



THE MERAMED PROJECT

Development of monitoring guidelines and modelling tools for environmental effects from Mediterranean aquaculture

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Cost /benefit analysis of sampling benthic infauna.

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Benthic infauna communities are widely used as indicators of the seabed conditions as well as for the detection of anthropogenic induced changes of the marine environment. The procedure is usually as follows: sediment samples are sieved through a mesh and the fauna retained on the mesh are commonly identified to species. However, monitoring of benthic communities is a rather time-consuming and expensive procedure both in terms of sampling effort in the field and laboratory analysis. For example, fine sieves retain more fauna and thus require more time for sorting and identification. Thus, cost-efficient methods for monitoring are needed to reduce the time and costs of a study while maintaining the ability to reliably detect any possible impact.

As part of the EU funded MERAMED project, a study was undertaken with the overall aim of identifying such cost-efficient methods for routinely monitoring the ecological change introduced by fish farming. More specifically, the study investigates the combined effects of decreasing taxonomic resolution, the use of different sieve mesh-size and the type of samplers used, on the quality of data obtained, in the context of mariculture impact on Mediterranean benthic communities.

To obtain a suitable dataset, samples were taken at various distances from the cages of a fish farm. To determine which taxonomic level is sufficient to detect an impact, abundance data were aggregated at higher levels, i.e. order, family, phylum. Furthermore, to determine whether the additional effort involved in examining material retained on a finer sieve adds extra information to the overall picture, the fauna retained on a 1.0 mm sieve were compared to the combined fauna retained on both 1.0 and 0.5 mm sieves. Finally, to compare benthic remote samplers, such as van Veen (0.1 m²) to diver-operated corers, samples were taken by both methods and then processed using all the above alternatives in terms of sieve mesh size and taxonomic resolution.

Sieve mesh-size and sampling gear efficiency

The 1.0 mm sieve retained more than 60% of the total individuals and more than 87% of the total species of the samples collected with corers. The overall retention efficiency increased significantly for the much larger samples collected with the van Veen grab; thus 72% for the total individuals and more than 96% for total taxa were retained on the 1.0 mm sieve.

The time needed to sort the samples was recorded separately for each of the two sieve fractions and the two different sampling methods. On average, samples that were taken with corers and retained on the 1.0 mm fraction took more than 2 h to sort while samples taken with the van Veen grab took more than 10 h to sort. Including the time needed to sort the sample fraction passing the 1.0 mm and retained in the 0.5 mm sieve it was found that samples collected by means of the van Veen grab needed on average 4 times more effort to analyse.

The multivariate analysis of macrofaunal species abundances aggregated at different taxonomic levels (Figure 1) resulted in a very similar pattern. Thus for graphs of the species and family level, points corresponding to the different replicates from the same stations are grouped together and only points corresponding to the 5 and 10 m stations as well as those corresponding to the 25 and 50 m stations show some overlap.

