

INFLUENCE OF ENVIRONMENTAL CONDITIONS ON EXTENSIVE AQUACULTURE IN TWO COASTAL LAGOONS OF THE NESTOS RIVER DELTA, NORTHERN GREECE

V. S. Theocharis¹, G. Sylaios², N. Stamatis^{2*} & V. Ragias³

¹ N.AG.RE.F., Bureau of Applied Hydroecology, P.O. Box 1103, 451 10 Ioannina, Greece

² N.AG.RE.F., Fisheries Research Institute, 640 07 Nea Peramos, Kavala, Greece

³ Lagoon Fish Farmers Co-operative of Kavala, Kavala, Greece

Abstract

The alteration of environmental conditions, under the influence of drainage canals and the intensification of agriculture the latest years, seems to be responsible for the qualitative change of fisheries at the lagoons Vassova and Eratino, Northern Greece. We have used a number of water quality parameters (temperature, salinity, nutrients) at selected stations as well as random samples of *Dicentrarchus labrax* (sea bass) population in order to study the influence of environmental conditions on the extensive aquaculture of the coastal lagoons of Nestos River. Results show that the reduction of water temperature during the winter period appears to be responsible for fish deaths reported at the winter enclosures. Condition factor analysis shows that peak nitrite and ammonium concentrations did not influence fish growth at winter enclosures. On the contrary, condition factor appears related to fish sex in the lagoonal samples and to food availability in the environment of the lagoon and the hatchery. The stabilization and reclamation of the lagoonal ecosystem demands the improvement of the biotope in nitrites and ammonium, the elimination of water discharged into the lagoons from drainage canals, the better oxygenation of the water column during the summer and the application of selected fertilizers during autumn.

Key-words: *Eutrophication, monitoring, mortality, growth, Aegean Sea*

Introduction

Coastal lagoons are key fishery ecosystems. Mediterranean in particular, offers a number of advantages and potentialities for lagoon aquaculture with high productivity. However, due to gaps in knowledge and technology, the majority of Mediterranean coastal lagoons are underexploited, with an annual production of 50-100 kg/ha/yr.

The lagoons Vassova and Eratino, shallow and small in size, having an area of 270 and 340 ha, respectively, and a depth that rarely exceeds 2 m., consist part of a coastal lagoonal system, with total area of 1700 ha, located at the western bank of Nestos River delta, Northern Greece (figure 1). Nestos River has a discharge, excluding the lower and upper five percentiles, which ranges from 8 to 106 m³/sec with an annual mean of 57 m³/sec [1].

Water circulation and mixing inside the lagoons depends strongly on the prevailed tidal conditions, wind effects and precipitation. Tidal range has a maximum value of 0.96 m. during spring tides and a minimum of 0.20 m. during neap tides [2]. Meteorological conditions show moderate NNE winds prevailing during autumn and winter periods, and stronger SW winds dominating during summer [3]. Annual rainfall at the area is on average less than 400 mm [4], while evaporation varies between 150-155 mm [5].

The eutrophic lagoons of Northern Greece are being exploited by the local fishermen cooperative using fish weirs, fish traps and facilities for size sorting and separation into special basins for fish wintering. Fishery production during the decade 1970-1980 was of the order of 17 kg/ha/year [6], while nowadays production dropped to 9 kg/ha/year, which is also accompanied by a negative qualitative change of production. This production level is near the minimum limit of the fishery production range (0.2-80 kg/ha/year) at a global scale [7].

The alteration of environmental conditions, under the influence of drainage canals and the intensification of agriculture during the last years, seems to be responsible for the qualitative change of fisheries. Especially for species like sea bass *Dicentrarchus labrax* and sea bream *Sparus aurata*, production during the same period dropped from 10 to 3 kg/ha/year, according to data from the local Aquaculture Cooperative. The main problems of local fishermen concern the massive winter deaths of fish that take place at the winter enclosures of the lagoons and the poor entry of fry in the basins.

