ECODEVELOPMENT IN PRESPA NATIONAL PARK, GREECE

By

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ABSTRACT

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Prespa National Park, in extreme northwestern Greece, was established in 1974 in order to preserve unique natural features, vegetation and wildlife.

The present study was undertaken to ascertain whether conflicts existed between park-land use operations and the preservation of several nearly-extinct bird species which breed in the park. The complete dedication of the Prespa National park to nature protection conflicts strongly with the interests of the 1000 people who now reside within its boundaries. For the park to meet its objectives and to contribute to human needs, improved regulation and management seems necessary.

Biophysical features, including flora, fauna and the lakes themselves, as well as the legal status of the park, were examined. Patterns of land use and vegetative change were evaluated by preparing maps from aerial images of 1945 and 1969-1970 (updated to 1984 through ground-truth appraisals). The conservation implications of changes in land use indicated that there is an accelerating concentration of human activities in the wetlands which have been officially defined as the nucleus of the park.

The use of park biotopes by the 12 rare/or endangered waterbird species was evaluated in order to appraise their conservation potential and ecological values of these habitats. Eight sampling sites were established.

Measurements of the abundance, species diversity and species richness of birds in these breeding and feeding/resting areas were made. Important environmental factors such as water level fluctuation and human impacts on the birds were assessed. It was determined that the wet meadows were of critical significance as feeding/resting grounds for all waterbirds during the nesting period.

Conflicts between bird habitats and land use in the national park were analyzed. Movements of bird populations and shifts in nesting locations due to human disturbance were documented. Drainage, agricultural activities and intrusions of local residents into the wet meadows were found to be the main factors which limit the abundance of waterbird species in the park.

Management suggestions are given which integrate conservation into development processes and enhance both nature protection and human culture in Prespa National Park.

To
my parents
and
my children

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PREFACE

In approaching the management of national parks, this study was inspired by and adopted K. Miller's (1978) objectives for ecodevelopment in national parks. These, he says, are to:

1. Maintain representative samples of major biotic units as functioning ecosystems in perpetuity.
2. Maintain ecological diversity and environmental regulation.
3. Maintain genetic resources, especially those of endangered species.
4. Protect sites and structures of cultural, historical and archaeological heritage.
5. Protect scenic beauty.
6. Facilitate education, research and environmental monitoring in natural areas.
7. Facilitate public recreation and tourism.
8. Support rural development through rational use of marginal lands and provision of stable employment opportunities.
9. Maintain watershed production.
10. Control erosion and sediments and protect downstream investments.

The author will be pleased to correspond with individuals who desire detailed scientific data.

INTRODUCTION

The loss of wetlands with their considerable economic and ecological values, is a matter of worldwide concern. Lake Mikri Prespa in Greece stands as one of the last refuges in Europe especially for its rich wetland fauna. An exceptional assemblage of waterbird species which are classified as rare or endangered breed in the area. This lake has been recognized by the International Union for the Conservation of Nature (IUCN) as being of great importance and the government of Greece has declared Prespa a national park.

The park contains villages whose residents live on its resources. The use of these resources by people has created a conservation problem. A strong conflict exists between human land use and nature conservation. The total exclusion of human activities, as practiced in the national parks of many countries, appears not to be the appropriate policy in Prespa. Like birds and their nesting sites, people and villages are integral parts of the area. The development of one aspect as opposed to the other will not benefit park values and objectives. It is believed that human culture and natural life should perpetuate themselves in this area where they have prevailed for hundreds of years.

Nevertheless, dedication of Prespa to national park status requires environmental regulation if the park is to meet its conservation objectives and contribute adequately to the ecodevelopment of the region. Such environmental regulation should integrate the social, economic and ecological values of the area. It should be based on knowledge of the park's resources and an understanding of the ways that ecosystems function.

At present, the park is operating without any environmental understanding, operational regulation or management plan. There is an urgent need for adequate ecological research and for zoning of the area before physical and touristic developments destroy the basic attributes which the park was created to preserve.

The presence of the villages within the park boundaries has an impact on the natural environment which must be studied and minimized. The wetland's resources are unique and susceptible to irreversible loss. Such fragile ecosystems must be maintained free of conflicting land uses. Governmental agencies must base administrative decisions on scientific findings and analysis.

Investigations are essential to develop a conceptual plan based on the objectives of national parks and the needs of the local people. The area itself is rural lying along the international border of Greece-Yugoslavia-Albania. The conservation and development of the national park and contributions to rural development all must involve the regulation of land use practices according to ecodevelopment principles. Ecological research and planning documents must be prepared to guide the management and development of the area.

