ICHTHYOFAUNA RECOVERY OF A NEWLY RE-FLOODED MEDITERRANEAN COASTAL LAGOON

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Abstract
The ichthyofauna of the illegally drained Drana lagoon (NE Greece) was studied, with the lagoon's hydrographic and water quality characteristics, during pre- and post-restoration works leading to its re-flooding. The low diversity, compared with other lagoonal ichthyofauna, is probably due to the recent re-flooding and the limited sampling intensity. The reduced presence of the mugilids may be related to the prevailing tidal inlet dynamics.
Keywords : Fishes, Lagoons, Restoration, Eastern Mediterranean.

Introduction
Fisheries exploitation of coastal lagoons is been applied in Greece since the ancient years. Nowadays most of them are managed by Fishing Cooperatives with "traditional"permanent fish entrapment devices, combined with fish wintering channels. In northern Greece, the lagoons extent in 11500 ha and during the last decade their average landings are 600 t/year, with a clear decreasing trend.
Drana Lagoon, located at the NW site of the Evros River Delta (N.E. Greece), a fishery-exploited lagoon (fish production of 8 to 20 tn during 1974-1986) was drained illegally in 1987 by local farmers, under the perception that the lagoon's saline water affects their adjacent cultivations (Figure 1). Lagoon's re-flooding (by the opening of a new 5 m wide entrance for the water), together with other restoration works, were carried out during June 2004. The project was funded by a LIFE-Nature project, aiming to: a) restore lagoon habitats structure and functions, b) conserve protected avifauna species, and c) upgrade the management effectiveness applied in the lagoon's broader area. It is expected that the lagoon's ichthyofauna restoration would allow further fisheries exploitation by the local cooperative.

Materials and Methods
A sampling program to determine the pre- and post-flooding ichthyofauna distribution (in terms of species abundance and diversity) was conducted, in association to hydrographic and water quality studies. Three samplings were attained: one before re-flooding (January 2003) and two after re-flooding (October 2004 and April 2005). Fish were collected using a nylon centre-bag seine net (3 mm bar mesh size) of 12 m length and 1.2 m height. The bag seine was hauled for 30-50 m in order to cover an area of 250 m^2, approximately. The relative abundance was estimated by the Catch per Unit Effort method (CPUE: 1.000 m^2). Fish samples were preserved in 6% formalin solution and later sorted and measured in the laboratory. Water flow, tidal elevation, water temperature, salinity and dissolved oxygen content were recorded at the lagoon's inlet during two consecutive tidal cycles (24 hrs) for each monitoring period. Nutrients and chlorophyll-a were also determined at 9 sites inside the lagoon, during the ebb and flood periods of each tidal cycle.

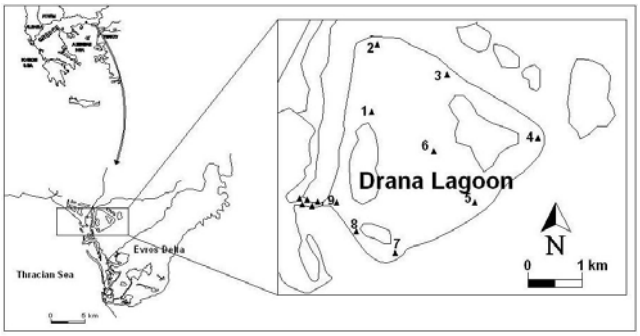

Fig. 1. Map of the Drana Lagoon (Evros Delta, Greece) indicating the sampling sites for fish fauna (black triangles) and oceanographic, physical and chemical water conditions (1-9).

Results and Discussion
Results from all samplings depicted the presence of saline water (up to 41 psu) inside the lagoon, due to sea water intrusion and increased evaporation rate. Dissolved oxygen distribution appeared to be mostly influenced by the wind mixing, rather than by the advection of oxygenated sea water through the inlet. Nutrient and chlorophyll-a levels showed negligible spatial and temporal variability. A mean concentration of 50 μgr/l for nitrates, 95 μgr/l for phosphates and a mere 0.2 μgr/l for chlorophyll-a was observed. Tidal variability at the mouth was approximately 0.2 m, producing tidal currents of up to 0.75 m/s.
Twelve species representing 8 families were caught during the 3 samplings. Seven species were caught during the pre-reflooding period at the entrance. Five new species were collected after re-flooding, while one species caught before re-flooding, was not found again (*Gambusia affinis*). Among all species caught, 5 species were characterized as permanent residents of lagoonal ecosystems, 6 as marine migrants and 1 as straggler (Table I). The inner part was dominated by five species. Among them *Atherina boyeri*, a species that permanently inhabits coastal brackish ecosystems, showed the higher presence (50.8%), followed by *Pomatoschistus marmoratus* and *Aphanius fasciatus*, both residents lagoon species, and two migrants, *Lithognathus mormyrus* and *Sygnathus abaster*. Generally, reduced species diversity was observed, compared to other lagoon ecosystems, probably due to the recent lagoon re-flooding and the limited sampling intensity. The reduced presence of the Mugilidae family species inside Drana Lagoon (2.1%), which constitutes the higher proportion of the Greek lagoons' catches (60-80%), could be related to the prevailing tidal inlet dynamics (i.e. strong ebb flow at lagoon inlet).

Tab. 1. Relative abundance of the ichthyofauna of the Drana Lagoon (Evros Delta, Greece), before and after restoration (R= resident species, M=migrant species, S=straggler species).

n	Family	Species	Life history	Before	After
1	Atherinidae	*Atherina boyeri*	R		37.6%
2	Cyprinodontidae	*Aphanius fasciatus*	R	0.4%	7.6%
3	Gobiidae	*Pomatoschistus marmoratus*	R		0.2%
4		*Knipowitschia caucasica*	S	5.6%	31.7%
5	Mugilidae	*Mugil cephalus*	M	0.7%	2.9%
6		*Liza ramada*	M	57.5%	0.6%
7		*Liza aurata*	M	32.7%	0.2%
8		*Liza saliens*	M	0.9%	1.2%
9	Poeciliidae	*Gambusia affinis*	R	2.2%	
10	Soleidae	*Solea solea*	M		0.3%
11	Sparidae	*Lithognathus mormyrus*	M		8.1%
12	Syngnathidae	*Syngnathus abaster*	R		9.4%

Inlet dynamics characterized by strong flood currents and limited ebb duration were considered to affect the entry of juveniles into Drana Lagoon. An improvement in the design of the lagoon's inlet was suggested, by increasing its width and produce areas of low flow conditions. Lateral friction could be enhanced with the positioning of medium-sized stones at the sides of inlet's banks.

References

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