



Target Fishery Species and Their Perspective in Prespa Lakes (West Macedonia, Greece)[#]

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Abstract : The trans-boundary Prespa Lakes Macro (Big) and Micro (Small) near past was considered as traditionally inland fishery areas, for the neighbouring countries, nowadays they tend to lose this characteristic profile due to the degradation and the overexploitation of their natural resources and the lessening of the most important commercially fish species, that are the target fishery species. This paper aims to consider the changes of fishery production through time for the target fishery species for the two trans-boundary Prespa Lakes (Micro and Macro) during the last 20 years of the last century in a yearly basis and in detail the fishery production of the Common carp (*Cyprinus carpio*), the Prespa roach or 'Platika' (*Rutilus prespensis*) and the European chub (*Squalius cephalus*). The Minitab 13.20 software was used to perform modelling and then, short - term forecasts regarding to the ratio of the target fish species caught from the fishermen. The results signify the evident degradation of the fishery production of these two trans-boundary lakes as also the selectivity of the fishery in the substitution of some important environmentally fish species. The conclusions of this study can be helpful to the neighboring responsible authorities within the development of a common trans-boundary sustainable fishery strategy aiming to protect biodiversity and sustain local economy.

Key words: Prespa Lakes, fishery, fishery models, fish biodiversity, trans-boundary lakes

Introduction

Investigated Area

The area of Prespa lakes (Fig.1) has been a vibrant region over the centuries and has been shaped both by nature and people, resulting in a rich natural environment. At the present time, the trans-boundary Prespa Lakes Macro (Big) and Micro (Small) that are among the oldest lakes in Europe they host many endemic life forms, as well as species with a very narrow geographic range in Balkans. They are located in the borders of Greece, F.Y.R.O.M. and Albania (Macro or Big Prespa), and Greece-Albania (Micro or Small Prespa), and they are significant wetlands due to their biodiversity and natural environment, while currently are protected from national and international legislation. At the same time, local natural resources act as a key factor that causes continuous changes in the ecosystem, through the impact on human activities. The freshwater of the lakes in particular is the main benefit of the area, including all sensible wild species as also and the human beings.

Even if in the near past the above lakes was considered as traditionally inland fishery areas, not only for Greece, but also for the neighbouring countries, nowadays they tend to lose this characteristic profile due to the degradation and the overexploitation of their natural resources and the reduction of the most important commercially fish species (Kokkinakis & Andreopoulou, 2006). Unfortunately, for the period of the last decades and mainly since the decade of 70's, fishery production was reduced enough, at least in the Greek part of Prespa lakes, due to reasons such as overexploitation of the natural biological resources as 'over fishing', environmental surcharge and conflict functions and uses of their waters (Economidis *et al.*, 2001; Kokkinakis *et al.*, 2003; Kokkinakis & Arabatzis, 2004; Kokkinakis & Andreopoulou, 2007). Even if a lot of environmental studies and scientific projects have been carried out concerning the protection of wild life and the biodiversity management in both of Prespa lakes (Pyrovetsi *et al.* 1984; Koutsoubidis 1988; Hollis & Stevenson, 1997; Papoutsis-

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Psychoudaki & Psychoudakis, 2000), only a few of them were occupied directly with human activities as the fishery and with the existing general management of the natural biological resources in the above lake systems (Crivelli *et al.*, 1997; Florina's Prefecture 1998; Economidis *et al.* 2001; Kokkinakis & Andreopoulou, 2007; Kokkinakis *et al.*, 2007).

Fishery is present in both Prespa lakes since ancient time. Nowadays, the number of active fishermen has constantly decreased and it is difficult to recognize how many fishermen currently continue fishing in each one of them from all the involving countries. In the Greek part only the people of the village 'Psarades' remain still fishermen on both Prespa lakes and they are less than fifteen. Other amateur fishermen are mainly farmers fishing in their spare time (Kokkinakis & Andreopoulou, 2007).



