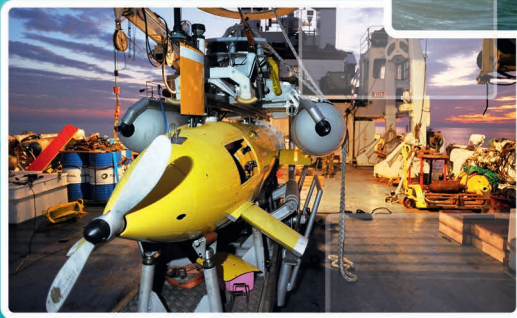
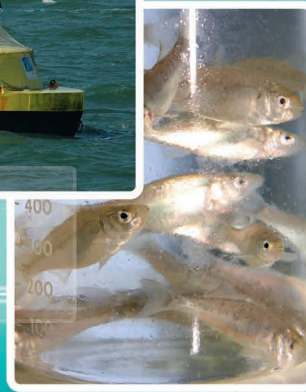
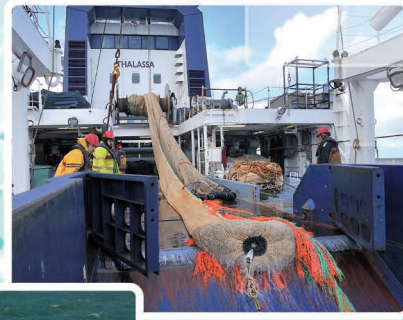
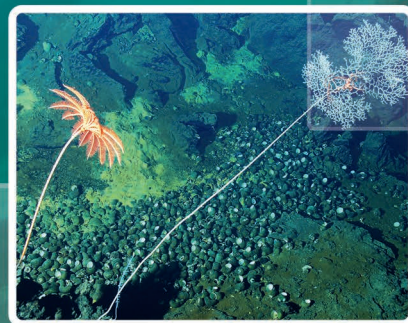


# Annual report 2012



## Ifremer's scientific action







# IFREMER'S SCIENTIFIC ACTION

04 / LEARNING ABOUT OCEAN DYNAMICS **TO IMPROVE THE DIAGNOSIS OF GLOBAL CHANGE**

10 / **UNDERSTANDING MARINE ECOSYSTEMS** TO BETTER PROTECT THEM

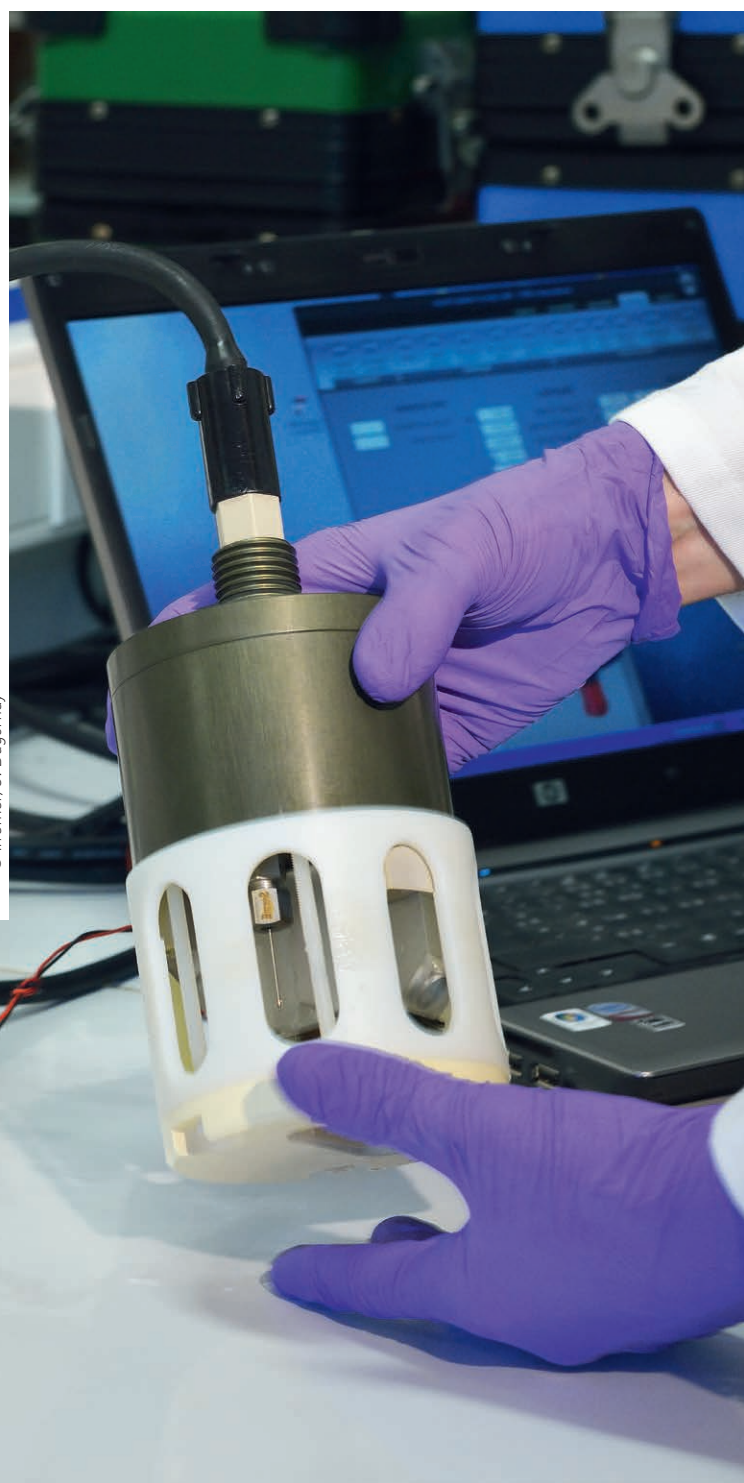
22 / **SUSTAINABLE VALUE** OF BIOLOGICAL RESOURCES

40 / **EXPLORING SEAFLOORS,** IDENTIFYING THEIR RESOURCES AND THEIR HAZARDS

52 / **DEVELOPING TECHNOLOGIES** AND INNOVATIVE INFORMATION SYSTEMS

67 / ACRONYMS AND **ABBREVIATIONS**

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# LEARNING ABOUT OCEAN DYNAMICS TO **IMPROVE THE DIAGNOSIS OF GLOBAL CHANGE**



## OCEAN PHYSICS

### Ocean at very high resolution (OHR)

Over the past few years, the team working on the “ocean at very high resolution” has been behind some major advances in understanding the interactions between fine-scale ocean features (structures of less than 5 km in size) and very large scales. This has highlighted the importance of these fine scales’ impact on the large-scale dynamics of ocean basins, on dissipation of energy and on physical-biological interactions which were totally unknown even ten years ago. These studies were made possible by the Japanese Earth Simulator (Jamstec) and active

scientific cooperation with researchers at Jamstec. Some of the results obtained provide a scientific justification for the future international SWOT altimetry satellite (CNES-NASA). Other outcomes have led to the start of work in close collaboration with geophysicists to better interpret the reflection seismics data in the water column in terms of the dissipation of mesoscale eddies. The numerical results secured in the framework of cooperation between UMR LPO (ocean physics laboratory), the spatial oceanography laboratory and the geodynamics and geophysics laboratory led to the creation of a line of research, or axis, on oceanic high resolution with Labex Mer.

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## Diagnosis concerning the effects of climate change

The Ovide project focuses on the variability of meridional overturning circulation, as well as the related transport of heat, tracers and water bodies using a hydrological section between Portugal and the southern tip of Greenland. This Ovide leg has been repeated every two years since 2002 between Lisbon and Greenland and was made again in 2012. Thirteen ARGO profiling floats were deployed and eighteen microstructure profiles were recorded.

The results obtained in the Ovide programme were highlighted in a publication by LPO in the *Nature Geoscience* journal in January 2013 and was also used to illustrate the journal's front cover. The article presented the results of the research conducted by a team of scientists from the *Instituto de Investigaciones Marinas* (IIM, CSIC1, Vigo, Spain) and the ocean physics laboratory (LPO, joint research unit UMR 6523 Ifremer, CNRS, IRD, UBO, Brest), studying the impact of the ocean conveyor belt on reducing the absorption of anthropogenic carbon in the North Atlantic between 1997 and 2006.



The international workshop which was organised by the ocean physics laboratory in late 2012 on very high resolution instrumentation in relation with the LabexMER axis 1: "Diagnosis of vertical exchanges at sub-mesoscales - and their impacts on ecosystems - from satellite and in situ observations" made it possible for the first time to bring together scientists who have already carried out experiments at sea devoted to fine ocean scales. Some initial conclusions were drawn with regard to future experimentation devoted to fine scales. A few highly promising instruments such as underwater acoustics or seismics for biology now appear to be indispensable for this sort of experiment.

A world first: the deep Arvor float has performed more than sixty cycles at

**3,500 m**  
in depth

### Équipex NAOS project: Deep Arvor

A deep profiling float model (deep Arvor -3,500 m) was successfully deployed during the Strasse cruise in August 2012, in the middle of the Atlantic. This new generation will meet the need to monitor deep water masses which play a key role in the study of climate change. The targeted depth was reached thanks to use of composite materials, engine type technology and CTD sensor developments. The deep Arvor float performed more than sixty cycles at 3,500 m, sending Argo standard profiles and high resolution profiles. For an Argo profiling float to reach a depth of 3,500 m while continuing its cycles was a world first. The project is in the industrialisation phase, working with the NKE firm.



▲  
*Testing Provor (profiling) floats Provor (with oxygen probe) at the test tank in the Ifremer centre in Brest*

© Ifremer/O. Dugornay



▲  
Arctic sea ice extent at the moment of annual minimum (September) for the year 2012 (red), 2007 (blue) and mean for years 1992 to 2006 (white).

## SPATIAL OCEANOGRAPHY

### Smostorm+

The SMOS satellite has proved its new capability to supply information for improved forecasting of hurricanes. Scientists at Cersat contributed to this discovery through the techniques developed to estimate surface wind velocities using SMOS temperature images.

### Sea ice

The satellite data (distributed and archived via Cersat) analysed at the LOS spatial oceanography laboratory enable the sea ice extent to be measured daily. In the Arctic, it has been decreasing rapidly over the past decade, and this year a record low for the sea ice surface area was reached on 16 September 2012, with just 3.5 million square kilometres of frozen extent, i.e. 700,000 km<sup>2</sup> less than in 2007 which was the previous lowest year, thus leaving the North-East passage (via Russian waters) entirely free of ice. The figure below shows sea ice extents in September in 2012 (red), 2007 (blue) and for the mean of the years 1992-2006 (white) during the period. Over this period, the sea ice surface area lost is six times the size of metropolitan France.

## RECORD WAVE HEIGHT OBSERVED

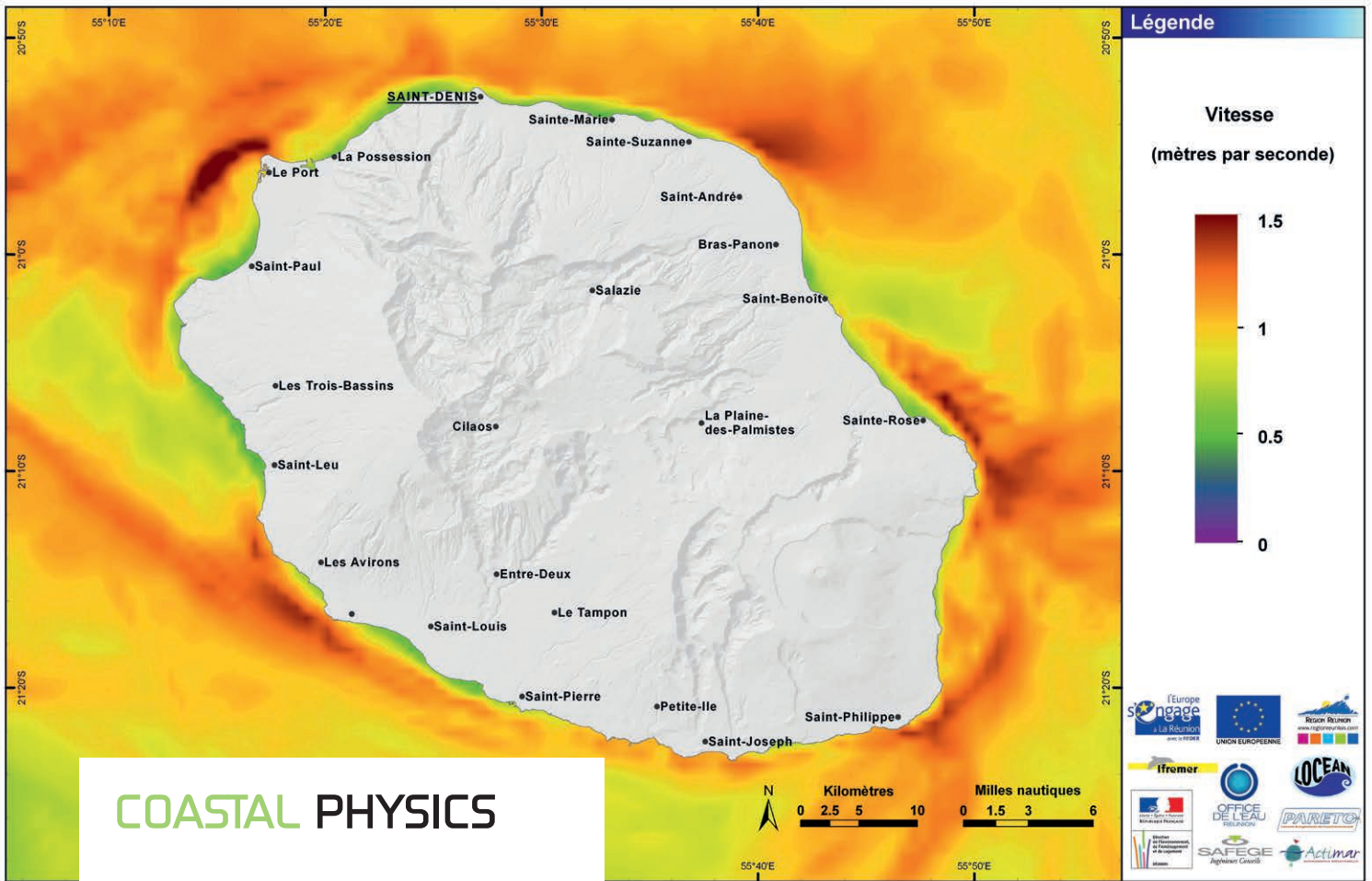
In a study published in December 2012 in the *Bulletin of American Meteorological Society*, a team from LOS, working with researchers from several institutions (University of New Hampshire, NOAA, CLS, SHOM, university of the Azores and IPGP) were able to show a new record for the highest waves ever measured in the ocean.

Giant waves from the North Atlantic storm Quirin occurring in February 2011 were measured using the radar altimeter of the Jason 2 satellite operated by CNES, Eumetsat, NASA and NOAA. The value of 20.10 m recorded on 14 February 2011 is the highest "significant wave height" to be measured by an altimeter since this type of measures began in the late 1980s. The significant wave height is an average of the highest one-third of wave heights. Although this radar cannot measure the height of waves individually, the wave height statistics suggest that the highest wave from Quirin was probably over 36 m high. Higher waves have most likely already existed, but they have never been measured in the middle of the ocean. Analysis of the Quirin storm showed that these extreme heights are made possible by the depression moving at the same speed as the waves.

**20.10 m**

This was the highest "significant wave height" of giant waves from the Quirin storm measured by a radar altimeter aboard the Jason 2 satellite

The BAMS publication on monster waves which a great part of the LOS team worked on collectively was: Jennifer Hanafin, Yves Quilfen, Fabrice Ardhuin, Joseph Sienkiewicz, Pierre Queffelec, Mathias Obrebski, Bertrand Chapron, Nicolas Reul, Fabrice Collard, David Corman, Eduardo B. De Azevedo, Doug Vandemark and Eleonore Stutzmann (2012). Phenomenal sea states and swell from a North Atlantic Storm in February 2011: a comprehensive analysis. *Bulletin Of The American Meteorological Society*, 93(12), 1825-1832. Publisher's official version: <http://dx.doi.org/10.1175/BAMS-D-11-00128.1>, Open Access version: <http://archimer.ifremer.fr/doc/00094/20538/>



## COASTAL PHYSICS

Ifremer studies coastal dynamics on the so-called “regional” scale (English Channel, Bay of Biscay, North West Mediterranean, Indian Ocean around Réunion Island) and on a more “coastal” or even “littoral” scale (Gulf of Lion, estuaries of large French rivers, lagoons and Polynesian atolls). A notable in publication in 2012 was that of a special issue of the *Journal of Marine Systems* published following the Isobay symposium organised in Brest on physics in the Bay of Biscay (seven Ifremer publications).

▲ Maximum speed of surface current

## INTERNAL WAVES AT RÉUNION

The aim of the Hydrorun project (2011-2013) is to understand and explain the processes of water body circulation on the coastal scale of Réunion Island in order to develop hydrodynamic modelling tools to provide help for managing the coastal fringe. The current and sea level measurements taken in 2011 and 2012 showed that numerical models systematically underestimated the variability which was observed. This variability could be explained by the presence of internal waves, where in contact with the seafloor relief (very sharp since these are volcanic islands), tidal currents excite the oscillations of large-amplitude layers of water (tens of metres) which slowly propagate to either side of the relief. Their period is that of the tide (12-24 hours) and they are deformed depending on the temperature conditions during their propagation. This means that propagation conditions of internal waves depend on the ocean temperature structure, the latter being linked to eddy structures whose exact dynamics are very difficult to anticipate. These studies have shown the interest of pursuing more extensive research on internal waves to improve the capabilities of realistic simulation of coastal dynamics in every region of the world where the configuration is similar to that of Réunion.

**104**  
publications on the theme  
of “learning more about  
ocean circulation to  
supplement the diagnosis  
of global change”



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## Studying eddies and biogeochemistry in the Mediterranean

The Physed (hydrodynamic and sedimentary physics) laboratory is involved in several projects of the Mistral Mediterranean programme. Its team works on physical aspects related to issues of primary production, fisheries and chemical contamination. Within this context, two ocean research cruises took place in the Gulf of Lion in the spring of 2012, deploying novel instrumentation aboard RV *Thétys*. The Imedia (French acronym for mesoscale instability detection instrumentation analysis) cruise was conducted jointly with LER/PAC. By using a new towed instrument called the Moving Vessel Profiler (MVP) it was able to track and observe the eddies which develop in the North current.

This was followed by the Mermex cruise which federated LOV, LSCE, university of Montpellier and Ifremer to better understand the structure of the plankton web and validate the hydrosedimentary and biogeochemical models developed in the North West Mediterranean. During this cruise, nearly twenty stations from the Rhone to Sète were investigated and two legs were performed with a towfish taking measurements in the upper 100 metres of the water column (measuring temperature, salinity, turbidity and chlorophyll).

These cruises also enabled the calibration and maintenance of instruments on the Mesurho buoy which is installed at the mouth of the Rhone River to measure hydrological (temperature, salinity, fluorimetry and nutrients), hydrosedimentary (currents, waves, turbidity) and meteorological parameters.



*Deployment of MVP profiling float on deck of RV Tethys II during the Imedia cruise*

## Estuarine dynamics

Estuaries are key zones in the continent/ocean continuum and represent a major coastal environmental research domain. The studies conducted in 2012 on the Seine estuary are representative of the scientific issues which Ifremer also addresses in other large estuaries in metropolitan France. They were co-financed by the Seine Aval scientific programme and the EC2CO/PNEC programme. In particular, they made it possible to analyse and utilise the observations acquired since 2008 and 2011 on the dynamics of the turbidity maximum and suspended particles in the water column, through an innovative combination of optical and acoustic measurement techniques via a partnership with the University of South Carolina (USA) and the University of Plymouth (United Kingdom). These observations were also used to validate the new MARS3D curvilinear model set up on the estuary. The modelling results were utilised in the frame of the Messcene (Fondation de France) project devoted to determining potential past, present and future habitats by using a functional-habitats GIS implemented by the PIG Seine Aval.

The C3E2 project (consequences of climate change on the ecogeomorphology of estuaries) also addresses the question of estuaries from the perspective of climate change and its impact on their ecogeomorphology. In 2012, the question of estuarine waters overflowing towards the alluvial flood plain led to *in situ* (hydrodynamic and sedimentary) measurements and fine-scale 3D modelling, working in association with the Artelia firm, the university of western Brittany UBO and the Loire Estuaire PIG who are partners in the project. The first study on schematic adaptation of estuary morphology in response to various scenarios for climate change trends has been carried out.



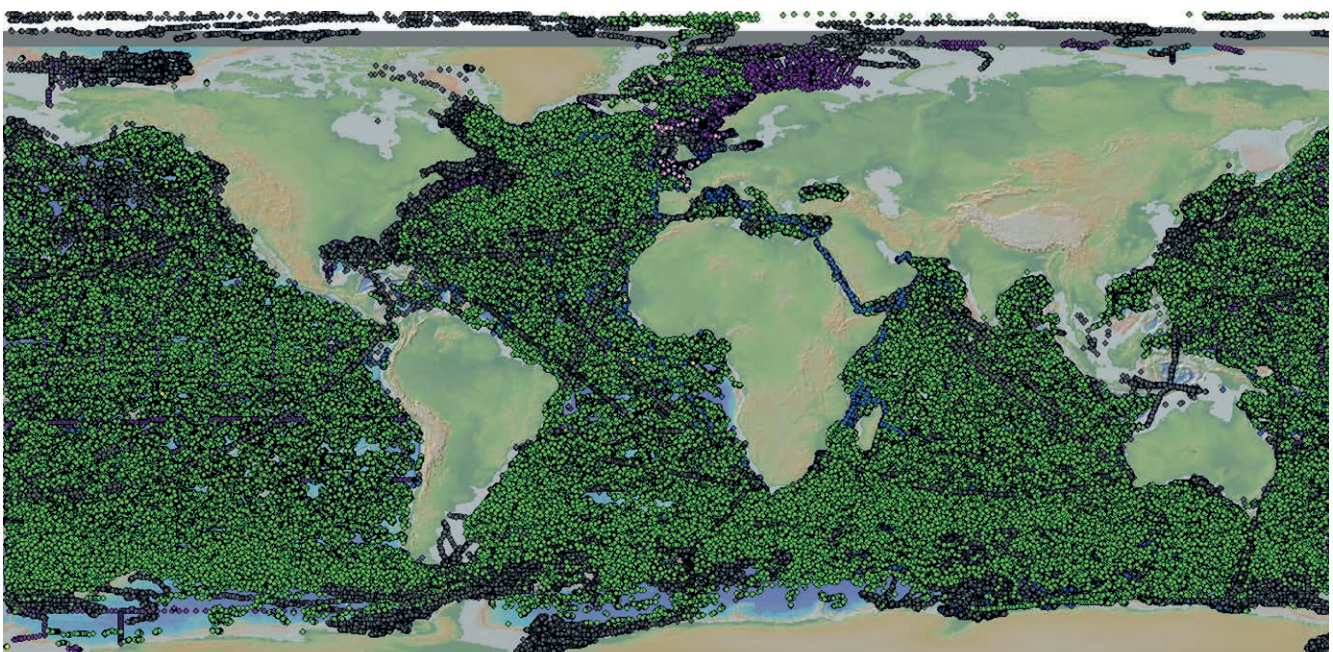
# OPERATIONAL OCEANOGRAPHY

The European GMES/Copernicus programme set up a European operational oceanography service (Copernicus marine service) covering the world ocean and European regional seas. It is coordinated by Mercator-Ocean thus asserting France's position in the Copernicus marine service. Most of the service's developments were achieved in the framework of MyOcean and MyOcean2 projects. The fourteen main partners in these projects, including Ifremer, joined up to prepare the implementation of the future European Centre for Ocean Monitoring and Forecasting (ECOMF). A partnership agreement between the 14 ECOMF members and EuroGOOS (Nicosia Strategic Partnership) was signed in late 2012 to organise the interaction between the European service and national services.

Globally speaking, the international GOOS programme has just set up its new governance structure, the GOOS Steering Committee, which Ifremer is part of. It will implement the recommendations from the Oceanobs09 symposium on global ocean observation, with an extension to biogeochemistry and biology. Ifremer also contributes to the *Godae OceanView* (international coordination of operational oceanography) programme which has set up a task team on coastal and open ocean coupling.

