



RTD Synopsis: TA 5 – Integration with the Environment

European research projects within the 5th and the 6th framework concerning the interactions of aquaculture with the environment have focused principally on the following:

- How to measure the impact of aquaculture
- How to reduce wastes and effluent
- The effects of escapes from aquaculture on wild stocks
- Assessments of the sustainability of aquaculture

In FP 5, research projects were funded mainly under key action 5 (sustainable agriculture, fisheries and forestry) of the Quality of Life programme. Under FP 6 the interaction with the environment was addressed under priority 5: food quality and safety, priority 6 : sustainable development, global change and ecosystems and under specific activities such as research for policy support and co-operative and collective research for SMEs.

In the Seventh Research Framework Programme (FP7), cooperative research priorities have been established for agriculture, forestry and fisheries in Theme 2 Food, Agriculture and Fisheries, and Biotechnology (FAFB). Environmentally sustainable aquaculture has been mainly addressed under the activity: sustainable production and management of biological resources from land, forest and aquatic environments.

This synopsis provides an overview of the main outputs of EU projects financed under **FP 6** and **FP 7** addressing the challenges identified by TA 5 within their draft Strategic Research Agenda.

Challenge: Management of organic wastes and nutrients

- **AQUAGRIS (FP6) - Reforming environmental management for improved sustainability**

The aim of the AquAgriS project was to coordinate research on the reform of environmental management to improve environmental, industrial and economic sustainability in the farming, fisheries and aquaculture (FFA) industries. The Aquagris Consortium developed a “State of the Art Review”, published in 2009, which collect tools, methods that are currently used or about to be developed in order to achieve mitigation measures. The first part of this review categorises wastes and their impacts on the environment, the second part addresses solutions to minimize the production of wastes and presents solutions to reduce waste once it is produced. This document is



available online: http://www.aquagris.org/docs/deliverables/deliverable_22.pdf .

Goal 1 – To establish fundamental scientific knowledge on the assimilation capacity of biogenic wastes from aquaculture in benthic and pelagic ecosystems

- **ECASA (FP 6) - An ecosystem approach for sustainable aquaculture**

ECASA aimed to support the aquaculture industry by providing guidance and tested tools to minimise environmental impacts whilst maximising sustainable productivity. The focus of the project was to provide industry and regulators with tested tools and methods for assessing assimilative capacity and for predicting ecosystem effects in an environment forced by economic and climatic variability.

Key Outputs:

- 53 quantitative and qualitative indicators of the effects of finfish and shellfish aquaculture on the environment and vice-versa have been identified and their applicability has been tested throughout Europe at 14 different study sites.
- ECASA developed a selection of environmental models which were capable of examining the relationship between the environment and aquaculture activities. These models were tested for their practical utility (“are they easy to set up, run and interpret?”), and their scientific robustness.
- Industry Handbook/Tool Box

This suite of indicators and predictive environmental models were incorporated in an ECASA “Tool-Box”, which also included a manual that presented the knowledge gained in the project, and will guide industry and regulators to the most useful tools appropriate for evaluating site suitability across varying environmental conditions. The project provided a consistent framework for the application of Environmental Impact Assessments, resulting in coherent and relevant Environmental Statements. <http://www.ecasatoolbox.org.uk/the-toolbox>

- **KEYZONES (FP 6) - Characterisation of the carrying capacity of key European coastal zones for commercial production of bivalve shellfish**

The research was designed to produce tools which would enable shellfish producers in the targeted areas to optimise production capacity, recruitment of young stock, and quality whilst reducing waste. Within the project integrated ecosystem models including primary production, primary consumption (by shellfish) and their interactions, were developed for different study sites. Using this model various scenarios and management strategies were investigated. The results of these scenario simulations have stressed the usefulness of the models to address carrying capacity issues and the importance of reliable input data for shellfish stocks. The models developed by the KEYZONES project



had a positive impact on local production and harvest of shellfish in the selected sites, improving the quality and sustainability of the produce. The models produced can be used to assist in the planning and management of fisheries and shellfish farms in other coastal zones.

