

Monitoring environmental impact of fish cages in the Mediterranean.

The MERAMED project (funded by the EU) undertook a screening cruise in July 2001 where 7 marine fish cage farms in Greece were surveyed to test Scottish and Norwegian environmental monitoring techniques (Figure 1). These farms covered a wide variety of cage site types, depth and annual production in order to ensure that the methodology and modelling that is being developed under the research project is suitable for all types of fish cage farms found in the Eastern Mediterranean.



Figure 1. Surveying a Greek cage farm

Surveys were undertaken at 7 cage farms in the Aegean and Ionian seas by the research vessel *Philia* (Figure 2) belonging to the Institute of Marine Biology Crete. Sites covered the full range of locations at different depths, at varying degrees of exposure to wave action, over different types of seabed at different production levels, farmed species and feeding practices.



Figure 2. Research vessel *Philia*, Institute of Marine Biology Crete

A range of survey methods and equipment was tested based on what is presently used in Norway, Scotland and Greece. This included current meters, conductivity, temperature and oxygen profiles through the water column (CTDO) (Figure 3), Sediment Profile Imaging (SPI) (Figure 4), video/underwater photography using a remotely operated vehicle (ROV) (Figure 5.), wind speed and direction measurements, bathymetry (Rox Ann), drifting buoy survey (drogues), macrofauna sampling, meiofauna sampling and sediment chemistry. At the same time methods were developed to try and measure the biomass of wild fish close to the cages and assess their effect on the quantity of suspended solids reaching the sediments below the cages.

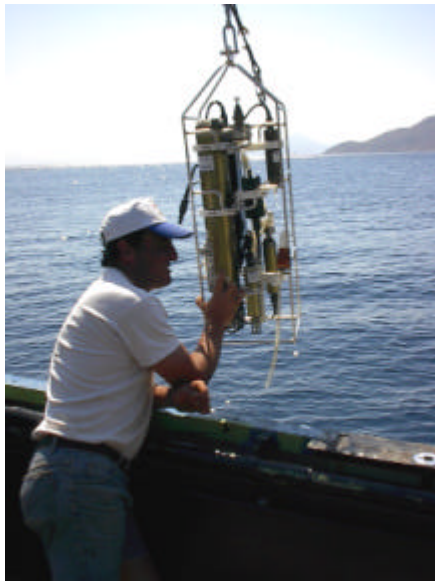


Figure 3. CTDO



Figure 4. SPI Sediment Profile Imaging



Figure 5. ROV remotely operated vehicle

This data was then linked to production data at the time of the survey to develop mathematical models to predict the impact of cage farms on the sediments below the cages under different conditions. The farmers received individual survey results with recommendations on ways to mitigate impact.

A second more detailed cruise was undertaken at 3 of the original Aegean sites in March this year. The objective of this cruise was to validate modelling predictions with real data. One of the other main aims was to carry out a cost benefit comparison study of survey methods and equipment.

During the second cruise, scientists also analysed the water column and sediments in more detail, to identify geo-chemical and faunal changes in the sediments with increasing distance from the fish cages. Data on fish production, food type and feeding rates was collected from the fish farmers.

The third and final cruise took place in October this year. The scientists again visited the same 3 sites and repeated all tasks in order to collect data after the summer season when the highest feeding rate takes place and the cages have the highest biomass before fish are sold. This is the official end of the research fieldwork although some of the wild fish assessment work will continue through 2003.

The Project aims to develop survey methods that can be undertaken by the fish farmer, independent surveyors and regulators depending on the site and potential environmental impact of the farm. Therefore a comparative analysis of the different survey methods was undertaken in order to propose a three-tier monitoring strategy. At each tier, accuracy, sensitivity and cost (time, equipment, and personnel training level) were evaluated for detecting the environmental effects of fish farming.