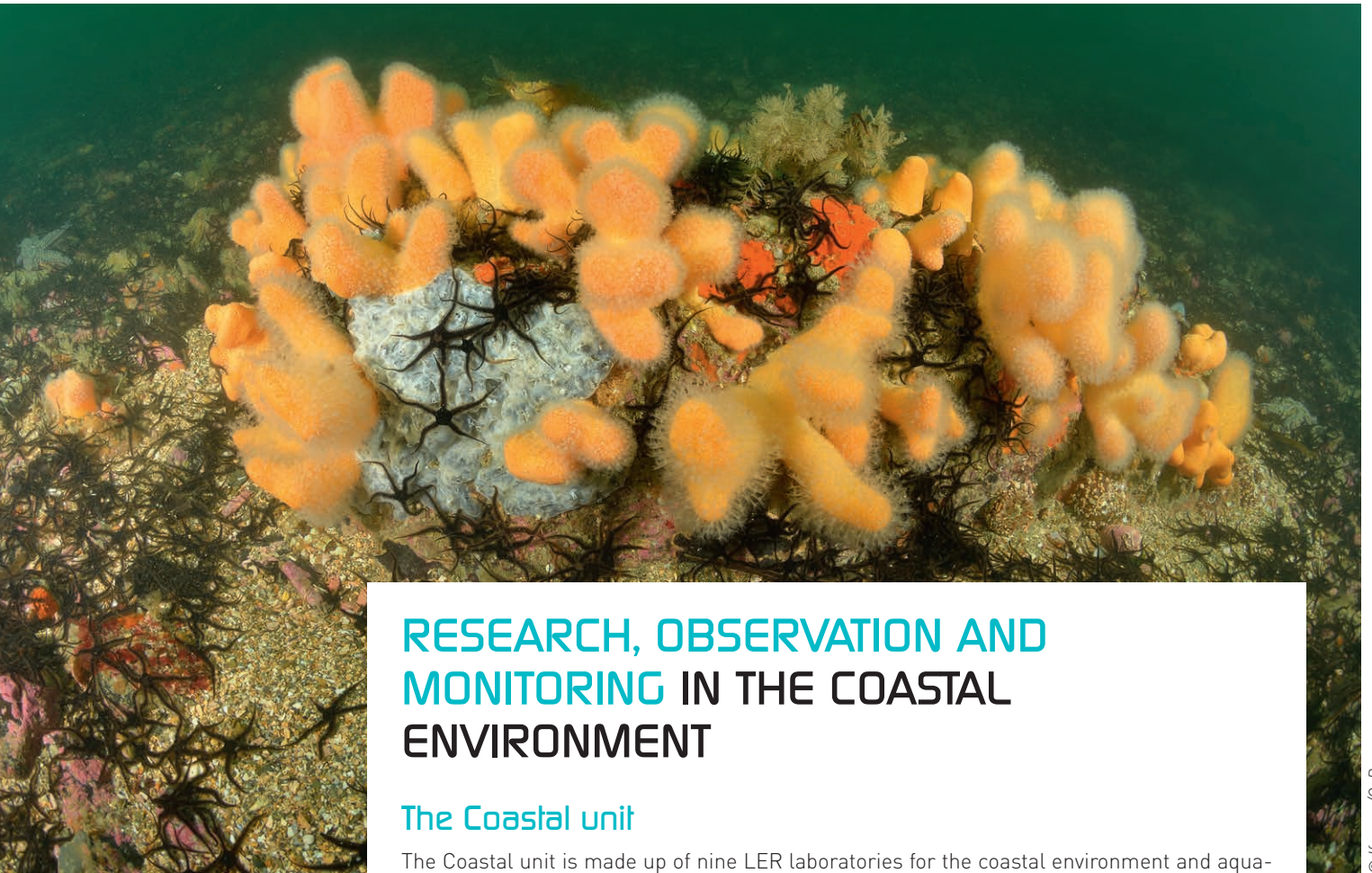
## WAVE MODELLING

Progress has been made in the understanding of waves and their modelling, from offshore to the coast. It has given rise to scientific spotlighting (e.g., in FILIPOT J.-F. and F. ARDHUIN (2012), A unified spectral parameterization for wave breaking: from the deep ocean to the surf zone, *J. Geophys. Res.*, 117, C00J08, doi:10.1029/2011JC007784) and has enriched operational coastal oceanography models.



▲ Coriolis/MyOcean: 2009-2012 coverage, world ocean scale

# UNDERSTANDING MARINE ECOSYSTEMS TO BETTER PROTECT THEM



## RESEARCH, OBSERVATION AND MONITORING IN THE COASTAL ENVIRONMENT

### The Coastal unit

The Coastal unit is made up of nine LER laboratories for the coastal environment and aquaculture resources and the PHYC phycotoxin laboratory, located over the three seafronts of metropolitan France. It is a technical plateau providing access to the sea and data, to analytical facilities and a wide range of research expertise. The ties which have been created with socio-economic stakeholders (managers, aquaculture and fisheries professionals, public authorities, etc.) and the wealth of experience acquired in the field of coastal sea observation and monitoring, are assets for the unit in developing cooperation with research structures working locally and in informing both local authorities and the devolved State services.

The two environment-resources laboratories on the Mediterranean seafront are a good illustration of the benefits of being established regionally. Their expertise and effectiveness in marine monitoring and observation activities has enabled their contributions (diagnoses of chemical contamination in the Mediterranean, the impact of large cities on contamination, lagoon monitoring network in Languedoc Roussillon and a tool to predict anoxic crises called "malaigues", etc.). More generally speaking, these ten laboratories have built strong partnerships with the five Water agencies (Artois-Picardie, Seine Normandy, Loire-Brittany, Adour-Garonne, Rhone Mediterranean and Corsica). The labs have engaged their efforts for greater research activity, leading to a growing number of scientific publications on the rise. The results of the 2012 Aeres assessment confirm this dynamic drive.

▲  
*Underwater landscape in Brittany (Bay of Brest). Black brittle stars (Ophiocomina nigra) and dead man's fingers (Alcyonium digitatum)*

## RÉPHY 2012 CONFERENCE

The 2012 Réphy Days event was held on the 25, 26 & 27 September at Ifremer's Nantes centre. It attracted some one-hundred-fifty participants, half of them from outside our Institute (representatives from DEB, DGAL, devolved State services, water agencies, CNEPM, fisheries and shellfish farming professionals, academics and representatives from Cetmef and Anses –the French Agency for food, environmental and occupational health and safety). The presentations showed Réphy's various facets, i.e. environment and health, research and monitoring. The participation by researchers was high for this 2012 Réphy days event, featuring a series of talks and a round table discussion on ASP toxins and the species *Pseudo-nitzschia*.



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## Alexandrium bloom in the Bay of Brest



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In early summer 2012, exceptional blooms of *Alexandrium minutum* occurred in the Bay of Brest. Concentrations greater than forty million cells of this dinoflagellate which is extremely toxic (producing PSP paralytic shellfish poisons) were observed in July in the Daoulas river. This alga develops especially in estuarine environments. Blooms of this scale had never been observed in this sector, but the reactivity of the teams who intervened in the frame of Réphy procedures made it possible to supply the State services that analytical results within forty-eight hours. No case of severe poisoning was reported. Samples and additional analyses were made to better understand the causes and the dynamics of these blooms.

**Exceptional blooms of *Alexandrium minutum* in July in the Bay of Brest: over forty million cells producing PSP paralytic toxins**





© Ifremer/X. Caisey

## Sediment core sampling survey for a paleo-ecology study on phytoplankton

Samples were taken in November 2012 in the Bay of Brest in the framework of the Veshpa (new methodologies to study variations in old phytoplankton communities and habitats in the coastal environment) project, supported by Labex Mer. These sediment cores will be analysed in order to understand the background of how phytoplankton diversity has evolved, focusing on the species of *Alexandrium minutum* and to develop chemical indicators of eutrophication.

## Emergent-MER

In the framework of the RNO national network for marine environmental quality monitoring, and since 2008 in the Rocch chemical contamination network, coastal contamination by PCBs has been monitored in bivalve molluscs. The results have highlighted very heavy contamination of the Seine estuary, with however, a significant reduction in the level of contamination since 1989. The Rocch sample bank is managed by the biogeochemistry and ecotoxicology unit, and holds true potential for long-term monitoring of how coastal marine environmental contamination evolves over time, as well as for acquiring

new knowledge about contaminants, for which very few data are available (emerging contaminants). Thus, in the frame of the Emergent-MER action, analyses were made on samples stored in the mussel collection for emerging contaminants like brominated flame retardants and more recently, perfluorinated compounds. The data obtained are archived in the Quadrige<sup>2</sup> database. This action is covered by a multi-annual contractual agreement in the framework of the Ifremer-Onema agreement, whose studies will be extended to other emerging contaminants.

## GDR MARCO

In strategic terms, the GDR MarCo research consortium's objective is to gather and structure the French scientific community sharing the theme-based aims for the understanding of marine populations' spatial dynamics.

This involves stimulating communications within this GDR network, in order to create the synergy needed to establish an active multidisciplinary research network with the following objectives:

- summarising and updating existing molecular, statistical and bioinformatics methods and monitoring the literature and methodologies, in order to ultimately propose a selection of tools available to the broader scientific community;
- setting up organised, collaborative structures which can develop joint projects and respond to ANR, ESF or EU types of calls for proposals, integrating the tools and outputs from various disciplines represented either within the GDR or in ensuing collaboration;
- multidisciplinary training of young researchers, promoting the geographical and thematic connectivity between various teams and scientific communications;
- organising working groups and theme-based courses of study (or Master's degree modules), to make the syntheses and progress required and to promote the training.

The two general assembly meetings of GDR MarCo (November 2011 and October 2012) provided the opportunity for forty or even fifty participants to discuss their latest research results, stumbling blocks or bottlenecks and multidisciplinary projects. In 2012, four collaborative mini-projects were selected, designed to promote interactions and student exchanges between teams in different disciplines, and financed by Ifremer's scientific division. For the year 2013, several workshops are being prepared in order to introduce participants to disciplines which are not their core business, but which do present some essential complementarity in studying connectivity (modelling, population genetics, setting up MPA networks, etc.).

## Determinism and dynamics of *Pseudo-nitzschia* blooms in Brittany waters

The Dynapse (dynamics of blooms and toxicity of harmful phytoplankton species from the *Pseudo-nitzschia* genus) project studied the determinism and dynamics of blooms of *Pseudo-nitzschia* in the waters of Brittany in relation to environmental parameters. It more specifically aimed to identify the dynamics of the most toxic species and to highlight the role played by hydrological factors that are favourable for their proliferation, in order to produce a pattern of the risks of ASP toxicity appearing. The project's novelty lay in very frequent monitoring conducted during the period which is favourable for the development of these algae (springtime), in a zone which is often affected by ASP toxins (Bay of Concarneau) to trace the bloom dynamics. Species-level determination of *Pseudo-nitzschia* was performed using genetic methods (PCR) coupled with simultaneous titration of the domoic acid present in the environment. The significance and the impact of *Pseudo-nitzschia* over all the coasts of Brittany, from both scientific and economic points of view, were demonstrated.

## A platform for assessment and modelling of marine coastal ecosystems

Ifremer has forged its acknowledged expertise both nationally and in Europe for the assessment and forecasting of the environmental and physical status of coastal marine ecosystems. To support the assessment and prediction of water body status, Ifremer developed the MARS modelling platform which is used to evaluate the risks of eutrophication in the context of European working groups (Ospar).

Co-developments have been made to this platform with other national research organisations (Ichtyop larval drift module with IRD, coupling MARS with the ECO3M biogeochemical module developed by MIO and MET&OR module from Ifremer). Ifremer's know-how has made it possible to set up this platform on every seafront in metropolitan France and to use it to analyse coastal processes such as eutrophication and sedimentary dynamics or to characterise the environment (trophic capacity, fisheries habitats). Along with these operational tools is also the development and validation of an empirical algorithm to analyse satellite ocean-colour images which can be used to assess the chlorophyll concentrations in coastal zones. This work is supplemented by an interactive information portal ([www.ifremer.fr/envlit](http://www.ifremer.fr/envlit)) explaining the environmental monitoring results for the stakeholders of the coastal zone and for the general public. The data acquired over all the shores of metropolitan France are based on the Quadrige<sup>2</sup> databasing system which is the principal marine component of the national water information system, chosen as such by the Ministry in charge of ecology amongst others.

In late 2012, Ifremer's ECO-MARS3D marine ecosystem model was used to define good environmental status for the MSFD "eutrophication" descriptor in the three marine sub-regions of the English Channel-Atlantic seafront. It was also used to assess the expected consequences if the various levels of reduction for nitrate and phosphate inputs to the sea from French rivers are attained.

The tools developed by Ifremer for the mapping of marine habitats are widely recognised at the European level. Ifremer coordinates the MeshAtlantic project aiming to construct a knowledge base on coastal habitats, with the European countries which are members of the Atlantic Area.

## ANR Paralex

ANR Paralex, begun in 2010 (collaboration with the Roscoff biological station) focused on study and modelling of host-pathogen dynamics applied to *Alexandrium minutum*, and to co-existing dinoflagellates. Numerous sampling surveys in the Rance and Penzé rivers enabled the clonal strains of hosts (690 for *A. minutum* and 270 co-existing species) and parasites (230 of *Parvilucifera* and 60 of *Amoebophrya*) to be isolated. Cross-infection assays were then conducted, along with the genotyping of the parasites. The parameters of mobility and growth for several species and strains of eukaryotic pathogens from the Penzé river were measured, making it possible to parameterize an IBM (Individual-based Modelling) model of host/pathogen dynamics. Once the predictive capability of the approach had been tested, the model was used to conduct a theoretical study of potential host/predator dynamics depending on biological parameters such as growth, infectivity, swimming behaviour, and so on.

## WFD (WATER FRAMEWORK DIRECTIVE)

In 2012, Ifremer was actively involved in supporting the implementation of the WFD with the Directorate for water and biodiversity, Onema and the water agencies.

In the scientific and technical plan, our institute coordinated the WFD actions for inshore waters in metropolitan France and supplied its support to WFD deployment in the French DOM overseas counties.

Numerous studies for developing methodologies and acquiring knowledge have been conducted nationwide and in various catchment basins. Specific actions (for instance, the exceptional survey on emerging contaminants) were led in anticipation of the WFD monitoring plan's review in 2014.

Ifremer took part in inter-laboratory trials in hydrology and on biological indicators.

The environmental status assessment was finalised and its results and feedback provided under the aegis of the relevant Ministry departments. This assessment enabled taking stock of what exists and starting to define indicators which are both realistic in terms of the monitoring to be implemented and correspond to the programmes of measurements to be enacted. More particularly, the need to take maximum sustainable yield into account to ensure the coherency of the MSFD and the future CFP should be noted.



## MSFD (Marine Strategy Framework Directive)

On behalf of the Ministry of ecology, in 2012 Ifremer continued the scientific and technical coordination of expert assessment studies related to the "environmental status" strand of the MSFD's initial assessment (IA) and the definition of good environmental status (GES). Taking on this role led the Institute to mobilise experts - both in-house and in other organisations - from a wide range of disciplines. Work to summarise the initial assessment and good environmental status based on the contributions from experts and lead partners was accomplished.

In the framework of drawing up the monitoring programme for the implementation of the Marine Strategy Framework Directive, which must be finalised by 15 July 2013, Ifremer was put in charge of leading studies on the following themes: "commercial species", "eutrophication", "hydrographic conditions", "contaminants", "health issues" and "marine litter". For this occasion, the existing systems and arrangements for data collection were inventoried over the last quarter of 2012.

Ifremer also took responsibility for MSFD reporting of the environmental status of the initial assessment and of good environmental status for France.

On the basis of environmental objectives defined by the devolved authorities, Ifremer, working jointly with AAMP, inventoried the existing indicators related to these targets and particularly the set of indicators listed in the European Commission decision of 1st September 2010.

On the French level, the process of MSFD implementation gave rise to the publication of decrees related to the definition of GES, initial assessment and environmental objectives in December 2012.

Significant support was additionally supplied to the Ministry of ecology, sustainable development and ecology (MEDDE) by experts from our Institute, on the European scale, by participating in meetings organised by the European Commission, Conventions for regional seas (Ospar and Barcelona) and ICES in the framework of MSFD implementation.

Lastly, the Institute took part in the European "Stages" project which aims to inventory the gaps in knowledge about the marine ecosystem and identify the research themes which should be developed as a priority to establish the scientific bases required to achieve and maintain the good environmental status of marine waters.

## INTERREG MARNET (MARINE ATLANTIC REGIONS NETWORK)

Marnet brings together a network of research bodies which are associated with regional entities, with a shared interest for analysing and utilising the available marine resources by setting up a maritime socio-economic network. This network aims to create and collect maritime socio-economic data and will use them to support initiatives for maritime social and economic development in the Atlantic area. It will examine the economic utility of the marine environment, stemming from the productivity of marine ecosystems in the Atlantic arc area. And finally, it will aim to support the competitiveness and sustainable development of the outlying Atlantic area by continuously providing a sound set of data.



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## GREEN TIDES

Ifremer is on the scientific committee of the Green algae plan which, up until July 2012, assessed the eight projects for catchments with very low nitrogen leakage in response to a call for proposals from the Prefecture. The Brittany prefecture used the eight collegial opinions published by the committee and made them available on line. Furthermore, on 27 April 2012, the Prefecture officially presented the report by CGEDD and CGAAER assessing the research conducted in Brittany over the past twenty-five years, in particular by Ifremer, on the mechanism of green tides. This report was supervised by Mr. Chevassus-au-Louis, and has been available on line since May 2012. It bears out the results and opinions provided by Ifremer.

## WGFAST symposium on ecosystem surveys

Along with IRD, Ifremer organised the ICES WGFAST 2012 working group from 24 to 27 April 2012 at the Brest centre. ICES WGFAST was created in 1984 following an ICES recommendation made in 1982. It reports on its work to the ICES "Steering group on ecosystem surveys science and technology". The group also organises an international symposium held every five years or so. The last of them was called "ICES Symposium on the Ecosystem Approach with Fisheries Acoustics and Complementary Technologies" and was held in Bergen in 2008. In 2002, the event took place in Montpellier and was co-organised by Ifremer and IRD.

WGFAST meets each year and provides the only international venue for exchanges for the acoustics, fisheries and marine ecology scientific community. It regularly brings together a hundred participants from some twenty countries. This community, initially focusing on acoustic methods has opened over to other approaches, particularly optics, over several years now. The objective is to contribute, through these observation methods, to ecosystem approaches to improve the assessments and management of marine living resources, understand the mechanisms and processes of change and stability and parameterize and assess models for the structuring and functioning of ecosystems.



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## LABEX MER

The starting up of the laboratory of excellence for the sea, Labex Mer, at the end of 2011 was a structuring factor enabling the Dynéco research unit to consolidate its knowledge and understanding of coastal zone functioning in the special context of climate change, with a research axis devoted to the evolution of marine habitats, adaptation of populations and role of biodiversity, which Ifremer helps coordinate. This Labex opens up new possibilities, especially though hosting international, highly skilled young researchers and the setting up of innovative training courses. An international chair in evolutionary ecology was created in late 2012 for a three-year period in the UMR Lemar (IUEM, Ifremer and IRD) joint research unit. Several Ifremer (PFOM, Dynéco) are involved in the related research topics, in particular for the experimental study of adaptive responses in some species of interest, for heritage or economic reason, like honeycomb worm reefs and cupped oysters).

Moreover, Labex Mer finances projects which enable the testing of new ideas and hosting of guest researchers. In 2012, the Dynéco unit received support for a novel isotope application, for the use of genomics tools to identify species of phytoplankton in sedimentary archives and for collaborative work with an American scientist for three months modelling the *Cr. virginica* oyster's response to environmental changes.

▲ *Ophiocomina nigra* black brittle star in the Bay of Brest

## Brest-Iroise workshop area

Another structuring, complementary element has been created by the CNRS awarding its label of approval to the Brest-Iroise workshop area (ZA) in 2012. Achieving this status was supported Lemar and LETG, and the ZA associates Ifremer in three of the scientific themes dealt with (Coastal vulnerability and hazards; Global change, environmental status and socio-ecosystem perspectives; and Management, uses, conservation) and two cross-cutting lines of research (Interactions between science and society and Models and information systems). The arrangement will facilitate interactions between scientific and socio-economic stakeholders on the stakes and challenges (pressures related to anthropization, existence of a marine park, coastal hazards) lined to this study area. It should be emphasised that this is the only marine-type ZA workshop area in France nationwide. Ifremer is directly involved in the facilitation of this ZA (in the cross-cutting Modelling and information systems axis). Its expertise in modelling, mapping and benthic ecology as well as the studies already carried out in this area will lead to the stepping up of collaborative projects.



## Isoecol 2012 international conference

Ifremer (ODE/Dynéco-benthic ecology laboratory), working with IUEM, organised the eighth Isoecol conference which was held for the first time in France in the Conference centre in Brest from 20 to 24 August 2012. Every two years, this international conference brings together an international community of researchers working to understand ecological and biological processes by using natural stable isotopes (mainly  $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{34}\text{S}$ ,  $^{18}\text{O}$  and  $^2\text{H}$ ) as a tool. This time the event drew two-hundred thirty-two research scientists and students from thirty-seven countries. It was an opportunity to present the progress made in isotopic ecology and to showcase French marine ecology research since a large number of this tool's users work in research centres in Brittany (Ifremer, IUEM and Roscoff).

## Study on *Ophiothrix fragilis* and *Ophiocomina nigra* epigeic brittlestar populations at the tip of Brittany: evolution and trophic ecology

This study was the main subject of the thesis by Aline Blanchet (Dynéco-Benthic ecology), defended in December 2012, which firstly validated and quantified a phenomenon of a hitherto unseen, extremely intense proliferation of the brittlestar *Ophiocomina nigra* which is generating profound modifications in interaction with *O. fragilis* in the Bay of Brest. The joint approach using stable isotopes and fatty acid markers confirmed that *O. nigra* is capable of exploiting a wide range of food sources present at different levels in the food web, which gives it an advantage with respect to *O. fragilis*, although the latter has been described as being stable in the Bay of Brest. The large amounts of detritic matter available in productive systems such as these and the ability of the species to utilize it may explain in part the success of this opportunistic species. These

results predict a change in the functioning of the Bay of Brest ecosystem and highlight the need to take account of a species which was "almost unknown" until now in the impact studies and which, following this study, appears to be a "key-stone" species in the changes observed.



## Participation in the ANR AmoraD project

Following the Fukushima accident, the ANR launched a call for projects on "Research on nuclear safety and radioprotection" within the Investments for the future framework. IRSN is coordinating the selected project, which will last eight years. The environmental strand comprises four orientations on atmospheric, continental, marine and ecotoxicology themes. Ifremer (Dynéco/Physed) is associated in this work, on the hydrodynamics and sedimentary dynamics aspects, on the study zones in the English Channel, Bay of Biscay, Mediterranean and Japan, in collaboration with the aerology laboratory in Toulouse. The project focuses on using observation and modelling to qualify the dispersal of radionuclides in water and their fate in sediment (burial, release and transport), against the backdrop of an accident. Along with the principal contributions, exploratory ecotoxicology workshops will also be organised.

## PCB IN THE MARINE ENVIRONMENT

Following the maximum levels set by regulations for polychlorinated biphenyls (PCBs) being exceeded in freshwater and estuarine fish species, the Ministries in charge of ecology, health, agriculture and fisheries launched a PCB action plan on 6 February 2008. One of its aims was to develop scientific knowledge about this family of contaminants.

The research actions and developments achieved during the plan's three years led to the drafting of an assessment of environmental knowledge about PCBs. The assessment was made by taking account of the major management stakes related to the pollution of aquatic environments by this family of contaminants, in order to draw out the lessons which can be transposed to other families of persistent organic contaminants (brominated flame retardants, perfluorinated compounds, etc.). The final seminar was organised by Onema, the ministry of ecology and the university of Bordeaux I, in partnership with the ministries in charge of agriculture and health, and took place on Thursday 31 May 2012 at the university of Bordeaux I. It was intended for the representatives of the institutions and organisations involved in assessing environmental and health hazards and in managing the quality of aquatic environments. It also attracted French and international scientific experts working actively on the issue of PCBs.

The Biogeochemistry and ecotoxicology unit, and more specifically the organic contaminant biogeochemistry laboratory (LBCO), presented three papers and took part in the round table discussion on the "perspectives for transferring knowledge acquired about PCBs to other organic pollutants of emerging interest".



© Ifremer/RBE/BE/LBCO

▲  
*PCB analysis in the organic contaminant biogeochemistry laboratory of Ifremer Nantes*

## Thermostable proteins and enzymes

Studies are being developed on the detection and characterisation of protein factors of enzymes involved in DNA replication, repair and recombination in hyperthermophilic marine prokaryotes, under conditions which are harsh for humans. The aim is to set up an approach to systems biology in a marine organism to better understand the equivalent processes in more complex, although related, higher eukaryotes. In addition, these proteins present an interest for biotechnology in the field of DNA engineering. Part of our activity consists in assessing the knowledge transfer possibilities towards diagnosis-type or biotech applications

For DNA polymerases and biotechnology applications, the main results delivered concerned:

- the structural and functional characterisation of DNA polymerase B when uracil, the product of cytosine deamination, is present,
- enzymatic characterisation of DNA polymerase D in the presence of uracil. This project involved collaborative work with Professors B. Connolly, from the University of Newcastle (United Kingdom) and Y. Ishino, from Fukuoka University (Japan),
- novel PCR performance of DNA polymerase D (e.g., greater resistance to inhibitors than that of *Taq*, the enzyme most commonly found in commercial testing kits).

For genome maintenance and the interaction network, study of RPA's biotechnological potentiality was pursued thanks to maturation funding being secured.

*A seminar on the assessment of environmental and health risks and the management of aquatic environmental quality*

# BIOGEOCHEMISTRY AND ECOTOXICOLOGY

## GDR-I- Execo

GDR-I-Execo on “contaminant exposure and ecotoxicological effects along continental-coastal continua” is an international trans-Atlantic research consortium in the field of ecotoxicology. It is coordinated by the Biochemistry and ecotoxicology unit at Ifremer Nantes, and comprises teams from the CIRE network (Inter-Institutional Ecotoxicology Research Centre in Quebec: INRS health in Montreal, Institute of marine science in Rimouski, Concordia university, university of Montreal, Mac Gill University, Aquarium of Quebec, Biosphere Canada, Biodome of Montreal, Environment Canada in Montreal, Centre of marine biotech research, CEAEQ environmental analysis expertise centre in Quebec), as well as academic teams and national institutions found all along the Atlantic arc (university of Le Havre, university of western Brittany, INRA in Rennes, university of Angers, Ifremer’s Atlantic centre and university of Bordeaux).

