Levels of Heavy Metals in Two Demersal Fishes, *Arnoglossus laterna* (Risso, 1810) and *Buglossidium luteum* (Walbaum, 1792) in Izmir Bay

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In this study, the quantity of data on the presence and content of heavy metals in two demersal fishes, (A. laterna and B. luteum) collected from Izmir Bay was accumulated between 1988-1989. The samples were chosen considering to their presence in every season and found them easily in the study area. The aim of this study was to determine the concentrations of Hg, Cd, Pb and Zn in the fillet of these fishes and compare the data of two years.

The analytical procedure applied involved a decomposition technique using HNO_3 - $HClO_4$ (5:1) acids in water bath with the temperature maximum 40°C under reflux system.

Determinations were carried out with Atomic Absorbtion spectrophotometer (Varian Techtron, Model 1250). Hg was determined by cold vapour technique using varian Model 65 vapour generation accessory and the other elements by flame (BERNHARD, 1976). The results have been calculated as µg/kg wet weight, medians and quartiles of data has been used for statistical evaluations (TUKEY, 1977; CLAUSSEN, 1988).

Concentrations of Hg in fillet of A. laterna didn't fluctuated much between 1988 and 1989 with lower quartile values of 9 and 13 µgHg/kg wet weight and with upper quatile 30-29 µgHg/kg respectively. Also, Hg concentrations of B. luteum in these two years ranged from 16 to 11 µgHg/kg as lower quartile and with the values 45-23 µgHg/kg upper quartile. It can be seen that Hg concentration has slightly decreased in 1989.

Cadmium concentrations of A. laterna ranged from 8 to 296 µgCd/kg as extreme values for 1988 while they varied from 72 to 334 µgCd/kg for 1989. Also, Cd concentrations of B. luteum ranged from 7 to 289 µgCd/kg in 1988 varied in between 56 to 175 µgCd/kg in 1989. So, Cd concentrations in B. luteum has increased in 1989 comparing to the data obtained 1988 (Table 1).

Lead concentrations of A. laterna was higher than of B. luteum generally. A. laterna has Pb concentrations between 127 to 4627 µgPb/kg as extreme values whereas accumulation in B. luteum varied between 94-3623 µgPb/kg in 1988. Also, Pb values obtained Pb from the samples collected in 1989 varied from 371 to 4138 µgPb/kg in A. laterna. It can be seen from the Table 1 that Pb concentrations in these organisms has decreased in 1989 comparing with these from 1988.

Zinc accumulations of A. laterna ranged from 3520-3863 µgZn/kg respectively as lower quartiles and 5669-5380 µgZn/kg as upper quartiles during 1988-1989. Also, Zn values of B. luteum ranged from 2680-2824 µgZn/kg as lower quartiles and 4325-3480 µgZn/kg as upper quartiles respectively during 1988-1989. The zinc values has decreased in 1989 in both fishs but Zn content of A. laterna was higher than of B. luteum (Table 1).

Table 1- Statistical values of trace metal concentrations in two demersal fishes (A. laterna and B. luteum) in Izmir Bay (µg/kg wet weight).

Species		Mercury 1988	Mercury 1989	Cadmium 1988	Cadmium 1989	Lead 1988	Lead 1989	Zinc 1988	Zinc 1989
	Mimimum	5	5	8	72	127	371	2751	2749
	Lower Quartile	9	13	39	83	531	771	3520	3863
A. laterna	Median	20	17	161	102	2363	946	3915	4577
	Upper Quartile	30	29	223	130	2671	1695	5669	5380
	Maximum	75	62	296	334	4627	4138	11296	6863
		n=20	n=19	n=16	n=9	n=19	n=14	n=20	n=20
	Mimimum	4	7	7	56	94	639	2164	2395
	Lower Quartile	16	11	76	87	873	1077	2680	2824
B. luteum	Median	26	22	106	100	1433	1156	3028	3288
	Upper Quartile	45	23	222	133	2045	1373	4325	3480
	Maximum	179	100	289	175	3623	1693	7990	3658
		n=23	n=13	n=17	n=8	n=20	n=9	n=23	n=14

A comparision of our data with those mentioned by other authors was not available because of lack of informations on this subject using these fishes on Turkish coasts. But, comparing with those reported from different areas of Mediterranean using similar kind of fishes, the heavy metal accumulations was not exeeded them (UYSAL, 1978; BARGAGLI at al. 1986).

However, the levels Pb indicated that we mustn't neglected it although the values are not high now.

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Aquaculture Production in Greece, 1980-1988

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ABSTRACT

Aquaculture production (excluding lagoons) in Greece increased from 2,000 t in 1980 to 3,900 t in 1988 with a mean production of 2,340 t representing 1-2 % of the mean annual fishery production in Greek waters. The mean 1986-1988 production was allocated as follows: 1983 t trout, 233 t carp, 132 t sea bream/sea bass, 570 t mussels, and 51 t other species (of which 7 t eels). The mean 1984-1986 production represented 0.4% of the mean (1984-1986) Mediterranean aquaculture production. A quadratic trend model explained 85% of the variability of aquaculture production in 1980-1988 and forecasts for 1992 amount to 7,900 t.