A summary of the approach and the corresponding activities at each level were tested in the surveys are presented in the table below.

| | Simple/cheap | → | Extensive/expensive |
|--------------------------|--------------------------------------|--|--|
| Activity | Visual or descriptive | Semi-quantitative | Quantitative |
| <i>Undertaken by:</i> | <i>Local diver plus farm boat</i> | <i>Farmer with some specialized equipment or small consultancy company</i> | <i>Research institute with specialized boat or large consultancy company</i> |
| Bathymetry | Sea chart | Echo sounder | Rox Ann |
| Site Characterization | Diver with photos | Remotely Operated Vehicle | Sediment Profile Imaging |
| Benthic/sediment samples | Small grabs | Large grabs | Corer |
| Sediment condition | Colour, smell, presence of Beggiatoa | Grain size, Total Organic Carbon | Full chemical analysis |
| Benthic fauna | Visual indicator species | Semi-quantitative analysis | Quantitative |
| Wild fish community | Presence of indicator species | Partial census | Quantitative census |

Wild fish are more abundant around the cages in the Mediterranean than the North Atlantic. Therefore research is assessing the affects of the more plentiful wild fish on the fate of the solid wastes (uneaten feed and faeces) and on the interactions between farmed and wild fish, focusing on farm effluent flux and biodiversity.

For estimating the abundance and size of wild fish around the fish cages (Figure 6) a visual census method was used, based on a digital stereo-video system and a software package for photogrammetric analyses. Sediment traps and feed pellets marked with a small amount of an indigestible food colour were used to trace the flux and dispersion of particulate wastes around cages (Figure 7). Stomach samples of wild fish were taken to identify fish species feeding on waste food or faeces. Feed pellets were released on the sea-floor below fish farms and the food consumption by wild fish was documented photographically (Figure 8). In addition, attempts are being made to identify potential indicator species that will act as eco-indicators that can characterize the impact of aquaculture activities on the fish community.



Figure 6. Mulletts underneath a fish cage

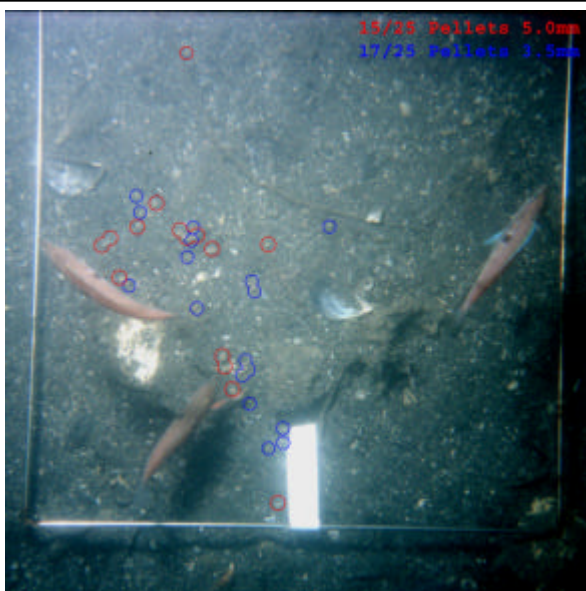


Figure 8. Wild fish (*Spicara maena*) consuming feed pellets (3.5 and 5 mm diameter) scattered inside a metal frame. Circles mark counted pellets.



Figure 7. Sealed sediment trap on the sea-floor

The initial results of the research will be ready by the end of 2003 and this will provide guidelines and recommended monitoring methods for fish cages in the Mediterranean. It is hoped that a training course will be conducted in May 2003 to

train fish farmers and other technicians in the methods and techniques developed from the research. In addition a web based training module will be developed in the major languages of the Eastern Mediterranean.

MERAMED is an EU funded research project. The full title is 'Development of monitoring guidelines and modelling tools for environmental effects from Mediterranean aquaculture'. The aims of the research are to investigate and develop scientifically validated methods for monitoring marine fish cage farms in the Eastern Mediterranean and the main survey work is being undertaken in Greece.

The research is carried out by 5 partners, Akvaplan-niva AS, Norway, Seas Ltd., Scotland, Institute of Marine Biology of Crete, Greece, Dunstaffnage Marine Laboratory, Scotland, and Institute of Marine Research of Kiel, Germany. Akvaplan-niva are coordinating the programme, from its offices in both Tromsø Norway and Athens.

Further information about the project and partners can be found at the web site at www.meramed.com