Its overarching objective is to study biological effects of chemical contaminants along the continental water to marine water continuum, working on three lines of research:

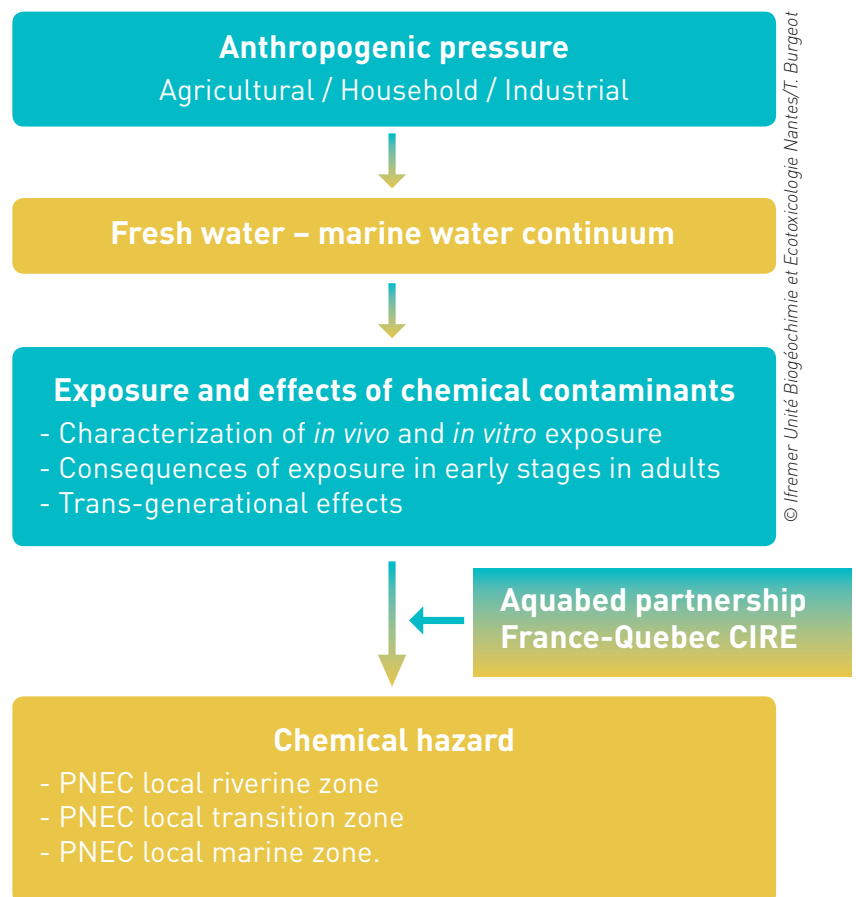
- characterising the relationships between exposure to parent compounds and to their degradation products and biological effects on an individual level;
- analysis of the consequences of exposure in early stages on effects at the population level;
- analysis of trans-generational effects of chemical contaminants.

GDR-I-Execo was launched in 2009 at the initiative of Ifremer’s Biochemistry and ecotoxicology unit, carrying on from the first marine ecotoxicology research consortium (GDR Imophys 2003-2007). GDR Execo has been awarded the Ifremer, INRA and CNRS labels of approval for the period from 2009 to 2013. The consortium’s dynamics firstly made it possible to set up a community of French ecotoxicologists to work on the theme of biological effects of chemical contaminants that can be observed on scales ranging from cell to living populations along the estuarine continuum. Extending the group to include the network in Quebec, GDR-I-Execo made it possible to create an aquatic ecotoxicology think tank. It is organised as a yearly seminar (Ecobim: ecotoxicology and marine biology), with exchanges of research scientists and in particular, support from the French embassy, supervision of PhD students, hosting of post-doc fellows, securing

an ANR project called Blanc IPOC (interactions between pollution and climate change: developing a monitoring strategy: 2012-2014), creating an international scientific journal named *Xenobiotics* in 2012 and producing a special issue of the journal *Environmental Sciences and Pollution Research* published in 2013.

Over a ten year period, the continuity of action coordinated by Ifremer since 2003 in these two consortia: GDR Imophys and Execo, was an appropriate stepping stone to implement a research theme in ecotoxicology on the “biological effects studied from gene to physiology”; structuring the foundations for Labex Cote in 2011 and structuring a French ecotoxicological scientific community which has now been broadened, since the annual Ecobim seminar, to comprise the universities of Metz and Reims, the *Ecole Pratique des hautes études* in Lyon, Irstea in Lyon and Ineris.

*Study of chemical exposure risk along the continuum of continental water and marine water*





## LABEX COTE

### ▲ *Shore of the Arcachon basin*

The laboratory of excellence called LabEx Cote (Continental to coastal ecosystem: evaluation, adaptability and governance) associates biological, ecological and social and economic sciences with the objective of analysing and understanding the multiple disturbances which ecosystems in the Aquitaine area are subjected to (studied along a continuum of forests, agri-systems, rivers and estuaries) and their consequences on the services which they can render, the most important of which is access to resources and their long-term utilisation.

The project is based on:

- a research strand with three orientations:
  - identifying the factors of environmental changes and the impacts on the ecosystem
  - ecosystem response and adjustment mechanisms (resistance and adaptation)
  - long-term response: more foresight-oriented, combining a multidisciplinary approach which greatly relies on modelling;
- a transfer strand, aiming to optimise the dissemination, transfer and utilisation of results through an expertise unit;
- an academic teaching strand, with the goal of increasing international attractiveness (organising an international summer school, mobility for PhD students).

It is led by the Bordeaux PRES university cluster, with ten participating laboratories specialised in terrestrial and aquatic ecosystems and two hundred research scientists involved. The biogeochemistry and ecotoxicology unit at Ifremer and the Environment resources laboratory in the oceanography and ecosystem dynamics department in Arcachon are partners of the four institutions represented in this laboratory of excellence, with the university of Bordeaux, Irstea and CNRS.

## ANR Gimepec project (Contaminants Ecosystem Health programme)

The Gimepec project aims to study the role that chemical contamination of the environment may play in episodes of summer mortality in Pacific oysters. It suggests a genetic basis to explain oysters' loss of resistance to physiological and environmental stress. Damage to the oyster's genetic material could be the consequence of a genotoxic impact due to pesticides, whose alterations to the genome (primary lesions and irreversible damage to chromosomes) would be responsible for oysters becoming less robust. This would lead to diminished physiological performances in terms of growth, survival, immunity and reproduction. Since it cannot be ruled out that the pernicious effects induced by pesticides can be transmitted from one generation to another, the trans-generational effects of exposure to pesticides will be particularly closely studied.

To do so, the project is calling on multi-disciplinary expertise and organised into two complementary approaches: an experimental approach conducted at Ifremer's hatchery at La Tremblade under controlled conditions and an *in situ* approach in the Charente estuary.

Knowledge acquired in the framework of the Gimepec project will not only contribute to understanding the causes of the excess mortality affecting the oyster farming value chain, but will also enable the seasonal fluxes of herbicides in the Charente estuary to be assessed and the toxic effects of pesticides in bivalve molluscs to be better known. The project will make it possible to study interactions between aquaculture and the environment.



The initial results obtained show toxicity of diuron for the Pacific cupped oyster after exposure to these environmental concentrations. A significant drop of 20% in the weight of broodstock exposed to diuron was observed. While no effect on reproduction (development of gonad, titration of sexual steroids) could be shown, the formation of primary structural lesions in the DNA and a moderate alteration of immunocompetence could be demonstrated in broodstock exposed to diuron. The genotoxic effect was observed not only in haemocytes but also in gametes, following the analysis of spermatozoa of diuron-exposed male broodstock. The transmission of damaged genetic material may be responsible for the negative impact observed on the rate of recruitment in the offspring of the group exposed to the weed killer (decrease in hatch rate, increase in abnormal development). In the spat stage, analyses by flow cytometry also made it possible to show the transmission of DNA aneuploidy, at a similar frequency to that observed *in situ* on the sites most affected by mortality events.



© Ifremer/Projet Gimepec

▲ Gathering broodstock tissues after exposure to diuron for biological and chemical analyses



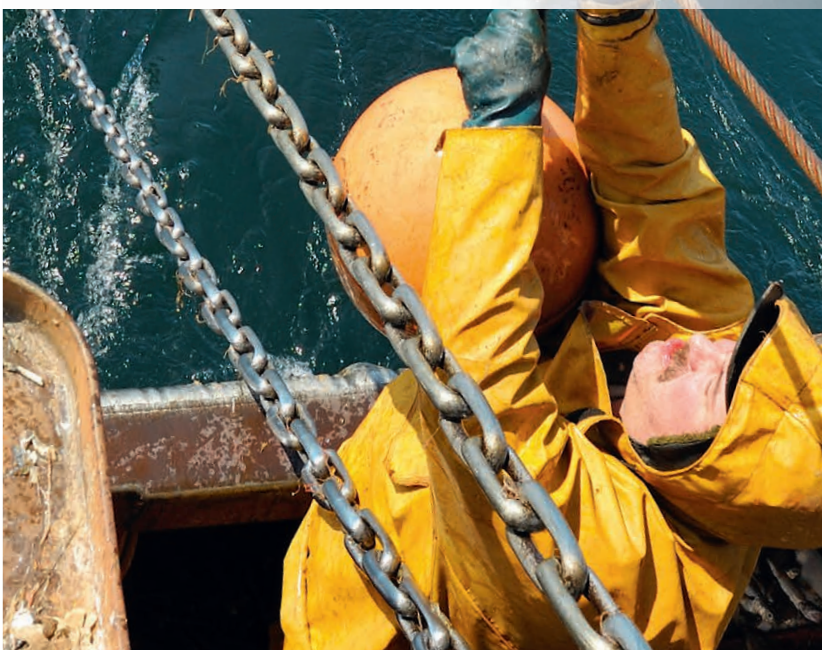
## ECOSYSTEM APPROACH IN FISHERIES

**MyFish, European project  
on management strategies  
to achieve maximum  
sustainable yield**

In the frame of this project, the “Ecology and fisheries models” unit is coordinating an integrator case study on fisheries and habitats of the Grande-vasière mud plain in the Bay of Biscay.

The concept of Maximum Sustainable Yield (MSY) was adopted as a basic principle in the *Reform of the Common Fisheries Policy (CFP) Green Paper* in 2009. This means a commitment to including MSY in the management of fish stocks by 2015. Attaining this goal is complicated by the lack of common agreement on the interpretation of “sustainability” and “yield” and by the unknown effects that achieving MSY for one stock may have on other stocks and broader ecosystem, economic, or social aspects.

# SUSTAINABLE UTILISATION OF BIOLOGICAL RESOURCES



*For balanced fisheries  
which respect the food  
chain*

MYFISH will provide definitions of MSY variants which maximise other measures of "yield" than biomass and which account for the fact that single species rarely exist in isolation in the ecosystem. Further, MYFISH will redefine the term "sustainable" to signify that Good Environmental Status (MSFD) is achieved and economically and socially unacceptable situations are avoided, all with acceptable levels of risk. In short, MYFISH aims at integrating the MSY concept with the overarching principals of the CFP: the precautionary and the ecosystem approach. The project consist in achieving these two objectives through addressing fisheries in all RAC (Regional Advisory Council) areas and integrating stakeholders (the fishing industry, NGOs and managers)

throughout the project. Existing ecosystem and fisheries models will be modified to secure maximisation of stakeholder approved yield measures while ensuring acceptable impact levels on ecosystem, economic and social aspects.

Implementation plans are proposed and social aspects addressed through active involvement of stakeholders and their insight. Finally, effects of changes in environment, economy and society on MSY variants are considered, aiming at procedures which will render the MSY approach robust to such changes. The expertise of 26 partners from relevant disciplines including fisheries, ecosystem, economic and social science are involved in all aspects of the project.



## WHAT'S NEW FOR THE FISHERIES INFORMATION SYSTEM

Fisheries cruises which are co-financed by Europe (DCF) and Ifremer and the observation programme for discards at sea (Obsmer), co-financed by Europe (DCF), DPMA and Ifremer, are all tools which enable fisheries biodiversity to be characterised while increasingly integrating the component of habitats, taken broadly, in anticipation of the implementation of the MSFD. In this way, the Pelgas (small pelagics in the Bay of Biscay) cruise has become a fully ecosystem-based cruise, with sampling of biotic (e.g., zooplankton) and abiotic (density) parameters and could be chosen as the model to incorporate various observations. The type of discards is crucial in order to understand the fraction of the ecosystem which is sampled through the selection made by the fishing gear, to better appraise the impacts, particularly on the functioning of the food web.

The coastal cruise Pelmed-12 (27 June to 1st August, Toulon) is an Ifremer mission whose aim is to assess the resources of small pelagic species in the Gulf of Lion using echo-integration and mid-water trawling, mainly in daytime. In the North West Mediterranean, the majority of spawning anchovy populations is located on the continental shelf of the Gulf of Lion and in North Catalonia during the month of July, which is why this period was chosen for the cruise. These studies on small pelagic fisheries have been made necessary by their intensive exploitation by trawlers and seinnetters in the Gulf of Lion as well as by foreign fishing fleets. Landings have reached high volumes since 1989. They now rank third amongst Mediterranean yields in terms of weight and second in terms of value. This fishery requires that advice be provided on a recurrent basis for its management, since assessments continue to show strong signs that its stocks are decreasing.

The 2012 Data Collection Framework programme was successfully completed, both for observations at sea (Obsmer) and observations of landings (Obsdeb), and for data acquired on activities and uses. Participation in European working groups (ICES, STECF) was ensured as expected and Ifremer's response to requests submitted to it by DPMA was judged to be highly satisfactory. Ifremer contributed to drawing up the dossier for recording of economic data at the national council for statistical information (CNIS), which enables quality certification for the data acquisition programme.

*Trawl full of anchovies aboard research vessel L'Europe*



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## Towards a new approach to fisheries?

### Think tank on the “balanced fisheries” concept

An international group of scientists has proposed a new way of looking at fisheries selectivity in a position article published in the journal *Science*. Their studies dealt with the concept of “balanced harvesting”, providing thought about taking better account of biodiversity and ecosystems in fisheries management. Of note, the article reports the recent results obtained by Marie-Joëlle Rochet, its co-author and a researcher at Ifremer’s Atlantic centre.

#### **A new paradigm with respect to conventional “selective fisheries”...**

“Worldwide, fisheries management has counted greatly, along with lowering the amounts fished, on increased selectivity: species of commercial interest are targeted, and by modulating the gear or mesh size of nets, the largest individuals are selected so that juveniles can grow and take part in breeding. And yet, these selective fisheries only focus on what’s in the net and its potential value. The idea developed in the article is to compare the catches in a given area with what comes down to the composition of the marine ecosystem”, explained Marie-Joëlle Rochet, fisheries scientist at Ifremer and co-author of the article. “This means we go from an economic and utilitarian viewpoint to an ecological viewpoint”.

#### **... but a shared vision of moderate exploitation of resources.**

The article compiles several scientific results as an argument for the numerous advantages of balanced harvesting, providing it remains reasonable. These fisheries would maintain sufficient numbers of adults necessary for breeding and secure following generations. It would conserve the natural population proportions within the ecosystem and would disrupt the food chain

less than conventional selective fisheries do. The authors also indicate that this could contribute to food security through higher total yields for the same level of ecological impact.

However, the article does not set balanced harvesting against conventional selective fisheries in every respect. There are subtle and complex points to consider. Balanced harvesting itself is selective, since it does not consist in indifferently removing just any marine organism. But its selectivity lies within a new, more ecosystem-based, perspective. At any rate, we recommend moderate fishing, which is required to restore the ecosystem and its communities. If, moreover, this is balanced, it could facilitate the restoration and enable higher, more sustainable yields...” explained Marie-Joëlle Rochet.

Garcia S.M., Kolding J., Rice J., Rochet M.-J., Zhou S., Arimoto T., Beyer J. E., Borges L., Bundy A., Dunn D., Fulton E. A., Hall M., Heino M., Law R., Makino M., Rijnsdorp A. D., Simard F., Smith A. D. M. (2012). Reconsidering the consequences of Selective Fisheries. *Science*, 335: 1045-1047.



© Ifremer/L. Tirmant

▲ In the marine ecosystem, large fish eat small ones, which feed in turn on smaller animals

### **Tools for the management of marine protected areas: the Pampa project**

The Liteau III Pampa (performance indicators for marine protected areas to manage coastal ecosystems, resources and uses) project coordinated by Ifremer (D. PELLETIER), ended in 2012 with a final seminar held at the Aquarium de la Porte Dorée in Paris. This project made it possible to define the indicators and how they'd be represented in the form score cards which are well adapted to MPA management. Above and beyond these tools, a methodology was developed for efficient interactions between managers and scientists. The Côte Bleue marine park, Bouches de Bonifacio marine park, Banyuls marine reserve and in overseas France: Réunion, Tahiti, New Caledonia, Mayotte and Saint-Martin were all stakeholders involved and all of them are potential sites for applying the tools developed by Pampa.





## THE ANNUAL GREAT JOURNEY OF PORBEAGLE SHARKS

For the first time in the Eastern Atlantic, the migration tracks of large sized porbeagle sharks have been monitored over a year, thanks to satellite tags. The operation was performed by Ifremer (fisheries resource laboratory in La Rochelle) and IRD (research institute for development) upon request from the DPMA (maritime fisheries and aquaculture division), who financed it with help from the Pays de Loire regional council. Additionally, the operation was an opportunity for a partnership with Cefas (Centre for Environment, Fisheries and Aquaculture Science), with one of their agents joining the Ifremer-IRD team aboard the Yeu-island long-liner vessel chartered to deploy the tags.

© IRD/B. Seret

Three female adult or sub-adult sharks whose size ranged from between 2 m and 2.60 m were tagged with pop-up archive tags enabling their journey to be reproduced thanks to the luminosity and surface water temperature data recorded. The tags are programmed to pop off after one year, so that the movements can be tracked over an annual biological cycle. Once they pop off, the logged data is transmitted by satellite.

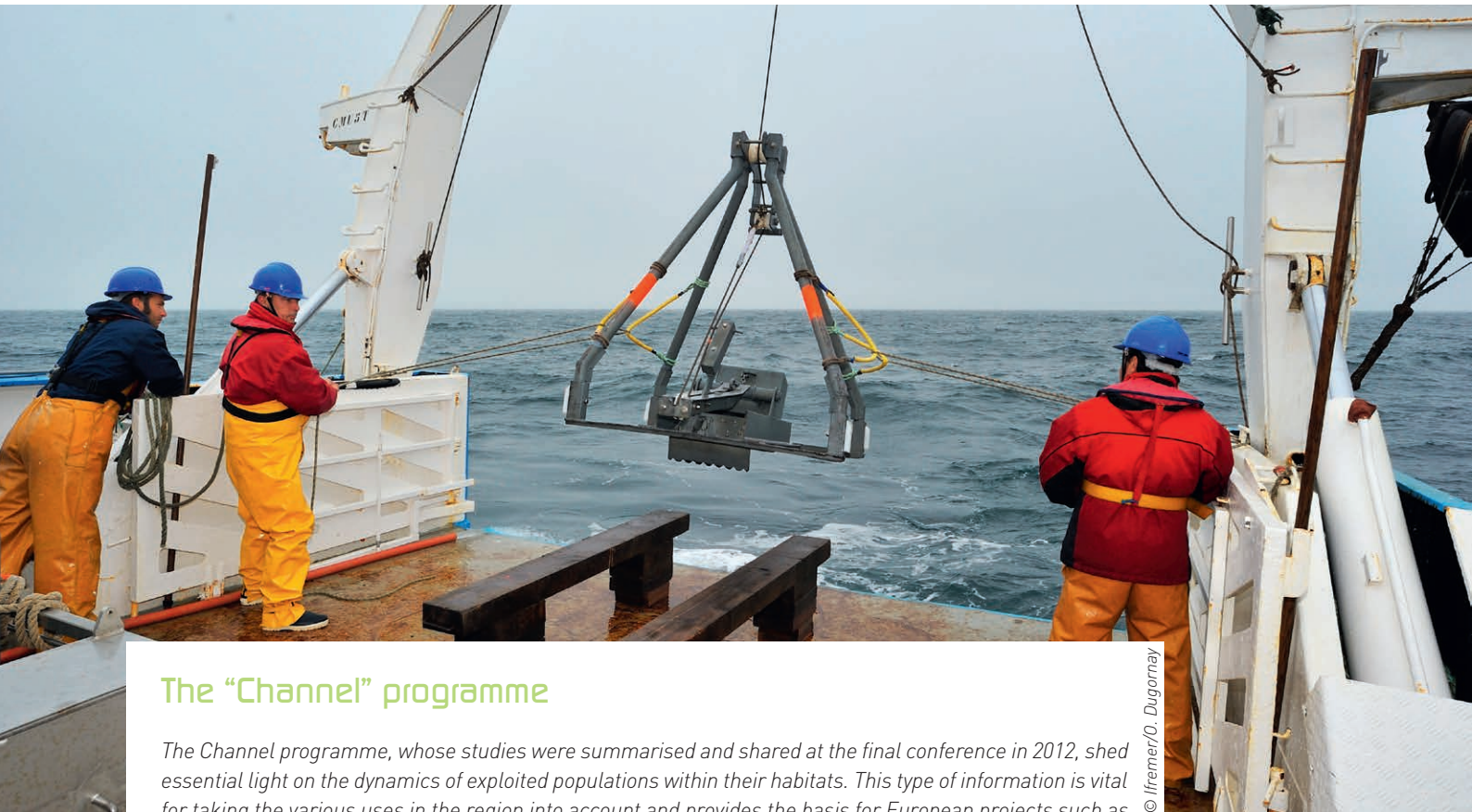
The animals were tagged in June-July 2011 on the North continental shelf edge off Brittany. The results show the very large distances that porbeagle sharks cover: going as far as the Arctic Circle for one of them travelling northward, and to offshore of Morocco for another towards the South, with the possibility, travelling westward, to reach the Mid Atlantic Ridge and to follow it back to the Azores. When it has been possible to monitor them over a year, the sharks came back to the area near the place they were tagged, for one of them, - even less than 10 nautical miles from the spot.

These surprising looped migrations seem to show a seasonal attachment to the shelf breaks in the Bay of Biscay and to the south-west of Ireland. This means that a cruise to monitor the abundance of the mature female biomass could be achieved at an affordable cost. The decision for this operation was taken in order to improve the knowledge base which is needed to reopen the fishery, following a European ban introduced in 2010 on the landing of porbeagles. Furthermore, the hypothesis of groups which are somewhat isolated can now be put forward. If this could be better demonstrated, it would have consequences for the current diagnosis on the East Atlantic stock.

Thus a small number of tagging operations have opened up attractive new avenues of research to improve knowledge about this large ocean shark's dynamics and thus help contribute to an objective assessment of the possibility of their being sustainably exploited.

▲  
*A tagged, 2.2 m-long porbeagle shark being released*





© Ifremer/O. Dugornay

## The “Channel” programme

*The Channel programme, whose studies were summarised and shared at the final conference in 2012, shed essential light on the dynamics of exploited populations within their habitats. This type of information is vital for taking the various uses in the region into account and provides the basis for European projects such as Vectors, in which Ifremer is making a significant contribution.*

The programme symbolises Ifremer’s ability to bring together and federate stakeholders in research and in territorial management, with the shared objective of understanding the dynamics of the biological resources exploited. It is strongly rooted in a European dimension, combining scientific excellence and operational valorisation, broken down into four operational orientations: descriptive approach, functional approach, impact studies and integrated applied approach. It is based on collectively developing research capacities to achieve multidisciplinary knowledge about how different marine and coastal ecosystems subjected to heavy anthropization. Following on from the Channel challenge operation begun in 2003, the Channel programme (2007-2012) was built upon some ten scientific projects contributing to this process, seven of them in European partnerships.

Over sixty scientific articles were published, four PhD theses were defended and ten are still underway. The programme has also contributed to implementing sustainable use of various environments, by defining the tools to assist management which can adapt the pressures to fit the degree of flexibility of ecosystems and the fisheries sector.

It has also provided the transfer and valorisation of acquired knowledge in order to consolidate partnership-based management of renewable resources and supplied elements to help public decision makers resolve conflicts of use. In more operational terms, it has made indicators and score cards available to managers, to characterise current states, measure the impact of various anthropic pressures on ecosystems and to assess the effectiveness of management measures. Since 2010, twenty-five events of various types to disseminate this progress have been organised, tailored both for scientific and professional circles and for the general public.

The Channel programme is designed to appraise the characteristics and functioning of habitats and the living resources they hold, on the scale of the Channel catchment basin. The goal is to set up an ecosystem-based approach to managing marine resources in the broadest sense of the term (living as well as mineral and energy resources) and to better adapt the pressure from numerous uses to the production capacity of different environments.

A regularly updated website at <http://wwz.ifremer.fr/defimanche>, shows the state of progress of this programme’s actions and projects.

▲  
A Hamon grab  
in the framework  
of the Charm  
programme

The Charm (Channel integrated Approach for Channel Resource Management) project, scientific spearhead of the “*défi Manche*” Channel challenge, was finalised in 2012 with scientific and general final conferences in Boulogne-sur-Mer, as well as communication outputs. The progress made by Charm in understanding the relationships between habitats broadly speaking and fisheries communities will be decisive for the rational exploitation of biological resources. This is to the credit of consensus-generating governance which has now set the scene for regional inter-partnership in the Channel-North Sea area.

Furthermore, the programme hosted new projects in 2012:

- ANR Camanoc (ecosystem cruise in the Western Channel) project, Dr Morgane Travers, Ifremer, project coordinator,
- Interreg IVA 2 Seas GIFS project, Dr Tim Acott, University of Greenwich,
- Interreg IVA project Panache (network of MPAs over the entire Channel ecosystem), Christophe Aulert, in the Channel-North Sea branch of the Agency for marine protected areas),
- and Interreg IVA project Valmer (Valuing Marine Ecosystem Services in the Western Channel).

## CRESH PROJECT

The Cresh project set out to describe the natural habitats of spawning grounds for cephalopods, especially cuttlefish, which were needed to understand which seabeds are essential for the renewal of these resources. The study contributed to improving understanding of the role played by juveniles of this species in the English Channel ecosystem, since their survival and successful recruitment depend on the ecology in the stages preceding recruitment. Thus, the project improved knowledge about the favourable habitats for cephalopod reproduction, estimated the contribution from different spawning areas to recruitment of the overall stock, studied the effect of temperature and abiotic and biotic factors on growth and survival in the first stages, perfected genetic markers for para-larva identification and specified the ecological characteristics of juveniles in each species, combined fisheries statistics and independent indicators

to update and refine the estimations of stock and of recruitment and proposed new recommendations to fishermen and their partners for the sustainable use of marine resources in the English Channel.