- **MEDVEG (FP 6) - Do marine cages affect Mediterranean vegetation?**

The objectives of MEDVEG were to examine potential effects of nutrients released during fish farming on macroalgae and the seagrass *Posidonia oceanica* in coastal zones in the Mediterranean. Field trials proved that seagrasses were affected by the farming activities on a physiological and an individual level as well as on community level. Results point out that a precautionary distance of 800 m should be adopted in the siting of a fish farms in the vicinity of important and well-established *Posidonia* meadows that environmental authorities have set as priority areas for conservation. The MEDVEG project provided new scientific knowledge to define guidelines to prevent, or at least minimise, the negative impacts of fish farming on water quality, on the benthic environment and on the health of *P. oceanica* meadows growing nearby.

- **PROMICROBE (FP 7) - Microbes as positive actors for more sustainable aquaculture**

PROMICROBE aims to disentangle the complex interplay between the different components of the aquaculture ecosystem through the study of microbial communities associated with aquaculture species (Tilapia, Cod and Sea bass) and of how these microbial communities can interact beneficially with the host.

The aim of the project is to develop new concepts to be translated into new or adapted protocols to rear aquaculture organisms in a biological stable and economical efficient way, possibly reducing the impact on the environment by (re-) using microbes present in aquaculture rearing systems to retain organic wastes and nutrients.

- **SAMI (FP 6) - Synthesis of Aquaculture and Marine Ecosystems Interactions**

The SAMI project reviewed and summarised the current knowledge in the field of environment and aquaculture. The project gathered together experts from the many aspects of aquaculture-environment interactions and provided the following outputs:

- State of the art review of environmental issues facing marine aquaculture in Europe;
- Advice for integration of environmental requirements into the Common Fisheries Policy; and
- Expert perspective on the sustainable development of marine aquaculture in Europe.

Moreover, a comprehensive review on emerging issues in aquaculture environment interactions collected in the book "Aquaculture in the ecosystem" is available online for consultation:

<http://www.springer.com/life+sciences/ecology/book/978-1-4020-6809-6>



Goal 2 – To minimise emission of biogenic matter on pelagic and benthic ecosystems

- **AQUAETREAT (FP 6) - Improvement and innovation of aquaculture effluent treatment Technology**

The AQUAETREAT project examined the feasibility of developing and implementing cost-effective systems for the treatment of aquaculture farms effluents and the valorisation and reuse of the products and by-products. AQUAETREAT looked at the need for fish farms to improve the management of wastewater and solids, to minimise pollution and optimise the recovery, disposal and re-use of solid waste.

The project developed effluent treatment systems, applicable to all types of land-based fish farms (open and closed systems, fresh water and marine operations) regardless of species. These treatment systems were tested at three sites and were supported by an Italian engineering SME with expertise in treating effluents.

One of the main outputs of AQUAETREAT is a manual on effluent treatment in aquaculture. The manual is intended to be a practical tool for land-based aquaculture in the implementation of water treatment technology to improve their environmental efficiency and credentials. It contains theoretical and practical information, RTD protocols, management guidelines and case studies in the field. The manual has been printed in 2000 copies and is available (in English) on the Aquaetreat website (www.aquaetreat.org) as a free PDF download.

- **SUSTAIN AQUA (FP 6) - Integrated approach for a sustainable and healthy freshwater aquaculture**

Within this project specific research, training and dissemination activities were carried out in the field of producing healthy and tasty freshwater fish and other economical valuable by-products mainly by optimising nutrient chains, water management and energy efficiency.

The results delivered by the project add substantially to the existing knowledge about freshwater farming and show European farmers in detail some of the ways that will make their operations more sustainable and more competitive. Proof of the positive impact of SustainAqua on the European aquaculture industry and research sector alike are the highly successful training and dissemination activities in the frame of the project and the production of a handbook in 12 languages for aquaculture farmers, a practical guide to sustainable freshwater fish farming:

<http://www.sustainaqua.org/images/handbook/EN.pdf> .

- **SUSTAINAQ (FP 6) – Sustainable aquaculture production through the use of recirculation systems**



Because RAS has low water requirements and produces a low volume of effluent water, it is probably the type of land-based aquaculture production that interferes least with the environment. Water can be drawn from a variety of sources, such as open waters or boreholes. The effluent can be treated before discharge or can be used for agricultural purposes while its effect on the environment can be completely controlled and even eliminated. Eastern European countries are facing challenges related to water use conflicts, wastes and maintaining breeder stocks of endangered fish species. Therefore, these countries may be the biggest beneficiaries of improved farming practice through the introduction of RAS.

