

III. Research & Development – Other than Oil & Gas

- a) Biotechnology
- b) Aquaculture
- c) Freshwater
- d) Other; ecotoxicology, method development, and environmental monitoring

a) **Biotechnology**

Proteomics (i.e. the study of proteins) as a tool for developing new diagnostic methods has been a priority area at Biomiljø for several years. This strategy has resulted in comprehensive experience within proteomic research, as well as, great laboratory facilities, which again has strongly influenced the new research focus of Biomiljø, represented by *biotechnology*.

Research based innovation and a close dialogue with our clients has been turned into industrial solutions. New diagnostic methods based on protein expression profiles have been developed and commercialised within topics such as

- Gender determination
- Protein production
- Tools for environmental risk and impact assessment

IRIS Biomiljø for years investigated the effects of environmental pollution using proteomics (as well as other biological and chemical methods). One of the interesting findings was that both proteins and animal responses were gender dependent. Based on this, our scientists developed a technique for early gender determination of juvenile organisms and gametes, using a proteomic approach. IRIS has chosen to commercialise the technology through its subsidiary company: *GenderGuide AS*. Gender determination and selection will have an important economic impact within breeding in both *aquaculture* and *agriculture*. For more information, - www.genderguide.no

Furthermore, IRIS Biomiljø collaborates with the Norwegian College of Veterinary Medicine to find diagnostic/prognostic proteinmarkers of animal health. An example is a project where the aim is to discover and identify preclinical diagnostic markers of the scrapie disease in sheep using a proteomics approach, and subsequently produce an easy-to-use commercial kit for fast diagnosis of the disease.

A similar approach is used in a cancer-research project in collaboration with *Stavanger University Hospital*, where the aim is to improve prediction accuracy of regression-or-not in women with high grade cervical intraepithelial (CIN2"-3) to reduce surgical overtreatment of such patients.

FUGE

Due to the modern state-of-the art infrastructure for functional genomics research and analytical chemistry at IRIS, we were recently invited to be a national technology platform in proteomics (in collaboration with University of Stavanger), by joining the NorProteomics Consortium of the Functional genomics program of the Research Council of Norway (FUGE)

Biomiljø also include the companies Biosentrum AS and Bioprotein AS:

Biosentrum AS is large fermentation and processing facility, delivering from “Gene to Product”. Biosentrum AS operates in the field of microbial fermentation, and has more than 15 years of experience as a contract research (CRO) and contract manufacturing organisation (CMO). The fermentation facility offers fermentation capacities ranging from small scale lab and pilot fermenters for non-clinical development, to commercial quantities.

Biosentrum covers all stages in the development of a manufacturing process. A fully equipped pilot scale facility covering upstream and down stream equipment as well as analytical services enables Biosentrum to bridge the gap between laboratory and successful production of active bio molecules. The speciality of Biosentrum is recombinant organisms, with a special focus on bacteria (*E. coli*) and yeast.

Bioprotein AS was established jointly by IRIS, University of Bergen and Norwegian University of Life Sciences (UMB) and collaborates with StatoilHydro. The overall objective is to develop alternative and cost efficient products/applications based on fermentation technology using Norwegian natural gas.

A first target is to be able to use natural gas for fermentation of biomass in order to obtain a nutritional supplement which can be used within aquaculture and agriculture. Production of protein derivates and high value products is also an important goal. These processes can be performed with lower energy consumption and less environmental impact than traditional feed production.

b) Aquaculture

IRIS Biomiljø offers research and consultancy within aquaculture fields such as assessment of high-technology systems and monitoring of environmental consequences of aquaculture. IRIS has been involved in numerous aquaculture related projects over the last 20 years, involving a whole range of fish and crustacean species as well as culture techniques. The main activity takes place in Norway and in shrimp producing Asian countries.