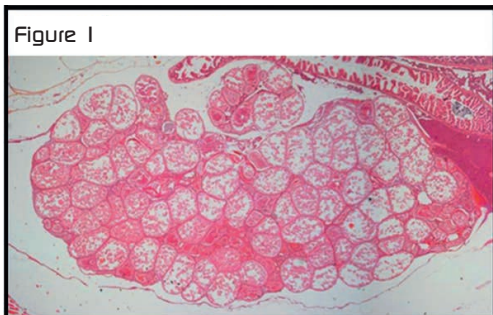
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▲  
Cuttlefish

## Charm project Phase 3

During three days of conferences designed to present the state of progress for the Channel programme and the final outputs of the Charm and Cresh projects (Chamber of commerce & industry of Boulogne-sur-Mer, 12 to 14 June 2012), the 13th June was devoted to presenting the results of phase 3 of the Charm project whose aim was to develop an ecosystem-based approach on the Channel seafront. This project started in 2003 with two phases each lasting two years and phase 3 (2009-2012), involving a hundred scientists from seventeen French and British research institutions, with a budget of 11.6 million euros, enabling the development of an ambitious multidisciplinary approach on the scale of the English Channel and the southern North Sea. The project objectives focused on orientations: collection, standardisation and mapping of data; data integration by modelling; and tools and dissemination of information. This work provided a comprehensive study of the English Channel, addressing every compartment of this ecosystem (from plankton to large predators).

It yielded a more thorough understanding of each ecological component and the implications for management were addressed. By developing habitat models for numerous species, as well as food web models, it was possible to simulate the foreseeable changes in varied scenarios of use or of climate change. Innovative studies on spatial planning were also implemented to take account of anthropic impacts (shipping, offshore wind turbines, marine aggregates, fisheries, tourism, and so on) on marine living resources and consolidate reflection on setting up marine protected areas or marine parks. The approach was supplemented by an economic and socio-cultural analysis of the fisheries sector, through understanding the patterns of distribution of efforts, examining the economic viability and diversification of activities as well as the cultural importance of fisheries in harbours along the shores of the English Channel. Lastly, the Charm project gave policy makers access to scientific information from various disciplines which was gathered and generated during the project's life span, by developing innovative information systems and tools for integrated and rational management of the Channel. An example is the dissemination of results via an interactive website, displaying interactive atlases on fishing activities and more, a dedicated geoportal and a gazetteer, all focused on this intensively exploited maritime area.



© IT Larcher - ONIRIS Nantes

▲  
Histological section of a normal ovary (figure 1) and the ovary of a contaminated fish (figure 2)

## CONPHYPOP

The eight partners of the ConPhyPoP (contamination and physiology of fish exposed to pollutants – ANR CES – 2010-2013) project worked to characterise the physiological effects of fishes' exposure to polycyclic aromatic hydrocarbon (PAH) mixtures. The exposures were performed by using exposure conditions that were environmentally relevant (doses, mode of exposure, etc.). The exposures were performed at the Fish ecophysiology platform at the La Rochelle station, taking advantage of a model with a short life cycle, the zebrafish.

The latest results highlighted alterations in several biological functions or processes following exposure to PAHs of pyrolytic origin, i.e., tumorigenesis, digestion, behaviour and reproduction, and this is the case at different levels of organisation (molecular and tissue). These alterations observed in a model fish species could indicate a risk for the quality of recruitment in wild fish species exposed to PAHs.



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## Costas (contaminants in the food web: phytoplankton, zooplankton, anchovy and sardine)

This project (ANR CES 2009) is coordinated by Ifremer and focuses on the bioaccumulation of persistent organic pollutants (POP) in the marine food webs of the Gulf of Lion. Understanding the mechanisms of bioaccumulation of chemical contaminants in fish is a major challenge for the Costas environmental risk assessment. The Costas project aims to understand and model the input and fate of chemical contaminants, from the first links in the food chain, i.e., plankton, to small pelagic fish (anchovies and sardines) in the Gulf of Lion. The latter are both an important resource which is fished in this region and an essential link in the trophic chain, between plankton and other fish-eating species of fish which are also exploited. The approach also incorporates the ecological dimension of the food web and that of contaminant biogeochemistry. By supplying some answers about

the mechanisms leading to the chemical contamination of these biological resources, the project has helped interpret the levels observed for the chemical contaminants studied (PCB and other organic and metallic contaminants) and their spatial variability. Modelling studies aim to provide a spatialised, dynamic interpretation of the observations, as well as an initial integrative approach (biogeochemistry, ecology and physics) to contaminant transfer to the first trophic levels. An initial dynamic energy budget (DEB anchovy) assessment was also made to model the bioaccumulation of contaminants in the anchovy. This combined modelling approach seems to be perfectly adapted to studying the fate of contaminants in fish and opens new pathways to realistic understanding of their effects on the main biological functions of these organisms.

# MARITIME ECONOMY

## Partnership agreement signed on collection and use of fisheries data

This tripartite agreement between DPMA, Ifremer and CRPM (regional committee for maritime fisheries and mariculture of Languedoc-Roussillon) provides the framework for cooperation between Ifremer and the Languedoc Roussillon CSIC (CRPMEM LR) for exchanges of fisheries data and data use. It is the tangible outcome of several years of partnership with CRPMEM LR. This collaboration began, firstly with the committee's desire to set up a fisheries observatory, based in part on the Fisheries Information System and its related methods, and secondly from the need for Ifremer to rely on partnerships with fisheries professionals in order to perpetuate data collection and validate its methodologies.

In the frame of this agreement, each year Ifremer and CRPMEM LR co-produce a report summarising the situation of fisheries fleets on the scale of the Languedoc-Roussillon region based on activity data and economic data. Ifremer also calculates the aggregated economic indicators on fleets in the region on behalf of CRPMEM LR. When CRPMEM adds to the density of an economic sample, Ifremer proceeds with validating the economic data in accordance with the FIS protocol and makes the data available to CRPM once they have been validated.

CRPM LR undertakes to communicate with professional fishers about the data collection programmes for activity and economics, and encourage them to respond. It takes part in the validation of economic data and fine-tuning of the baseline references. It applies the FIS methodologies for economic data collection when it contributes to growing the density of the economic sample in the region.

## Integrated analysis of small-scale fisheries in Europe

Although small-scale coastal fisheries represent 75% of fishing vessels in Europe, its structure, its conditions of viability and its impacts on ecosystems are rather poorly known. This publication is the result of significant work in compiling data on nine case studies in locations over the Baltic, Atlantic and Mediterranean (also see the report for the project funded by the Directorate-General for Maritime Affairs and Fisheries, DGFISH). The data for the French cases come from Ifremer's fisheries information system. A multi-criteria approach was developed: the indicators studied concern the ways fisheries are regulated and the mechanisms of fishermen's participation in management, impacts on stocks and competition for resources and space in the coastal zone, both with fisheries with a long range of action and with other maritime activities. The analyses also focus on fleets' productivity and their socio-economic yield (value from species, employment, etc.). They have sought to identify the indicators which could be used to characterise their vulnerability. In a context of high heterogeneity of activities, this study has iden-

tified a number of factors which are common to small-scale fisheries. Their conclusions are also based on more comprehensive understanding of small-scale fisheries in Europe. Amongst the results that can be mentioned, they are less vulnerable economically speaking, with respect to larger vessels, thanks to better increasing the value of their yields and being less dependent on fuel. However, the fishing rights for these fleets are not always secure and competition can be harsh for access to coastal areas. The authors recommended that arrangements to monitor these activities be reinforced, so that their impact can be evaluated in the framework of integrated assessments of coastal socio-ecosystems.

*France Filière Pêche, created in 2012, is a driving force in strengthening the partnership between scientists and professional fishers. A framework agreement is being drawn up, but several projects have already been proposed and accepted, whether for fishing gear technologies or for acquiring knowledge about the dynamics of small pelagic stock in the Mediterranean.*

### DEVELOPING A FISHERIES MODEL IN THE ANR ADHOC PROJECT FRAMEWORK

The ANR Adhoc (modelling the viability of fisheries and marine biodiversity) project coordinated by CNRS is developing a case study in French Guiana and in the Bay of Biscay. It is organised into three sets of tasks: the first on ecology (which Ifremer is responsible for), the second on economics and the third on modelling. In French Guiana, a model including the twelve main species for inshore fisheries (80% of small-scale fishing yields) and the four fleets exploiting them is being developed. It will form part of a PhD study (integrated approach to coastal fisheries, the case of French Guiana) done by A. Cissé whose grant is 100% financed by ANR. The study has already been the subject of papers presented at several conferences and an A-rank publication, whose corrections were finalised in February.

A new website enabling fisheries research cruise data to be visualised



## FISHERIES TECHNOLOGIES

### CASLANG\_2012 RESEARCH CRUISE

As part of the State-region plan contract (CPER Bretagne for the development of software for design and numerical simulation of fishing gear), aimed to supplement knowledge and observations made on the practice of Nephrops pot fishing in the Bay of Biscay. Trials conducted in the past aboard professional fishing vessels (particularly those in the ITIS and Prespo projects have showed the need to better understand the keys to this fishing technique. So, the fisheries technology team in the Fisheries science and technologies unit (STH) tested the effects of different types of pots, bait, soak times and gear depths on Nephrop prawn catches. Physical measurements were also taken to better understand the way gear and lines behave during the different phases of the fishing operation (shooting, catching and hauling). The experimental zone off Bayonne was chosen following the results obtained during previous trials aboard a professional vessel (ITIS project) and because it is not used by trawlers. Indeed, one of the obstacles to developing pot-fishing techniques for Nephrops is the loss of equipment in sectors which are exploited using towed gear.

The catches made contained large Nephrops prawns with very high market value, although in fairly small quantities and by-catches such as whelk, conger eels or dogfish, often released alive as discards. Analysis of the data collected is underway and, if the samples prove to be sufficient, this could show the effect of the choice of pots, bait, soak time and environmental parameters (e.g., depth, tidal coefficient) on catches. Additional data on the composition in size, sex ratio and sexual maturity of catches taken in pots were collected and remain to be analysed with respect to Nephrops stock dynamics, to better understand the impact that the possible development of this fisheries technique would have on the resource.

Once again, the Caslang cruise illustrated the strong interaction between technical developments and biological knowledge in the context of the ecosystem approach to fisheries.

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# MARINE FINFISH FARMING

## Digere project (digestion, energy, efficiency)

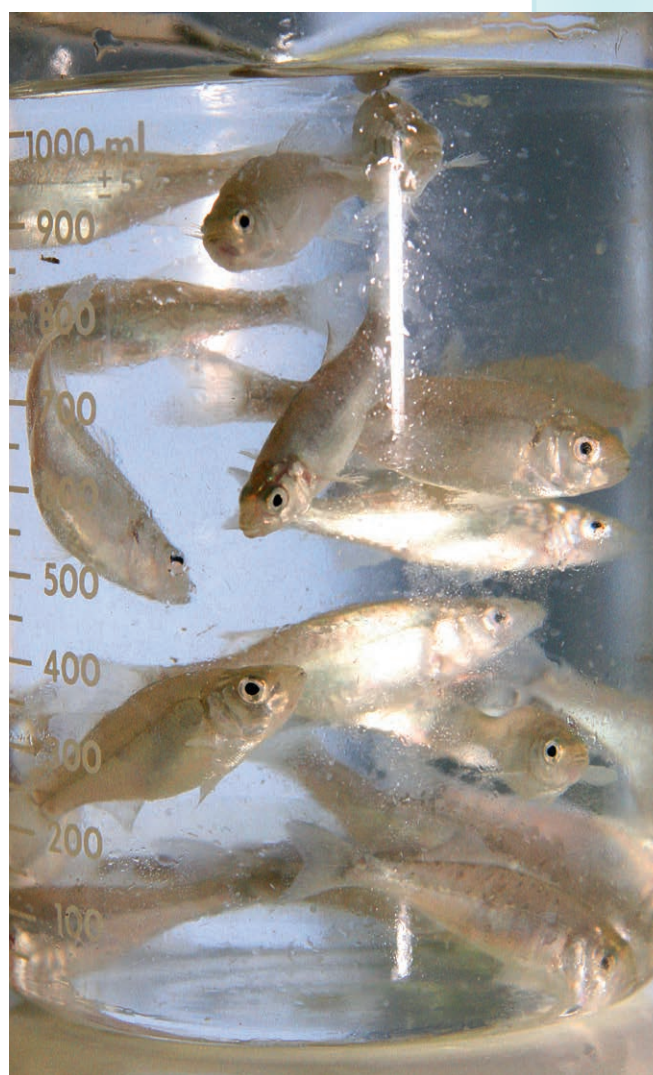
In the seabass, there is a correlation between feed efficiency and the indirect trait of starvation resistance or “fasting tolerance”. The Digere project aimed to better define the digestive processes which enable better feed efficiency and in particular, assessing the metabolic cost (and pathways) in animals which are resistant or not when deprived of food. The basic hypothesis is that animal with a high tolerance to fasting (whose feed efficiency is better) have lower metabolic maintenance costs. All project partners worked on the first generation of European seabass produced via divergent selection performed by Ifremer in the facilities at Palavas-les-Flots.

Digere has first demonstrated that the offspring of parents selected for their high or low weight loss during prolonged fasting (called FD- and FD+ for more or less strong fasting tolerance) also show differences in their tolerance to feed deprivation, i.e. fasting-tolerant parents engender fasting-tolerant offspring and *vice versa*. The following step will be to quantify the selection response, to then quantify the degree to which this trait is transmitted from one generation to another and to check that this fasting tolerance does indeed generate differences in feed efficiency. The final step will be to quantify the economic (savings on feed purchases for the selector) and environmental (reducing the needs for marine fish meals and oils) impacts that selecting for this trait could engender.

The results also showed that a high rate of weight loss is directly linked to the existence of a high metabolism, although this does not explain the differences in tolerance between the two genotypes (their mean maintenance cost is the same). They likewise prove that both genotypes are characterised by different energetic and digestive strategies: tolerance to fasting would be associated with a lower capacity for catabolising proteins and the genotype characterised by a longer postprandial period.

At any rate, if they are confirmed, the characteristics already identified in the fasting-tolerant genotype offer new possibilities for fish farming. Effectively, if this genotype is less affected (in terms of weight loss) by punctual fasting, it could be used preferentially in production systems

where the feeding is not totally controlled, such as extensive farms in outside ponds or tanks or intensive, sea cage farms (when access can sometimes be limited by the weather conditions). Finally, if it is confirmed that lipids are their preferred energy source, these genotypes may be the best choice in order to reduce the amounts of proteins used in fish feed. This hypothesis could be easily confirmed in targeted nutrition experiments, including body composition analyses to understand where and how these elements are stored (gut, muscles), so that the quality of fish remains compliant with the expectation so producers and consumers.



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# MARINE BIOTECHNOLOGIES



## Labelfish, Interreg Atlantic Arc project

The Science and technology of the marine biomass laboratory (Biotechnology and marine resources department), is a partner in the Labelfish project dubbed "Atlantic network on genetic control of fish and seafood labelling and traceability". The rules for labelling of fish and seafood sold on the market and which have been compulsory since 2005 in the European Union stipulate that three obligatory indications must appear on the labelling: the commercial name, the mode of production (sea fishery, inland water fishery, or aquaculture) and the catch zone. Fully implementing this regulation requires both appropriate information management and setting up methods which enable this information to be verified. One relevant aspect of controlling traceability and labelling is the possibility of identifying and authenticating the biological species. In recent years, a very large number of studies have been conducted to develop DNA-based methods to identify fish of commercial interest.

However, it is still necessary to harmonise the methodologies used over different laboratories as well as to update the databases and genetic sequences of seafood and products of commercial interest, so that a standardised response is supplied regardless of the country or the laboratory where the analyses are performed. In particular, this database will constitute a tool to support European Union policies concerning the conservation of biological resources.

The main Labelfish objective is to set up a network of entities interested in developing a joint strategy and using innovative and standardised analytical techniques to check the genetic traceability and labelling of products from the sea. This overarching aim comprises two specific objectives, i.e. developing a new database which will gather the genetic data which already exist (genetic DNA markers for the most part) and selecting tested and validated analytical tools to identify fish species of commercial interest in regions of the Atlantic area. Workshops will be organised in each participating country. The studies carried out will thus protect both European consumers and SMEs working in the fisheries and aquaculture sector of Atlantic regions.

## GENETIC IMPROVEMENT, ANIMAL HEALTH AND THE ENVIRONMENT

### Excess mortality conference - feedback on Ifremer's scientific studies on 18 January 2012 at the Ministry of agriculture, food, fisheries, rural affairs and spatial planning

This one-day conference was organised under the aegis of DPMA at Maaprat, drawing a public of institutional partners, DPMA and DGAL, representatives from the professional sector, CNC and CRCs, representatives from regional technical centres and research colleagues from other institutions such

as the universities of Caen and Montpellier. Ifremer's chairman emphasized how the Institute's teams had mobilised their forces, adding that Ifremer does not claim to have a monopoly on research on the subject and that cooperation with other research bodies should be sought. The presentations made underscored the importance of acquiring field knowledge to better describe the spatial-temporal dynamics of pathologies and their relationship with the environment. In particular, the importance that hydrodynamic conditions have in the propagation of infection was highlighted on the study sites in the Thau lagoon and Pénerf river (Morbihan). In 2011, the mortality associated with infection by the  $\mu$ var variant of the OsHV1 virus was experimentally confirmed, as well as that by the *Vibrio* most commonly associated with viruses during mortality episodes, i.e. *V. splendidus*. Several research projects are underway, notably the Gimepec project which aims to study the transmission between generations of DNA damage induced by chemical pollutants in the oyster and the consequences on the physiological performances of individuals (growth, immunity and survival against pathogens and reproduction). It was a day of many enriching and fruitful discussions between the different stakeholders.

Exposure of *Crassostrea gigas* broodstock to diuron at Ifremer's experimental hatchery in La Tremblade





## ANR GIGASSAT PROJECT (AGROBIOSPHERE PROGRAMME)

Global change is amplifying the phenomena of epidemic diseases, excess mortality in shellfish, toxic algae blooms and other sorts of proliferation. Shellfish farming is undergoing increasingly frequent occurrences of diseases that can be attributed, at least in part, to global warming climate change. In France, the stakes are high for oyster farming, which is the leading aquaculture industry in the country. The oyster-farming industry, which relies on the utilisation of the Pacific oyster *Crassostrea gigas*, is effectively experiencing the worst crisis in its history since the species was introduced in the 1970s. Since 2008, the mortality rate of juvenile *C. gigas* has been extremely high, over all the geographical zones of production. The presence of a specific genotype of the OsHV-1 virus and of bacteria in the *Vibrio* genus is generally linked with excess mortality events. This phenomenon is a major source of concern for the future of all players in the oyster-farming value chain, including farmers, producers, associations and public authorities. Faced with this problem, the Gigassat project will set up an integrated and participatory research programme in order to study the socio-economic and environmental impacts of global change on the oyster-farming industry. The purpose of the project is to observe, analyse and help manage oyster-farming ecosystems, by studying the effects of climate change on oysters' health and physiology and on the ecological and economic status of the ecosystems where they are produced. Acquiring new knowledge in the fields of ecology, physiology, pathology and epidemiology, farming, modelling, economics and social sciences will be done through a cross-cutting and collaborative approach, which will enable Gigassat to extend the range of solutions needed to make oyster farming viable and sustainable. The project has four structuring orientations:

- observing environmental and socio-economic changes over the past ten to twenty years in oyster-farming ecosystems, in the light of recent mortality episodes,
- analysing, by both laboratory and field experiments, the effects of environmental parameters on the propagation of diseases and mortalities,
- modelling and predicting the transmission of diseases and the propagation of mortality, assessing measures to control epidemics and finally, proposing solutions to improve the economic and ecological state of an oyster-farming industry which is vulnerable to climate change,
- communicating the results to oyster farmers, associations and institutional stakeholders in the supply chain. The project will last forty-two months and involve ten partners and six colleagues from public research institutions and private-sector enterprises. Four Ifremer units are taking part: the Coastal unit (environment and resources laboratories), the Functional physiology of marine organisms department, the Genetic improvement, animal health and environment department and Dynéco.

## Launch of the Preda-DOR project on predation in shellfish farms by gilthead sea bream

Gilthead sea bream are the cause of mortality in young shellfish in various areas, especially in southern Brittany. The damage they cause affects oyster farming and mussel farming. A new project (Preda-DOR), aiming to better describe the phenomenon and to test several different solutions, was approved by the Brittany marine cluster in late 2011. The regional shellfish-farming committee for southern Brittany (lead partner), Ifremer, the MNHN national museum of natural history in Concarneau and several professional oyster and mussel farmers from the bay of Quiberon and bay of Brest are the partners. On part will study the local behaviour of the species, studying acoustic solutions to repel them and improving physical protection systems for farms. Funding by the Brittany regional council was secured in late 2012 for the project to be officially launched in early 2013. Preliminary trials on acoustic repellent devices were performed on wild species in captivity and a stand-alone system was deployed on a mussel farm, with some promising initial feedback. Numerous trials are planned on various farms in the bay of Brest and the bay of Quiberon, between 2013 and 2015.



## SCIENTIFIC SUPPORT FROM IFREMER TO DEVELOP VALUE CHAINS IN OVERSEAS FRANCE

2012 was a year when Ifremer continued to position itself within its core business of finalised research with respect to French overseas aquaculture value chains: in the South Pacific, bringing a technical centre for shrimp farming into being, managed by several local authorities in New Caledonia, pursuing the transfer on batfish and shrimp in French Polynesia, in close collaboration with the DRM directorate for marine resources in the Polynesian territory; in the West Indies, a transfer for production of red drum larvae; the signing of an agreement specifying Ifremer's contribution to the research and development centre for fishfarming in Mayotte. In the West Indies and in Mayotte alike, Ifremer's action is clearly situated within an "inter-DOM" framework (i.e. between French overseas counties) coordinated by the French overseas aquaculture producers union (UAOM).

The PhD thesis by Caroline Joubert (winner of the PhD prize in the 2012 Ifremer Trophies) in Tahiti, which she defended in 2012, was the first study to identify the marker genes determining biomineralisation and its regulation. The results are of great importance for the supply chain, since they make it possible to envisage selecting the individuals which could produce pearls of higher quality on average, with substantial gains in competitiveness for the Polynesian pearl farming sector. More generally speaking, the integrated approach to pearl oyster farming has been clearly emphasised, taking account of the ecosystem whether as a nourishing habitat

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for the pearl or as the receptacle of pearl farm discharges; which is perfectly in line with the studies conducted by the UMR research unit on Oceania island ecosystems.

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*Pearl oyster genetics laboratory at the Pacific centre*

In New Caledonia, significant progress has been made on understanding the process of mortality affecting shrimp livestock, with potential knock-on effects on future programmes to select more resistant strains. The PhD study by Dominique PHAM in particular highlighted the importance of good abiotic conditions, especially temperature and salinity, for the larval stage development of *Litopenaeus stylirostris*, the shrimp farmed in New Caledonia. The direct application arising from this work has been to define the right *preferenda* of salinity and temperature at different stages.

The amplification of the impacts of chlordecone contamination in the French West Indies marked the year 2012. Ifremer is working on drawing up the specifications for fisheries fauna sampling strategies to assess the degree of contamination. Our Institute is actively participating in discussions to draw up management measures.

Furthermore, Ifremer is a driving force for proposals in research dynamics on the subject with the university of the French West Indies and Guiana (UAG) in Guadeloupe.

Ifremer worked on the fisheries sector expert assessment at Saint-Pierre-et-Miquelon in 2012. One recommendation made was to promote scallop fisheries, seeing that health of the resource, monitored yearly by Ifremer, is good.

Ifremer is a stakeholder in setting up the FIS in Mayotte, providing scientific and technical support to AAMP, which is the main contractor for the operation in this new French département (county) in the Indian Ocean.

## Contamination of the marine environment by chlordecone in Martinique

In 2012, Ifremer's work on the chlordecone problem focused on four parts, conducted simultaneously. They were devoted to the results of a study on contamination of spiny lobsters in Martinique; an analysis of the literature on the biology and ecology of the lionfish *Pterois volitans*; the proposal for a study in the framework of the national plan II and preparing a workshop to build a research programme at the land-sea interface.

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### Contamination of spiny lobsters in Martinique in question

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The study on the contamination of spiny lobsters in Martinique, which was commissioned by the Martinique Directorate for food, agriculture and forest in early 2011, yielded its full results in February 2012. It focused on two species of spiny lobsters, i.e. the Caribbean spiny lobster *Panulirus argus* and the spotted spiny lobster *Panulirus guttatus*, regularly caught in Martinique, mostly on the central Atlantic coast.

In March 2012, a mission in Martinique on the issue of chlordecone in the West Indies took stock with local partners (State services, the water office and fishermen) of the progress made in knowledge about the contamination of marine fauna, based on the results of three studies led by Ifremer. These studies showed:

The Institute is helping a value chain to produce microalgae come to the fore in New Caledonia. The first phase of identifying candidate species presenting nutritional interest for aquaculture will be followed by pilot-scale testing using raceways, and the corresponding technical centre should be located in the North province. It is expected that research and development will take at least eight years before it will be possible to utilise these microalgae on an industrial scale.

Value enhancement of extremophile bacteria in the South Pacific continued, though the finalisation of a PhD thesis which was co-supervised by Institut Pasteur in New Caledonia and Ifremer (BMM-Brest laboratory and LEAD-NC unit).

