4%	-3,050,937	-2.8%	-2,595,591	-2.4%
Fleet-related spending	42,707,565	41,539,800	39,848,587	19.6%	-1,691,213	-4.1%	-2,858,978	-6.7%
Expenses related to scientific activities	35,410,111	32,414,975	34,504,336	17.0%	2,089,361	6.5%	-905,776	-2.6%
Logistics/centres	14,146,485	17,551,510	16,502,722	8.1%	-1,048,788	-6.1%	2,356,237	16.7%
Support expenses	3,197,971	3,238,907	3,002,398	1.5%	-236,509	-7.3%	-195,573	-6.1%
Cross-cutting activities	1,919,912	3,547,244	3,127,402	1.5%	-419,842	-11.8%	1,207,490	62.9%
<b>Total expenditure (not including depreciation and internal transactions)</b>	<b>206,590,043</b>	<b>207,955,780</b>	<b>203,597,851</b>	<b>100%</b>	<b>-4,357,929</b>	<b>-2.1%</b>	<b>-2,992,191</b>	<b>-1.5%</b>
<b>Depreciations not including internal transactions</b>	<b>863,069</b>	<b>3,065,000</b>	<b>1,711,750</b>	<b>1.3%</b>	<b>-1,353,250</b>	<b>-44.3%</b>	<b>848,681</b>	<b>98.3%</b>
<b>Internal transactions</b>	<b>23,257,597</b>	<b>22,800,000</b>	<b>20,558,868</b>	<b>16.1%</b>	<b>-2,241,132</b>	<b>-9.8%</b>	<b>-2,698,729</b>	<b>-11.6%</b>
<b>Total expenditure (including depreciation and internal transactions)</b>	<b>230,710,709</b>	<b>233,820,780</b>	<b>225,868,469</b>	<b>100%</b>	<b>-7,952,311</b>	<b>-3.4%</b>	<b>-4,842,239</b>	<b>-2.1%</b>
Payroll expenses (Ifremer + Genavir)	131,270,087	131,567,344	128,048,408		-3,518,936	-2.7%	-3,221,679	-2.5%

(\*) amended budget No.2

# FINANCIAL RESULTS

Balance at closing before allocation of profit or loss (in euros)

BALANCE SHEET - ASSETS	2015			2014	Trend
	Gross	Depreciation and provisions	Net	Net	
<b>FIXED ASSETS</b>					
<b>INTANGIBLE FIXED ASSETS</b>					
Initial expenses	13,270.16	13,270.16	0.00	0.00	-
Research and development costs	20,000.00	6,888.89	13,111.11	19,777.78	-33.7%
Concessions and other rights, patents, licences, trademarks, processes, software and rights	35,217,270.66	31,704,574.93	3,512,695.73	3,350,406.75	4.8%
Purchased goodwill	0.00	0.00	0.00	0.00	-
Other intangible fixed assets	208,522.16	208,522.16	0.00	6,916.67	-100.0%
Intangible assets in progress	5,006,275.04	0.00	5,006,275.04	3,634,759.26	37.7%
Advances and prepayments on orders for intangible fixed assets	2,930,740.01	0.00	2,930,740.01	2,520,347.45	16.3%
<b>TOTAL - INTANGIBLE FIXED ASSETS</b>	<b>43,396,078.03</b>	<b>31,933,256.14</b>	<b>11,462,821.89</b>	<b>9,532,207.91</b>	<b>20.3%</b>
<b>TANGIBLE FIXED ASSETS</b>					
Land and developments	7,474,429.72	1,130,024.81	6,344,404.91	6,309,048.81	0.6%
Buildings	115,776,784.00	66,502,586.67	49,274,197.33	51,631,464.52	-4.6%
Industrial fixtures, plant and equipment	124,377,925.05	112,580,305.37	11,797,619.68	11,665,785.21	1.1%
Collections	895,724.14	0.00	895,724.14	932,975.82	-4.0%
Vessels and underwater vehicles	215,543,087.01	132,762,390.62	82,780,696.39	89,562,081.22	-7.6%
Other tangible fixed assets	34,901,981.48	31,936,291.13	2,965,690.35	3,508,880.22	-15.5%
Tangible assets in progress	6,187,069.85	0.00	6,187,069.85	4,957,787.45	24.8%
Advances and prepayments on orders for tangible fixed assets	17,823,758.43	0.00	17,823,758.43	10,874,869.52	63.9%
<b>TOTAL - TANGIBLE FIXED ASSETS</b>	<b>522,980,759.68</b>	<b>344,911,598.60</b>	<b>178,069,161.08</b>	<b>179,442,892.77</b>	<b>-0.8%</b>
<b>INVESTMENTS</b>					
Holdings	680,089.93	164,511.85	515,578.08	515,578.08	0.0%
incl. other forms of investment (QUAE)	125,000.00	0.00	125,000.00	125,000.00	0.0%
Receivables attached to holdings	0.00	0.00	0.00	0.00	-
Portfolio investments	0.00	0.00	0.00	0.00	-
Other investment securities	0.00	0.00	0.00	0.00	-
Loans	5,716,334.10	0.00	5,716,334.10	5,586,511.10	2.3%
Other (deposits and guarantees paid)	441,130.17	0.00	441,130.17	446,873.85	-1.3%
<b>TOTAL - INVESTMENTS</b>	<b>6,837,554.20</b>	<b>164,511.85</b>	<b>6,673,042.35</b>	<b>6,548,963.03</b>	<b>1.9%</b>
<b>TOTAL - FIXED ASSETS</b>	<b>573,214,391.91</b>	<b>377,009,366.59</b>	<b>196,205,025.32</b>	<b>195,524,063.71</b>	<b>0.3%</b>