<p><i>Technology and efficiency measures:</i></p> <ul style="list-style-type: none"> • Water recirculation technology • Oxygenation/aeration cages and ponds • Effluent treatment • Utilization of waste & by-products <p>A selection of projects:</p>	<p><i>Production systems and species:</i></p> <ul style="list-style-type: none"> • Cold water marine systems: <ul style="list-style-type: none"> - cage-based farming of salmon and cod - landbased farming of lobster • Tropical brackish water systems: <ul style="list-style-type: none"> - pond-based farming of shrimp • Freshwater systems: <ul style="list-style-type: none"> - farming of salmon smolt, trout
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Need for oxygen injection in fish cage farms (2001-2005)

The project started by monitoring environmental conditions at the EWOS Innovation cage farms. At these and other farms, both in Norway and Canada, *dissolved oxygen concentrations* inside and outside salmon cages were the focus of attention. Studies showed that fluctuating oxygen concentrations, especially at high temperature, affect the appetite and growth of the fish stock. Further studies confirmed the need of adding oxygen in the salmon cages, in order to optimise environmental conditions.

Intensive shrimp culture systems in Thailand

The aim of the project is to study the effects of adding liquid oxygen in order to optimise environmental conditions in shrimp ponds. Collaboration with Asian Institute of Technology, University of Bangkok.

Recirculation technology in aquaculture (Asian Sea Bass) in Sri Lanka

The objective of this new project is to study and to test the efficiency of the systems.

Development and testing of systems for production of salmon and tilapia in Eastern Europe and China

Environmental and socio-economic impacts of shrimp farming in Bangladesh

This is a 6-year project involving Bangladesh Agricultural University, Norwegian Institute for Water Research, and IRIS.

Online monitoring in Aquaculture

Joint project between IRIS and Orbit Aquacam using submerged camera connected to environmental sensors for surveillance of fish stock and environmental conditions in cages.

c) Freshwater

IRIS Biomiljø offers research within fields related to environmental quality in lakes, rivers and streams. IRIS has - for a number of years - conducted a whole range of studies dealing with the eutrophication problems of freshwaters in the Jæren region. IRIS is an important partner for the County Council project "Aksjon Jærvassdrag".

Studies range from basic monitoring to problem solving as for specific recipients. Providing the scientific basis for pollution abatement strategies, identifying changing environmental conditions are some of the monitoring strategies. Is continued in Chapter 4: 'Service and consultancy other than oil and gas'

d) Other; Ecotoxicology, method development, and environmental monitoring

IRIS Biomiljø has expertise in the field of histology, the microscopic study of tissues of living organisms. Our scientists use histological methods in environmental monitoring as well as in laboratory experiments. Histological techniques, such as histochemistry and immuno histochemistry, make it possible to observe pathologic effects due to pollutants and other stress factors.

Histology, histopathology and genotoxicity: developing new techniques for use in biomonitoring (2006-2008)

Internal Strategic Program (ISP): The project focus on developing and establishing techniques for invertebrate histopathology and genotoxicity. Bivalves (e.g. *Mytilus edulis*, *Pecten maximus*, and *Chlamys islandica*) and crustaceans (*Pandalus borealis*) are the prioritized groups of animals, but methods will also be established for important marine fish species like the Atlantic cod and polar cod (Arctic).

Financing: The Research Council of Norway

ISP Microbiology:

Development of new tools and competence in microbiology and molecular biology for impact assessments of pollutants in the marine environment. (2009-2012)

The aim of this project is to develop an early warning system for oil pollution by analysing the microbial community and investigating gene expression levels in the marine environment. The impact of petroleum related compounds on the microbial population will be monitored in terms of changes in the population composition as well as changes in the expression of genes known to be involved in the degradation of these compounds

Financing: The Research Council of Norway

ISP - Effects of ocean acidification on invertebrate calcifying larvae (2009-2012)

Scientists are becoming increasingly concerned about yet another problem with the burning of fossil fuel. There is growing evidence that CO₂ emissions are causing subtle changes to ocean chemistry in a process known as ocean acidification (Orr et al. 2005, Haymet 2008, Børsheim 2008, Doney et al. 2009). The oceans take up CO₂ from the atmosphere which initiates a series of chemical reactions in seawater. It increases the hydrogen ion concentration (H⁺), lowers the pH and reduces the number of carbonate ions (CO₃²⁻) available (IPCC 2007).