- the influence of inputs from land on the levels of contamination in marine fauna, as well as bioamplification along food chains, from primary producers to second order carnivores. This study also highlighted the variability of bioaccumulation depending on the species;
- contamination of marine sediments which is strictly limited to the terrigenous inputs at the immediate inflows from water courses, with significant differences depending on the streams.
- the spread of contamination in the Caribbean spiny lobster (main species exploited) to the entire lagoon area off of the most contaminated catchment basins, with contamination levels being lower in smaller individuals. The meetings with professional fishermen provided the opportunity to begin discussing the ways the resource could be managed in order to increase the potential yield, while guaranteeing on average the compliance with standards for spiny lobster which are marketed.

The scientific teams from the main research institutions who are mobilised on the subject: Ifremer, Cirad, IRD, UAG and BRGM, have acknowledged the following priorities for research in the marine field: growing the knowledge about the fate of chlordecone in marine ecosystems (especially through food webs); transfers of contamination along the land-sea continuum and the background of contamination in the marine domain to infer the outlook on how this contamination will evolve. They agreed to propose a workshop to be held under the aegis of AllEnvi in order to coordinate future research.



## Marine resources in French Polynesia

**An article was published in the Proceedings of the National Academy of Sciences of USA (PNAS, Impact Factor 9,68) demonstrating that the formation of shell structures (prism and nacre) in the pearl oyster *Pinctada margaritifera* is controlled by corteges of different proteins.**

Article: *Different secretory repertoires control the biomineralization processes of prism and nacre deposition of the pearl oyster shell*, PNAS: Marie, B., Joubert, C., Tayalé, A., Zanella-Cléon, I., Belliard, C., Piquemal, D., Cochenec-Laureau, N., Marin, F., Gueguen, Y., Montagnani, C. (2012)", in press. 20986-20991.

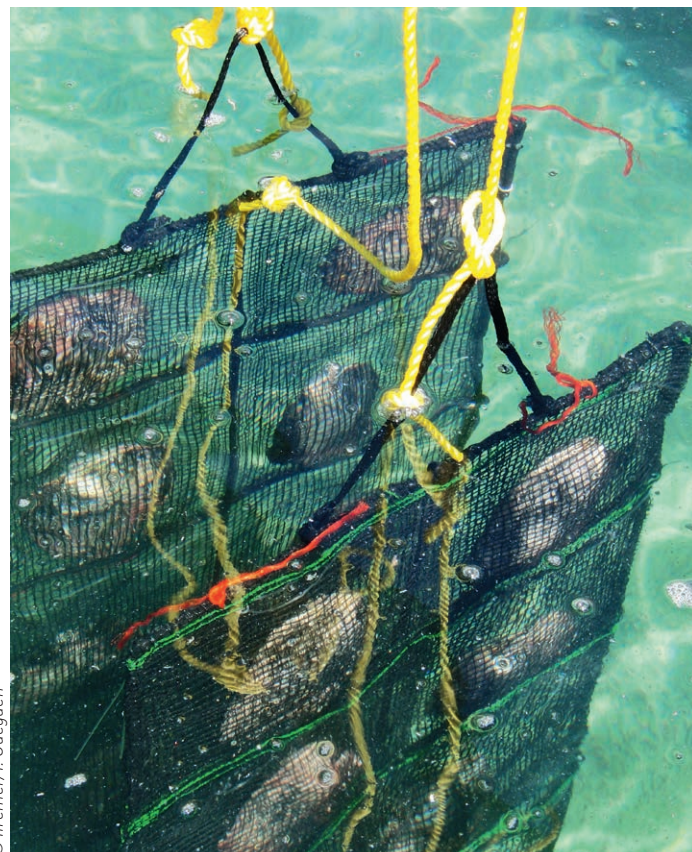
This article is one of the milestones for the GDR Adequa (for improvement of pearl quality in French Polynesia, 2008-2012) research group. GDR Adequa is a research consortium formed by ten public- and private-sector partners from French Polynesia and metropolitan France, whose goal was to study the biological mechanisms involved during grafting and acquire knowledge about the mineralisation processes of pearls in order to improve their quality. To do so, complementary functional genomics approaches, such as transcriptome analysis of the mineralising tissues in the pearl oyster (the mantle) and proteome analysis of shell- (and pearl-) forming structures were implemented.

The acido-soluble and insoluble proteins in prisms (calcite-forming structure) and nacre (aragonite-forming structure) of the shell were extracted, digested and then analysed using mass spectrometry. All of the peptides analysed were assigned, by checking homologies, to non-redundant sequences in the EST collection of *Pinctada margaritifera*, mantle, sixty-six of them had never been reported in the scientific literature. Remarkably, thirty of these proteins are specific to nacre-shell structures, forty-five are specific to prismatic ones and only three proteins are found in both structures, i.e. prism and nacre. Thus these results show that the formation of both shell structures (prism and nacre) is controlled by different protein corteges.

Additional analyses of gene expression and localisation of transcripts using *in situ* hybridization furthermore indicated that the genes coding for the proteins associated with prisms or nacre correspond to distinct functional areas of the outer mantle epithelium.

This study provides a quasi-definitive answer to an "old" scientific question, in sway for over a century, concerning pteriomorph bivalve molluscs and more generally all molluscs with nacre-prism shell micro-structures, i.e.: do the calcite and aragonite prismatic layers contain the same organic constituents? It demonstrates that the secreting regime of the mantle epithelium zone which synthesises the prisms is completely different from that of the epithelium synthesising the nacre, which represents major progress in our knowledge about biomineralisation.

### Experimentation on pearl-oysters



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## REGENPERL PROJECT

The Regenperl project on genetic resources for Polynesian perliculture (under a State-French Polynesia contract, 2010-2012), which was coordinated by Ifremer and carried out with our partners Criobe (EPHE-CNRS), the university of French Polynesia and Dalhousie University (Canada), has just come to a close. The objectives of this research project were to assess the impact of pearl farming on the genetic variability of wild populations, analyse the mechanisms of evolution of the biodiversity of pearl oysters in the farmed lagoons and to pursue studies aiming to optimise spat collection and spat production in hatcheries. The main results obtained concerned:

- the absence of genetic drift in pearl farms. Capturing juveniles from different cohorts, combined with spat collectors from different lagoons being grouped together in pearl farms has promoted the emergence of genetic heterogeneity and prevented the formation of bottlenecks in farmed populations. Over the long term, however, there appears to be a risk of genetic homogenisation between farmed populations and wild populations.
- The studies carried out on the dispersal of larvae have shown greater concentrations at mid-depth (25 m), with a migration towards the surface at night and towards the seabed in daytime, a heterogeneous distribution over the lagoon scale, significant daily variations

and transfers between lagoon sectors, which demonstrate the intra-lagoon connectivity suggesting there are source and sink sectors. It also seems that recruitment in *P. margaritifera* can show high genetic heterogeneity at very small spatial and temporal scales. The dispersal of larvae is clearly influenced by the wind conditions and thus takes on a marked seasonal characteristic.

- the dynamic energy budget (DEB) model's general nature was confirmed in the critical development phases of the pearl oyster *P. margaritifera*: the pelagic life of the larvae and reproduction in the adult stage. Four main parameters considered to be specific in theory made it possible to successfully adapt the model to the larval stage of *P. margaritifera*. A preliminary adult DEB model has also been proposed, explaining growth and reproduction, via the forcing factors of temperature and chlorophyll a, of the ingestible phytoplankton which themselves are submitted to the wind regime.

The larval identification tool using *in situ* hybridization was optimised during the project and is now functional. It is now possible to detect a cohort of *P. margaritifera* larvae which are almost ready to get attached. This tool will also make it possible to specify the mechanisms which influence larval development and dispersal.

▲ Pearl oysters in experiments

## Assessing resource management scenarios for reef fish in the South West Lagoon of New Caledonia

Having simulation and decision-support tools available that can incorporate many types of knowledge is a major stake for the sustainable management of marine resources and their exploitation, whose presence is unevenly distributed, particularly in a reef-lagoon environment where the habitat is fragmented, as in the South West lagoon of New Caledonia.

In partnership with IRD and the university of New Caledonia, a PhD study (B. Preuss) was made with the aim of implementing a model which integrates knowledge on both biology and ecology of exploited species (three species modelled here) and professional and recreational fishing activities, in both seasonal and spatial aspects. Special attention was given to studying the effect of uncertainty about some knowledge on the results of simulations, through sensitivity analyses. The model was then used to test management scenarios ("*status quo*", setting up marine protected areas, regulating minimum catch sizes and increasing the number of professional fishers). The results showed generally moderate effects on the populations of fished species, although sometimes with significant effects locally (inside reserves, for instance), nevertheless the responses differed by species depending on the scenarios considered.

## Oil and fisheries prospection in French Guiana

Ifremer is a driving force in thought and discussions to set up projects for an ecosystem-based approach to fisheries in French Guiana, made all the more important by the fact that the oil prospecting surveys on the Guiana shelf will provide an opportunity to work with other research partners to construct projects to acquire basic knowledge about ecosystem function there, which is quite particular in this context of multiple uses (fisheries and oil production). A seminar was held in 2012, assessing current knowledge with the scientific orientations to be given priority, including knowledge about functional habitats and the quantification of major environmental forcing at various scales.



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## A microalgae aquaculture project in New Caledonia (Amical)

Maritime areas in overseas France and especially those in New Caledonia, hold exceptional biodiversity as well as containing significant resources, which must be utilised in a way which is both environmentally-friendly way and particularly benefiting local populations. This utilisation or valorisation is a major strategic axis for the various forms taken by France's national maritime policy on the scale of each sea basin (*Blue Book, a national strategy for the sea and oceans*, 2009). With this perspective, biological resources could contribute to the development of "blue biotechnologies" by 2020-2030 and "the exploitation of algae is one promising area, whether macroalgae or microalgae; marine biomass could be used for food or to produce energy (biofuel)." (*Blue book*, 2009). Developing this sector, particularly in New Caledonia, will open up true opportunities, especially in the animal nutrition market, with high added value and high environmental quality, for the natural heritage represented by this biodiversity will make sustainable utilisation possible in an integrated management framework. This issues raised by this project also entirely fit with the framework of the "Calédonie 2025" foresight reflection launched by the High Commissioner and the government of New Caledonia, more specifically in its orientations for: "company life and performance" and "environment and living environment" and its three programmes on: "development of enterprises and society", "environment natural resources" and energy and global warming.

In this context, the Amical project will incorporate both applied research supported by the microalgae laboratory (LEMA), backed by the algae physiology and biotechnology laboratory (LPBA, Ifremer Nantes) and development and transfer ensured by microalgae technical centre (LTMA). LTMA is the organisation which depends directly on the local authorities. The Adecal/Technopole science park supervises and manages it. The LEMA laboratory will be built by Adecal/Technopole on the Saint-Vincent site. Ifremer will help Adecal for the construction, within a special contracting assistance agreement. LEMA, like the Saint-Vincent station, will be the property of the New Caledonian authorities and made available to Ifremer within our framework-agreement and a special agreement (both currently being negotiated with the govern-

ment of New Caledonia and the Provinces). The terms and conditions for collaboration/transfer between LEMA and LTMA will be set out in the frame of an agreement.

LEMA will select native (or even endemic) species of algae whose properties can be applied to animal nutrition (source of proteins and essential fatty acids), cosmetics, animal and human health (antioxidants, immune stimulants, etc.) and for energy (third generation biofuel). The laboratory will validate the cultivation of these microalgae in an outdoor pond on a small scale before transferring them to LTMA.



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▲  
**LEMA**  
*laboratory in  
the framework  
of the Amical  
programme*

LTMA will be in charge of studying the technical and economic feasibility, in pilot installations, of growing and processing the microalgae species selected by LEMA. Ultimately, LTMA will transfer the chosen algae species and the know-how to cultivate them to New Caledonian industrial projects.

Within this project, whilst diversifying its activities in New Caledonia, Ifremer will supply its know-how and scientific research capacity to support the development of a promising value chain.

Special attention is being given to ensuring that all of the activities involving microalgae in the IMA, GreenStars and Amical projects are coherent, based on the conclusions and opinions expressed by Ifremer's Scientific committee on 5 December 2011.

# EXPLORING SEAFLOORS, IDENTIFYING THEIR RESOURCES AND THEIR HAZARDS



## DEEP MARINE MINERAL AND ENERGY RESOURCES

### Industrial partners pursue the “Futuna” draft agreement with Ifremer

The Futuna programme is the outcome of an initial draft agreement signed by Ifremer, Areva, Technip France, Eramet, AAMP marine protected areas agency and BRGM.

This public-private partnership makes it possible to take advantage of synergies and has already proved its effectiveness during the two cruises already financed in 2010 and 2011, in locating mineralisation resources in untouched areas of our exclusive economic zone to the south of Futuna island. Innovative tools and strategies were implemented during the first two cruises. These studies were scheduled in the framework of the prerequisite authorisation for prospection (APP), which was achieved in July 2012. The third cruise in this zone proved to be essential in order to close phase 1 of the exploration. It is the successful outcome of the planned exploration strategy. This should enable the second phase defined by the consortium formed by Technip, Eramet and Ifremer to be engaged, in order to assess the resources, study the baseline state of the ecosystems before there is any impact if exploitation takes place and conduct a framing study for a pilot mining site.

▲  
*Active black smoker*



## Collective scientific expertise

The CNRS and Ifremer were mandated by the general commissioner for sustainable development (MEDDE) to lead a collective scientific expert assessment (ESCO) on the environmental impacts of exploiting deep sea mineral resources. The assessment should focus on both the deep seabeds under French jurisdiction and on zones situated beyond these jurisdictions. First of all, this means taking stock of scientific knowledge about the ecosystems and environments in question, as well as their functioning, the services they provide for us and the uses that society can derive from them as of now or in future. An inventory of the economic analysis of the value of these services is to be included. Finally, the potential impacts on these environments, services and uses must be characterised and the measures required to monitor changes in these environments and control the impacts of various phases of exploitation must be identified.

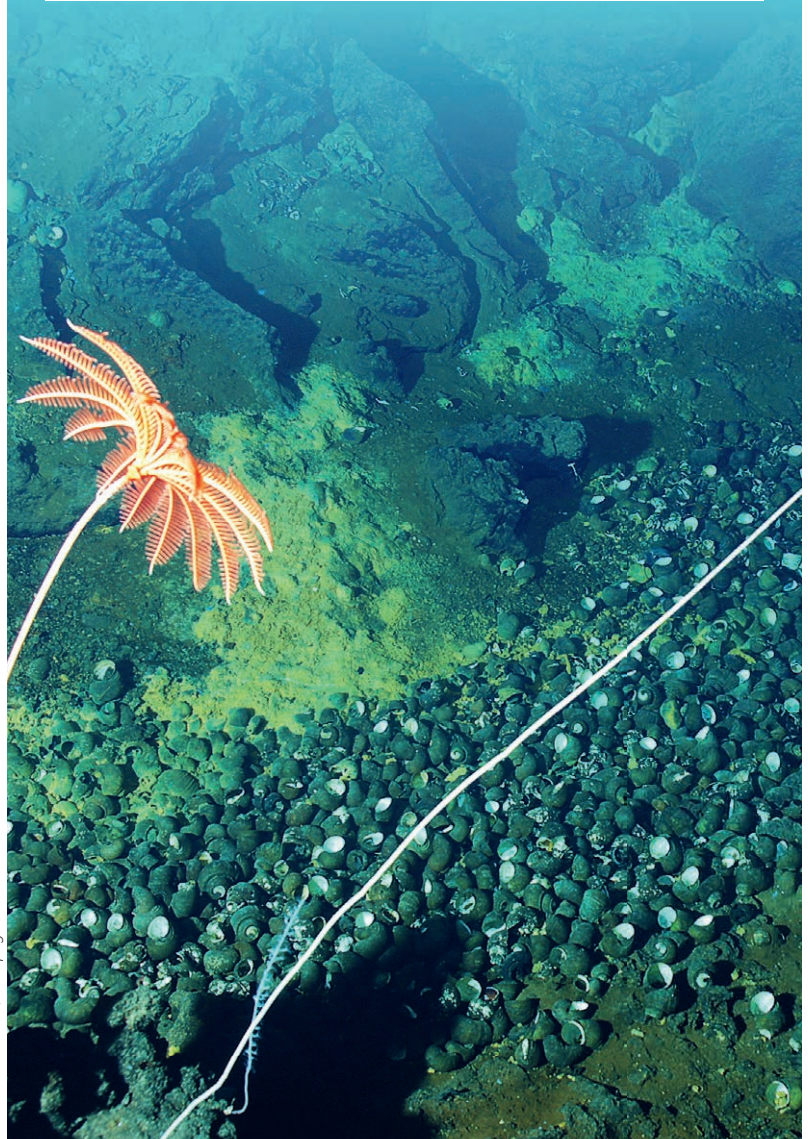
The steering committee members are Nadine LE BRIS, François LALLIER, Sylvain LAMARE for INEE, Jérôme DYMENT for INSU and Olivier ROUXEL and Pierre-Marie SARRADIN for Ifremer.

The expert assessment reports are to be delivered in September 2013. The ESCO results will be presented at a symposium in February 2014.

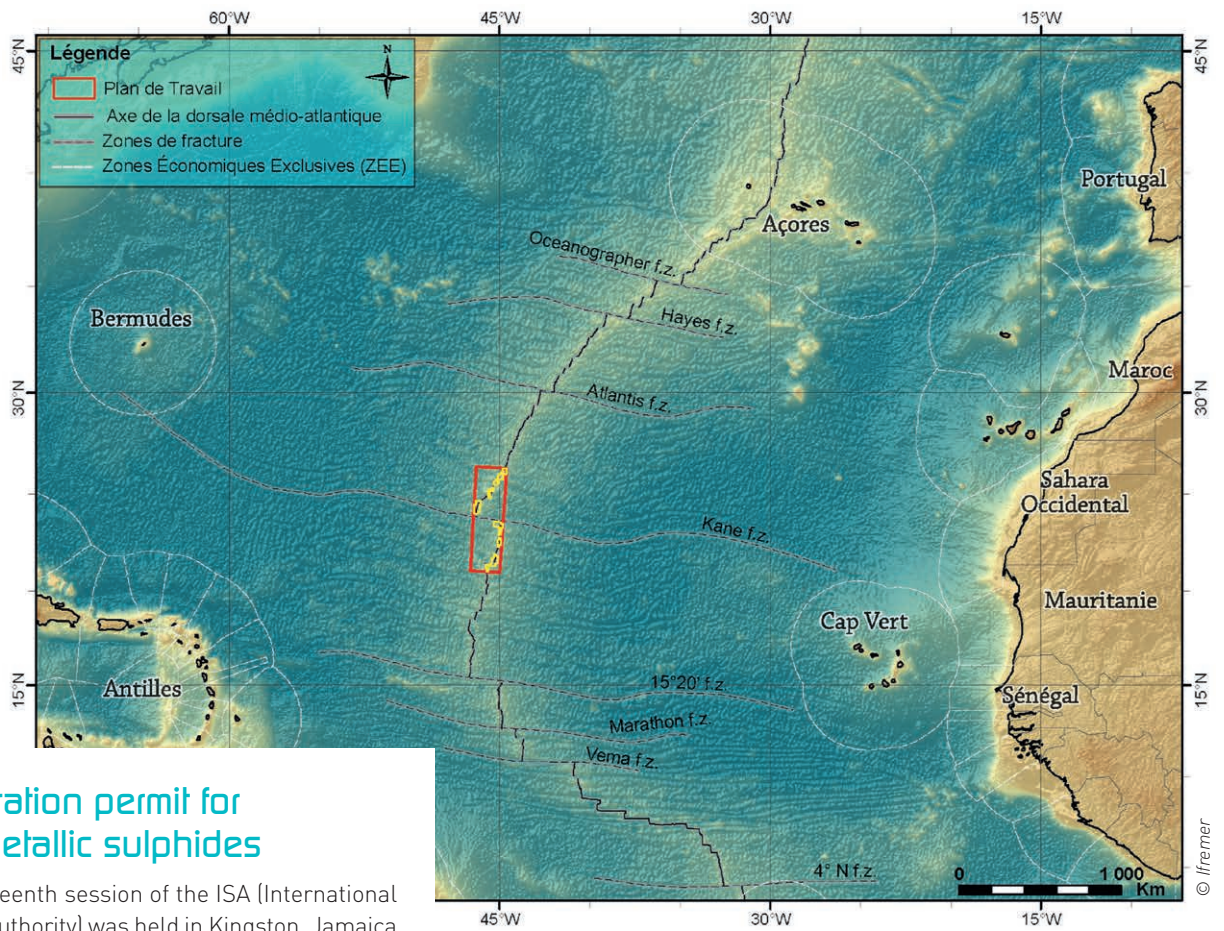
*Sulphides, crinoids and coral on an inactive site* ▶

## FUTUNA 3 CRUISE, 16 MAY TO 22 JUNE 2012

The Futuna 3 cruise took place from 16 May to 22 June 2012 in the Exclusive Economic Zone of Wallis and Futuna (head scientist Yves Fouquet, REM/Edrome/GM). The objective was to specify the location, extent and nature of hydrothermal mineralisation resources discovered during the first two cruises in 2010 and 2011 and to study the deep sea ecosystems. Dives were planned on five main targets and two secondary targets. The general cruise strategy was focused on dives by the *Nautile* submersible during daytime and dives by the AUV during the night. The period between the end of the *Nautile* dive and the start of the AUV dive was used to perform additional operations on the dive targets: mapping at five knots, CTD casts and dredging. Thanks to this strategy and extremely effective teamwork, numerous active and inactive sites were highlighted on the first study target. Seeing the scope of these discoveries, efforts have been especially concentrated on this zone. This means that more detailed exploration of the other targets, which are certainly just as interesting, remains to be made.



© Ifremer-Nautile/Campagne Futuna 2012



## Exploration permit for polymetallic sulphides

The eighteenth session of the ISA (International Seabed Authority) was held in Kingston, Jamaica from 16 to 27 July 2012. The French application submitted by Ifremer with the backing of the French State was presented and defended there by Yves FOUQUET (Ifremer, REM/Edrome), who was the only French representative present with Mr. Élie JARMACHE. Upon the recommendation of the legal and technical commission, the ISA Council chaired by Mr. Alfredo GARCIA CASTELBLANCO (Chile) approved five applications for work plans, including that submitted by Ifremer (ISBA/18/LTC/L3\*) concerning exploration for polymetallic sulphides. The area is located along the Mid-Atlantic Ridge, between 21 and 27°N (~ 600 km North to South by ~ 200 km East to West). The plan of work consists of 100 blocks, each measuring 10 km x 10 km, grouped into six clusters of between 8 and 25 blocks each, covering a total surface area of 98,660 km<sup>2</sup>.



▲  
Sulphide prospection zone

### Microbial community diversity and functioning in deep sea ecosystems subjected to methane-rich fluid migrations from cold seeps and the methane cycle: PhD thesis defended by Adrien VIGNERON in December 2012 and Master's thesis by Marine MINIER.

*At the continental margins, and more particularly in what are called cold seep zones, complex microbial and animal communities develop locally on the surface of the sediment. These communities use reduced chemical compounds (H<sub>2</sub>S, CH<sub>4</sub>, CO<sub>2</sub> etc.) contained in a low-temperature fluid percolating through the sediments which is produced by geological phenomena and various microbial processes. The diversity of microbial communities was studied on samples (surface sediments from 0-20 cm, as well as deeper < 9 mbsf), which were taken along the Sonora Margin (BIG cruise, 2010) to understand both the role they play in the environment and the environmental parameters which influence their distribution and ecophysiology. This research study was able to determine the structure and diversity of the microbial communities that are metabolically active in these sediments; to highlight the different ecophysologies amongst the "players" in the methane cycle (methanogenic, anaerobic methanotrophic and sulphate-reducing bacteria) which are predominant in this ecosystem and to discover the presence of new microbial strains and functions in the sediments of cold seep zones on continental margins.*

**BIONOD CRUISE (28 MARCH  
TO 11 MAY, ATALANTE/SCAMPI,  
HEAD SCIENTIST L. MENOT)**

The Bionod cruise is the outcome of collaboration between Ifremer and BGR. It fulfils the obligations of these two institutes in the framework of maintaining the mining permits for polymetallic nodule zones in the North East Pacific.

The cruise follows on from Ifremer's Nodinaut cruise which was conducted in the same geographical zone in 2004. Nodinaut had made it possible to show, for the first time, that nodule fields formed a specific habitat for numerous species and that they contribute to fostering biological diversity on sea-floors in the abyssal plains.

The objective of the Bionod cruise is to refine knowledge about the geographical distribution of species associated with nodule fields and to determine the environmental factors which can influence this distribution. Temporal monitoring of the zones studied during the Nodinaut cruise will also enable an assessment of how dynamic the ecosystems formed by nodule fields are.

Two sites are targeted, corresponding to the two main zones of the French and German exploration permits. These two sites are located nearly 1,200 km apart. Sampling of the fauna and its surrounding environment was done on two scales: firstly, a regional scale (1,200 km) which will make it possible to describe the geographical distribution of species and to test the effect of variations in surface primary production on the structure of communities; and secondly, a local scale (of approximately 10 km), in order to test the influence of the presence/absence of nodules on the different size classes of the fauna. Exploration of new zones in the French mining permit will also ultimately make it possible to better describe and understand the spatial distribution of nodules.

## EXPLORATION PERMIT FOR NODULES

The work programme for 2011 to 2016 was approved by the ISA Secretary general (letter from Mr. Nii ALLOTEY ODUNTON on 13 July 2012), in the framework of the contract between ISA and Ifremer.

This programme involves drawing up strategies to protect and preserve biodiversity in the Clarion-Clipperton nodule zone which is hindered by poor knowledge about the distribution of species over the scope of this huge area covering nearly 6 million square kilometres.

This lack of knowledge is mostly due to the great species richness of the benthic fauna on the one hand and the lack of taxonomic expertise for these deep-sea, small-sized and not very symbolic species, on the other hand. Therefore, species-level identification is only possible for a very small number of taxonomic groups. Amongst them, experience has shown that 50 to 90% of abyssal species have been newly discovered by science.