Figure 1.he Pespa lakes in the region of West Macedonia (Greece)

This paper describes the changes in the composition of the fishery production regarding to the 'target fish species' caught in the Greek part of the above lake systems during the last decades of the 20th century and further attempts to perform through modeling short - term forecasts regarding to the ratio of the dominant fish species caught from the fishermen. The aim of the present work is to review current knowledge of the existing structure of the fishery production in Prespa lakes and to detect the trends in the near future of the fish populations in both of the above lakes.

Material and Methods

Data concerning only Greek parts of the Prespes lake ecosystems, were collected from scientific references and bibliography (Crivelli *et al.* 1997; Catsadorakis & Malakou, 1997; Kokkinakis *et al.*, 2003, 2007; Kokkinakis & Arabatzis, 2004; Kokkinakis & Andreopoulou, 2007), relative environmental studies (Florina's Prefecture Study, 1998), recent research programs (Economidis *et al.*, 2001), and from the relative responsible Greek governmental offices as the "Fishery Department" of Florina's Prefecture, also responsible for the fisheries in the Greek part of Prespa lakes.

The collected data concerned yearly fishery production of the most important commercially fish species that are the 'Target Fish Species' for the fishermen as the Common carp (*Cyprinus carpio*), the Prespa roach or 'Platika' (*Rutilus prespensis*) and the European chub (*Squalius cephalus*) separately.

The collected fishery data were initially organized and analysed with MS-Excel and further the composition of the fishery production was estimated through the percentage of the most important commercial fish species (target fish species). Then, it was presented and discussed separately for the two lakes the changes in the composition of the fishery.

Finally, the Minitab 13.20 software was used to perform through modelling, for each one of the two lake ecosystems, short - term forecasts regarding to the ratio of the target fish species caught from the fishermen for 95% confidence. Within the development and application of statistics in the environmental sciences, also called "Environmetrics", time-series analysis has been widely used for modelling water resources and environmental systems (Hipel & McLeod, 1994). 'Trend Analysis' fits a general Trend Model to time series data and provides forecasts, as extrapolations of the trend model. Models are mathematical representations of real-life system that can be computerized and modelling process is a key ingredient to decision making, as it supports managers in non-routine decision tasks (Jackson & Harvey, 1997; Hair *et al.* 1998). A model is a substitute of a real system and mathematical

models for environmental systems are used to represent the interconnections in the ecosystem (Ford, 1999; Olden & Jackson, 2002). Data prior to the forecast origin year are used as input to fit the trend.

Results

a. Lake Macro Prespa

The composition of the fishery production for the last two decades of last century for the lake Macro Prespa is described in Fig. 2. In Fig. 3 are presented the percentage of the target fish species in relation to the total fishery production, as the Common carp (*Cyprinus carpio*), the Prespa roach or 'Platika' (*Rutilus prespensis*) and the European chub (*Squalius cephalus*). In the same figure are presented also the forecasts for their percentage in total fishery production for the next 3 years. The rest of the fishery species as *Barbus prespensis* and *Carassius gibelio*, are not presented in detail in this study for the reason that their yearly percentage in the total fishery catch was very small. In Figs. 2a and 2b are presented only their mean percentage in the total fishery production of Lake Macro Prespa for the decades of 80's (period A) and 90's (period B).

Aiming to examine the composition of fish species in the fishery it is evident the predominance of Platika for all the years we had available data except of the years 94-96 where the dominant species is the carp (Figure 3). The predominance of the most commercial fish species of the inland European waters is preserved only for these years while in the rest of the years dominate in Macro Prespa fisheries the smaller and not commercially important species, such as the Platika, that represents for the 80's a percentage higher than 80% of the production and the European Chub in a stable percentage below 20%. The appearance of higher percentage of carps during the years 1994, 1995 and 1996 can be explained from possible enrichments that took place during that period in the neighboring Lake Micro (Small) Prespa (Economidis *et al.*, 2001), where the fishermen have dropped arbitrary a part of the brought fish in the system of Macro (Big) Prespa.