The aim of this work is to report the seasonal evaluation of current meteorological and hydrological patterns at the basins of the lagoons Vassova and Eratino, to describe their eutrophic character and to study the results of the experimental enrichment of these lagoons by sea bass fry.

Materials and Methods

Sampling of surface waters at six selected stations (B1, B2, B3 & B4 for Vassova, E1 & E2 for Eratino) took place with a monthly rate, during the period July 1994 - January 1996, at the aquatic ecosystem of the lagoons Vassova and Eratino. Stations B1, B2, and E1 are located at the main basins of these two lagoons, stations B3 and E2 at the adjacent drainage canals and station B4 at the coastal area out of the lagoons (figure 1).

The collection and preservation of water samples in plastic bottles of 100 ml for the determination of nutrients followed the methodology of [8]. Nutrients concentration was determined by photometric methods as: nitrates [9], nitrites [10], ammonium [11] and phosphates [12].

Data sampling was always taking place at the above stations on the day of maximum tidal range (spring tide), during the entrance of saline water into the lagoons. This sampling strategy eliminates the effect of tidal circulation on the temporal variability of the physical and chemical parameters of the system [13].

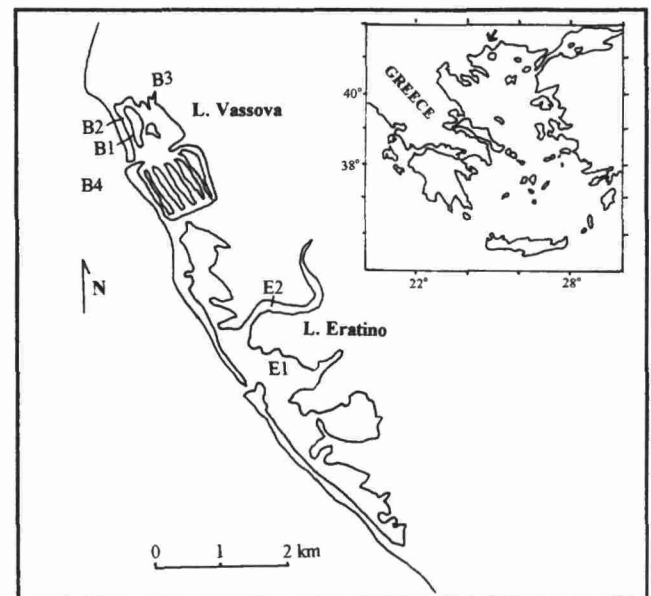


Figure 1 : Map of Vassova - Eratino lagoons and sampling stations.

Random sample (N=224) of *Dicentrarchus labrax* population was examined on a weekly basis for the whole fishing period (November - February 1993-94), for the determination of their main biometric characteristics, such as total length, fork length, net body weight and gross body weight, for both sexes. Comparative fish sample (N=76) was taken once (October 1994) from a nearby hatchery (Fanari) in order to examine the growth of the same population under culture conditions. A calculated index, named condition factor "Clark" [14] was considered as appropriate to compare the growth of populations under different feed and environmental conditions, between the lagoons and the hatchery.

Results and Discussion

The seasonal patterns of the physicochemical parameters and nutrients concentrations at three stations representative of fresh, brackish and saline water at Vassova lagoon, are presented at figure 2. The reduction of water temperature during the winter period at the lagoons Vassova and Eratino appear to be responsible for the fish deaths reported at the winter enclosures. Low winter water temperature inhibits fish growth, a mechanism not well recorded as summer anoxia, while the influence of strong winds flowing over these shallow lagoons increases turbidity causing fish deaths [15]. The summer phosphate peak occurring at the lagoons Vassova and Eratino follows closely the amount of fresh water discharged in the system. This fact indicates the long-term influence of fresh water into the lagoon and the sinking of phosphates which reappear in the water column during summer remineralization [16, 17].

Reduced precipitation and fertilizers are the most important factors determining nitrate concentration. The concentration of nitrates, in comparison to nitrogen fertilization loading of the broader area (100