For the period from 2012-2017 Ifremer proposed to work in association with *Bundesanstalt für Geowissenschaften und Rohstoffe* (BGR) and *Deutsches Zentrum für Marine Biodiversitätsforschung* (DZMB) of the Senckenberg Museum to organise an oceanographic cruise targeting two sectors with nodules which have been attributed to France and Germany, whose mean geographic coordinates are respectively 14°N-130°W and 12°N-118°W.

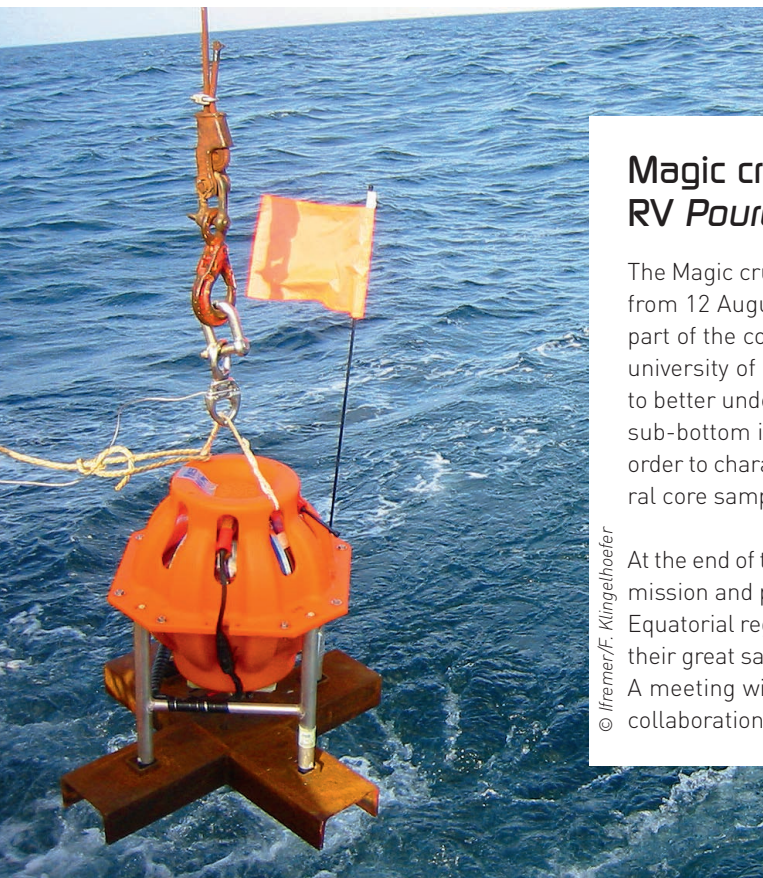
## Deep sea mineral resources: strategic stakes for France and the European Union



© Ifremer/StudioBen

▲ Archiving polymetallic nodules at the rock library in the Ifremer Brittany centre

# STRUCTURING OF SEDIMENTARY ENVIRONMENTS AND MARGINS



## Magic cruise, 12 August to 21 September, RV *Pourquoi pas ?*

The Magic cruise (Margins of Brazil, Ghana and Ivory coast) took place off Brazil, from 12 August to 21 September 2012 aboard RV *Pourquoi pas?*. The cruise is part of the collaborative work conducted by Ifremer, IUEM, university of Lisbon, university of Brasilia and the Petrobras Cenpes research centre Magic set out to better understand the structure and evolution of a transform margin, through sub-bottom imaging using multi-channel and wide-angle seismic methods. In order to characterise the active processes at the sediment-ocean interface, several core samples and piezometer measurements were also taken.

© Ifremer/F. Klingelhoefer

At the end of the cruise a report was delivered to Cenpes and a presentation of the mission and preliminary results was given, with the Production manager for the Equatorial region and the Director of Cenpes in attendance. They both expressed their great satisfaction with the quality of the studies and the preliminary results. A meeting will be held in December, to examine the next projects of scientific collaboration on the Espirito Santo margin and the Pelotas margin.

▲  
*Deploying a MicrObs ocean bottom seismometer. The (13 inch) glass sphere contains the electronics, release system and geophones*

## Pamela, a five-year programme of research in partnership with Total

Representatives working in geosciences at Total and Ifremer decided to work collaboratively in an innovative research programme dubbed Pamela (for Passive Margin Exploration Laboratories ») on passive margins which incorporates subjects such as the geological structure, distribution of sediment bodies, instabilities, fluids and ecosystems. The objective is to answer questions which are common to both entities. Several meetings were held in November and December 2012 to decide on the various scientific themes, partners from academia, the project's organisation and governance structure. Jean-François BOURILLET, a geologist from the marine geoscience unit was designated as Ifremer's manager in the Pamela programme; Philippe BOURGES, who is in charge of the Research and Development project at Total Exploration & Production, is his counterpart for Total. The scientific themes addressed included the ther-

mal evolution of a margin, the spatial and temporal distribution of deposits from a sedimentary system over a climate cycle, the specificity of the carbonate system, sea level recordings, the connection of lobes and sedimentary levees at the foot of the slope, the relative share of various factors (canyon profile, type and volume of sediments) on the transport efficiency of canyons, the influence that the type of sediments has on hydrate behaviour, searching for proxies for detection of plumes in the water column, ecosystems associated with fluid seeps, biodiversity of subsea carbonate platforms, etc. The Ifremer actions underway will be either extended (Golo, GuinecoMebo) or broadened (Ptolémée) and the Ifremer actions which were on hold (plumes in Aquitaine) will be launched. This multi annual project (to last five years or more) will be a structuring activity for the REM department and the GM, EP and RDT units.

## ANR CONGOLOBE PROJECT

A marine core sample reveals the environmental footprint of humans in Central Africa 3,000 years ago

The main objective of the CongoLobe project (coordinated by C. RABOUILLE, LSCE) is to study the deep ecosystems of the terminal lobes of the Congo River's deep-sea fan, whose significant inputs of terrigenous matter at very great depths make it an exceptional case study for the biodiversity and biogeochemistry, not only in the region but also for the world ocean. Our project aims to determine the linkage between the type and magnitude of organic matter inputs from the Congo River and the exceptional ecosystems which have been discovered in the terminal zone of the canyon. Along with describing the biodiversity in these ecosystems, whose biological composition resembles that of the chemosynthesis-based communities in pockmarks (active zones of methane-rich fluid seeps), the goal is to study their functioning and quantify the fate of organic inputs from the Congo as a direct or indirect source for their metabolism. This ecosystem could be nourished by organic inputs from the Congo canyon/channel system, and their diagenesis in the

top few metres of sediment (or deeper), which could accompany the genesis of sulphur- and methane-rich reduced fluids. These reduced compounds could enable chemoautotrophic microbial production and the development of biological communities which depend on it.

The CongoLobe project is based on two cruises: the WACS cruise (February 2011) which was devoted to exploring the Lobes zone and the CongoLobe cruise (December 2012-January 2013), associating geologists who are specialists on this deep-sea fan, organic geochemists to characterise the origin and reactivity of organic matter, marine geochemists to assess the recycling and conservation of biogenic compounds, microbiologists to study the diversity and activity of bacteria and archaea in the sediment and symbioses with invertebrates and finally biologists to determine the distribution, biodiversity and functional of faunal communities.

## GEOLOGICAL HAZARDS

### Marsite, European programme to study seismic risks in Istanbul

The region of Istanbul, whose population exceeds fifteen million inhabitants, is greatly exposed to seismic risk, due to the presence of the North Anatolian Fault in the Marmara Sea. For this reason, it is a high-priority area or "Supersite" within European initiatives for monitoring natural hazards. In this context, the European Union decided to finance the Marsite programme (to the amount of €7m) in the ENV.2012.6.4-2 call for proposals ("Long-term monitoring experiment in geologically active regions of Europe prone to natural hazards: the Supersite concept"). Marsite is coordinated by Koeri, and brings together twenty-three partners, including for France: BRGM, Ineris, Ifstar, CNRS (Grenoble, Strasbourg and Brest) and Ifremer.

The programme has various terrestrial, spatial and marine components. The marine component is dealt with in Work Package 8, which will be coordinated by Ifremer and performed using Italian (RV *Urania*), Turkish (RV *Yunus* from ITU) and French vessels. MarsiteCruise, which was ranked as P1 by CNFH, is slated to take place in 2014 in the Marmara Sea.

For Ifremer, the Marsite programme is a crucial challenge to promote the development of multi-parameter seafloor observatories for the monitoring of the environment and natural hazards.

*City of Istanbul at daybreak and the Marmara Sea*



© Ifremer/O. Dugornay



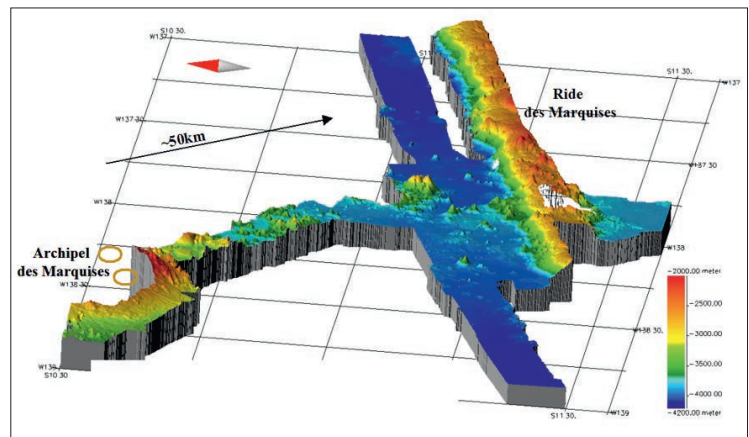
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## THE LEGAL EXTENSION OF THE CONTINENTAL SHELF

### Polyplac cruise, 1st to 12 September 2012, RV *L'Atalante*

The Polyplac research cruise is part of the Extraplac project, whose purpose is to submit and defend the claims to extend the French legal limits of the continental shelf in the framework of the United Nations Convention on the Law of the Sea.

This cruise was the first operation for the project in the French Polynesia region and concerned a zone located to the east of the Marquesas Islands. It took place aboard RV *L'Atalante*, with a scientific team for Ifremer hailing from the Ifremer centres in Brest and the Pacific and from the New Caledonian delegation. In order to comply with the guidelines for drawing up an extension claim submission, the objectives given priority in the Polyplac cruise were to characterise the natural extension from the land mass of the Marquesas Islands to the edge of the continental margin and to supply the elements to characterise the "foot of the slope", which is the limit from which a 60-nautical mile extension could be proposed. Within this context, the Polyplac was principally based on acquiring multi-beam acoustic data for the mapping of the region, as well as magnetism and sub-bottom profiler data and samples taken with by rock dredging. The cruise report will be sent to the Extraplac steering committee before the end of 2012.



Mapping of archipelago towards the Marquesas ridge ►

## MAPPING OF THE CONTINENTAL SHELF

### Walter ROEST elected to the French extension programme commission to the UN Commission on the Limits of the Continental Shelf

During the twenty-second session Meeting of States Parties to the United Nations Convention on the Law of the Sea in New York, the election of twenty-one members to the Commission on the Limits of the Continental Shelf (CLCS) was held on 6 June 2012, ensuring equitable geographical representation. Thus, three seats were given to members from the Western Europe and Other states Group, or WEOG, which also includes Canada, Australia and New Zealand. This group had presented four strong candidates, including Dr Walter R. ROEST from Ifremer, who is the head of the French programme for continental shelf extension called Extraplac. The other candidates came from Canada, Spain and Denmark and are also actively involved in their respective national programmes to extend shelf limits. The CLCS examines and rules on the applications to extend the continental shelf limits submitted by all coastal states, and hence on the sovereign rights to exploit these resources. The permanent mission of France to the United Nations had led an electoral campaign during the months preceding the election and organised meetings between France's candidate and the representatives of over 140 countries which are members of the convention. The head of the French delegation, Elie Jarmache, representative of the Secretariat general for the sea, strongly supported this application. Walter ROEST was elected to a five-year term in the first round, having secured over two-thirds of the votes from 162 States present which voted. This election is a major sign recognising both

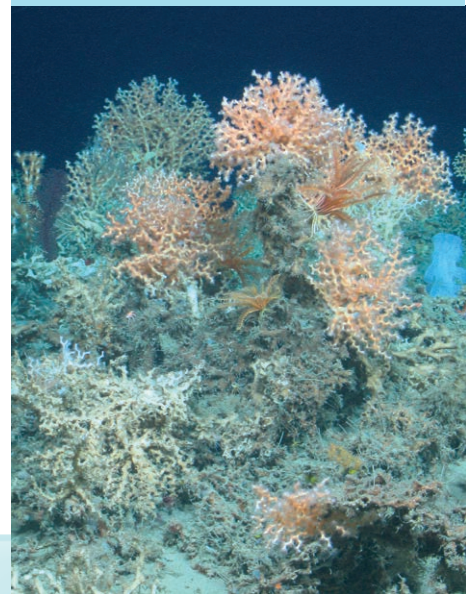
the quality of the work and studies carried out, already presented in part to the previous commission by Ifremer, as project manager for the Extraplac programme since 2003, and the expertise of the candidate himself. The newly elected commission began its work on 30 July in New York.



© Ifremer

Seeing the difficulties in financing the cruises needed for the modern mapping of the continental shelf, only the most limited actions were undertaken, in this case, a cartographic publication entitled: *Sur les traces des coraux d'eau froide du golfe de Gascogne* (tracking cold water corals in the Bay of Biscay), including eight bathymorphological and geomorphological maps, scale 1:100 000.

The publication is the outcome of two phases, i.e.: compiling recent multibeam echosounder data on the margin of the Bay of Biscay, which significantly refined the mapping resolution, and developing special methodology for classification, which led to the drawing up of geomorphological maps. This approach is conducted directly with the CoralFish project.



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# SEABED ECOSYSTEMS

## MaCuMBA, European project (*Marine Microorganisms : Cultivation Methods for Improving their Biotechnological Applications*)

This project has just begun and is coordinated by Prof. Lucas Stal (NIOZ), involving a consortium of twenty three partners from academia and SMEs. Its goal is to develop and implement innovative methods to improve the growing of marine microorganisms (gaining access to new species with potential value developments). The targeted environments are microorganisms in the water column and microorganisms in extreme deep-sea environments (cold seeps,

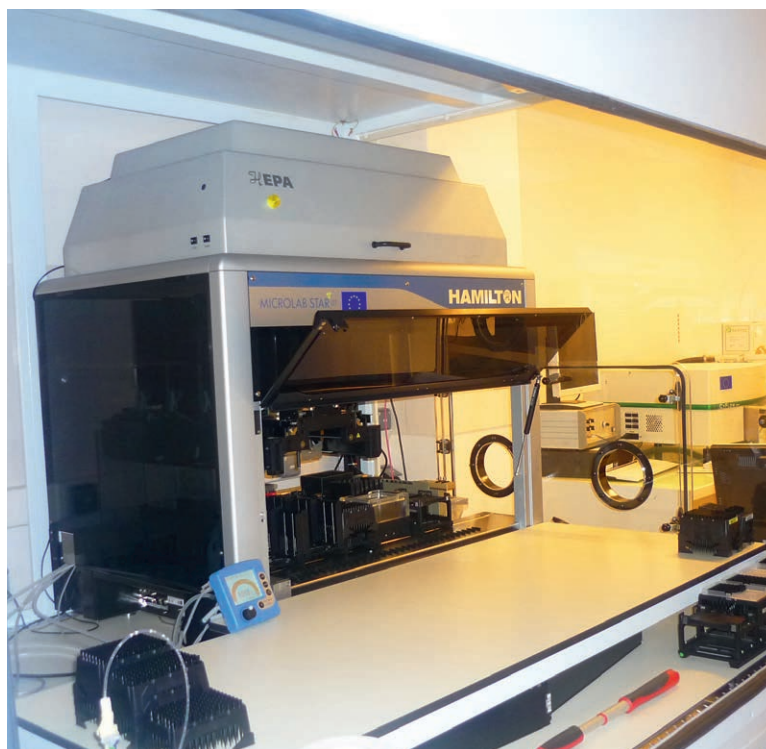
hydrothermal vents and underwater salt lakes). For the LM2E (UMR6197) lab, mainly involved in three of the project's work packages, including WP3 (*Improving culture efficiency of already isolated and cultured microorganisms*), led by Anne Godfroy, this means implementing the Cocagne high-throughput isolation and cultivation platform (financed by CPER 2007-2013), as well as improving the growing of hyperthermophilic microorganisms in bioreactors.



## Archelyse, ANR project on novel protein degradation pathways in Archaea, Programme Blanc 2012

Protein destruction within cells regulates many cellular functions and rids the cell of abnormal proteins. This means that intracellular proteases are therefore involved in stress response and ageing. The deregulation of proteolysis is responsible for many human degenerative diseases and cancers. The ubiquitin-proteasome mechanism is the main protein destruction system. However, how proteasome activity is regulated remains poorly understood. Furthermore, it is suspected that degradation pathways exist. The Archelyse project aims to address these important questions by studying the primitive proteasome regulatory system in Archaea. These microorganisms form a separate domain of Life, with many aspects of their biology, including proteolysis, being closer to the eukaryotes.

LM2E's involvement (Didier FLAMENT, Anne GODFROY) in this project coordinated by Bruno FRANZETTI (UMR 5075, IBS Grenoble), is based on its expertise in the physiology and cultivation of hyperthermophilic Archaea and the study of protein-protein interactions.



© Stéphane L'Hartoin/LM2E, UMR6197, IUEM

▲  
The parts of the Cocagne automated platform for culture and isolation of microbes (IUEM): fluid-handling robot, anaerobic chamber and flow cytometer

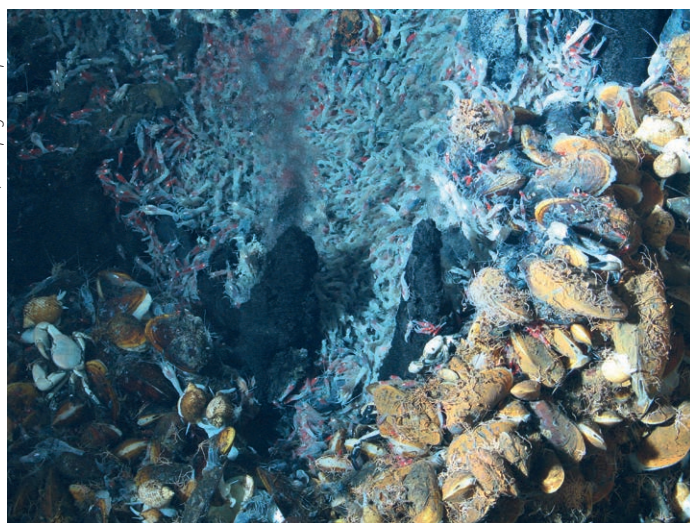


## Hermione, European project (2009-2012) studying deep-ocean ecosystems on European margins

This project aimed to study the deep-sea ecosystems on European margins and the impact of human activities on these environments. Some twenty technicians, engineers and scientists from Ifremer were involved in four of the project's seven work packages: WP2 (submarine canyons), WP4 (corals), WP5 (chemosynthetic ecosystems) and WP7 (data management) and in coordinating the "Biological capacities and adaptation" research theme. Several papers were presented during this meeting, including several involving Ifremer scientists. A summary report produced after 18 months was produced in late September and the financial statement was submitted in November 2012. A photo database was created, working in collaboration with our partners from Jacobs University and Marum, and this led to the publication of a report called "Video-photographic database and GIS on distribution of chemosynthetic habitats and associated megafauna at main target sites", as well as a GIS illustrating the different chemosynthetic habitats on the margins visited during the project being put on line (<http://www.faculty.jacobs-university.de/vunnithan/hermione>). Amongst the project's milestones is the authoring of a summary publication on the biodiversity of cold seep ecosystems on European margins, bringing together scientists from seven European research institutes including researchers from Ifremer (Vanreusel *et al.*, in prep.). A workshop was organised by the theme coordinator (S. ARNAUD-HAOND, Biological station in Roscoff, 22-23 May 2012) on the physiological and genomic adaptations which are specific to the deep-sea environment. Several articles on genetic connectivity in the deep-ocean environment have either been published or are being assessed for publication.

The final meeting of the EU Hermione project was held from 11 to 14 September 2012 in Faro, Portugal.

Shrimp around a black smoker



© Ifremer-Victor/Campagne Serpentine

## Technological mastery: third year for the Azores observatory (MoMAR)

The MoMarsat 2012 oceanographic cruise, jointly conducted by Ifremer (REM UR/RDT and UR/EEP), the IPGP earth physics institute in Paris and the university of the Azores, took place exactly as planned on the Mid-Atlantic Ridge off the Azores Islands, ending on 24 July. Aboard RV *Thalassa*, the mission's objective was to recover the instruments moored there and to redeploy them after maintenance operations. The buoy resumed its transmissions via satellite (pressure data, detection of earthquakes, video snapshots, chemical and temperature data for hydrothermal fluids), ensuring the continuous observation of earthquakes and hydrothermal vents on the Lucky Strike volcano at a depth of 1,700 metres, for the third year running.

## The "Abyssbox, life under pressure" exhibition inaugurated at Océanopolis on 7 April 2012

This exhibition is the result of close collaboration between Océanopolis, Pierre & Marie Curie university and Ifremer and will give the general public an opportunity to observe living species from the abyssal seafloors in pressurised aquariums. These organisms (about twenty *Mirocaris fortunata* vent shrimp and three *Segonzacia mesatlantica* crabs) are specimens which were taken on hydrothermal vents in the Lucky Strike field located on the Mid-Atlantic Ridge to the south of the Azores, during maintenance cruises on the MoMAR observatory.

<http://wwz.ifremer.fr/institut/L-institut/Actualites-Agendas/AbyssBox>

# MARINE RENEWABLE ENERGIES

In the field of marine renewable energy sources, there are several natures of research objectives:

1. Consolidating knowledge about the environment and structure response
2. Developing our knowledge about environmental and societal impacts
3. Accrued participation in demonstrators and proposing technological innovations

Ifremer is involved in research, to varying degrees, in all MRE sectors, i.e. offshore wind (including floating), tidal energy, wave energy and ocean thermal energy conversion (OTEC). Ifremer contributes to the development of these value chains, both through research and development studies, particularly in the framework of European projects, studies and service provision, and finally through expert assessments, especially for State services. Likewise, Ifremer facilitates and participates in national (Ancre, preparing the FEM IEED submission, DGEC, etc.) and international (ISSC, Marine Board, etc.) working groups.

## IEED France Energies marines

In 2010, in response to the call for projects on Institutes of excellence devoted to carbon-free energy (IEED), a particularly broad-based public-private partnership was created, thus embodying the initial national ambition. The France Energies Marines project was submitted in March 2011, leading to its official approval under the IEED label on 9 March 2012. The amount of co-financing granted was 34.3 million euros, for a budget of approximately 130 million euros affected over nine years. On 15 March 2012, the Interim association for the IEED France Energies marines was created in Brest, setting the following objectives:

- drawing up the project agreement with ANR, the body which manages IEED institutes
- setting up the definitive organisation, which will be a Public Interest Grouping
- launching the first research projects.

## A floating tidal energy converter concept tested in the Boulogne-sur-Mer wave-current circulation tank

The Tidalys company in Cherbourg trialled the first 1:13 scale prototype of its floating tidal stream device, called Electrimar. This is a floating structure of about 30 m by 18 m, constructed using 80 % composite materials, with an 18-m diameter rotor coupled to a generator whose mean capacity is 1.8 MW.

## WINFLO PROJECT (FINANCED BY ADEME)

The main objective was to develop a 1 MW floating offshore wind demonstrator. Ifremer is contributing to the project through tank testing (series of tests in 2012 in Brest), trials on materials for the mooring lines (tests performed in 2012 at REM/RDT), monitoring of some environmental parameters and analysing the demonstrator's behaviour *in situ*.

## ORCA project (financed by Ademe)

This project's principal aim was to develop a 1 MW tidal energy demonstrator. Ifremer's contribution to the project takes the form of analysing the *in situ* wave and tidal current measurements, running test tank trials to characterise performances and installation techniques, as well as analysing anti-corrosion protection.

Since the start of the project, the ORCA concept developed by Alstom has evolved significantly, going from a six-blade device with an outer casing to a three-blade device without casing. A series of tests was performed on this most recent concept in Ifremer's wave-current circulation tank at Boulogne-sur-Mer, at the scale of 1:25.

## Sabella D10 project (financed by Ademe)

Industrial choices and difficulties related to making budgetary ends meet did not favour major participation by Ifremer teams in the project in 2012. In fact, only monitoring of hydrodynamic studies was conducted. Supporting activity for the tests proposed in the frame of the European Marinet project will be provided in early 2013. The acoustics and composite materials strands gave rise to special studies, for selecting the materials to be used in the D10 tidal energy converter. Characterisation and weathering tests were performed on the materials for the blades and on the assemblies, and checks were run on the quality of the manufactured parts. For noise measurements, the studies conducted in 2012 were related to pursuing the development and qualification of the new autonomous acoustic recording system (*Sea-Ear NG*).

## BILBOQUET PROJECT

The Bilboquet (French word for a cup-and-ball toy) is an innovative concept for an omnidirectional point absorbing wave energy converter. Studies carried out in 2012 on the Bilboquet project mostly focused on developing a numerical model of the concept using Aqua+ software.

## Merific project (Marine Energy in Far peripheral and Island Communities)

The project's objective is to increase the adoption of marine energy across Cornwall and Finistère, in island communities in the Iroise marine park area and the Isles of Scilly. In 2012, Ifremer's contributions concerned: mooring dynamics; conducting numerical modelling and experimental studies on the dynamic behaviour and synthetic moorings for marine energy converters; assessing and mapping the resource; implementing new algorithms to improve the measurement of surface currents and estimation of the sea state using HF radar (outsourced to Actimar); implementing hindcast models of sea states to construct climatologies in the Iroise Sea.