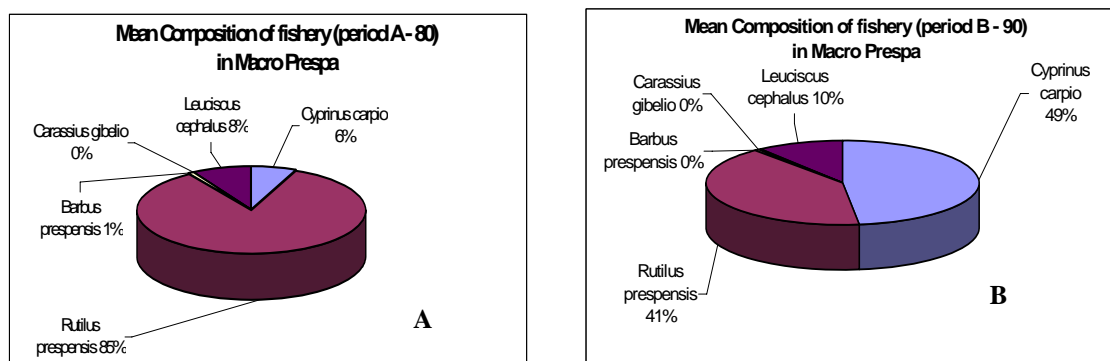


Figure 2. The mean fishery composition of Macro (Big) Prespa for a) the decade of '80 (period A) and b) the decade of '90 (period B).

In Figure 3 is estimated through the "Trend Analysis" method the percentage of fishery production of the main catch in Big (Macro) Prespa, that is Common carp, Platika, and European chub provided from historical data only in the decade of the 90's. In Tab.1, are presented the equations for the models generated for each species partially and their forecast percentages in the catch for the coming years.

Table 1. The fitted equations using "Trend Analysis" for the target fish species in Macro (Big) Prespa and the forecast for their percentage in the Total Fishery Production of the lake.

Target fish species in the fishery production of Macro (Big) Prespa	Fitted 'Trend equation'	Percentage Forecast		
		2000	2001	2002
<i>Cyprinus carpio</i>	$Y_t = 123,21 - 30,5546*t + 2,09107*t^{**2}$	11,70	12,6	17,59
<i>Rutilus prespensis</i>	$Y_t = -28,26 + 35,9779*t - 3,73929*t^{**2}$	40,30	20,2	0,00
<i>Squalius cephalus</i>	$Y_t = -11,78 + 6,28*t$	32,10	38,4	44,74

The analysis shows that only the species European chub will contribute with a higher participation in the catch during the coming years, because it is evident that it starts to be chosen from the fishermen as an alternative species with a significant commercial interest.