All of these things were viewed as needs of the present study. A major objective was to analyze and to help resolve conflicts between resource use and the preservation of birds which are nearly extinct in Europe. A central point of land use analysis was to plan for the future of the park by reviewing the past, comparing it with present conditions and offering suggestions for the future. In this appraisal, it was essential that the conservation potential and ecological evaluation of the various park biotopes be estimated through the use of these habitats by the several rare waterbirds.

Important questions regarding conservation in the park which the study considered are:

1. How compatible is present land use and exploitation of the area's natural and cultural resources with its long-term conservation?
2. Are those habitats which are critical to the survival of the endangered birds adequately identified and protected against change?
3. Do the present regulations and conditions in the park meet the standards for excellence established by the government of Greece and the world community?

Geographic Location

Lake Mikri Prespa National Park is located in the northwest corner of Greece (40° 45' N, 21° 37' E) in the Prefecture of Florina (Figure 1). The area is a mountainous plateau bordered on the north by Yugoslavia, on the west by Albania, and to the south by the Prefecture of Kastoria (Greece). On this plateau are Lake Mikri Prespa (small Prespa) which is shared between Albania and Greece (Figure 2). Adjacent is Lake Megali Prespa (large Prespa) shared between Yugoslavia, Albania and Greece. On the Greek side, the two lakes are bordered by Mounts Varnous and Triklarion. The altitude ranges between 853 m above sea level, the mean water level of the two lakes, and 2177 m on the alpine summit of Mount Varnous.

The national park covers nearly 25,690 ha. The total water surface within the park comes to 8604.8 ha, distributed as follows: Lake Mikri Prespa with a surface area of 4850 ha of which 4350 ha belong to Greece and approximately 500 ha to Albania. A small portion of Lake Megali Prespa, coming to 3763.7 ha, belongs to Greece as part of the national park.