## MARINET PROJECT

Our participation in the Marinet project consists both in conducting research action in the framework of a European partnership in the field of marine renewable energy and hosting European research teams under "Transnational Access" (TA) in our facilities (test tanks in Brest and Boulogne-sur-Mer and Materials laboratory) in the MRE field, and lastly to take an active part in the management of this project which brings together twenty-eight partners and forty-two experimental facilities in Europe.

## TRIALS IN THE MARINET EU PROJECT FRAMEWORK

Three projects, representing twenty-seven days of testing, were hosted at the wave-current circulation tank in Boulogne and the test tank in Brest.

For instance, in Boulogne, the Bluewater firm tested the behaviour in waves of a floating support platform of a tidal stream energy converter with two three-blade, horizontal-axis turbines. The movements were analysed based on motion tracking measurements and the tension in mooring lines was measured.

Numerous configurations (rotational direction of blade) and turbine operational points will be tested during two weeks of trials in January 2013. Two projects, each for two weeks of testing, were hosted in Brest.

- The Scottish company Albatern tested a wave energy conversion system. This system is made up of an array of floating modules and the energy harnessed comes from the relative movement of these modules with respect to each other.
- The Norwegian Institute for Energy Technology tested a support platform with catenary lines for a floating wind turbine.

# DEVELOPING TECHNOLOGIES AND INNOVATIVE INFORMATION SYSTEMS



## TECHNOLOGICAL DEVELOPMENTS TO SERVE THE EXPLORATION AND OBSERVATION OF THE MARINE ENVIRONMENT

The large number of vehicles and equipment designed and maintained by Ifremer's teams of engineers enable scientists to take very high quality measurements and observations and to safely explore the seafloor. Thanks to the quality processes which are developed and implemented, the engineering teams, working with the fleet operator, can perform continual improvement cycles and thus reach high levels of reliability for these prototypes. Ifremer vessels are equipped with a range of high-tech echosounders. Analytical engineering and processing the data from these sounders is one strong orientation for our Institute's global standing, as has been illustrated by numerous examples of engineering services provided to other research institutions which possess this sort of equipment. To mention just a few of our emblematic facilities: the underwater vehicle *Nautile* (manned submersible, 1,700 dives), *Victor 6000* (remotely operated, over 5,000 hours at the bottom of the sea), *AsterX* and *IdefX* (autonomous vectors). Research and development activities in underwater technologies combine technological innovation, through research projects conducted in partnership with industrial firms and operational efficiency at sea, stemming from Ifremer/Genavir's experience and the drive to reduce ownership costs. This has led the Institute to acquire underwater research systems which put it in the world class. Innovation springs from technical research projects carried out in cooperation with companies, thus supplying novel tools for scientists. Both the near-bottom seismic profiling and the hybrid ROV project, which is a first worldwide, are illustrations of this. Finally, the improvement strategy is definitely part of consolidating our international cooperation.

▲  
*AUV Aster<sup>x</sup> on  
the deck of RV  
Suroît during  
the Marmesonet  
cruise*

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## SEXTANT

Sextant is Ifremer's georeferenced information system: it comprises a geographic data repository, a web portal compliant with ISO georeferencing standards and a series of software program blocks which can be used by project portals.

A large number of projects and partners make use of Sextant, as those working in the coastal environment, but often in different areas, making it somewhat irrelevant to share data; however, the sharing of tools, interfaces and the same obligations under the Inspire directive explains why the annual meetings organised by IMN/IDM/Sismer are so necessary.

Efforts to inventory the Marine geosciences unit's digital terrain models have led to the catalogue on the Sextant server, which can be viewed by all visitors and accessed in accordance with the rules for dissemination.

Sextant is becoming the essential reference on the coast, in terms of disseminating data and metadata, both in metropolitan France and in the overseas departments (counties).

Special focus was given to the projects of Ifremer's three overseas stations in which Sextant is involved.

The presentation by MEDDE (Ministry of ecology, sustainable development and energy) partners in the GIMel working group (marine and coastal geoinformation) opened up discussions on the need to create and share geographical information for all State services and public institutions.



## Seadatanet2

### Training course

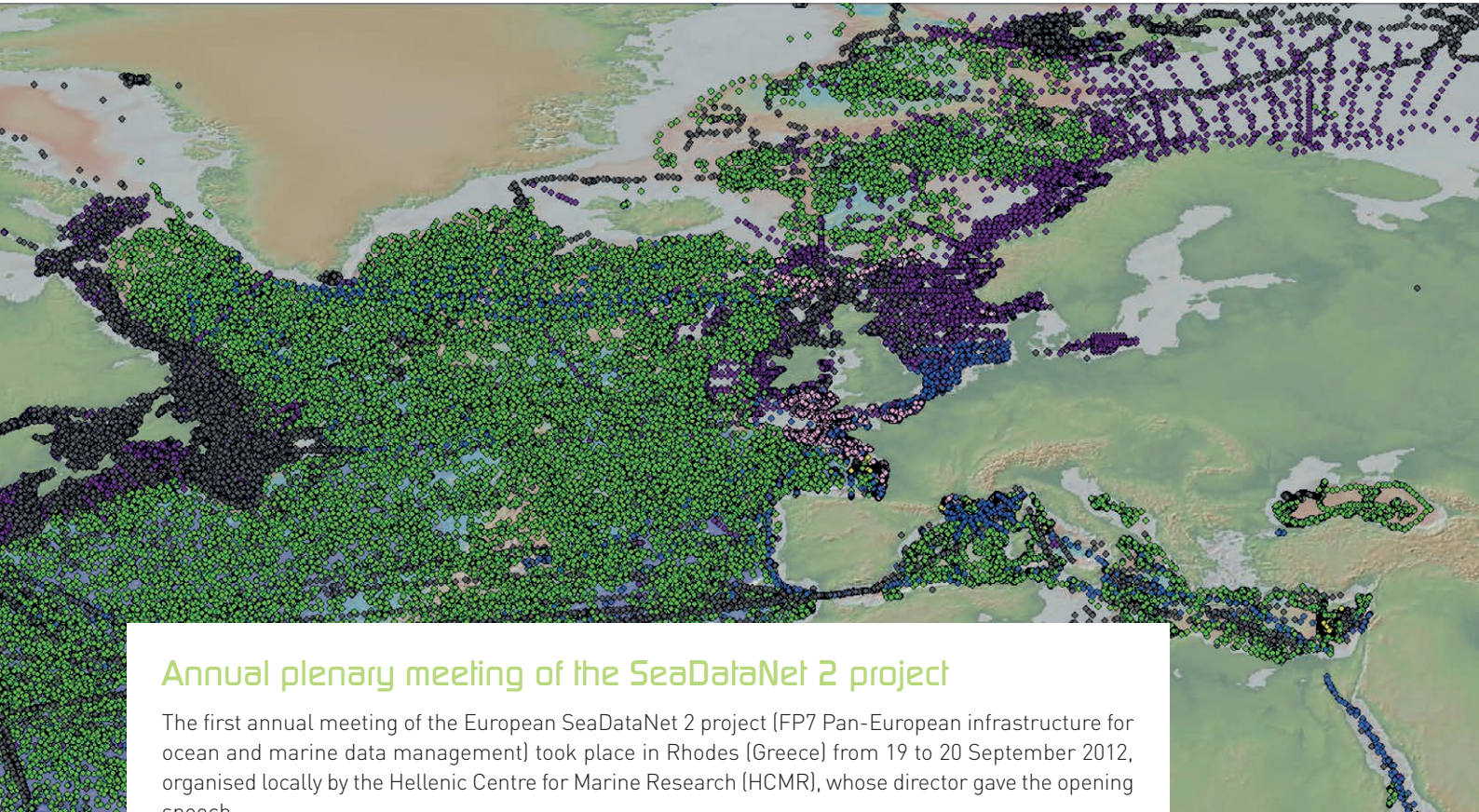
In the framework of the SeaDataNet 2 project, Sismer, as project coordinator, worked in collaboration with the Intergovernmental Ocean Data Exchange (IODE) Project Office to organise a training course in Ostend (Belgium) from 2 to 6 July 2012.

This course was designed for marine data managers and technicians in charge of operating data centres, with the aim of learning how to use the different tools and formats developed during the project and implement them in their data centres. Forty-one data managers attended the different courses and exercises proposed by the training instructors.



▲  
Marel Iroise buoy

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## Annual plenary meeting of the SeaDataNet 2 project

The first annual meeting of the European SeaDataNet 2 project (FP7 Pan-European infrastructure for ocean and marine data management) took place in Rhodes (Greece) from 19 to 20 September 2012, organised locally by the Hellenic Centre for Marine Research (HCMR), whose director gave the opening speech.

There were eighty participants from some forty countries present at the meeting. The advisory committee includes Margarita Conkright Gregg (director of US-NODC in Washington), Robert Keeley from the World Meteorological Organization and Intergovernmental Oceanographic Commission's joint WMO-IOC commission, as well as representatives from Scripps and the OBIS international marine biodiversity programme.

The event was preceded by a joint meeting with the GMES/MyOcean project to define shared climatology products.

This meeting served to highlight the progress accomplished during the project's first year:

- continuing to set up standards for the management of marine data in order to guarantee interoperability between various data centres in the network and to comply with the technical guidelines of the Inspire directive,
- updating of associated data management tools (ISO 19139 metadata management, NetCDF for the needs of the ocean/atmosphere scientific community, tools for detecting duplicate observations, etc.) enabling integrated and coherent observation collections to be created,
- automated access to data found in different centres) in order to constantly analyse availability and enable the whole system to be supervised (see map below)
- pursuing the integration by the system of available data: to date, over 1 million data sets have been made available for downloading.

Finally, SeaDataNet has proved to be a technical foundation for many other projects, including the preparatory action for the European Marine Observation and Data Network (EMODnet – EC - DG Mare), preparations which were in great part successfully completed in 2012. Numerous proposals have been drafted on behalf of the SeaDataNet consortium in response to the calls for proposals launched by DG Mare in September 2012 in order to extend these EMODnet preparatory activities, to provide a base of data for the needs of the Marine Strategy Framework Directive, and to analyse limitations in terms both of the availability of data and the necessary interactions between the initiatives of DG Mare, DG Environment and the European Environmental Agency (in particular, WISE-Marine).

## European Emodnet Hydrography/Seabed Mapping project

This action began in June 2009 and its first phase was brought to completion in June 2012, for the inventory, cataloguing and production of digital bathymetry products, leading to the creation of a digital terrain model with a spatial resolution of 500 m for European seas. Ifremer led the production of models for the entire Mediterranean and for the Bay of Biscay and Iberian seafront in the Atlantic, working in association with a dozen partners.

## Andro atlas data now on line

By reprocessing the data from Argo floats covering the period from 2000 to 2009 inclusive, a global database of deep displacements was generated. The 606,119 displacements supplied by 6,212 Argo floats make up the Andro "atlas", which can be freely accessed on the LPO website (<http://wwz.ifremer.fr/lpo/>). These data (which required six years of work), have already made it possible to estimate the absolute dynamic surface at 1,000 dbars, i.e. a baseline surface as reference for the absolute geostrophic circulation, which has been the subject of research since ocean physical studies began. To remain relevant, this unprecedented dataset will have to be updated. An updating strategy must be defined with Ifremer's partners so that the integration of data acquired since 1st January 2010 can be prepared as of this year.

The first two publications on this work are:

Ollitrault & Rannou (2012): *ANDRO: An Argo-based deep displacement dataset*. *J. Atmos. Ocean. Technology* (In press).

Ollitrault & Colin de Verdière (2013): *The Ocean général circulation near 1000 m depth*. *J. Phys. Ocean* (Submitted).

## Quadrige<sup>2</sup>: information system for coastal environment data

Ifremer is in charge of the national repository for coastal environmental data in the framework of compliance with the Water Framework Directive. This system, called Quadrige<sup>2</sup>, also enables the storage of data collected by the different environmental monitoring networks as well as their dissemination and applications. In 2012, the system began to feed data to the Onema water status assessment system, which should make it possible to calculate the environmental indicators required by the directive.

Quadrige<sup>2</sup> also secures and integrates marine environmental data coming from various partners. In the latter case, a large set of historical data from the programme to monitor fisheries zooplankton on the sites of nuclear power plants on the seaside was incorporated into the Quadrige repository. This represents 8,466 samples and over 200,000 results for taxon abundance and the stage of development, as well as over 16,000 hydrology results, from 1975 to 2006. Likewise, the data concerning monitoring of corals in the tropical environment were integrated into the system.

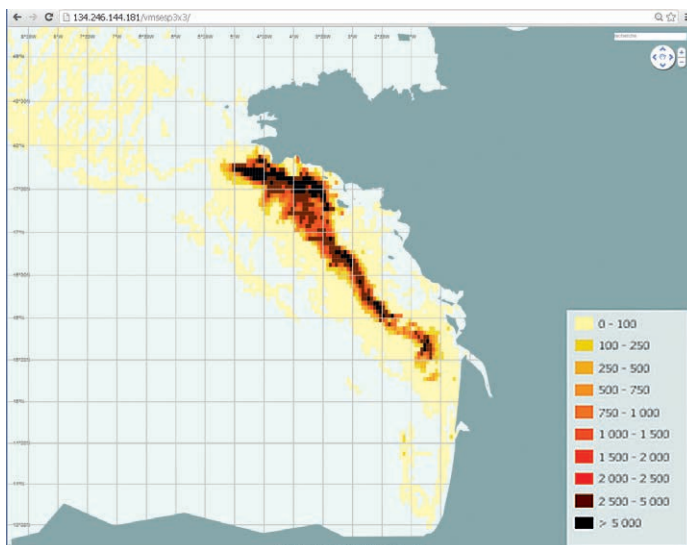
## NATIONAL MONITORING SUMMARY

A new edition of the national monitoring summary was published in December 2012. This document supplements the regional bulletins and presents monitoring and observation activity on the national scale. It was written by the heads of the REMI, Réphy, Rocch, Resco and Rebent network and contains a meteorological and hydrological assessment as well as a focus on the monitoring situation in the departments of overseas France.

It should also be noted that the first layout indicating on-line access to the monitoring graphs was created (a first step towards a "digital bulletin") The coastal environment littoral (EnvLit) website now has new modules, focused on integrating time series animations with the first application made to concentrations of Dinophysis over a twenty year period and presenting toxicity episodes related to phytoplankton blooms (four years of data) for ten countries, taken directly from the Haedat database. It should also be noted that a WFD atlas DCE was published for all districts and a file on Dinophysis was created.

## National sea and coast observatory (www.onml.fr)

Ifremer, working alongside the CGDD commission for sustainable development, SOeS observation and statistics service of the Ministry (MEDDE) and the AAMP (French agency for marine protected areas) took part in creating the ONML. Its website is now operational and is interfaced with Ifremer's Sextant cartographic data management tool, whose contents are regularly harvested. Several data sheets are being drawn up by Ifremer and our institute's expertise has been particularly mobilised for the environmental status, pressures and maritime economy strands.



*Spatial distribution of selected Nephrops prawn catches in 2012 by vessels equipped with the VMS system (European Union system for satellite monitoring of vessels)*

## Harmonie: development of a fisheries databasing system now completed

The development of the Harmonie fisheries database system's core was completed at the end of 2012. Harmonie aims to be an integrated system collecting all data which characterise the "fisheries system" from resources to uses and the profession's economy.

It is defined as a system for scientific purposes, research and support for expert assessments.

Based on a joint repository, it effectively integrates most of the fisheries data acquired by Ifremer through surveys and observations on shore or aboard fishing vessels and on assessment cruises, as well as the regulatory information transmitted via the DPMA's fisheries and aquaculture information system (SIPA): ship's logs, vessel locations (VMS), notes on landings, etc. Being interfaced with SIPA, Harmonie allows for continuous data exchanges.

Having recovered all the historical data available, Harmonie provides a unique memory base for the development of fisheries.

## SMOS (CATDS) satellite data processing centre

The objective of the SMOS (Soil Moisture Ocean Salinity) satellite mission is to produce data on the salinity of the oceans and the moisture of soils (on emerged land masses).

The downstream SMOS data processing centre, developed by CNES in cooperation with Ifremer and Cesbio, is devoted to L3 and L4 products, i.e. the levels where the processing which distinguishes between salinity and moisture is produced.

The CPDC (Data Production Centre) is the part of CATDS which is in charge of producing and routinely distributing these Level 3 and 4 products.

IMN/IDM/Sismer is responsible for utilising the CPDC.

One-hundred-four requests for access to SMOS products had been noted as of 1st June 2012 (59 for ocean salinity products and 45 for soil moisture).

Currently the CPDC is functioning only nominally, but there is nothing to prevent its operational qualification. A step is being prepared for a contractual agreement between CNES and Ifremer, so that the centre can be officially put into operation.

Following an integration phase which was finalised in 2012, the SMOS satellite data processing chains (ocean surface salinity, soil moisture) on Ifremer's IT resources, particularly the CAPArmor supercomputer, the production centre is now fully operational, both for routine processing of new data and for reprocessing data from previous years.

On this occasion, an agreement was signed in January 2013 with CNES, delegating both operational production and maintenance work on the centre's management software to Ifremer, with the exception of the processing chains themselves, whose developments fall under the authority of a scientific council which Ifremer belongs to (ODE-LOS).

Ensuring the processing at Ifremer will also make inter-calibrations with *in situ* salinity data measured in the framework of the international Argo (floats) and Gosud (TSGs fitted on ships of opportunity) programmes which are stored by the Coriolis system.



# UNDERWATER SYSTEMS

## Start of HROV building phase (project milestone)

The detailed definition of the system is now complete and the main key components are being developed and tested within the SM unit as project manager. The next major milestone will be the delivery by Ifremer of components for the Hybrid ROV to the ECA Robotics company, architect and integrator that will then complete the vehicle's integration with Ifremer in autumn 2013, as slated. Many industrial firms working in the offshore field have indicated great interest in the concept. Ifremer is negotiating a non-

exclusive licence agreement with the ECA firm in order to help develop a value chain based on this new generation of underwater systems.

The HROV will join Ifremer's mapping and operational tool kit, between the deep sea ROV *Victor*, which can be deployed from Ifremer's ocean going vessels, and the AUVs used for mapping.



## STUDY AND CREATION OF A LED PROJECTOR

Over the past several years, LED technology has flooded the lighting market. Indeed, LEDs provide highly competitive light output, interesting power/size ratio and unprecedented operating life.

Although industrial solutions exist for deep sea underwater applications, the integration solutions chosen do not enable LED possibilities to be optimised. This means that projectors are twice

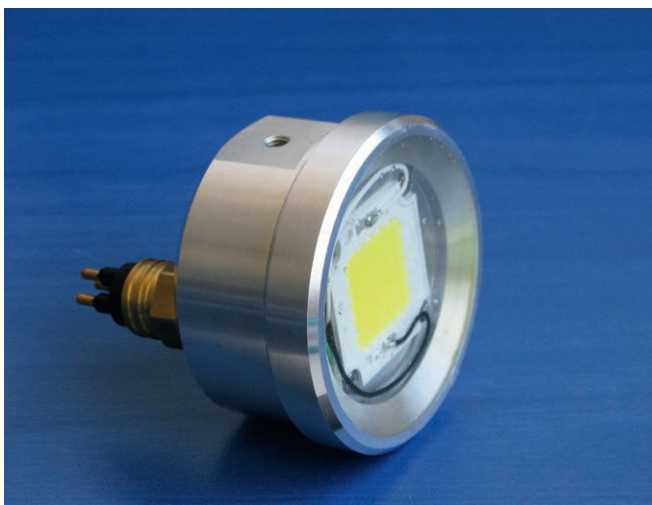
as heavy and voluminous and three times more expensive than conventional solutions.

The S3E service has developed and validated an innovative optimised solution that can resist pressure to 600 bars. It consists of a projector made up of a 100 W LED which is placed between an aluminium plate and an optical resin.

The aluminium ensures that heat is dissipated and the optical resin makes it possible to protect the LED from sea water whilst maintaining its light output.

The different parts of the projector are made using standard materials in order to optimise the cost, weight and volume. Testing for the qualification of this equipment is now underway. Currently, trials conducted under pressure have been successful and it has functioned continuously at rated capacity in a pool for 1,000 hours.

The next step is to fit it on a vehicle like *Nautile* or *Victor 6000* for use on an operational mission.



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## Record set for distance under ice for Mimosa software

Mimosa is the mission management tool for all of Ifremer's underwater vehicles.

In the realm of mapping, it is used to perform the functions of preparing missions, scheduling dives, real-time monitoring of system's mobile devices and technical processing of data. Today, it has been used for over sixty sea cruises with Ifremer vehicles, making over 630 deep sea dives (for more than 4,500 hours of use).

Mimosa is also distributed to outside partners, like the German research centre Marum for its ROV *Quest* and AUV *B-Seal*, the descendant of Ifremer's *Explorer* AUVs in its design, the American University of Southern Mississippi for its AUV *Eagle Ray* and the Canadian Memorial University of Newfoundland for its AUV, both of the latter being *Explorer*-type vehicles, or the Department of Natural Resources Canada (NRCan) for its AUVs *Yamoria* and *Qaujisati* of the same type, produced by ISE (International Submarine Engineering, Vancouver).

## FUI SYCIE PROJECT APPROVED

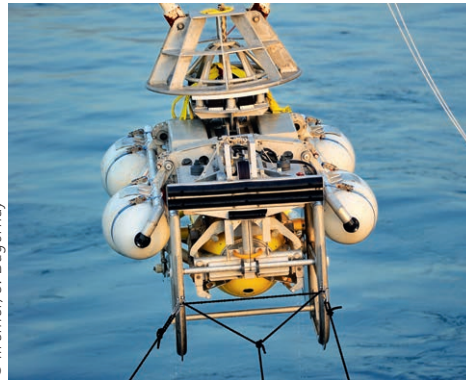
The objective of the Fui Sycie project is to develop a system (equipment + software) to plan, simulate and supervise a new-generation, multi-vehicle mission for air, sea and underwater drones. This tool should ensure that missions are efficient and effective under difficult environmental conditions, while guaranteeing the safety of participants in scheduled missions and minimising their environmental impact. Users will be given every form of assistance to guarantee the mission's success and safety. The proposed system will be able to manage a range of different vehicles (underwater, airborne or surface craft), cooperating with each other in different and complementary roles and capabilities. The project is being conducted in partnership with DCNS, Prolexia and USTV. It is based on the Mimosa programming system developed by Ifremer for all of its underwater vehicles. The Oseo/Ifremer contract will be signed in January 2013.

## Manta project: developing a seismic data acquisition system

The Oseo Manta project was launched at the end of 2012, with the signing of a contract between four parties on 1st December 2012. In cooperation with the Kietta, Acsa and Tronico companies, this is to develop innovative towing drones for marine seismics applications.

## Technology transfer for the Caliste recovery system

Deployment operations for autonomous marine or underwater vehicles are especially tricky in the phases of vehicle recovery, particularly due to the lack of physical link with the diving support ship and the difficulties related to the kinetic and dynamic constraints when the vehicle is taken from the surface of the water to the deck of the vessel.



◀ Recovery of AUV Aster<sup>x</sup> aboard RV Suroît

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The initial Caliste specifications, thought out by Ifremer, specified a simple, low-cost, reliable and safe system, which would be as compact as possible, interoperable from one vessel to another and adaptable to different deck and hoisting gear configurations. *In fine*, these objectives provide a competitive advantage in terms of ease of mobilisation and non-specialisation of the ship used, which is especially important for industrial utilisation. From the outset of the project, Ifremer wanted to protect the concept by patenting the vital components, with the perspective of selling the licence to an industrial partner, who was sought at the same time. The system, Ifremer Trophy-winner in the "Innovation" category, can optimise and ensure the safety of autonomous vehicle deployments.

On its side, ECA Robotics (<http://www.eca-robotics.com/>), as a supplier of AUVs and USV2 (2nd generation Unmanned Surface Vehicle), was looking for competitive and proven system for the deployment of its vehicles. Realising this, ECA Robotics contacted Ifremer to negotiate the utilisation of its know-how and patents for the Caliste system and to share its experience and feedback in this field. A partnership with ECA Robotics was then engaged, in order to develop a range of systems with the Caliste legacy that are adapted to industrial markets (offshore, naval and scientific) for marine or underwater autonomous vehicles. A licence contract between Ifremer and ECA Robotics for the manufacturing and commercialisation of the Caliste system was finally agreed on 6 July 2012. The Caliste project was awarded an Ifremer Trophy on 19 November 2012

## SUCCESS OF THE OSEO MANTA PROJECT

Manta is an innovative project aiming to develop a seismic data acquisition system. The system is based on classic reflection seismics principles, but its innovation lies in the way it is deployed. The project will be conducted in partnership with the industrial firm Kietta.

A series of air guns is combined with an array of distributed receivers which are submerged on streamers towed by drones in a "comb" shaped formation below the surface.

The streamers are designed to act as static or almost static cables with respect to the terrain (neither towed by a vessel like conventional streamers nor set on the seabed like OBCs).

The receivers are submerged much deeper (~100 m) than the classic towed streamers are (~10 m).

Seismic sensors measure both the pressure and the *P-waves* movements, which make it possible to eliminate ghost reflection effects.

This provides a key advantage in terms of performances and operational costs, but the deployment and networked piloting of an array

of streamer-towing drones remains a major operational challenge, requiring more research and development on the supervision and piloting of mobile devices.

Based on the software developments made for Ifremer's AUVs and its expertise in piloting and deploying fleets of drones acquired in the European projects Grex and Feednetack, Ifremer proposed a technical and operational study of the deployment of an array, a feasibility study on multi-drone piloting and supervision, an in-dock assessment of a pair of drones and a submerged streamer controlled by ballast and in this context, an assessment of the telecommunications network.

The pilot integration will be done on the Toulon site, using the industrial tools at the base (CETSM).

Ifremer's commitment in the Manta is not due to any direct interest for the seismic solution, but is rather based on the transfer of our expertise in implementing marine and underwater drones, in keeping with our programmes for AUVs and drone piloting and deployment.