The overall objective of this project is to identify factors that are restricting the sustainable production of seafood in Europe. This is to be achieved by establishing a consortium of aquaculture research partners and aquaculture SMEs across Europe.

Challenge: Pollution of lakes and coastal waters from aquaculture and other industries

- **AQUAS (FP 6) - Water quality and sustainable aquaculture: Links and implications**

The project aimed to better "structure" the understanding on the relationship between aquaculture and water quality (WQ) by collecting and combining existing field observations with available numerical simulations, "paving" the way for quantifying the relation between WQ and farm productivity. The project also aimed to establish a set of aquaculture-related predictors for WQ.

Goal 3: To minimise the use of persistent agents in aquaculture and phase-out the most harmful agents used to manage bio-fouling and fish health

- **MODELKEY (FP 6) - Models for Assessing and Forecasting the Impact of Environmental Key Pollutants on Marine and Freshwater Ecosystems and Biodiversity**

MODELKEY comprised a multidisciplinary approach aiming at developing interlinked and verified predictive modelling tools as well as state-of-the-art effect-assessment and analytical methods generally applicable to European freshwater and marine ecosystems.

Key findings of MODELKEY include:

Evidence of toxic stress in aquatic ecosystems

Evidence that impairment of ecological status results from impact of multiple stressors

Tiered approach to assess impact of chemicals on ecological status



New approach for deriving candidate compounds for monitoring and prioritisation

Improvements for WFD water quality monitoring programmes

New integrated tools for basin-scale risk assessment and decision making

Decision Support System to support river basin management and recommendations for WFD implementation

- **TBT IMPACTS (FP 6) - Assessing impacts of TBT on multiple coastal uses**

The project examined the implications of pollution by TBT and its ban, and costs and benefits of TBT-based antifoulants and other alternatives. It aimed to suggest alternative antifouling strategies, develop tools for monitoring and managing environmental impacts of organotin compounds, and raise awareness towards this end. It also aimed to develop a biomonitoring system to regulate the impacts of TBT that exist in coastal environments.

Challenge: Escapes and interactions between wild and farmed stocks

Goal 4: To establish more fundamental scientific knowledge on the interactions of farmed and wild stocks including genetic impacts, spreading of parasites and disease, and ecological interactions with wild fish and other wild-life.

- **ALIENFISHMIGRATIONS (FP 6)**

The primary aims of ALIENFISHMIGRATIONS were to determine the dispersion potential of predatory fishes, in particular, with specific reference to the frequency and timing of salt/brackish water incursions by pikeperch; and to assess the dependence of successful establishment in river catchments by the sedentary omnivorous North American sunfish, pumpkinseed *Lepomis gibbosus* on access to adjacent still waters, with particular regard to diel and seasonal movements. The project has contributed to a greater awareness of issues associated with alien species, moreover it has led to an improvement in the understanding of pan-European patterns in non-native species legislation regarding freshwater fishes.

- **ESCAPEPROOFNET (FP 6) - An escape-proof net for cod, bass and bream fish farming**

ESCAPEPROOFNET aimed to develop a sea cage net system especially suitable for farming of the sea bass, sea bream and cod, net aggressive fish species, which are currently important in the European fish farming industry. New knowledge gained within the project on fouling, fish behavior and operational requirements, as well as on specifics of relevant new materials, additives and filament



production techniques, was used for the development of a cost-effective net filament with exact physical characteristics and incorporated impregnation and repulsive agents for the prevention of fouling, biting & snatching behavior. In addition, an adaptation of the existing net manufacturing technique for optimal exploitation of material characteristics has been developed.

- **IMPASSE (FP 6) - Environmental impacts of invasive alien species in aquaculture**

The project is a Coordination Action (CA) designed to support the draft EC regulation 'Rules governing the introduction of exotic species and on containment of stock in aquaculture' (FISH A3/RB/2004025-A3). The overall goal of the project was to develop guidelines for environmentally sound practices for introductions and translocations in aquaculture, guidelines on quarantine procedures, and risk assessment protocols and procedures for assessing the potential impacts of invasive alien species in aquaculture.