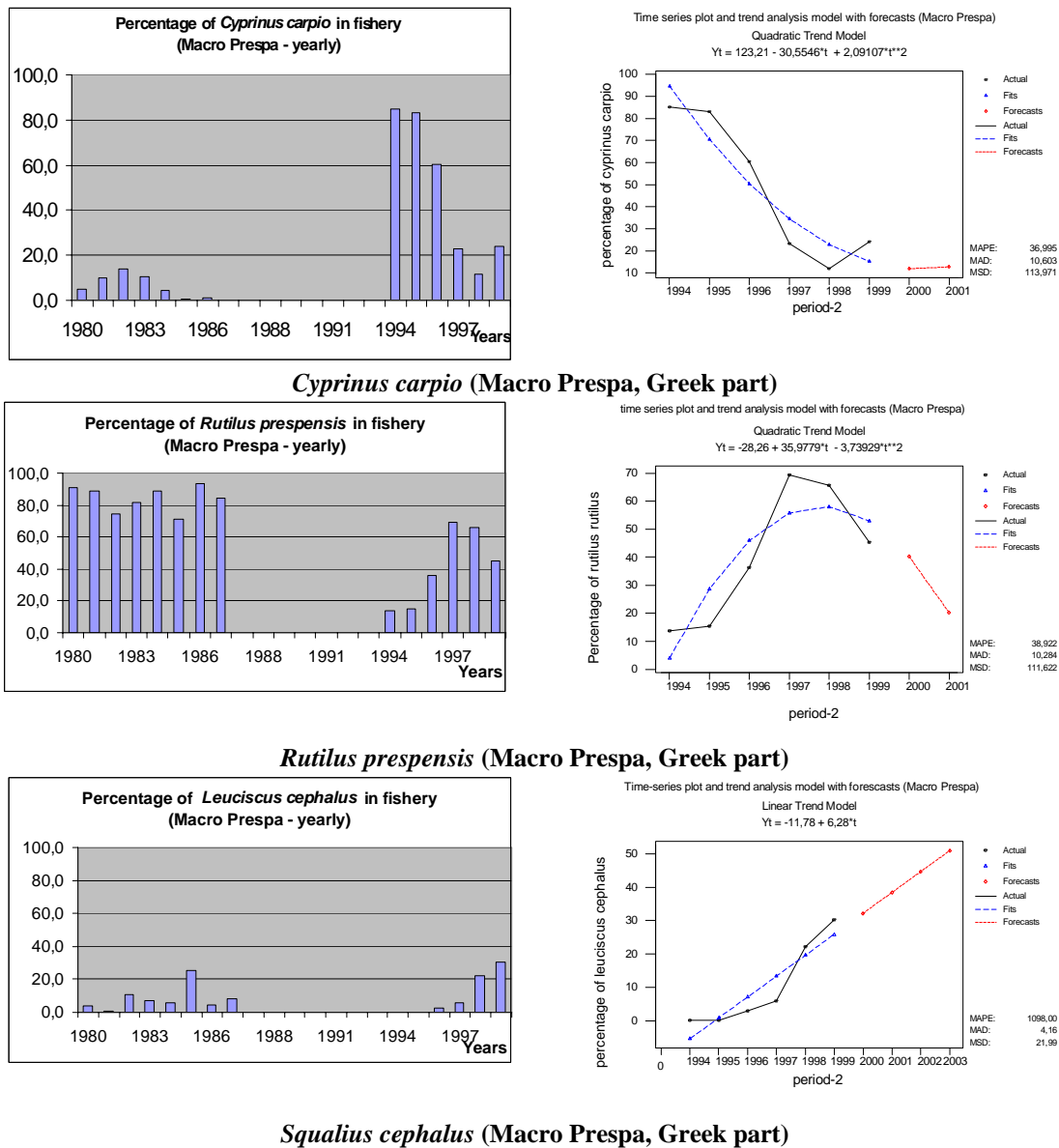


Figure 3. The percentage and the ‘Trend models’ for the estimation of the percentage of target fish species in fishery composition of Macro (Big) Prespa

b. Lake Micro Prespa

The composition of the fishery production for the last two decades of last century for the lake Micro (Small) Prespa is described in Fig. 4. In Fig. 5 are presented the percentage of the target fish species in relation to the total fishery production, as the Common carp (*Cyprinus carpio*), the ‘Platika’ or Prespa roach (*Rutilus prespensis*) and the European chub (*Squalius cephalus*). In the same figure are presented also the forecasts of their percentage in the total fishery production for the coming 3 years. Table 2 is presented the fitted equations using the ‘Trend Analysis’ method for the target fish species. The fish species *Barbus prespensis* and *Carassius gibelio*, are not presented also here as for lake Big Prespa, for the reason that their yearly percentage in the total fishery catch was very small. In Figures 4a and 4b are presented only the mean percentage in the total fishery production of Lake Micro Prespa for the decades of 80’s (period A) and 90’s (period B).

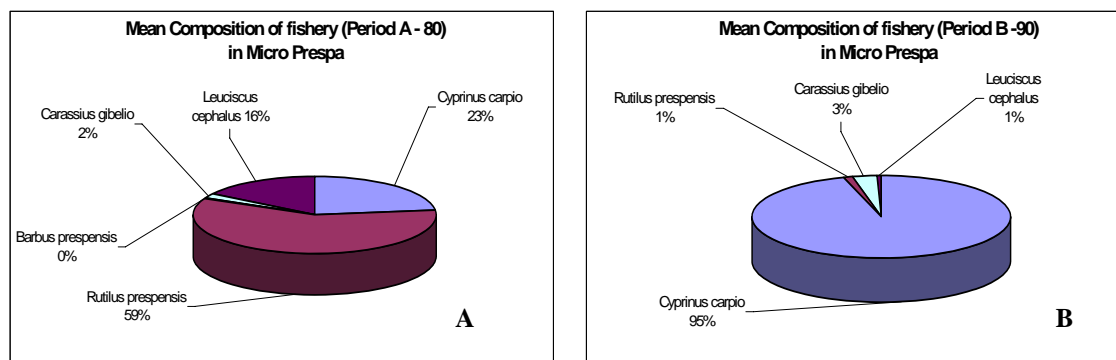


Figure 4. The mean fishery composition of Micro (Small) Prespa for a) the decade of '80 (period A) and b) the decade of '90 (period B).

