ENVIRONMENTAL EFFECTS OF THE THREE FISH FARMS IN IZMIR BAY (AEGEAN SEA-TURKEY) ON WATER COLUMN AND SEDIMENT

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Abstract
In order to detect environmental impacts of three fish farms; water and sediment samplings were carried out on a monthly basis between June 2001 and May 2002. Physico-chemical variables, chlorophyll *-a*, particulate organic carbon values of water samples, organic carbon values of sediment samples were investigated. We found that each of the fish farms affected the marine environment adversely, but the effects of the fish farm situated in a less protected cove compared to the other two were more apparent due to wrong feeding strategies and its shallow depth.
Keywords : Aegean Sea, Aquaculture, Monitoring, Pollution.

Introduction
Turkish efforts in aquaculture started in 1970's and developed rapidly with the contribution of marine aquaculture in 1980's. Uncontrolled expansion of fish farms have led to environmental problems [1]. Uneaten feeds and feces adversely effected water column and sediment especially in closed and semi-enclosed coves. Our aim was to determine environmental effects of the three fish farms located in the Izmir Bay.

Materials and Methods
Samplings were carried out at three fish farms in Izmir Bay (Aegean Sea-Turkey) between June 2001 and May 2002 on a monthly basis (Fig. 1). All farms produced sea bream (*Sparus aurata*) and sea bass (*Dicentrarcus labrax*); 60, 240 and 160 tons/year and depths in the farms were 8, 20 and 10 m. respectively (Farm 1, 2 and 3). Two stations were chosen for sampling in each farm, one at the cage unit and a control station 200 meters away. Water samples were collected by Nansen Sampling Bottle, sediment samples were obtained using an Van-Veen grab. Visibility was measured by Secchi disc. Temperature and dissolved oxygen (Winkler titration) measurements were carried out *in situ*, pH, salinity (Mohr-Knudsen) analyses were done at the laboratory. Nutrients, chlorophyll-a and Particulate organic carbon (POC) concentrations were obtained according to standard methods [2]. Organic carbon values of sediment were determined as described [3]. In order to detect statistical difference between samples at the cage and the control stations, T-test was performed.

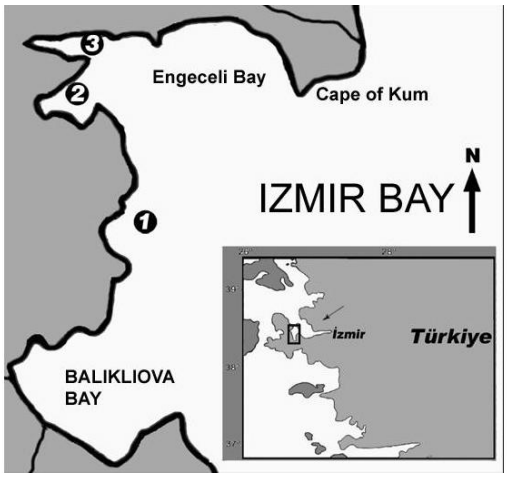

Fig. 1. Map showing the location of the studied fish farms.

Results and Discussion
Results of analyses of the three fish farm stations (cage and control) are given in table 1. Temperature, salinity and pH values fluctuated throughout the sampling period in relation to seasonal changes. DO concentrations were low in the summer months at all stations due to increased temperature and there were no significant differences between cage and control stations. Secchi disc readings were higher at all control stations. Nitrate+nitrite values were higher at cage stations than control stations in summer samplings in all fish farms. But these differences were not important statistically.

Tab. 1. Range of variables troughout the sampling period in the fish farms.

Variables	1		2		3	
	Cage	Control	Cage	Control	Cage	Control
Temperature (°C)	14,0-27,0	14,5-26,0	14,5-27,2	13,8-27,0	15,0-26,5	15,0-27,0
PH	7,76-8,13	7,68-8,10	7,54-8,20	7,60-8,29	7,75-8,12	7,74-8,12
Salinity (ppt)	33,93-41,54	33,93-41,54	33,64-40,95	33,35-42,41	33,93-42,12	33,64-42,12
Secchi disc (m)	6,83-7,88	8,10-15,75	3,15-8,93	4,73-20,10	3,68-9,45	7,88-17,85
DO (mg/L)	6,0-10,0	5,8-8,4	6,0-8,4	6,0-9,2	6,0-7,6	6,0-9,2
Nitrate+Nitrite (μM)	Nd-5,77	Nd-3,97	0,04-4,22	Nd-4,56	Nd-5,21	Nd-6,43
Ammonium (μM)	Nd-11,40	Nd-3,13	Nd-5,76	Nd-4,01	0,24-2,25	Nd-1,80
Phosphate (μM)	Nd-0,87	Nd-0,62	Nd-0,87	Nd-0,46	0,07-0,85	Nd-1,20
Silicate (μM)	Nd-7,47	Nd-5,66	Nd-9,56	Nd-11,10	Nd-5,45	0,06-5,83
Chl-a (μg/L)	Nd-2,56	Nd-2,56	Nd-3,36	Nd-2,56	Nd-4,17	Nd-4,59
POC (mg/L)	0,174-1,094	0,226-1,096	0,236-1,044	0,132-1,012	0,264-1,000	0,219-0,953
Org. carbon (%)	2,42-10,54	0,21-1,40	0,66-3,67	0,80-2,04	2,50-3,50	0,48-1,35

Significant increases in concentrations of ammonium were detected at cage stations over control stations in the first and the third farms. Phosphate concentrations were significantly higher at cage station only in the first farm. However, no significant differences were found between cage and control stations for chlorophyll-a and POC. This lack of POC and chl-a respond to nutrients is consistent with other studies in the Mediterranean [4,5]. In the first and third fish farms, organic carbon concentrations at cage stations were very significantly higher than control stations. Similar increased nutrient and organic material concentrations at cage stations have been also reported in the Mediterranean [4, 5, 6]. We found that the fish farms examined, impacted adversely the marine environment, and although the first fish farm was situated in a less protected cove compared to the other two farms, its effects were more apparent due to overfeeding and shallow depth of the area.

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