- **CLOSEDFISHCAGE (FP 7) - Development of an innovative, cost-effective environmentally friendly closed cage for sea-based fish farming**

The main goal of ClosedFishCage is to develop a closed, escape proof, constant volume sea-based cage for fish farming. Among the project's innovative elements there are the development of a very durable and flexible polymer plastic net pen, of a predator guard and a control system, and of an easy set-up and replacement of damaged cage parts. The technological solutions involved in the sea-based cage will preserve advantages of land-based fish farming while at the same time take advantage of the cost efficiency of seabased fish farming.

- **PREVENTESCAPE (FP 7) - Assessing the causes and developing measures to prevent the escape of fish from sea-cage aquaculture**

Solving technical and operational problems related to escapes is dependent on a combination of research into several technological disciplines and biological knowledge related to the behaviour of fish in sea-cages. Therefore the project aims to develop better culture technologies and techniques to prevent escape of fish from sea-based aquaculture and to develop knowledge on the behaviour of fish pre-escape and post-escape and integrate this into species- and site-specific risk assessments for sea-based farms. Moreover, the Prevent Escape project will conduct and integrate biological and technological research on a pan-European scale to improve recommendations and guidelines for aquaculture technologies and operational strategies that reduce escape events.

- **SALMOTRIP (FP 7) - Feasibility study of Triploid Atlantic Salmon Production**

The overall aim of the Salmotrip project is to enhance knowledge on how triploid salmon should be reared and its potential performance. This will be achieved by testing and refining current production practices for triploid salmon as well as by assessing how such a product would be perceived throughout the salmon food chain and how it could be marketed. The project is centred on a full scale feasibility study and market perception analysis. This will determine whether triploid salmon



are suitable for farming as a means to minimize the impact of farmed fish on the environment (i.e. sterile escapees) while improving fish welfare and providing a consistent year long quality product.

- **SMARTCATCH (FP 7) - The development of a Novel Remote Sensing System to Increase Safety, Efficiency and Reduce Environmental Effects in Fishing and Aquaculture sector**

The Smartcatch project aims to develop a remote sensing system which will increase safety and reduce environmental impact in the fishing and aquaculture sector. The Remote sensing system will enable the prevention of damages of the fishing nets, fishing ropes and mooring ropes of aquaculture cages by monitoring the stress applied on these ropes.

Challenge: Societal, cultural and political aspects of environmental impacts

Goals 5 & 6: To communicate unbiased scientific knowledge on the environmental interactions of aquaculture in order to ensure appropriate environmental legislation for European aquaculture and improve public perception

- **ECOMANAGE (FP 6) - The EcoManage project aimed to push the capacity of assisting managers to join horizontally knowledge from ecological and socio-economic disciplines.**

Three coastal zones showing conflicting interests between urban, industrial and agricultural pressures and environmental maintenance have been selected for developing the system. The selected areas were: Aisén Fjord in Chile, Bahía Blanca estuary in Argentina and Santos estuary in Brazil. Within the project, development scenarios in these areas and management options have been tested through the development of models with the specific aim of testing the outcome of different management policies in the ecological state of the system and assisting the decision making process.

The project has promoted strong public involvement of stakeholders and public and private institutions at each site were involved and co-operated with the scientific staff of the project.

Moreover, based on the new knowledge gained within ECOMANAGE, a spatial decision support system, to provide guidelines for restoration and sustainable development of the sites, was set in place. Outcomes of the project were of significant interest to both scientific and water resources management communities.



Other EC funded projects relevant for TA 5:

- **EUROLIMPACS (FP 6) - Integrated project to evaluate impacts of global change on European freshwater ecosystems**

Euro-limpacs was concerned with the science required to understand and manage the ecological consequences of climate change for freshwater ecosystems (lakes, rivers and wetlands). The project focused on the key drivers of aquatic ecosystem change (land-use, nutrients, acid deposition and toxic substances) and examined their interactions with global change using time series analysis, space-for-time substitution, paleolimnology, experiments and process modeling. It also identified approaches for achieving good ecological status in freshwater habitats, according to the Water Framework Directive (WFS). Project results take a number of different forms, including reports, deliverables, a bibliography, training and dissemination and key questions arising from project activities.

- **MARBEF (FP 6) - Creating an interdisciplinary network for marine biodiversity and ecosystem functioning**

The Marine Biodiversity and Ecosystem Functioning network of excellence functioned as a platform to integrate interdisciplinary marine research and to disseminate knowledge on marine biodiversity with links to researchers, industry, stakeholders and the public through unique training, exchange and outreach initiatives.