BALANCE SHEET - ASSETS	2015			2014	Trend
	Gross	Depreciation and provisions	Net	Net	
<b>CURRENT ASSETS</b>					
<b>TOTAL - INVENTORIES AND WORK IN PROGRESS</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>-</b>
<b>TOTAL - ADVANCES AND PREPAYMENTS ON ORDERS</b>	<b>3,918,547.17</b>	<b>0.00</b>	<b>3,918,547.17</b>	<b>3,948,819.88</b>	<b>-0.8%</b>
<b>DEBTS</b>					
Customer and related accounts receivable	8,825,498.41	1,668,570.12	7,156,928.29	10,193,828.10	-29.8%
<i>Others</i>	26,826,380.41	0.00	26,826,380.41	25,979,787.88	3.3%
<i>incl. Payroll and related accounts</i>	120,345.15	0.00	120,345.15	92,047.40	30.7%
<i>incl. social security and social admins</i>	0.00	0.00	0.00	0.00	
<i>incl. State and local authorities</i>	26,706,035.26	0.00	26,706,035.26	25,887,740.48	
<i>incl. subsidies</i>	6,686,152.39	0.00	6,686,152.39	8,702,771.23	
<b>TOTAL - DEBTS</b>	<b>35,651,878.82</b>	<b>1,668,570.12</b>	<b>33,983,308.70</b>	<b>36,173,615.98</b>	<b>-6.1%</b>
<b>TOTAL - NON-OPERATING LIABILITIES</b>	<b>1,064,312.41</b>	<b>0.00</b>	<b>1,064,312.41</b>	<b>68,459.66</b>	<b>1,454.7%</b>
<b>CASH</b>					
Shares (listed securities)	0.00	0.00	0.00	0.00	-
Other securities	0.00	0.00	0.00	0.00	-
Banking	36,003,922.48	0.00	36,003,922.48	34,153,282.70	5.4%
<i>incl. Private banks</i>	459,248.05	0.00	459,248.05	308,598.39	48.8%
<i>incl. Public finances general directorate</i>	35,536,190.30	0.00	35,536,190.30	33,800,571.08	5.1%
Cash account	3,165.62	0.00	3,165.62	3,321.79	-4.7%
Authorisation to incur expenses	49,449.87	0.00	49,449.87	40,502.27	22.1%
Authorisation to receive funds	50.00	0.00	50.00	50.00	0.0%
<b>TOTAL - AVAILABLE FUNDS</b>	<b>36,056,587.97</b>	<b>0.00</b>	<b>36,056,587.97</b>	<b>34,197,156.76</b>	<b>5.4%</b>
<b>ADJUSTMENTS</b>					
Deferred charges	26,307.76	0.00	26,307.76	17,354.11	51.6%
<b>TOTAL - ADJUSTMENTS</b>	<b>26,307.76</b>	<b>0.00</b>	<b>26,307.76</b>	<b>17,354.11</b>	<b>51.6%</b>
<b>TOTAL - CURRENT ASSETS</b>	<b>76,717,634.13</b>	<b>1,668,570.12</b>	<b>75,049,064.01</b>	<b>74,405,406.39</b>	<b>0.9%</b>
<b>TOTAL - ASSETS</b>	<b>649,932,026.04</b>	<b>378,677,936.71</b>	<b>271,254,089.33</b>	<b>269,929,470.10</b>	<b>0.5%</b>