From the examination of the fishery composition it is evident the superiority of Platika (*Rutilus prespensis*) for all the years we had available data except of the first year of period A (decade of 80's) where the superior species is the carp (Fig. 3a). The carps however, reestablishes its predominance in the catch and becomes the prevailing fishery species in the next decade of the 90's, and substitutes heavily all the other species till it finally occupies the 90% of the fishery production in Micro (Small) lake. The appearance of higher percentage of carps in the midst 90's and especially during the years 1994, 1995 and 1996 can be explained, as in the case of Macro (Big) Prespa from the enrichments that took place during that period of time mainly in Micro (Small) Prespa lake (Economidis et al., 2001).

In Fig. 5 are estimated using the 'Trend Analysis' method the percentage of the fishery production of the main fish species catch in Micro (Big) Prespa lake, that is Common carp, Platika, and European chub, provided from historical data only in the 90's. In Tab.3, are presented the equation for the models generated for each species specifically and the forecast percentage in the catch for the coming years.

It is derived from the above analysis that only the species *Cyprinus carpio* will continue to be the predominant species while the participation of the species *Rutilus prespensis* will be continually increasing as an attempt to cover the losses from carp. Yet, another small but important species for fishery, the species *Squalius cephalus*, will continue its increasing trend to participate in the total catch of the lake, trying also to counterbalance the losses from the main commercial species, that is *Cyprinus carpio*.

Table 2. The fitted equations using 'Trend Analysis' for the target fish species in Micro (Small) Prespa and the forecast for their percentage in the Total Fishery Production of the lake.

Target fish species in the fishery production of Micro (Small) Prespa	Fitted'Trend equation'	Percentage Forecast		
		2000	2001	2002
<i>Cyprinus carpio</i>	$Y_t = 99,31 + 1,36679*t - 0,616071*t^{**2}$	78,69	70,81	61,71
<i>Rutilus prespensis</i>	$Y_t = 0,04 - 0,407857*t + 0,175*t^{**2}$	5,76	7,97	10,54
<i>Squalius cephalus</i>	$Y_t = 0,42 - 0,387857*t + 0,103571*t^{**2}$	2,78	3,94	5,32

Discussion and Conclusions

Prespa lake ecosystem constitutes a sensitive and vulnerable ecosystem with a great importance for local biodiversity and moreover, for the benefit of local populations through their multiple exploitation.

The results signify the evident degradation of the fishery production of these two trans-boundary lakes and also the selectivity of the fishery in the substitution of some important environmentally fish species with sensitive life cycles.

The Common carps (*Cyprinus carpio*) constitute the main commercial target species in both lakes; however, the production in the Macro (Big) Prespa Lake has been intensely decreased. In Micro (Small) Prespa lake the fishery production of that species has been reestablished for some time

through enrichments that took place, yet they were not able to reinstate the populations in the lake, since they were ‘over fished’ (Economidis et al. 2001). It is derived from the findings of the study that the limitation in ‘over fishing’ for the most commercial species that are the target species for the fishermen, will help to the reestablishment of their population and the balance of the populations into the ecosystem of both lakes and consequently, in the recovery of the lake equilibrium. The population recovery of carps with strictly controlled enrichments or maybe with the prohibition of fishing the species for some years can be a critical factor towards the protection of the populations of smaller fish species such as Prespa roach or ‘Platika’ (*Rutilus prespensis*) and the European chub (*Squalius cephalus*) which however play a decisive role in the function of the lake ecosystem.