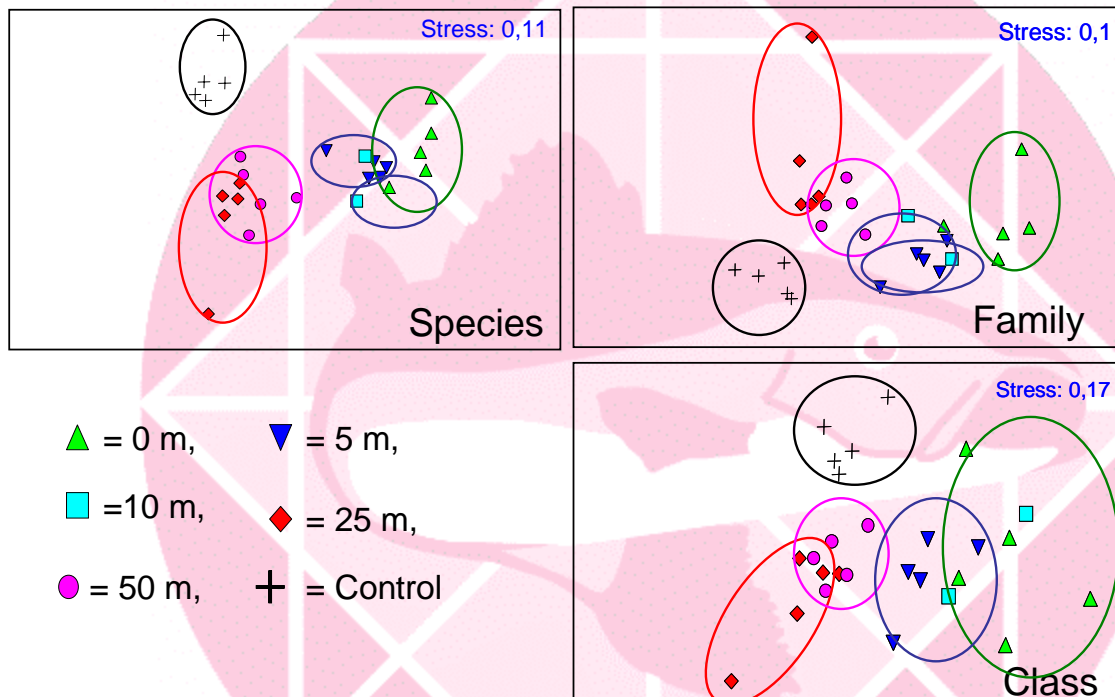


Figure 1. Multidimensional scaling (MDS) graphs of macrofaunal abundance data. Samples were taken at various distances from the edge of a fish farm. Results show abundance data from the 1.0 mm sieve fraction. Species data were aggregated also at the family and class level.

Information loss

A cost/benefit ratio analysis for the two sampling and the two sieving methods (Figure 2) showed minimal values for the van Veen samples (both 1.0 mm and combined fraction) at the family level, indicating that analysis at this level gives the best balance between precision of the results and decrease in taxonomic effort. For samples taken with corers, the decrease in precision is not compensated by the drastic decrease in the number of taxa, which, even for the species level is as much as 34 % (Table 1). However, if the time needed to sort the samples is included in the analysis (Figure 3), then, samples taken with corers using a 1.0 mm sieve and identified to families seems like a good compromise between precision and cost.

It was found that information loss was relatively low as data were aggregated at higher taxonomic levels, particularly up to the level of family or even order. It was also found that the extra information gained by sieving samples through a 0.5 mm sieve did not improve the ability to distinguish the potentially impacted sites from the control stations. Finally it was found that, a relatively large proportion of the available information concerning the community structure such as abundance, biomass or diversity is lost when sampling is carried out with corers. However, under certain circumstances, the use of corers and consequently much smaller samples could be useful, especially in routine monitoring studies where factors such as time and cost are more important than precision.

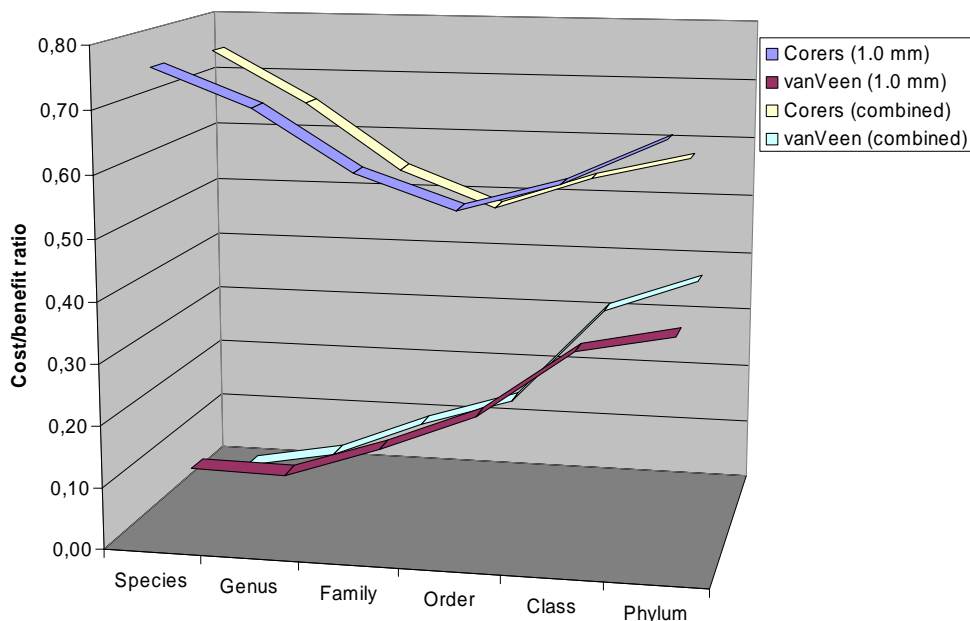


Figure 2. Cost/benefit analysis of different taxonomic levels for two different sampling and two different sieving methods.