## Balance at closing before allocation of profit or loss (in euros)

BALANCE SHEET - LIABILITIES		Financial year 2015	Financial year 2014	Trend
<b>EQUITY</b>				
<b>CAPITAL</b>		<b>0.00</b>	<b>0.00</b>	<b>-</b>
<b>ALLOCATION CONTRIBUTIONS</b>				
State - Allocations		347,193.57	347,193.57	0.0%
State - Additional allocations		497,528,413.76	508,754,379.43	-2.2%
Other organisations - Additional allocations		0.00	0.00	-
Balance sheet carry forward		- 355,070,918.96	- 347,666,401.30	2.1%
Capital donations and legacies		0.00	0.00	-
Premiums from share issues, mergers, assets brought in		0.00	0.00	-
<b>TOTAL - ALLOCATION CONTRIBUTIONS</b>		<b>142,804,688.37</b>	<b>161,435,171.70</b>	<b>-11.5%</b>
<b>TOTAL - REEVALUATION RESERVES OR SURPLUS</b>		<b>18,760,830.03</b>	<b>19,581,213.74</b>	<b>-4.2%</b>
<b>RESERVES</b>				
Legal reserve		0.00	0.00	-
Statutory or contractual reserves		0.00	0.00	-
Regulated reserves		0.00	0.00	-
Optional reserves		5,190,947.72	1,728,698.74	200.3%
Other reserves		0.00	0.00	-
<b>TOTAL - RESERVES</b>		<b>5,190,947.72</b>	<b>1,728,698.74</b>	<b>200.3%</b>
<b>BALANCE BROUGHT FORWARD</b>		<b>228,164.75</b>	<b>228,164.75</b>	<b>0.0%</b>
<b>RESULT FOR FINANCIAL YEAR (PROFIT OR LOSS)</b>		<b>14,223,938.53</b>	<b>2,641,865.27</b>	<b>438.4%</b>
<b>INVESTMENT GRANTS</b>				
Investment grants		25,362,775.53	24,375,368.16	4.1%
Balance sheet carry forward		- 14,399,665.43	- 13,693,777.70	5.2%
<b>TOTAL - INVESTMENT GRANTS</b>		<b>10,963,110.10</b>	<b>10,681,590.46</b>	<b>2.6%</b>
<b>TOTAL - EQUITY CAPITAL</b>		<b>192,171,679.50</b>	<b>196,296,704.66</b>	<b>- 2.1%</b>
<b>PROVISIONS</b>				
Provisions for contingencies		1,611,000.00	1,703,105.00	-5.4%
Provisions for expenses		16,884,833.82	16,085,453.82	
incl. Provisions for pensions and similar obligations		12,660,320.08	12,038,717.08	5.2%
incl. Provisions for Unedic commitments		3,345,498.18	3,167,721.18	5.6%
incl. Other provisions for charges		879,015.56	879,015.56	0.0%
<b>TOTAL - PROVISIONS</b>		<b>18,495,833.82</b>	<b>17,788,558.82</b>	<b>4.0%</b>
<b>LIABILITIES</b>				
<b>LOANS AND RELATED LIABILITIES</b>				
Convertible debenture loans		0.00	0.00	-
Other debenture loans		0.00	0.00	-
Loans and liabilities from credit institutions		0.00	0.00	-
Misc. loans and financial debts		34,771.41	34,771.41	0.0%
<b>TOTAL - LOANS AND RELATED LIABILITIES</b>		<b>34,771.41</b>	<b>34,771.41</b>	<b>0.0%</b>
<b>ADVANCES AND PREPAYMENTS ON ORDERS</b>		<b>537,058.34</b>	<b>318,894.36</b>	<b>68.4%</b>
<b>OPERATING LIABILITIES</b>				
Trade accounts payable and related accounts		8,407,947.08	10,276,860.53	- 18.2%
Tax and social security payable		42,963,933.89	37,520,792.65	14.5%
incl. Payroll and related accounts		11,465,690.95	11,242,999.04	2.0%
incl. Social security and social organisations		11,150,164.59	11,155,008.90	
incl. State and local authorities		5,352,553.46	4,165,854.22	
incl. advances and prepayments received on grants		14,995,524.89	10,956,930.49	36.9%
<b>TOTAL - OPERATING LIABILITIES</b>		<b>51,371,880.97</b>	<b>47,797,653.18</b>	<b>7.5%</b>
<b>NON-OPERATING LIABILITIES</b>				
Liabilities on fixed assets and related accounts		5,131,612.91	3,346,293.49	53.4%
Other liabilities		3,462,058.38	3,960,830.18	-12.6%
<b>TOTAL - NON-OPERATING LIABILITIES</b>		<b>8,593,671.29</b>	<b>7,307,123.67</b>	<b>17.6%</b>
<b>ADJUSTMENTS</b>				
Deferred income		49,194.00	385,764.00	-87.2%
<b>TOTAL - ADJUSTMENTS</b>		<b>49,194.00</b>	<b>385,764.00</b>	<b>-87.2%</b>
<b>TOTAL - LIABILITIES</b>		<b>60,586,576.01</b>	<b>55,844,206.62</b>	<b>8.5%</b>
<b>CONVERSION LOSSES</b>		<b>0.00</b>	<b>0.00</b>	<b>-</b>
<b>TOTAL - LIABILITIES</b>		<b>271,254,089.33</b>	<b>269,929,470.10</b>	<b>0.5%</b>