## SEAEXPLORER

The underwater glider SeaExplorer was developed under the aegis of the PACA marine cluster in the framework of a partnership between French scientific bodies and industrial firms in the Provence-Alps-Côte d'Azur (PACA) region. The glider is able to analyse scientific data at depths reaching 700 metres and can carry out autonomous missions for periods of one to two months.

The first demonstrator, which is two metres long, weighs 70 kg and costs around 100,000 euros, goes back and forth from the shore to as far as 50 km offshore, surfacing regularly to deploy its antenna and send its data to researchers.

Scientists in the region have been using American-made underwater gliders for the past five years, deploying them between Corsica and Nice. The French vehicle, equipped with rechargeable batteries, could make

more accurate and more flexible trajectories possible.

Obviously, industrial firms want to get a foothold in this market which will open up all sorts of applications, well beyond the field of science.

The underwater glider is equipped with miniaturised sensors which can measure temperature, salinity, chemical concentrations or even phytoplankton concentrations. Ultimately, it could be equipped with other sensors, for instance to detect jellyfish or dissolved hydrocarbons.

The following organisations or companies are contributing to this applied research project:

- ACSA industrial architect
- ACRI company
- Ifremer
- COM (oceanology centre of Marseille).

# SHIPBOARD SYSTEMS

## Assessing the performances of the Schmidt Ocean Institute's RV *Falkor*

SOI, the Schmidt Ocean Institute (an American foundation created by the co-founder of Google), has entrusted Ifremer and the university of New Hampshire with the sea trial operations and expert assessment of the performances of all the acoustic sensors aboard its blue water vessel RV *Falkor* (83 m) whose overhaul has just been completed in a German shipyard. The cost after acceptance was 160,000 euros.

RV *Falkor* is equipped with two Kongsberg EM 710 and EM 302 multibeam echosounders, two conventional Kongsberg EA 600 and Simrad ER 60 multifrequency echosounders, two Doppler Teledyne OS75 and WH300 current meters, a Sonardyne ultrashort baseline system, a Knudsen 3260 sub-bottom profiler and a Simrad SH 90 panoramic omnidirectional sonar.

The main cruise took place from 2 to 20 May 2012 in Norway. After a leg in transit from Horten to Bergen, RV *Falkor* carried out most of the sea trials in the magnificent setting of Sognefjord (1,300 m deep), and returned to Bergen. The trials focused on performances of all of these systems, as well as measuring the ship's noise. An echosounder calibration system developed by NSE was installed on board and put into operation. The tests made validated the excellent level of acoustic performance for both the vessel and its equipment.

Additional trials were conducted in July. Thus, Ifremer took part in the discovery of the S.S. *Terra Nova* wreck in Greenland. This vessel symbolises polar exploration at the turn of the 20th century, and amongst other things, was the support ship for the famous and tragic expedition by Captain Scott in Antarctica from 1910-1913. The *Terra Nova* sank in 1943 near the southern coast of Greenland. Ifremer's team defined and supervised the operations to survey the zone with a multibeam echosounder (Kongsberg EM 710) and processed the sonar data.

Based on a call for proposals, SOI proposes to make its vessel available free of charge for scientific and technical cruises. One- to two-page expressions of interest are received, analysed and decided on. Then well-structured applications must be produced for the short-listed selected cruises. In another field, but in the same context, SOI has created the Marine Sciences and Technology Foundation (MSTF) to finance innovative technological developments. The "average" project budget is around US\$500,000. The NSE unit volunteered and was chosen to act as an interface between Ifremer and SOI.



### Assessing energy potential. Characterising environmental conditions. Database

A hindcasting programme of sea states is being created to construct a set of directional spectra data on a high resolution grid. The set of data produced on the basis of sea state model configurations developed in the framework of the lowaga research project and tested in the framework of the Prévimer demonstrator will enable fine scale climatologies to be constructed, adapted to the

studies conducted by RDT to support projects for marine energy converter developments (resource assessments, estimating product potential, design, fatigue behaviour and so on).

These studies will give rise to transfers as of this year through the PAPH (Ademe) and Merific (Interreg IV) projects.

## Commercial developments for real-time data acquisition software

The shipboard software engineering service in the NSE unit develops, maintains and disseminates a full range of software for use on board vessels and underwater vehicles. Amongst them, the real-time acquisition and processing software programs take pride of place. The technology transfer and value creation policy set up has made it possible to distribute and install these products on numerous foreign platforms.

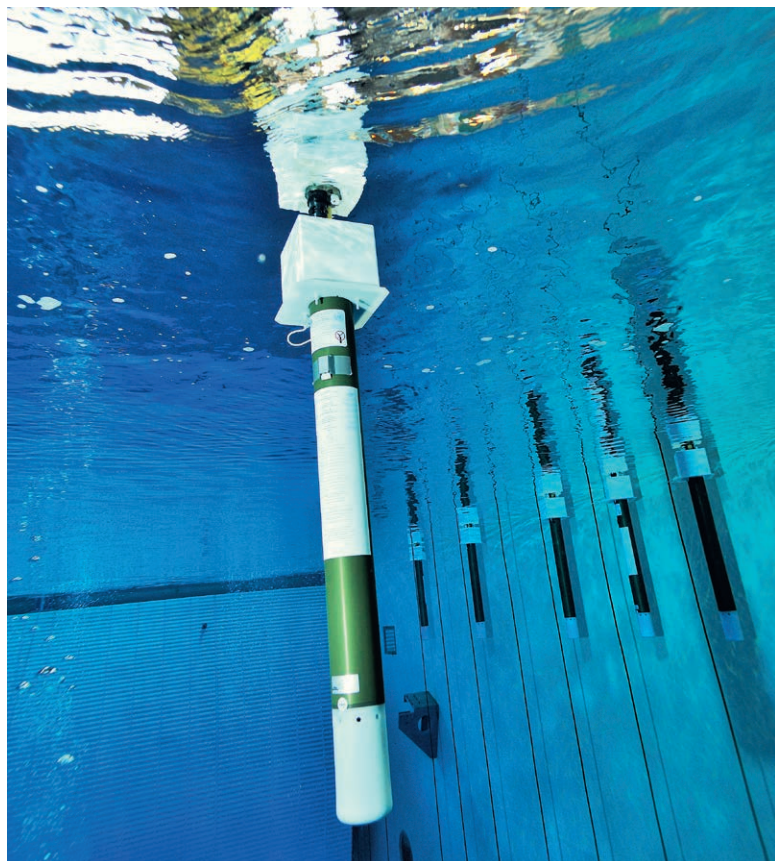
For instance, in England, the National Oceanography Centre, or NOC, purchased the rights to use the Techsas software in the context of upgrading the data acquisition tools aboard its vessels: RV *James Cook*, *Discovery* and the deep sea ROV *Isis*. In the Netherlands, NIOZ (*Nederlands Instituut voor Onderzoek der Zee*) purchased Techsas, SDIV+ and Casino+ in 2009 for RV *Pelagia* (66 metres LOA, built in 1991). In 2008, Techsas, SDIV+, Sumatra and Casino+ software

tools were installed aboard RV *Southern Surveyor* belonging to the Australian Commonwealth Scientific and Industrial Research Organisation (Csiro).

In 2012, an €80,000 contract was signed with AAD (Australian Antarctic Division) to supply and install the SDVIV and Techsas acquisition system aboard the vessel *Aurora Australis*. More generally speaking, the Ifremer-Csiro-AAD teams want to pursue their collaborative work, particularly in developing the software tools specified for the future Australian research vessel (*Investigator*), but also on methodologies for calibration, standardisation of acquisition protocols and databasing. The Eurofleets approach has also been greatly discussed and synergies are possible on many points (Water column processing, codification of operations at sea, Charlie, acoustic sensors and video for fisheries, etc.).



## MEASUREMENT AND OBSERVATION SYSTEMS



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▲ Testing Arvor (profiling) floats in the test tank of the Ifremer Brittany centre

### Developing sensors on profiling floats

In the field of drifting profiling floats, coastal *Arvor* successfully completed one thousand cycles in September (with a drift of less than 250 metres a day). The cycles were performed during operational missions, mainly on behalf of the Oceanography and ecosystem dynamics department. Two prototypes of multi-sensor coastal *Arvor* floats were manufactured and delivered, pending full qualification acceptance testing in 2013. Another model, equipped with a "low cost" fluorimeter and turbidimeter is being developed. Additionally, the electronics and optics NOSS (NKE) Optical Salinity Sensor were made more reliable during the Proteus cruise aboard RV *Pourquoi pas?*. This sensor was developed in cooperation with Télécom Bretagne, SHOM and the NKE firm and is ultimately intended to equip profiling floats, as an alternative means to access ocean salinity. Finally, the *Provor* float fitted with an Isus nitrate sensor was retrieved after over a year's service at sea, which means that a publication with our partners (Mercator/Coriolis Mission Group and Villefranche-sur-Mer oceanography laboratory) can be foreseen. The sensor was recalibrated at RDT for future redeployment in the framework of the NAOS project.

## AMARIS

Sea ports, marinas and fishing harbours all receive many metallic (tin, copper, zinc, etc.) and organic (PAHs, pesticides, etc.) contaminants. They mainly come from catchment basins, nearby industries, urban development or from the users themselves. Currently, the frequency of analyses and monitoring remains low and subject to regulations which are often applied inappropriately (for instance, frequency and hydrological or biological compartments which are not representative of pollutant inputs). Harbour managers view their legal responsibility with concern and are trying to better manage discharge reductions.

This was the perspective for setting up the Amaris collaborative research project, whose goal is to help in decision making thanks to an *in situ* system to analyse the contaminants put into the harbour environment.

The project was accepted by the Brittany regional council for a twenty-four-month period, and is based upon cooperation between the Accoast SME and Ifremer, including subcontracting by Veolia and participation by SMEL (joint consortium for coastal amenities).

Analytical tools were chosen for their ease of use, i.e. the DGT (Diffusive Gradient in Thin Film) technique for metallic contaminants and the SBSE (Stir Bar Sorptive Extraction) technique for organic ones. Two pilot sites were studied to test these techniques: the Lorient-Keroman fishing harbour and the large Nantes-Saint-Nazaire sea port.

Ifremer is in charge of developing multi-purpose instrumentation for use *in situ*.

## Developing Marel Samhyn, an automated hydrobiology data acquisition for rearing flat oyster spat in a controlled environment

A measurement station developed by the RDT unit was transferred to the hatchery in Argenton. This facility is taking part in setting up so-called "new generation" mollusc hatcheries and this is a significant technological breakthrough. The tool, called Marel Samhyn, can optimise the management of farms (broodstock, phytoplankton, larvae and fingerlings).

## SBSE KIT

An automated and portable version of the SBSE technique (SBSE kit) was developed in the framework of an Onema/Ifremer 2012 agreement working in close collaboration with Cèdre. It is designed to be used in the context of monitoring chemical contamination in water bodies.

This new version enables standard solution and derivative reagents to be introduced, so that polar compounds can be titrated as well. The technique can be applied to both marine and inland waters.

The main objectives of this Onema/Ifremer action are to:

- continue to package this automated SBSE system in the form of "kits" and validate extraction protocols for polar and nonpolar compounds in the lab; and
- confirm that the kits are indeed operational, by having "field operators" use them to take water samples and perform *in situ* extraction of various organic contaminants.



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*The one-thousand cycle mark (with less than 250 metres drift per day) was passed in September 2012 by the coastal Arvor loat*

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Sea deployment of the Molit buoy, a measurement station for continuous monitoring of marine water quality parameters



## Captiven: sensors and data for environmental quality of water and soil

The ANR inter-Carnot Captiven (sensors and data for environmental quality of water and soil) project was secured in the framework of the Investments for the future project funding scheme, and was officially launched on 19 December. The kick-off was given during a strategic orientation committee meeting where the three partner Carnot institutes (BRGM, Irstea, Ifremer-Edrome), a collegial grouping of public bodies (including ANR, Ademe, OSEO, etc.) and professionals from the socio-economic sector were all present. Its objective is to develop partnerships between SMEs and public research laboratories in the field of environmental metrology. More particularly, for Ifremer-Edrome, this involves developing sensors, *in situ* measurement systems, and monitoring, forecasting and alert systems on emerging pollutants, natural hazards or risks related to development of coastal areas. To this end, meetings were organised in October and November between small and medium sized business and the Brittany and PACA (Mediterranean) marine clusters. Ifremer-Edrome makes its Marel Iroise, Molit and Marel Carnot (Boulogne-sur-Mer) measurement platforms available to interested SMEs, to serve as test platforms for proposed innovations. The initial feedback has shown that these platforms act as good gateways for SMEs to join this cooperation.

## JERICO

The Jerico project for the integration of European research infrastructures started in 2011. It is coordinated by Ifremer and has twenty-seven European partners from seventeen countries, all with a seafront. Its aim is to harmonise, perpetuate and foresee the technological developments of a network of coastal observation systems: fixed platforms, gliders, coastal profiling systems and ships of opportunity.

Jerico launched its first "Transnational Access" call for proposals, which closed in April 2012 to allow free access to the European coastal observatories and measurement facilities supplied by the consortium. Nine submissions were selected and the corresponding experiments are now

underway. The project's first general assembly meeting was held in October. It provided the occasion to organise two workshops, one on the theme of "How to share a common vision and build a strategy for the next ten years" and the other on best practices in the field of coastal observation systems. Jerico also laid the foundations for the first actions of the Forum for Coastal Technologies, a place where suppliers and users of coastal instrumentation can discuss and communicate.



## EMSO

The European EMSO project completed its preparatory phase by drawing up a submission for a permanent research infrastructure geographically distributed over several sites in European waters and several countries. Ifremer made a major contribution to the legal submission and the cost estimates. But above all, we studied the obstacles and technical choices for cabled or stand-alone observatories (WP8). The reports which were drafted in this framework summarise the know-how available worldwide and provide the basis for future EMSO developments like technology transfers.

EMSO ERIC is being set up, with the support of seven countries and Italy as lead partner. The validation phase for each country is rather long, but an MoU was signed, by France as well, to start the project.

In 2012, the technological advances made in the Esonet years on sites which are now part of EMSO have enabled multi-annual target observations to be performed.

For MoMAR Azores, the annual cruise was made successfully, under minimal conditions for a short cruise aboard RV *Thalassa* with *Victor 6000*. It led to the decision to manufacture spare components, so that maintenance can be carried out under optimal operational conditions.

- In the East Ligurian Sea, the marine geosciences laboratory ran trials on instruments. Negotiations for a landing point near the waste treatment plant of Nice have put the cabled observatory project back on the agenda.
- For the Marmara Sea, previous data are being analysed and stations being designed for bubble monitoring and broad-band seismics to prepare the cruises for the European Marsite project.

In the field of multi-disciplinary cabled seafloor observatories, Ifremer pursued its experiment for continuous connection of its instruments (piezometer, video camera, chemical analyser) to the Neptune Canada network and deployed equipment of its own design. More specifically, at the outcome of the development period, the setting up and operation of the Molène observatory were crowned with success. The financing is ensured by the Interreg MeDON project which ended in late 2012. This life-size demonstration of a node and 300-W junction box was accompanied by the deployment of a video camera, current meter and hydrophones used to fine-tune software programs from the ENSTA-Bretagne engineering school.

A post-doctoral fellow examined the potential for an opto-power supply over several kilometres on a seafloor observatory, thus continuing an action by the GIS Europôle Mer scientific interest group. He validated the fibre optics feedthrough up to 3.5 W and 600 bars.

A basic engineering study for the concept of a Horus cabled seafloor observatory was conducted for Total R&D, in the context of a deep water production site which is threatened by seabed instability, aiming to deploy it in less than two years' time.

In the field of stand-alone observatories transmitting via acoustics, new low consumption electronics called Costof2, which will increase the amount of data acquired, even with seismic sensors, was launched.





## MeDON

The MeDON (Marine e-Data Observatory Network) project is conducted in partnership with French and English institutes and co-financed by the Interreg IV-Channel programme and the EMSO project. Its aim is to define, test and develop a real-time pilot cabled seafloor observatory, intended to supplement the range of coastal monitoring systems available.

The observatory has been in continuous operation since June 2012. The underwater section holds an instrumental module and is set up 2 km north-east of Molène island, in the Iroise marine park. On the edge of a zone of sand and riprap, at a depth of 20 metres, this metal structure weighing 2 tonnes (3 m x 4 m x 1 m in height) moors the underwater tip of the cable. The cable linking the observatory to the island is telecommunication cable supplied by France Télécom Marine, made up of eight optical fibres and a copper conductor. Its underwater portion is laid on the seabed and buried at its arrival point on the foreshore. The control-room containers on shore holds the IT server which runs the software programs to pilot, record and pre-process the

data, as well as the software for network administration and supervision.

The undersea node holds the observatory's electronic core instrumentation: the node transforms the optical signal into an electric signal at its outlet, the junction box or JB distributes power to the instruments, transmits instructions and data acquired, protects the system in the case of electrical malfunction and sends alarms. Above and beyond the initial objective of monitoring species, the facility has some essential technological objectives: monitoring station for exploited underwater sites (zones for water abstraction, resources and energy sources), French test site for seafloor observatories made available to scientists and industrial firms who want to ensure the reliability of their instrument developments under real operating conditions, a technological demonstrator and multi-disciplinary pilot seafloor observatory which will enable future developments on EMSO sites around Europe to be approached with confidence.



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▲ Banc test de l'observatoire « fond de mer » MeDON

## Opticom project secured at Citeph: subsea optical communication system

The subsea systems unit, along with its industrial partners Subseatech, Oxxius and Aquitaine Electronique, secured funding for a Citeph (concerted actions in innovation for exploration-production in the hydrocarbon industry) project to develop new underwater optical communication technologies based on laser transmission and photomultiplier or diode array reception.

The project's objective is to develop a subsea optical communication system which can supply high broadband transmission over short range while being very energy-efficient. The table below summarises the performances of each of these technologies in the subsea environment.

<b>Cabled</b>	1,000 km	qqGb/s	600,000 bits/joule
<b>Wifi RF</b>	15 cm	50Mb/s	
<b>Acoustic</b>	several km	1 kb/s	100 bits/joule
<b>Optical</b>	100 m	1 Mb/s	40,000 bits/joule

In the frame of the project, we will be in charge of trials and benchmarking for the BlueComm solution developed by WHOI, which Sonardyne is working to bring to market. BlueComm technology, a stand-alone optical communication system using LED transmitters, uses a costly and bulky receiver based on photomultiplier technology. Our proposal is to develop an emission model with a pressure-balanced LED matrix (we've already mastered this technology for lighting with our novel developments for high power-LED projectors on *Victor 6000*) and to prototype a receiver matrix designed with avalanche diodes. Putting the latter into balanced pressure will also be studied. The objective is to prototype an energy-efficient array which will enable a data transfer rate of 1 Mb/s over a range of 50 metres in omnidirectional emission (in the dark). The project re-utilises research studies carried out over the past three years in partnership with the Fresnel institute and within the European Sensenet project (field of underwater instrumentation).

**MeDON:**  
an underwater laboratory for real-time transmission of data from the seafloor



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## Marum/CETSM post-doc: perfecting photo-mosaic methods

In the CETSM (European centre for underwater technology) framework, a research contract was concluded by Ifremer and Marum (centre for marine environmental sciences, Germany) to perfect new real-time photo mosaicking methods which will be incorporated in Ifremer's Matisse software, which is already being used by the scientific and technical teams at Marum. Along with the contract is an agreement to co-finance a post-doc fellowship jointly with Marum. This cooperation is in keeping with the Joint Research Activity Work Package in the Eurofleets 2 contract, also involving the university of Girona, Spain and coordinated by the underwater systems unit at Ifremer.

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*CETSM: like a “ship on shore”  
for underwater technologies*

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## NUMERICAL DEVELOPMENTS

### Contribution to managing marine data from the Moose project

Moose (Mediterranean Ocean Observing System on Environment) is an INSU project whose objective is to monitor water bodies, thermohaline circulation and fluxes of matter in the North West Mediterranean. To this end, Moose will link up existing monitoring means in a network to create a series of consistent and homogeneous measurements.

In the framework of a multi-organisation approach to marine data management, relying on the existing data management infrastructures at Ifremer which are operated by IMN/IDM/Sismer, a Mediterranean data portal was set up.

The data acquired by INSU and its partners are put into databases for long term storage before being distributed.

### Creation of a working group on “Biological data management”

In order to fulfil the requirements of European and French initiatives in the field of biodiversity, particularly for the application of the Marine Strategy Framework Directive (MSFD) and examine the software upgrade for the Biocéan deep environment database, the IDM unit took the initiative of calling a working group on biological data management. It will:

- pursue the consultative study on Ifremer's needs in terms of managing deep sea biological observations, as well as related environmental and molecular biological data;
- propose a management plan for these data which takes account of the existing systems at Ifremer, especially Quadrigé<sup>2</sup> for the coastal environment and Harmonie for fisheries science. In order to provide an integrated response to expectations covering the entire continental shelf and margins and to optimise the cost of setting up and operating information system, it is highly desirable and recommended that the management of the existing Harmonie, Biocéan and Quadrigé 2 systems be harmonised. Integrating Quadrigé<sup>2</sup> and Biocéan could be envisaged;
- define the functional and technical specifications by which existing software programs can evolve.

The working group is made up of IT scientists, data managers and scientists representing the disciplines involved. It aims to define a biodiversity database scheme which will become a computerised taxonomy reference repository shared by all the information systems which need it.



# ACRONYMS AND ABBREVIATIONS

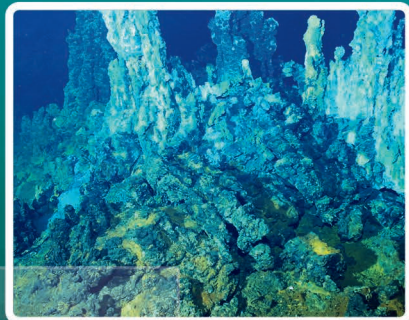


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<b>AAD</b>	Australian Antarctic Division	<b>INEE</b>	CNRS Institute of Ecology & Environment
<b>AMPP</b>	agency for marine protected areas	<b>INSU</b>	national institute of sciences of the universe
<b>ANR</b>	French national research agency	<b>IODE</b>	Intergovernmental Ocean Data Exchange
<b>Anses</b>	French agency for food, environmental & occupational health & safety	<b>IPGP</b>	earth physics institute in Paris
<b>BEE</b>	consultancy for European studies	<b>IRSN</b>	institute for radioprotection & nuclear safety
<b>BRGM</b>	geological & mining research bureau	<b>Irstea</b>	national institute for scientific & technological research for the environment & agriculture
<b>Cefas</b>	Centre for Environment, Fisheries & Aquaculture Science	<b>ISA</b>	International Seabed Authority
<b>Cenpes</b>	<i>Centro de Pesquisas Leopoldo Américo Miguez de Mello</i> (Brazil)	<b>ITIS</b>	project for innovative technology & instrumentation to serve sustainable development of the fisheries sector
<b>Cersat</b>	ERS archiving & processing centre	<b>IUEM</b>	European university institute for the sea
<b>Cetmef</b>	marine & river technical studies centre	<b>LOV</b>	oceanology laboratory of Villefranche-sur-Mer
<b>Cesbio</b>	centre for the study of the biosphere from space	<b>MAPA</b>	ministry of agriculture, food, fisheries, rural life & spatial planning
<b>CETSM</b>	European centre for underwater technology	<b>MSFD</b>	Marine Strategy Framework Directive
<b>CFOSAT</b>	Chinese–French Oceanic Satellite	<b>MSTF</b>	Marine Sciences & Technology Foundation
<b>CFP</b>	Common Fisheries Policy	<b>MSY</b>	Maximum Sustainable Yield
<b>CLCS</b>	Commission on the Limits of the Continental Shelf	<b>NASA</b>	National Aeronautics & Space Administration
<b>CLS</b>	satellite localisation & data collection	<b>NOAA</b>	National Oceanic & Atmospheric Administration
<b>CNC</b>	national shellfish-farming committee	<b>NOC</b>	National Oceanographic Centre
<b>CRC</b>	regional shellfish-farming committee	<b>NIOZ</b>	<i>Nederlands Instituut voor Onderzoek der Zee</i>
<b>CNES</b>	national space research centre	<b>Onema</b>	national office for water & aquatic environments
<b>CNRS</b>	national centre for scientific research	<b>PFOM</b>	functional physiology of marine organisms
<b>CRPMEM</b>	regional committee of maritime fisheries & mariculture	<b>PIES</b>	Pressure Inverted Echo Sounder
<b>CSIC</b>	<i>Instituto de Investigaciones Marinas de Vigo</i> (Spain)	<b>Prespo</b>	Sustainable development of artisanal fisheries in the Atlantic Area
<b>CSTEP</b>	scientific, technical & economic committee for fisheries	<b>RAC</b>	Regional Advisory Committee
<b>DDVPE</b>	development, technology transfer & economic partnerships division	<b>RDT</b>	technological development network
<b>DGAL</b>	French directorate-general for food & Fisheries	<b>RNO</b>	national marine environmental quality monitoring network
<b>DGFish</b>	Directorate-General for Maritime Affairs & Fisheries	<b>SHOM</b>	Hydrographic & Oceanographic Service of the French Navy
<b>DPMA</b>	maritime fisheries & aquaculture division	<b>SIPA</b>	information system for fisheries & aquaculture
<b>ECOMF</b>	European Centre for Ocean Monitoring & Forecasting	<b>SMOS</b>	Soil Moisture & Ocean Salinity
<b>FCS</b>	federation for scientific cooperation	<b>SOI</b>	Schmidt Ocean Institute
<b>HCMR</b>	Hellenic Centre for Marine Research	<b>Solas</b>	International Convention for the Safety of Life at Sea
<b>ICES</b>	International Council for the Exploration of the Sea	<b>TNA</b>	Trans National Access
<b>Imber</b>	Integrated Marine Biogeochemistry & Ecosystem Research		



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