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# MERAMED: Development of monitoring guidelines and modelling tools for environmental effects from Mediterranean aquaculture<sup>1</sup>

K.D. Black\*, T.H. Pearson\*\*, J. Kögeler\*\*, H. Thetmeyer\*\*\*\* and I. Karakassis\*\*\*\*\*

\*Scottish Association for Marine Science, Dunstaffnage Marine Laboratory, Oban PA34 4AD, UK

\*\*SEAS Ltd, Dunstaffnage Marine Laboratory, Oban PA34 4AD, UK

\*\*\*Akvaplan-niva AS, 9296 Tromsø, Norway

\*\*\*\*Institut für Meereskunde, Düsternbrooker Weg 20, 24105 Kiel, Germany

\*\*\*\*\*Institute for Marine Biology, Crete, Heraklion, Greece

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**SUMMARY** – In the last decade aquaculture of sea bass and gilthead sea bream has experienced a period of exponential growth in the Mediterranean region, however little detailed information is available on the environmental impacts of this industry. In general, it has been assumed that impacts will, at least qualitatively, follow the pattern established in northern latitudes. The environment of the Mediterranean is, however, profoundly different to northern temperate seas in terms of temperature, salinity, tidal energy, biota and trophic status and this might be expected to heavily modify the processes involved in assimilating organic wastes. We are researching the physical, biological and chemical effects of cage farming at several sites around Greece within a modelling framework in order to provide modelling and monitoring tools for the environmental management of this industry. Specifically we aim to parameterise an existing Scottish model for Mediterranean conditions taking into account the different cultured fish species and processes such as the scavenging of carbon from the immediate locality by wild fish and epifauna.

**Key words:** Mediterranean, aquaculture, impacts, models, benthos, wild fish.

**RESUME** – "MERAMED : Développement de directives pour la surveillance et d'instruments de modélisation relatifs aux effets environnementaux de l'aquaculture méditerranéenne". Lors de la dernière décennie, l'aquaculture du bar et de la daurade a connu une période de croissance exponentielle dans la région méditerranéenne, mais cependant peu d'information détaillée est disponible sur les impacts environnementaux de cette industrie. En général, il a été supposé que les impacts suivront, du moins qualitativement, la tendance établie dans les latitudes Nord. L'environnement de la Méditerranée est cependant profondément différent des mers tempérées du Nord en termes de température, salinité, énergie des marées, biotes et statut trophique, et il faudrait s'attendre à ce que ceci modifie fortement les processus intervenant dans l'assimilation des rejets organiques. Nous étudions actuellement les effets physiques, biologiques et chimiques de l'élevage en cages dans plusieurs sites autour de la Grèce dans le cadre d'une modélisation afin de mettre au point des instruments de modélisation et de surveillance pour la gestion environnementale de cette industrie. Plus spécialement, notre propos est de paramétrer un modèle écossais existant pour des conditions méditerranéennes qui prenne en compte les différents espèces cultivées de poissons et des processus tels que la récupération du carbone des alentours immédiats par les poissons sauvages et l'épifaune.

**Mots-clés :** Méditerranée, aquaculture, impacts, modèles, benthos, poissons sauvages.

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## Introduction

In the last decade aquaculture of sea bass and gilthead sea bream has experienced a period of exponential growth in the Mediterranean region, however little detailed information is available on the environmental impacts of this industry. In general, it has been assumed that impacts will, at least qualitatively, follow the pattern established in northern latitudes. Environmental assessment strategies, developed and proven in northern European cage farms, underpin effective regulations in those areas. However the application of such strategies to Mediterranean coastal cage farms would be inappropriate without modification and adaptation to the ecological particularities of the Mediterranean Sea. In addition to differences in the species cultured, the climate, the current regime, and the level of

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eutrophication, differences in the composition and diversity of fauna and flora between the North Atlantic and the Mediterranean Sea must be addressed.

The development of an appropriate and effective impact assessment and monitoring system for cage farms is essential in order to ensure the sustainable development of aquaculture in Mediterranean coastal areas, whilst taking into consideration other aspects of integrated management of the coastal zone, including tourism, fisheries and environmental protection.

In order to address these various concerns MERAMED aims to develop and establish a model based control system for the environmental monitoring of fish cage farms in the eastern Mediterranean. This will require the fulfilment of three major objectives:

(i) To undertake a review of procedures used in the regulation and monitoring of marine cage fish farms in Norway, Scotland and elsewhere to be used as the basis for creating an appropriate set of protocols, monitoring systems and techniques for the control of such farms in Mediterranean conditions.

(ii) To carry out a field research programme to provide appropriate data on the environmental impact of marine cage fish farms in a range of conditions in the eastern Mediterranean.

(iii) To develop a predictive model to simulate the environmental response at Mediterranean sea cage farms to differing cage stocking levels and feeding regimes. This will be designed as a management tool for both the industry and regulatory authorities.

## **Workpackages**

A review will be made of the current regulations governing marine fish cage farms and of the environmental monitoring required at such farms operated in Norway, Scotland and elsewhere. The aspects of these regulations and requirements that are appropriate to marine cage farms in the Mediterranean will be identified and adapted to reflect the differing conditions. The best practices currently being used in regulating cage aquacultural operations in the other areas will then be used to suggest guidelines, control protocols and monitoring techniques suitable for regulating cage farms in the eastern Mediterranean.

Surveys will be undertaken at a series of cage farms in Greece that are representative of different environmental conditions and farming practices. Environmental conditions in the water column and sediments will be measured in the vicinity of the cages and in control areas beyond the influence of the cages. Assessments will be made of the benthic infauna and epifauna and of wild fish populations in both control and impact areas. Fish assemblages around cage farms and their effect on the flux of solid wastes will be evaluated. Detailed feed and production data from the farms over the years prior to the surveys will be collected. These various information sets will be analysed and collated to provide both an overview of the environmental impact of cage farms in the eastern Mediterranean and an appropriate data set to drive and validate a predictive model of cage farm effects.

This model will build on the experience already gained in modelling impacts at marine cage farms. Current models based on conditions in northern European tidal waters will be reconfigured and developed to ensure that model outputs truly reflect the complexity of Mediterranean conditions and are sufficiently sensitive to safeguard the interests and needs of both the industry and the regulatory authorities.

The project comprises four workpackages:

(i) WP1. Development of an appropriate set of protocols, monitoring systems and techniques for the control of marine cage fish farms.

(ii) WP2. Field research programme to provide appropriate data on the impact on the sedimentary environment of marine cage fish farms in a range of conditions.

(iii) WP3. Fish assemblages around cage farms and their effect on the flux of solid wastes.

(iv) WP4. Development of a modelling tool for predicting the environmental response to waste inputs from marine cage farms production of sea bass (*Dicentrarchus labrax*) and gilthead sea bream (*Sparus auratus*) in the eastern Mediterranean.

## Methods

Workpackages 2 and 3 will be implemented during research cruises visiting 8 fish farms in Greek waters during Summer 2001 being followed up by more detailed investigations at 3 farms during 2 cruises in 2002. In addition WP3 will be developed during several extended visits to Greek farms. The proposed work is multidisciplinary encompassing marine physics, ecology, biogeochemistry and animal behaviour.

The modelling component WP4 will take as its starting point the DEPOMOD model (Cromey *et al.*, 1998; submitted) developed by the first two partners for Scottish waters and parameterise this for the Eastern Mediterranean

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