The first MarBEF research program, “**Global Patterns of Marine biodiversity across Ecosystems**”, explored how patterns of marine life in Europe, from the level of genes to ecosystems, change over large areas and long time periods. This research program helped scientists to develop methods to detect significant change in biodiversity resulting from human impacts on global events such as climate change.

“**Marine Biodiversity and Ecosystem Functioning**”, aimed to unravel the complex relationship between marine biodiversity and ecosystem functioning. Scientists within MarBEF compared rates of ecosystem processes for a variety of systems and seasons across Europe and investigated the validity of transposing terrestrial paradigms in ecological theory into marine ecology. A 100 page synopsis of 5 years of research can be downloaded from the website

<http://www.marbef.org/documents/glossybook/MarBEFbooklet.pdf> .

“**Socio-economic Importance of Marine Biodiversity**”, aimed to establish the economic, social and cultural values of marine biodiversity for a set of reference sites across Europe. These values were determined by integrating perspectives from natural scientists, economists, sociologists, and socio-anthropologists and will effectively translate natural science into an accessible format, enabling educated and balanced management functions.



Future needs:

Gaps in knowledge on the impact of aquaculture on the environment have to be identified and the scientific knowledge in the field of impact assessment of environmental pollution on aquatic ecosystems and their biodiversity has to be strengthened. Further specific environmental indicators to measure the impact of aquaculture have to be identified and models have to be developed to assist managers, regulators and decision makers in site selection. Moreover decision support systems have to be set in place for the identification of best management options and informed decision making.

Research on the interaction between aquaculture and the environment has to be addressed in a holistic way, involving the research community as well as the industry, promoting knowledge transfer and training activities and the identification of best practices and new technologies to reduce the impact on the environment. Projects' results and experts' perspective and guidance have to be integrated in future directions for EU environmental research policy concerning the aquaculture sector.

A full list of the projects addressing the challenges identified within Thematic Area 5 – Integration with the environment – can be found in the annex. More detailed information is provided in the Technical Leaflet (TL) describing the main outputs and deliverables of each project.



Thematic Area 5 – Integration with the environment

F.P.	Acronym	Project Title
6	ALIENFISHMIGRATIONS	
6	AQUAGRIS	Reforming environmental management for improved sustainability
6	AQUAETREAT	Improvement and innovation of aquaculture effluent treatment Technology
6	AQUAS	Water quality and sustainable aquaculture: Links and implications
7	CLOSEDFISHCAGE	Development of an innovative, cost-effective environmentally friendly closed cage for sea-based fish farming
6	ECASA	An ecosystem approach for sustainable aquaculture
6	ECOMANAGE	Integrated Ecological Coastal Zone Management System
6	ESCAPEPROOFNET	An escape-proof net for cod, bass and bream fish farming
6	EUROLIMPACS	Integrated project to evaluate impacts of global change on European freshwater ecosystems
6	IMPASSE	Environmental impacts of invasive alien species in aquaculture
6	KEYZONES	characterisation of the carrying capacity of key European coastal zones for commercial production of bivalve shellfish
6	MARBIF	Creating an interdisciplinary network for marine biodiversity and ecosystem functioning
6	MEDVEG	Do marine cages affect Mediterranean vegetation?
6	MODELKEY	The European Water Framework Directive (WFD) demands for a good ecological status of European surface waters by 2015
7	PROMICROBE	Microbes as positive actors for more sustainable aquaculture
7	PREVENTESCAPE	Assessing the causes and developing measures to prevent the escape of fish from sea-cage aquaculture
7	SALMOTRIP	Feasibility study of Triploid Atlantic Salmon Production
6	SAMI	Synthesis of Aquaculture and Marine Ecosystems Interactions
7	SELFDOTT	From capture based to self-sustained aquaculture
7	SMARTCATCH	The development of a Novel Remote Sensing System to Increase Safety, Efficiency and Reduce Environmental Effects in Fishing and Aquaculture sector
6	SUSTAIN AQUA	Integrated approach for a sustainable and healthy



		freshwater aquaculture
6	SUSTAINAQ	Sustainable aquaculture production through the use of recirculation systems
6	TBT IMPACTS	Assessing impacts of TBT on multiple coastal uses