Project Progress Summary

Title of the project BIOFiltration and Aquaculture: an Evaluation of Hard Substrate Deployment Performance within Mariculture Developments		
Acronym of the project BIOFAQs		
Type of contract 5th Framework: Quality of Life and Management of Living Resources		**Total project cost** (in euro) 1,980,512 €
Contract number Q5RS-2000-30305	**Duration** (in months) 36 Months	**EU contribution** (in euro) 1,299,827 €
Commencement date 1 December 2000	**Period covered by the progress report** 1 December 2000 – 30 November 2001	
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Key words (5 maximum - Please include specific keywords that best describe the project.). Biological Filters, Aquaculture, Environmental Impact, Environmental Modelling, Cost/ benefit analysis		
World wide web address: www.sams.ac.uk/biofaqs		
List of participants Provide all partners' details including their legal status in the contract i.e.,contractor, assistant contractor (to which contractor?)		

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Section 2: Project Progress Report **NOT CONFIDENTIAL**
(2 pages maximum. Use short sentences. Be factual. Avoid technical terms as much as possible)

Objectives:

1) To quantify the validity (effectiveness) of biofilter use in association with mariculture within both economic and environmental frameworks on a pan-European scale. As components of this the project aims to:

(i) review the current knowledge base relating to mariculture impacts on a pan-European scale;

(ii) appraise current and past biofilter initiatives within Europe and outside Europe and synthesise this previously disparate research;

(iii) examine existing biofilter designs to determine design principals that could be transferred from aquarium recirculation systems to open water deployments;

(iv) develop and/or advance quantitative impact assessment models and methodologies;

(v) undertake test field deployments of biofilters in association with existing mariculture concerns over a range of mariculture types and impact levels;

(vi) examine the potential for combining additive mariculture concerns with the physical structure of the biofilters.

(2) To optimise biofilter designs and placement protocols in line with geographical differences and validated model predictions. This objective will be assessed principally through mesocosm experimentation and will examine:

(i) biofilter design and performance over a range of temporal scales, a range of environmentally relevant physico-chemial parameter variations and under differing organic loading rates;

(ii) energy and nutrient fluxes in order to estimate levels at which intervention (removal or cleaning) will be required;

(iii) the dynamics and/or requirements for biofilter fallowing;

(iv) the placement parameters of biofilter deployment in relation to the relative location organic input point source and prevalent hydrological influences.

3) To examine the environmental and regulatory options governing post-biofilter usage and to provide detailed economic analyses of biofilter use compared with existing practices. Within this objective, the project aims to:

(i) review the current regulatory status of mariculture impacts and hard substrate deployments in European waters and to ascertain the likely acceptance of biofilters within these regulatory frameworks;

(ii) evaluate the transferability of legal models within the European context;

(iii) develop an analytical tool within the framework of comparative legal analysis; prepare pan-European cost/benefit analyses of biofilter deployment in association with mariculture development with specific reference to environmental value.

Results and Milestones:

WP01: FULL LITERATURE REVIEW - A review report has been completed. This is introduced by a discussion of the environmental impacts of aquaculture, biofiltration processes and techniques, biofiltration characteristics of marine fauna and bio-fouling of marine structures. It is proposed that this review forms the basis of a scientific publication to be submitted to a review journal during 2002. The Milestone (M01) and Workpackage (WP01) are now complete.

WP02: MARICULTURE MODELLING - In Year 1, preliminary modelling of the bio-filter location at the UK Dunstaffnage fish farm site in the UK has been undertaken to determine predictions of solids flux at the filter arising from the fish farm. This required the development of DEPOMOD model code so that a bio-filter domain could be defined. An assessment of the level of exposure of the filter to the fish farm effluent, with particular reference to fine particulate material was also conducted and the bio-filter exposure for different depths was tested. Finally, the relevant data with a view to undertaking similar modelling exercises for all other BIOFAQS fish farm sites has been collated. The first milestone (M02 A) in this workpackage, development of model modules of bio-filter biogeochemical function: Model V1 is due to be completed in Month 14.