RESULTS (IN EUROS) - PART 1	Financial year 2015	Financial year 2014	Trend
<b>OPERATING INCOME</b>			
Sales of goods	58.32	415.49	-86.0%
<i>Revenues from studies and service provision</i>	16,103,974.91	21,320,018.90	-24.5%
<i>Revenues from related activities</i>	2,016,035.37	1,831,333.30	10.1%
Production sold	18,120,010.28	23,151,352.20	-21.7%
Net turnover	18,120,068.60	23,151,767.69	-21.7%
Stock of finished goods	0.00	0.00	-
Capitalised production	1,583,524.88	1,326,366.84	19.4%
<b>TOTAL - PRODUCTION FOR FISCAL YEAR</b>	<b>19,703,593.48</b>	<b>24,478,134.53</b>	<b>-19.5%</b>
Subsidies for public service responsibilities	156,015,728.60	141,367,825.03	10.4%
Subsidies from National research agency	1,843,410.57	2,048,291.65	-10.0%
Other non-taxable subsidies received from State	568,824.66	4,771,798.66	-88.1%
Other non-taxable subsidies received from local authorities	1,449,050.52	1,960,079.04	-26.1%
Non-taxable subsidies received from other public bodies	12,498,164.32	12,498,091.31	0.0%
Other operating grants	1,666,142.69	1,237,754.80	34.6%
<b>TOTAL - OPERATING SUBSIDIES</b>	<b>174,041,321.36</b>	<b>163,883,840.49</b>	<b>6.2%</b>
<i>Share written off of funding related to assets</i>	20,558,868.11	23,257,596.73	-11.6%
<i>Reversals of provisions</i>	1,374,370.03	744,389.08	84.6%
<i>Transfers of operating expenses</i>	66,278.87	63,759.75	4.0%
Write-off of provisions and depreciations / transfers of expenses	21,999,517.01	24,065,745.56	-8.6%
Other revenues	1,832,707.33	1,688,482.58	8.5%
<b>TOTAL - OPERATING INCOME</b>	<b>217,577,139.18</b>	<b>214,116,203.16</b>	<b>1.6%</b>
<b>OPERATING COSTS</b>			
<i>Raw materials</i>	0.00	0.00	-
<i>Other supplies</i>	0.00	294.00	-100.0%
Purchases of goods	0.00	294.00	-100.0%
<i>Raw materials</i>	0.00	0.00	-
<i>Other supplies</i>	0.00	0.00	-
Change in stock	0.00	0.00	-
Other purchases and external charges	5,780,476.42	6,376,991.59	-9.4%
<i>Purchases of studies and services</i>	43,022.01	28,494.79	51.0%
<i>Purchases of equipment, plant and work</i>	6,017.30	967.30	522.1%
Purchases incorporated in products	49,039.31	29,462.09	66.4%
<b>TOTAL - PURCHASES</b>	<b>5,829,515.73</b>	<b>6,406,747.68</b>	<b>-9.0%</b>
Outsourcing and subcontracting	36,647,242.63	40,238,409.52	-8.9%
Rentals and rental expenses	1,534,761.05	1,394,961.96	10.0%
Maintenance	4,773,045.48	3,915,404.27	21.9%
Insurance premiums	879,375.08	860,115.78	2.2%
Studies and research	934,237.70	954,609.75	-2.1%
Miscellaneous	682,587.00	860,900.44	-20.7%
Outside staff	548,046.23	441,108.44	24.2%
Payments to intermediaries and fees	488,332.55	696,174.91	-29.9%
Advertising, publications, external relations	285,873.16	307,395.09	-7.0%
Travel, missions and receptions	4,470,141.25	4,404,917.73	1.5%
Postal and telecommunications costs	985,141.86	885,038.31	11.3%
Banking and related services	1,267.12	2,416.75	-47.6%
Miscellaneous	14,580,463.32	14,389,752.38	1.3%
<b>TOTAL - OUTSIDE SERVICES</b>	<b>66,810,514.43</b>	<b>69,351,205.33</b>	<b>-3.7%</b>
Total intermediate expenses	72,640,030.16	75,757,953.01	-4.1%
Payroll taxes	7,900,015.31	8,010,976.43	-1.4%
Taxes and other organisations	1,320,984.22	1,267,865.86	4.2%
<b>TOTAL - TAXES, DUTIES AND SIMILAR LEVIES</b>	<b>9,220,999.53</b>	<b>9,278,842.29</b>	<b>-0.6%</b>
Salaries and appointments	66,755,253.95	66,683,752.34	0.1%
Social contributions	30,272,170.76	30,571,585.12	-1.0%
<b>TOTAL - PAYROLL EXPENDITURE</b>	<b>97,027,424.71</b>	<b>97,255,337.46</b>	<b>-0.2%</b>

