

### “BIOFAQS”

## How effective are biological filters in reducing the environmental impact of finfish cages?

*Marine finfish farming in cages has grown and developed immensely over recent years. In northern European waters it is dominated by the culture of Atlantic salmon and in southern Europe by the farming of sea bass and sea bream. Since most of the cages these species are farmed in are located in inshore coastal waters, where the sea is relatively calm, large amounts of dissolved inorganic nutrients (nitrogen and phosphor) and particulate organic matter (uneaten feeds, faeces), coming from the cages, accumulate in the surrounding environment, and consequently affect the biological composition of seabed communities.*



Over the last few years, the use of **biofiltration as a way of optimising water quality** has become standard practice in land based intensive mariculture systems, where used water is (partially) recycled. Biofiltration is a technique designed to control pollution, whereby use is made of **living organisms to filter out or chemically remove pollutants**. It is this technique which has been tested in the **BIOFAQS** project for its ability to reduce the environmental impact of intensive cage mariculture in inshore coastal waters.

The project had three main objectives:

- to quantify the **effectiveness of the biofilters** in reducing the impacts of mariculture across Europe from both an economic and environmental perspective;
- to determine the **best design and placements** of the biofilters, accounting for differences in geography, hydrology, nutrient input etc. between countries;
- to examine the **environmental and regulatory options governing the use** of the biofilters at the end of their life-span and to provide detailed **economic analyses** of biofilter use compared to existing filtration methods.

After an extensive literature review, a biofilter was designed and tested near four fish farms and at nearby reference sites in the north Atlantic, northern Adriatic, eastern Mediterranean and northern Gulf of Aqaba. To guarantee the effectiveness of the biological filters, the level of interception with the effluent discharged needed to be maximised. Key factors such as biofilter location, depth, orientation and design were optimised using a model that was based on the discharge characteristics, environmental conditions at the site and uptake rates of dissolved and particulate waste by the filters.



VIEW OF A HORIZONTAL ARRAY OF BIOFILTERS DEPLOYED IN THE BIOFAQS TESTS. SOURCE: K. BLACK/SAMS

It was found that the biofilters designed were able to remove nutrient wastes released by fish farms, thereby reducing the nutrient load in the water column. The efficiency of these devices was modified by the successive biological composition colonizing the biofilters, changing

**Project acronym:**

BIOFAQS

**Full title of Project:**

Biofiltration and Aquaculture: An evaluation of hard substrate deployment performance within mariculture developments

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[www.sams.ac.uk/biofaqs](http://www.sams.ac.uk/biofaqs)
**Coordinator**

Dr. Kenny Black  
Scottish Association for Marine  
Science, Dunstaffnage Marine  
Laboratory  
Dunbeg, Oban PO Box 3  
Argyll, PA34 4AD  
United Kingdom

Phone: +44 1631 559259

Fax: +44 1631 559001

Email: [kdb@sams.ac.uk](mailto:kdb@sams.ac.uk)

from stripping dissolved nutrients from the water column (smaller organisms) to consuming fine particulate material (sponges, molluscs). This change in composition was influenced by spatial and temporal variations in environmental parameters (e.g. seawater temperature) and by the biofilter substrate.

**Commercial application** of this technology would not be cost efficient, as the number of filters needed for a significant reduction of the nutrient wastes is too high. However, it could possibly be very useful in cases where

- even a small reduction in loadings could be critical for the environmental health;
- the filters could assist macroalgae and filter feeders in integrated aquaculture systems in reducing the waste.

Under present market conditions, **economic analysis** has demonstrated its potential in an integrated salmon-mussel aquaculture system. Moreover, surveys have shown the public concern about the environmental performance of aquaculture, which could mean that people might be willing to pay a price premium for salmon produced in a more environmentally benign way.

**Legal analysis** has highlighted one potential regulatory dilemma concerning the motivation for use: farmers might use the filters just to increase farm production rather than to reduce environmental impact. Whilst unlikely to result in the prohibition of biofilter use, it may affect the extent of use, and in particular the economic viability and incentive for deployment. Therefore it was recommended that management guidelines be developed to highlight this and other potential difficulties and offer methods for overcoming these.

In **conclusion**, this research has shown that a reduction in waste effluent from cage aquaculture is possible with biological filters, which, if managed in an integrated fashion, could allow the co-development of aquaculture and other activities that are dependent on water quality (notably recreation and tourism) in coastal areas.

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