INTRODUCTION

Although aquaculture experience in Greece goes back to the 1950's, it is only since 1980 that aquaculture developed systematically; from 1981 to 1988 more than 12 million USD have been spent for the development plant of marine aquaculture (ANONYMOUS 1990) whereas more than 100 million USD were planned to be invested for aquaculture during 1987-1991 (KALLIFIDAS 1990). Here aquaculture production in Greece (excluding lagoons) is reviewed for 1980-1988. Yet, since forecasting of aquaculture production will be beneficial for the development of aquaculture infrastucture, forecasts are developed using decomposition (trend analysis) time-series techniques.

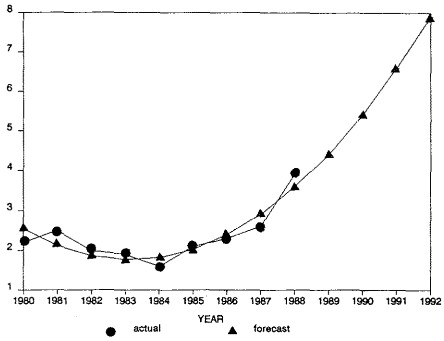

Fig. 1. Aquaculture production (excluding lagoons) in Greece, 1980-1988, and forecasts produced by the quadratic trend model (1980-1988: in-sample forecasts; 1989-1992: out-of-sample forecasts).

MATERIAL AND METHODS

Annual aquaculture production in Greece (excluding lagoons) for 1980-1988 and production per species (1986-1988) are taken from the Ministry of Agriculture, KALLIFIDAS (1990) and ARGYROU (1990). Trend analysis was used to model aquaculture production for 1980-1988 and, consequently, in-sample (1980-1988) and out-of-sample (1989-1992) forecasts were produced. The following measures of forecasting accuracy were computed: (1) Absolute Percentage Error, APE, (2) Mean Absolute Percentage Error MAPE, and (3) Mean Error (according to MAKRIDAKIS et al. 1983) and the coefficient of determination (according to SAILA et al. 1979).

RESULTS AND DISCUSSION

Aquaculture production (excluding lagoons) in Greece increased from 2,000 t in 1980 to 3,900 t in 1988 (Fig. 1) with a mean production of 2,340 t representing 1-2 % of the mean annual fishery production in Greek waters (STERGIOU 1990a). The mean 1986-1988 production was allocated as follows (Fig. 2): 1983 t trout, 233 t carp, 132 t sea bream/sea bass, 570 t mussels, and 51 t other species (of which 7 t eels). The mean (1984-1986) production amounted 2,000 t representing 0.4% of the mean (1984-1986) Mediterranean aquaculture production (= 496,000 t; GIRIN 1989). The mean (1984-1986) trout production ranked fourth in the Mediteranean salmonid production representing about 2 % of the mean (1984-1986) (= 66,000 t; France, Italy and Spain made up more than 90% of salmonid production during that period, GIRIN 1989).

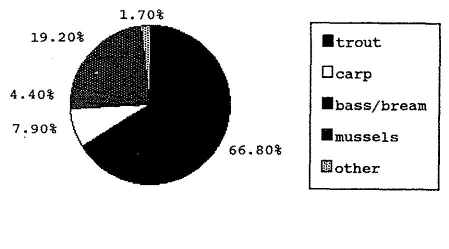

Fig. 2. Mean (1986-1988) aquaculture production per species (excluding lagoons) in Greece

Production per farm during 1986-1988 increased significantly for mussels (from 15 t/farm to 46 t/farm) and carp (from 5 t/farm to 14 t/plant) whereas it did not exhibit any significant increase for the remaining species (ARGYROU 1990).

Forecasting as applied to biological systems is mainly oriented towards modeling on the basis of: (a) explanatory, regression techniques (simple, multiple, categorical) which take into account other input variables, and (b) stochastic, time series techniques that treat the system as a black box (AutoRegressive Integrated Moving Average models, transfer function models, spectral analysis) (see STERGIOU 1989, 1990b). These techniques cannot be applied to our data because (a) the factors that mainly affect aquaculture production in Greece (e.g. such as technical and scientific expertise, management skills) cannot be parameterized, and (b) production time-series is short. Hence, a simple, decomposition method (trend analysis) was used to model and predict aquaculture production. Decomposition methods try to identify components of the basic underlying pattern and forecasting is based on extrapolation each of these component patterns separately and recombining them into a final forecast. The following quadratic trend curve was fitted to the 1980-1988 data: $X_t = 3.12 - 0.65\,T + 0.08\,T^2$, where X_t = production (in 1000 t) and T = time. ME and MAPE were estimated to be 0.0 and 9.5% respectively. APE ranged from 3.3 to 15.9%. The model explained 85% of the variability of aquaculture production in 1980-1988 and forecasts for 1992 amount 7,900 t (Fig. 1).

Forecasting plays a central role in managerial decisions: it preceeds planning which, in turn, preceeds decision making (MAKRIDAKIS et al. 1983). Forecasting of annual Greek aquaculture production within an APE ranging from 3.3 to 15.9% (MAPE = 9.5%) is an important goal. Aquaculture production in Greece is influenced by many factors and is confronted by all sorts of uncertainty (management skills, availability of fingerlings, availability of food, technical and scientific expertise). Yet accurate forecasts will be beneficial for the development of aquaculture infrastructure (fry and feed production both of which at present are mainly imported increasing the cost of products and render them not competitive for exportation), predict future prices, and planning exports and absorption by the local market.

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