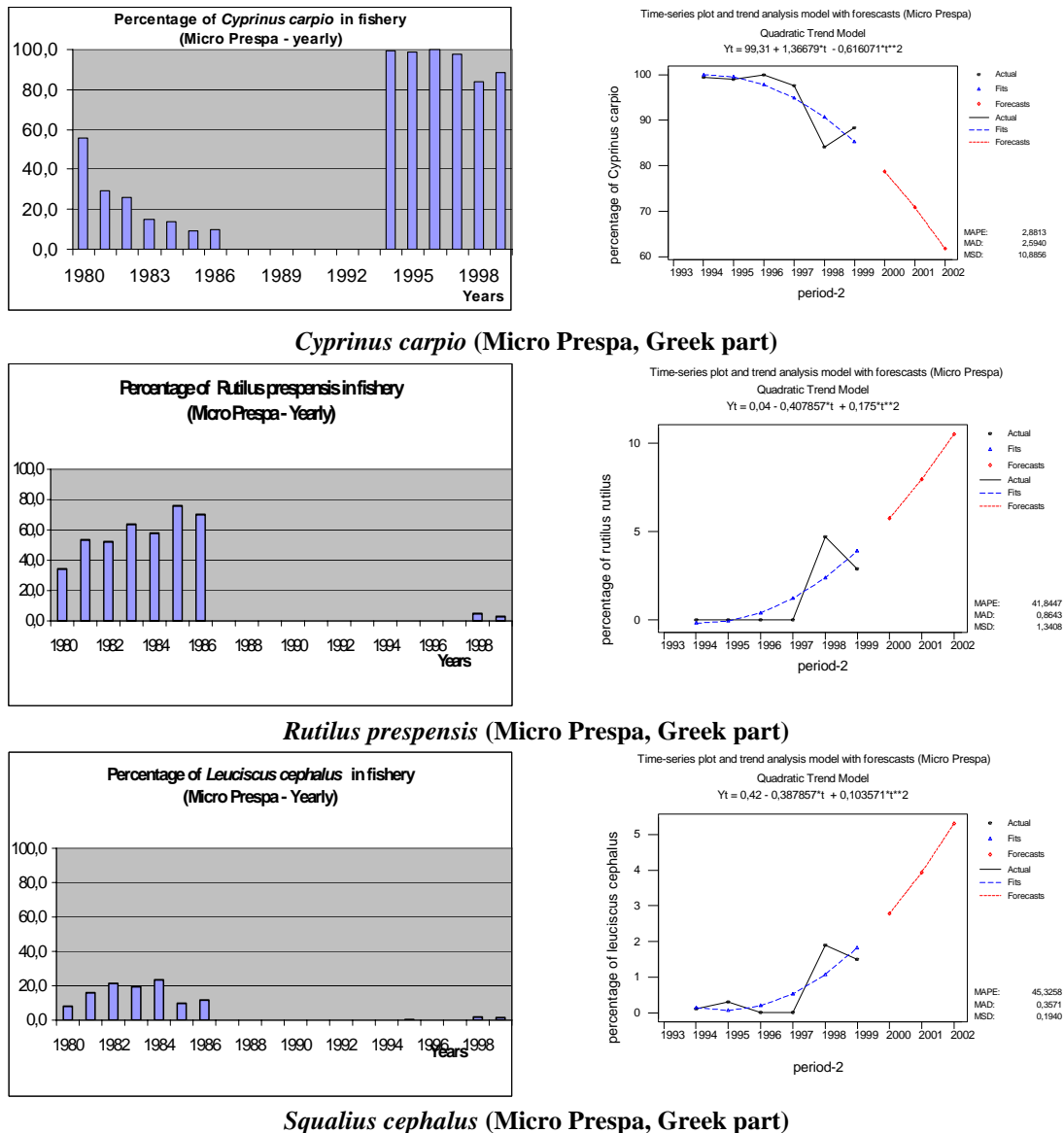


Figure 5. The percentage and the ‘Trend models’ for the estimation of the percentage of target fish species in fishery composition of Micro (Small) Prespa.

Aiming to support well-informed decision making concerning the management of fish populations, the analysis of fish composition and the application of these estimates is a key factor to management strategy and to the development of sound management decisions. Findings can be helpful to the neighboring responsible authorities within the development of a common trans-boundary sustainable fishery strategy aiming to protect biodiversity and sustain local economy for the Prespa lakes.

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