RESULTS (IN EUROS) - PART 2	Financial year 2015	Financial year 2014	Trend
<i>Depreciation of fixed assets</i>	21,996,036.60	24,062,214.30	-8.6%
<i>Impairment of fixed assets</i>	0.00	0.00	-
<i>Impairment of current assets</i>	203,361.50	463,240.47	-56.1%
<i>Provisions for contingencies and charges</i>	1,090,380.00	4,186,677.00	-74.0%
Depreciation, amortization and impairment of fixed assets	23,289,778.10	28,712,131.77	-18.9%
Other charges	1,234,186.36	420,824.33	193.3%
<b>TOTAL - OPERATING COSTS</b>	<b>203,412,418.86</b>	<b>211,425,088.86</b>	<b>-3.8%</b>
<b>OPERATING INCOME</b>	<b>14,164,720.32</b>	<b>2,691,114.30</b>	<b>426.4%</b>
Share of profits or losses from joint operations or ventures	0.00	0.00	-
Profit or transferred loss	0.00	0.00	-
Loss or transferred profit	0.00	0.00	-
<b>FINANCIAL INCOME</b>			
Income from equity holdings	70,911.00	69,750.00	1.7%
Income from securities and financial fixed asset receivables	5,390.97	6,275.21	-14.1%
Other interest and related income	281.60	0.00	-
<i>Reversals of provisions</i>	0.00	0.00	-
<i>Transfers of charges</i>	0.00	0.00	-
Write-off of provisions and transfers of charges	0.00	0.00	-
Realised gains on exchange differences	9,473.87	6,279.61	50.9%
Proceeds from sale of securities	0.00	0.00	-
<b>TOTAL - FINANCIAL INCOME</b>	<b>86,057.44</b>	<b>82,304.82</b>	<b>4.6%</b>
<b>FINANCIAL EXPENSES</b>			
Depreciation and provisions	0.00	0.00	-
Interest and related expenses	159.14	110.52	44.0%
Realised exchange losses	9,385.72	10,761.14	-12.8%
Net loss from sale of securities	0.00	0.00	-
<b>TOTAL - FINANCIAL EXPENSES</b>	<b>9,544.86</b>	<b>10,871.66</b>	<b>-12.2%</b>
<b>FINANCIAL PROFIT OR LOSS</b>	<b>76,512.58</b>	<b>71,433.16</b>	<b>7.1%</b>
<b>INCOME BEFORE TAX</b>	<b>14,241,232.90</b>	<b>2,762,547.46</b>	<b>415.5%</b>
<b>TRAORDINARY INCOME</b>			
Extraordinary income from management operations	11,857.00	0.00	-
<i>Proceeds from disposal of assets</i>	799,610.60	8,467.04	9343.8%
On capital operations	799,610.60	8,467.04	9343.8%
Other extraordinary income	838.00	0.00	-
Write-off of provisions and transfers of charges	0.00	0.00	-
<b>TOTAL - EXTRAORDINARY INCOME</b>	<b>812,305.60</b>	<b>8,467.04</b>	<b>9493.7%</b>
<b>EXTRAORDINARY EXPENSES</b>			
Extraordinary income from management operations	438,619.13	14,569.46	2910.5%
<i>Net book value of assets sold</i>	274,581.22	58,451.08	369.8%
<i>Other extraordinary charges</i>	91,399.62	21,128.69	332.6%
On capital operations	365,980.84	79,579.77	359.9%
Reversals of provisions and transfers of charges	0.00	0.00	-
<b>TOTAL - EXTRAORDINARY CHARGES</b>	<b>804,599.97</b>	<b>94,149.23</b>	<b>754.6%</b>
<b>RAORDINARY RESULT</b>	<b>7,705.63</b>	<b>-85,682.19</b>	<b>-109.0%</b>
Employees profit sharing	0.00	0.00	-
Corporate tax	25,000.00	35,000.00	-28.6%
<b>GROSS PROFIT OR LOSS</b>	<b>14,248,938.53</b>	<b>2,676,865.27</b>	<b>432.3%</b>
<b>TOTAL - INCOME</b>	<b>218,475,502.22</b>	<b>214,206,975.02</b>	<b>2.0%</b>
<b>TOTAL - EXPENSES</b>	<b>204,251,563.69</b>	<b>211,565,109.75</b>	<b>-3.5%</b>
<b>PROFIT (+) OR LOSS (-)</b>	<b>14,223,938.53</b>	<b>2,641,865.27</b>	<b>438.4%</b>