WP03: MESOCOSM STUDIES - In Year 1, mesocosm studies have been conducted in Crete (*in situ*), Oban (aquarium based) and Piran (*in situ*). Mesocosms have been designed and tested in the different study sites and the initial bio-filter design has been tested. An preliminary assessment of the uptake of fish effluent, particularly suspended particulate material has been conducted and the influence of the bio-filters on the water column in terms of inorganic and organic nutrients, bacteria, cyanobacteria and phytoplankton abundance has been measured either in total or in part in Crete, Oban and Piran. Finally, mesocosm experiments in Crete have monitored the influence of different fish species (sea bream, sea bass) on water quality, in terms of particulate organic carbon (POC) and nitrogen (PON), nutrients, total bacterial counts and urea water at hourly intervals over a 24 hour period. Preliminary results show that the *net* uptake of suspended particulate material by fouling organisms that colonised the bio-filters in the first 6 months was low and that there was significant release by these organisms of ammonia and phosphate into the water column. The first milestone (M03 A) in this workpackage, the establishment of mesocosms and the development and testing of initial bio-filter designs is now complete.

WP04: FIELD STUDIES - In Year 1, bio-filters and their associated support frames have been designed, constructed and deployed in association with mariculture operations in an experimentally-relevant way and at a field-relevant scale off the west coast of Scotland, in the Adriatic Sea, the Mediterranean and the Gulf of Aqaba (Red Sea). All the bio-filters are based on the same design and were deployed across Europe over a two week time-span in June 2001. It is envisaged that structural and temporal synchrony will aid comparisons between development rates of bio-fouling communities at the different pan-European study sites. Detailed protocols have also been developed to standardise the approach to field assessments of fish effluent-related impact assessment between the study sites. The protocols cover the measurement of biological, biochemical and hydrological parameters at each site.

Preliminary results, 6 months after deployment show that the bio-filter design and supporting framework have withstood the hydrological conditions at each site and that all the bio-filters have become colonised by fouling organisms. In 2 of the field sites (Oban and Eilat), a greater biomass of organisms has been recorded at the fish farm than at the respective control sites, while the opposite trend has been observed in Piran. In Crete, Piran and Eilat, biofilter surfaces (at both fish farm and control sites) were initially colonized by benthic algae, probably as a result of ample light penetration to 8m depth. In Oban, it is possible that the water was too turbid to accommodate extensive algal growth, though there were observations of red macroalgae at a later stage. The pioneer invertebrate taxon colonizing bio-filters at all sites was the hydroidae, followed by the bryozoa and the polychaetes.

Results of biochemical studies have found that differences in stable isotope fingerprints of particulate organic matter and fouling organisms at reference locations and at fish cages are large enough to be used as a tool for assessment of effectiveness of bio-filters. However,

samples of POM and fouling organisms must be repeatedly analysed to enable such assessments. Milestones M05 A (Deployment of bio-filters) and M06 A (Protocol to assess Biofilter Performance) & B (Deployment of bio-filters on a field-relevant scale) have been completed.

WP05 Legal Analysis and Regulations - A pan-European and global review of legal frameworks related to the use of artificial substrate as a bio-filter for the mitigation of the environmental effects of aquaculture is complete and the identification and collation of appropriate legal materials is almost finished. An evaluation of the transferability of legal models within the European context is underway and an analytical tool is being developed within the framework of comparative legal analysis based on 'functional' comparative law. Milestone M07 is to be completed by the end of Year 3.

Benefits and Beneficiaries:

Environmental improvement will benefit the European mariculture industry through enhanced growth and survival of the mariculture species and it will also add value to the environment thus benefiting the fish farmers and users of the marine environment (i.e. sport fishermen, tourists, SCUBA divers etc.). There is also the possibility that commercially important animals could be grown on the bio-filters (e.g. mussels, scallops) and harvested periodically thus providing the fish farmers with an additional income from a site.

Future Actions (if applicable):

The next scientific co-ordination meeting is planned to coincide with Ocean Sciences 2002, Hawaii (11 – 15 February) that the science co-ordinators all attending (not funded by this project) and the following steering group meeting will either be hosted by IOLR (Eilat) or a central European city (TBA) in the summer.

D. Angel is organising a 10 day workshop in Eilat for BIOFAQs partners in 2002. MERAMED and MEDVEG partners have also been invited to attend. Additional funding for environmental impact assessment outside the scope of BIOFAQs is being sought through the EU Accompanying Measures scheme.

All partners will continue to work towards the completion of the workpackages outlined in the Technical Annex.