EFFECTS OF PHYSICAL AND CHEMICAL QUALITY OF THE SEA BOTTOM ON THE DISTRIBUTION OF THE SHRIMP *PENAEUS KERATHURUS* IN WESTERN GREECE

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Abstract

Sediment chemical quality and the associated aerobic and anaerobic chemical reactions on the sediment surface affect significantly the distribution and mortality of species that live on the sea bottom. The shrimp *Penaeus kerathurus* is native in Greek and Italian waters (Ionian Sea coasts). An important aspect of the biology of the species is that burrows in the sediment and therefore, pollution from the uses of the coastal human activities that degrade sediment quality affect the populations significantly. High concentrations of nutrients were measured in the habitat. resulting in high natural mortality and specific distribution patterns.

Keywords: sediment, Penaeus kerathurus, distribution

The shrimp species *Penaeus kerathurus* is endemic in North Mediterranean coast and an important fishery resource for Greece and Italy. The productivity of this stock has been decreasing the past 20 years as a result of pollution from coastal human activities and certain aspects of the species biology that hinder its survival potential. Most important of these aspects is the preference of the species to utilize closed gulf habitats, which are more susceptible to pollution and bioaccumulation of pollutants, which, in turn, reduce the survival rates of the species as well as the fishery productivity. The present study is focused on the Greek population of the shrimp *Penaeus kerathurus* located in Amvrakikos Gulf (Western Greece; Fig. 1). The data were gathered during the project 037/98/EU DG XIV [1].

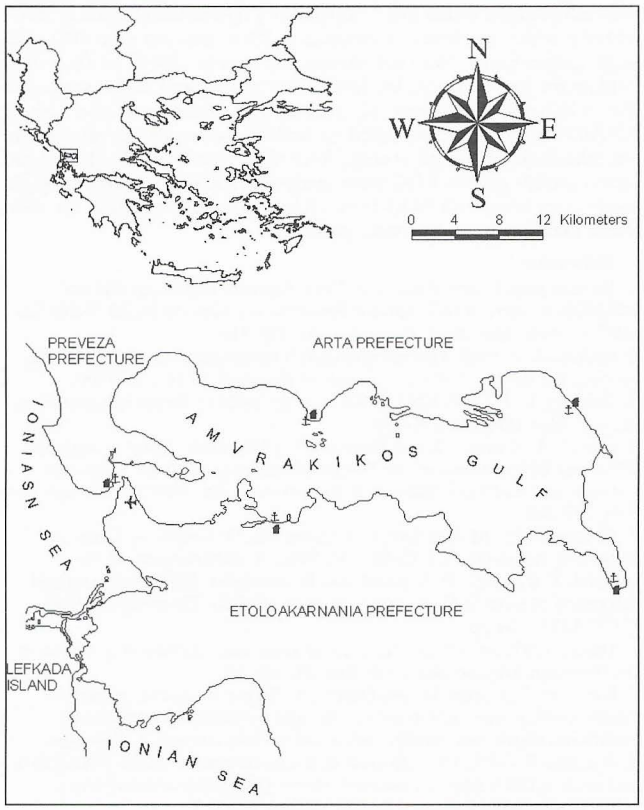

Figure 1. GIS map of the study area in Western Greece

The aim of the study is to analyse the population distribution patterns in Amvrakikos Gulf in relation to the physical and chemical quality on the sediment level taking into consideration the fact that the species lives on the sea bottom and usually burrows in the sediment. The means for this analysis is the fishery productivity index (C.P.U.E.; Catch Per Unit of Effort) in terms of landings (in g) per 1000 m of trammel net per month, which gives a direct indication of the distribution pattern of the shrimp in the Gulf. The physical and chemical parameters which were measured and used in the modelling, are: temperature (T; °C), pH, dissolved oxygen (mg/L and % saturation), Total Nitrogen (mg/L), Total Phosphorus (mg/L), sulfides (by product of H_2S, in ug/L) and a dummy variable (*AreaDummy*) which takes the values 1,2,3 and 4 for the West, North, South and East parts of the Amvrakikos Gulf. The dummy variable was included in the model in order to provide a spatial dimension of the fishery productivity. Cluster analysis of the four regions in Amvrakikos Gulf using all physical and chemical parameters, showed that there is a great similarity between the East-South and North-West regions at the 93% and 96% similarity level (Bray-Curtis dissimilarity index; [2]). The clustering of all regions occurs at the 70% level, which is high enough. The same results were obtained from Correspondence Analysis. The conclusion from these analyses is that the South and East parts of the gulf show high productivity (average C.P.U.E. =4630.1±456.8g) while the West and North regions show low productivity (average C.P.U.E. =2212.2±117.4g). The availability of the shrimps indicates that most of the population is gathered in the South and East regions of the Gulf. The productivity of the fishery, modelled using a simple multiple linear regression equation, showed significant correlation. The equation was found :

$$C.P.U.E. = -150.7 \cdot T + 868.2 \cdot pH + 62.9 \cdot DO(mg/l) - 39.9 \cdot DO(\%) - 225.7 \cdot (TotalN)$$
$$(-0.79) \quad (1.17) \quad (0.04) \quad (-0.38) \quad (-1.11)$$
$$+294.6 \cdot (TotalP) - 43.1 \cdot (S^{-2}) + 1402.3 \cdot (AreaDummy)$$
$$(1.16) \quad (-2.2) \quad (3.06)$$

r^2=0.938, P=0, d.f.=8,21, Durbin-Watson=2.434 (t-test in parentheses)

The high correlation showed that the C.P.U.E. index is affected significantly by the selected physical and chemical variables. The sensitivity of the C.P.U.E. to each parameter separately was analysed through a log multiple regression model. This model using the log10 values of the same parameters gave also a very good correlation. The log model is the following:

$$\log_{10} C.P.U.E. = +1.20 \cdot \log T + 15.2 \cdot \log pH + 4.9 \cdot \log DO(mg/l) - 8.34 \cdot \log DO(\%)$$
$$(-0.33) \quad (2.43) \quad (0.57) \quad (-1.2)$$
$$+0.18 \cdot \log(TotalN) + 0.522 \cdot \log(TotalP) - 0.219 \cdot \log(S^{2-}) + 0.763 \cdot \log(AreaDummy)$$
$$(0.19) \quad (0.54) \quad (-0.50) \quad (2.93)$$

r^2=0.902, P=0, d.f.=8, 26, Durbin-Watson=2.001 (t-test in parentheses)

The coefficients of the log model equal to the sensitivity of C.P.U.E. to each parameter. From the equation, it is clearly seen that temperature and dissolved oxygen (mg/L) are extremely important and affect positively C.P.U.E. Increase of temperature and/or dissolved oxygen (mg/L) will cause an increase of C.P.U.E. In addition, the Total Nitrogen, Total Phosphorus and the *AreaDummy* variables also affect positively the C.P.U.E. to a less extent than the others. The % saturation of dissolved oxygen shows a strong negative effect to C.P.U.E. The over-saturation values measured in various regions seem to affect the C.P.U.E. negatively. The conclusion of this study is that the physical and chemical quality of the sea bottom in Amvrakikos Gulf affects significantly the distribution of the shrimp population of *Penaeus kerathurus* as measured through the catch per unit of effort of the fishery activity in the area.

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