# APPENDICES

## Board of Directors as of 1<sup>st</sup> October 2015

### **CHAIRMAN OF THE BOARD OF DIRECTORS**

François JACQ

### **MEMBERS REPRESENTING THE STATE**

#### **Ministry in charge of Higher education and Research**

Élisabeth VERGÈS

Alternate: Bernard COMMÈRE

#### **Ministry in charge of the Environment**

Philippe COURTIER

Alternate: Aurélie SUNARA

Laure TOURJANSKY

Alternate: Marie-Bénédicte PEYRAT

François MITTEAULT

Alternate: Ludovic SCHULTZ

#### **Ministry of Defence**

Rear-admiral Anne CULLÈRE

Alternate: Captain (Navy)

Bertrand DUMOULIN

#### **Ministry in charge of the Budget**

Guillaume MICHALOUX

#### **Ministry in charge of Industry and Digital affairs**

Sylvie METZ-LARUE

Alternate: François VILLERAZ

#### **Ministry of Foreign affairs and International development**

Pascal LE DEUNFF

Alternate: Mona DEBBOUN BOUSSEDRA

### **MEMBERS CHOSEN FOR THEIR EXPERTISE IN FIELDS CLOSE TO THOSE OF IFREMER**

Julien LAMOTHE

French national association of producer organisations

Michel EDDI

Cirad

Françoise MÉCHIN

Ifpen

Stéphanie THIÉBAULT

CNRS

Gérald VIAUD

CNC national shellfish-farming committee

### **MEMBERS ELECTED BY IFREMER PERSONNEL**

CFDT

Jean TOURNADRE

Loïc LE DÉAN

Catherine SATRA LE BRIS

Cathy TRÉGUIER

Loïc PETIT DE LA VILLÉON

CGT

Carla SCALABRIN

Joël KNOERY

### **MEMBERS VOTING IN ADVISORY CAPACITY**

Chairman of Ifremer's scientific committee

Patrick LANDAIS

Government commissioner

Benoît DEBOSQUE

Ministry of Overseas France

Marie-Pierre CAMPO

General comptroller

for finance and economics

Philippe DEBET

Secretary general for the Sea

Michel AYMERIC

Acting head accountant of Ifremer

Olivier SAUVAGE

CCE secretary

Jean-Bernard DONOU

# Advisory committees

## Scientific committee as of 1<sup>st</sup> October 2015

### MEMBERS APPOINTED BY JOINT DECISION OF THE SUPERVISORY AUTHORITY MINISTRIES

Patrick LANDAIS  
Chairman

Deputy director for innovation and development at Andra

Denis ALLEMAND  
Scientific director of the Scientific centre of Monaco

Chris BOWLER  
Director of research, CNRS, École normale supérieure,  
Director of ecological and evolutionary genomics section