The main objective in the proposed ISP is to build an exposure system for testing effects of ocean acidification on invertebrate larvae and test this system with several species of larvae. A large percentage of planktonic larvae die of natural causes. Any additional stress due to contaminants or ocean acidification could increase the total mortality. The small percentage of larvae that survive through the early life stages may be sensitive to additional environmental stress like contaminants or ocean acidification.

Financing: The Research Council of Norway

BEEP - Biological Effects of Environmental Pollution

BEEP was a 3 year EU R&D programme with 30 participating laboratories. The aim was to improve and develop knowledge about biomarkers in marine organisms exposed to chemicals. The programme was to strengthen the quality of environmental data, in order to improve environmental understanding which can contribute to a better protection of the environment in the marine food chain. Three geographic areas were investigated, the Mediterranean, the Baltic Sea and the North Sea. IRIS was responsible for the co-ordination of the North Sea package.

The objective was to determine and standardise a set of biomarkers which can be used with different ecologically relevant species in the marine ecosystem. These can be implemented in national and international monitoring programmes. The methods are also to be used in environmental risk analysis to define acceptance criteria for exposure.

The programme also contributed to the development of sensitive methods for monitoring in different environmental pollution scenarios.

Financing: EU

E-lab Ny-Ålesund

This project has established a remote environmental monitoring facility at Ny-Ålesund and validation with ecological experiments. The main objectives are as follows: To establish effective communication of biological sensor information between at least two laboratories remote from one another. To develop a repertoire of simple biological test methods that provide ecologically relevant information, the results of which can be evaluated in real time from a remote location. Develop the necessary technology to deploy such methods in the field.

EU-funded projects:

IRIS Biomiljø has coordinated and participated in several EU-funded projects on monitoring methodologies related to accidental oil and chemical spill at sea. Examples of such projects:

PRAGMA (2006-2007)

A pragmatic and integrated approach for the evaluation of environmental impact of oil and chemicals spilled at sea: input to European Guidelines. Simple, easy-to-perform methodologies based on the biomarker approach, that can indicate general health status and impairments, related to - for instance - reduced fitness of individuals. Biosensors evaluated as a first screening device, for their cost-effective use in biomonitoring.

RESPILL(2007-2008)

Response means to chemicals spilled at sea and environmental damage.-The project applies methodologies used in PRAGMA

ECORAID – Ecological Risk Assessment Information Data-mining and Comparison (2009)

The project is financed by the Research Council of Norway, - which participates in a European project consortium, financing research activities complementary to PRAGMA and RESPILL.) The project addresses the question on how to best incorporate new and existing biotools into risk assessment methodologies for chemical spills.

Financing: NFR-Ampera

BEEP

IRIS - Biomiljø was coordinating the North Atlantic activity of the BEEP Project: Biological Effects of Environmental Pollution in Marine Coastal Ecosystems.

EU-SMT fish Bile Reference material

Preparation and certification of fish bile reference materials for exposure monitoring of polycyclic aromatic hydrocarbons in the aquatic environment. Together with collaboration partners in Netherland and Scotland, scientists at IRIS Biomiljø carried out

a three year project where the objective was to improve and to standardize analytical methods for polycyclic aromatic hydrocarbons in fish bile.

TRENDS Thematic network

The overall goal of TRENDS is to meet Europe's future demands /needs for sustainable, secure, safe and clean energy supplies, by identifying major challenges within Health, Safety, Environment and Quality. IRIS was responsible for outlining state-of-the-art within Environmental Risk Assessment.

BE QUALM ring tests

Regular participation in European ring testing of central biomarker analyses (protein, EROD, CYP1A, VTG). This was last carried out in 2004/2005 and in progress for 2008. Ring testing has also been carried out which is not a part of BEQUALM with a French collaborator (GST, Catalase, MDA).