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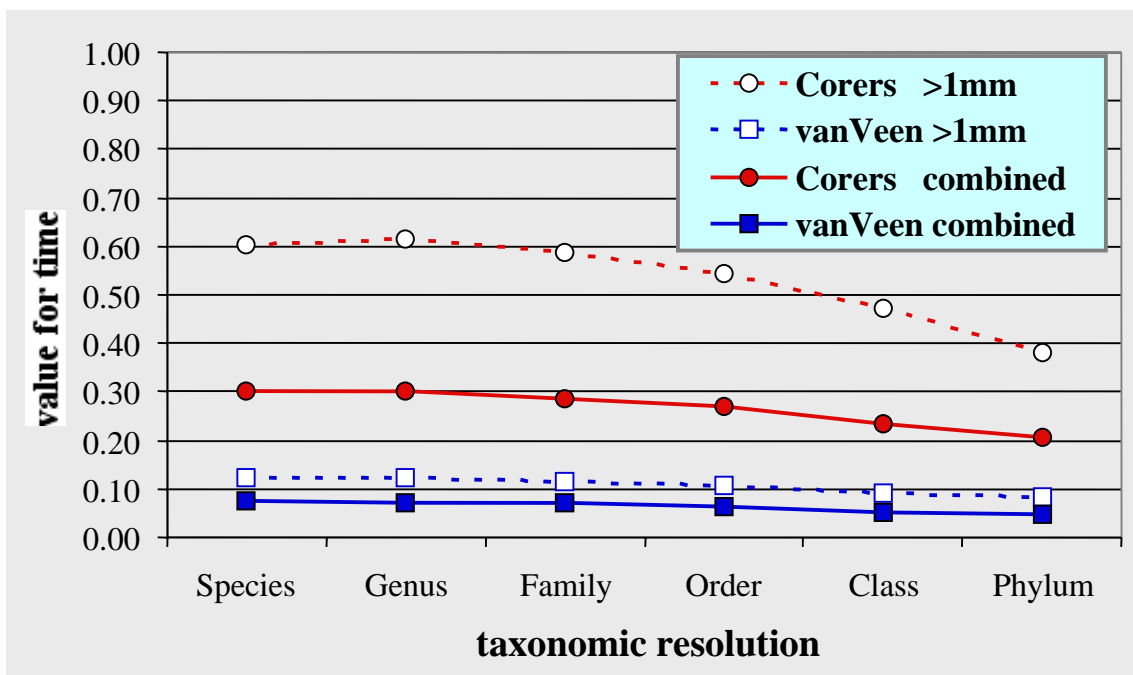


Figure 3. Value for time of different taxonomic levels for two different sampling and two different sieving methods.

Table 1. Percentage (%) of taxa retained at each taxonomic level for the different sampling and sieving methods.

	Corers (1.0 mm)	vanVeen (1.0 mm)	Corers (combined)	vanVeen (combined)
Species	34	82	39	88
Genus	30	69	34	73
Family	19	42	21	46
Order	8	17	9	18
Class	6	7	6	7
Phylum	3	4	3	4

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Conclusions

It is concluded that cost-efficiency of fish farm monitoring in the Mediterranean is improved significantly when employing a 1.0 mm sieve and identifying fauna to the family level. Sieving sediment samples through a 1.0 mm sieve reduces the time and therefore the cost of sample processing significantly, without reducing the quality level of the information provided. The strict adherence to the "species-level" identification is also unjustified in the monitoring context since the loss of information between this level and intermediate levels such as family or order are almost negligible. Finally, the choice of the sampler (van Veen vs. corers) may further reduce the cost of a monitoring programme since the similarity between samples taken at the same station by means of these two samplers is rather high (>70%) and the univariate estimates such as abundance and diversity seem to be very little affected by the sample size.

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