Francesco CHIOCCI  
Professor at La Sapienza University, Earth sciences department, Rome

Pascale DELÉCLUSE  
Director of INSU at CNRS

Marion GEHLEN  
Director of research CEA, laboratory of environmental and climate sciences, Gif-sur-Yvette

Peter HERMAN  
Senior Adviser, Deltares, Delft, The Netherlands

François LALLIER  
Director of UMR joint research unit on adaptation and diversity in the marine environment, Pierre & Marie Curie University, Roscoff

Marina LÉVY  
Director of research CNRS, laboratory of oceanography and climate experiments and digital approaches Pierre Simon Laplace Institute, Paris

Jean-Marie MOUCHEL  
Professor, Pierre & Marie Curie University, Paris, director of Piren Seine programme

Fabienne PETIT  
Professor, University of Rouen, director of federation sciences applied to the environment

Edwige QUILLET  
Director of research at INRA, head of aquaculture genetics team, UMR GABI, Jouy-en-Josas

Hélène REY-VALETTE  
Lecturer, UMR Lameta, Faculty of economics, Montpellier

### MEMBERS ELECTED BY IFREMER PERSONNEL

Marie-Édith BOUHIER, CFDT full member  
Acoustics engineer

Franck COPPIN, CFDT substitute  
Fisheries dynamics engineer

Catherine DRÉANNO, CGT substitute  
Research scientist in molecular biology

Raymond KAAS, CGT full member  
Research scientist in algal ecophysiology and biology

Karine OLU-LE ROY, CFDT substitute  
Research scientist in ecology of chemosynthesis systems, life sciences

Jean-François PÉPIN, CFDT full member  
Mollusc animal health supervisor

### PERMANENT GUEST MEMBERS

Philippe BERTRAND  
AllEnvi Sea task group, deputy scientific director Océan-Atmosphère, INSU

Jacqueline GARNIER-LAPLACE  
AllEnvi Risks task group, director of research and expert assessment of environmental hazards department, Institute of radioprotection and nuclear safety

Yves-Marie PAULET  
AllEnvi Sea task group, Professor, University of western Brittany UBO, Brest

Sylvie REBUFFAT  
Professor, National museum of natural history  
AllEnvi scientific steering committee

Thomas CHANGEUX  
AllEnvi Sea task group, AllEnvi Overseas France committee, IRD

### SCIENTIFIC COMMITTEE SECRETARY

Marie-Hélène TUSSEAU-VUILLEMIN  
Scientific director of Ifremer



## Technical and industrial committee as of 1<sup>st</sup> October 2015

Jacqueline LECOURTIER  
**Chairwoman**

Éric PAPIN  
**DCNS**

Pierre BALIGUET  
**Sercel**

Arnaud BOCQUET  
**Pierre Fabre**

Maurice BOUTECA  
**Ifpen**

Julien DENÈGRE  
**Technip**

Marie-Christine HUAU  
**Véolia**

Gérard JACQUIN  
**INRA**

Bruno JARRY  
**Académie des Technologies**

Jean-Claude LE BLEIS  
**NKE**

Fabien NAPOLITANO  
**iXblue**

Valérie QUINIOU-RAMUS  
**Total**

Ludovic DONATI  
**ERAMet**

Jean-Pierre VADET  
**ECA Robotics**

Jean-Baptiste DE FRANCQUEVILLE  
**Ministry in charge  
of the Environment**

Thomas LOMBES  
**Ministry of Higher education  
and Research**

### IFREMER MEMBERS

François JACQ  
**Chairman and Chief Executive  
Officer**

Patrick VINCENT  
**Deputy General Director**

Marie-Hélène TUSSEAU-VUILLEMIN  
**Scientific director**

Corinne CHARONDIÈRE  
**Director of Development,  
business development and  
economic partnerships**

Ingrid PUIILLAT  
**CGT trade union representative**

Christine CHOPIN  
**CFDT trade union representative**

# Ifremer sites

HEADQUARTERS 155 rue Jean-Jacques Rousseau - 92138 Issy-les-Moulineaux Cedex  
Tel. 33(0)2 46 48 21 00

## ENGLISH CHANNEL-NORTH SEA

### Channel-North Sea centre

150 quai Gambetta, B.P. 699  
62321 Boulogne-sur-Mer Cedex  
Tel. 33(0)2 21 99 56 00

### Port-en-Bessin station

Avenue du Général de Gaulle, B.P. 32  
14520 Port-en-Bessin  
Tel. 33(0)2 31 51 56 00

## BRITTANY

### Brittany centre

ZI Pointe du Diable  
CS 10070  
29280 Plouzané  
Tel. 33(0)2 98 22 40 40

### Argenton experimental site

Presqu'île du Vivier  
29840 Argenton-en-Landunvez  
Tel. 33(0)2 98 89 29 40

### Ifremer Cresco Station

38 rue du Port-Blanc, B.P. 70134  
35801 Dinard Cedex  
Tel. 33(0)2 23 18 58 58

### Concarneau marine biology station

place de la Croix, B.P. 40537  
29185 Concarneau Cedex  
Tel. 33(0)2 98 10 42 80

### Lorient station

8 rue François Toullec  
56100 Lorient  
Tel. 33(0)2 97 87 38 00

### La Trinité station

12 rue des Résistants, B.P. 86  
56470 La Trinité-sur-Mer  
Tel. 33(0)2 97 30 19 19

## ATLANTIC

### Atlantic centre

rue de l'île-d'Yeu, B.P. 21105  
44311 Nantes Cedex 03  
Tel. 33(0)2 40 37 40 00

### La Rochelle station

place Gaby Coll, B.P. 7  
17137 L'Houmeau  
Tel. 33(0)2 46 50 94 40

### Bouin station

polder des Champs  
85230 Bouin  
Tel. 33(0)2 51 68 77 80

### La Tremblade station

avenue de Mus de Loup  
Ronce-les-Bains, B.P. 133  
17390 La Tremblade  
Tel. 33(0)2 46 76 26 10

### Arcachon station

quai du Commandant-Silhouette  
33120 Arcachon  
Tel. 33(0)2 57 72 29 80

### Anglet branch

UPPA  
1 allée du parc Montaury  
64600 Anglet  
Tel. 33(0)2 29 00 85 92

## MEDITERRANEAN

### Mediterranean centre

zone portuaire de Brégaillon, CS 20330  
83507 La Seyne-sur-Mer Cedex  
Tel. 33(0)2 94 30 48 00

### Palavas-les-Flots station

chemin de Maguelone  
34250 Palavas-les-Flots  
Tel. 33(0)2 67 13 04 00

### Sète station

avenue Jean-Monnet, B.P. 171  
34203 Sète Cedex  
Tel. 33(0)2 99 57 32 00

### Corsica station

Immeuble Agostini  
SCI Endajola-Pastoreccia  
ZI de Bastia-Furiani  
20600 Bastia  
Tel. 33(0)2 95 38 00 24

### Montpellier site

Université de Montpellier  
place Eugène Bataillon, CC80  
34095 Montpellier Cedex 5  
Tel. 33(0)4 67 14 46 25

## OVERSEAS FRANCE

### Pacific Centre

B.P. 7004  
98179 Taravao  
French Polynesia  
Tel. +689 54 60 00

### French Guiana delegation

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97331 Cayenne  
French Guiana  
Tel. +594 30 22 00

### Saint-Pierre-et-Miquelon delegation

Antenne Ifremer, quai de l'Alysse,  
B.P. 4240  
97500 Saint-Pierre  
Saint-Pierre-et-Miquelon  
Tel. +508 41 30 00

### New Caledonia delegation

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101 promenade Roger Laroque,  
B.P. 2059  
98846 Nouméa Cedex  
Tel. +687 28 51 71

• Saint-Vincent station  
98812 Boulouparis  
New Caledonia

### French West Indies delegation

79 route de Pointe-Fort  
97231 Le Robert  
Martinique  
Tel. +596 66 19 40

### Reunion Island delegation

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97822 Le Port Cedex  
La Réunion  
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