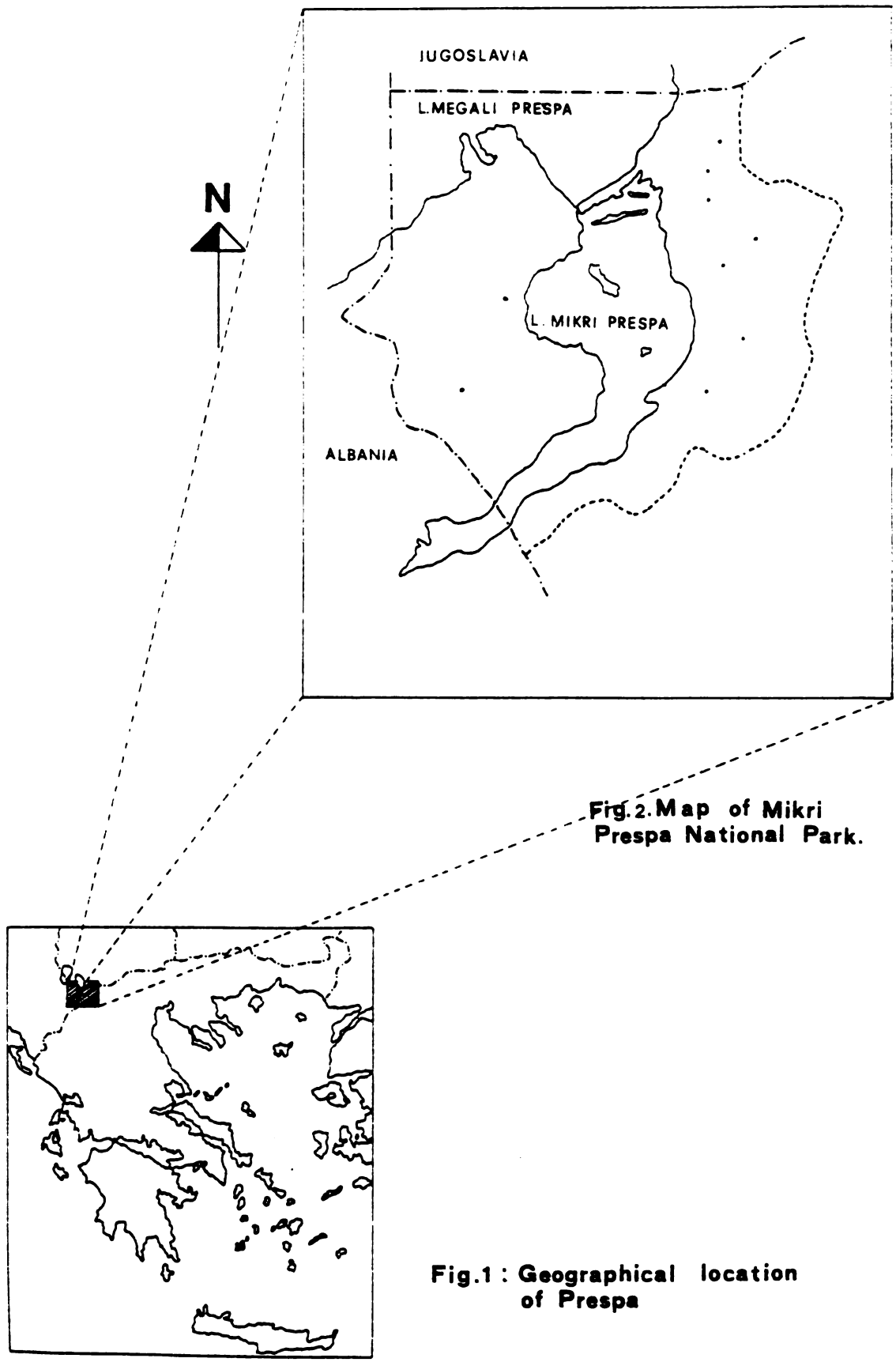


Fig.2. Map of Mikri Prespa National Park.

Fig.1 : Geographical location of Prespa

Being within the Prefecture of Florina, Prespa is most closely associated with the capital city, Florina, located 47 km east of the Park. A two-lane paved road joins Prespa with Florina. The city of Kastoria is situated approximately 53 km south of Prespa and connected with it by a paved road.

Albania is adjacent to the entire western border of the Park. There is no road or any means of access across the border from either direction. The border between Yugoslavia and Greece lies along the northern boundary of the Park. There is no direct access to Greece from Yugoslavia at Prespa.

Previous Studies

The first reference in recent years about the Prespa area is the geological study of Cvijić (1911). This was followed by the limnological-hydrological reports of Schröder (1923), Parenzan (1931) and Jakovljević (1935). It is strange that Prespa is not included in the comprehensive works on Macedonian ornithology by Gengler (1920) and Stresemann (1920) and is also omitted from Reiser's (1933) "Ornis Balcanica."

The first ornithological observations in the area are given by a Cambridge hydro-biological expedition led by Thorpe in 1934 (Thorpe et al., 1936). The team found "Mikri Prespa rather disappointing as a habitat for birds." An explanation for this may be that the area was visited during late September, at a time when most of the birds have migrated to their wintering grounds. Another view may be that Lake Malik, nearby in Albania, had not then been drained and might have been a more important bird habitat.

For more than 30 years there has been no ornithological information from Prespa due to the Second World War and the Greek Civil War. During the latter, the area was a critical battlefield. Sage (1966), Bodenstein and Kroymann (1967) and Brosselin and Molinier (1968), after visits to the area, gave a list of the wildlife and fish species present there and offered the first conservation suggestions regarding Mikri Prespa. Terasse et al. (1969), Terasse and Terasse (1970), Géroudet (1973), Kempf and Wersinger (1974) and Makatsch (1980) presented somewhat later ornithological observations from the lake region.

Bauer et al. (1969, 1970, 1973) included the birds of Prespa in their Catalogous Faunae Graeciae. In 1971, Hoffmann and his associates representing the International Union for the Conservation of Nature and

Natural Resources (IUCN), the World Wildlife Fund (WWF) and the International Wildfowl Research Bureau (IWRB) proposed (Hoffmann et al., 1971) the establishment of Prespa National Park. After park establishment in 1974, Broussalis (1974) published a general description of the national park, including its flora and fauna.

A series of short articles about the park by various authors (Sevastos, 1974; Sfikas, 1977; Kühnelt, 1978; Pyrovetsi, 1983) have stressed the importance of the area and the need for its preservation. Ornithological and limnological missions to the park by Crivelli (1977), O'Gorman (1977), Biber and Crivelli (1978), Crivelli and Hafner (1978), Crivelli and Vizi (1981), and Crivelli et al. (1983) provided additional general information on the birds of Prespa.

Other biologists who have carried out research in the area include Lavrentiades (1956) who appraised the aquatic vegetation, Stathatos et al. (1972), Mourkides et al. (1978), Karvounaris (1979) and Koussouris and Diapoulis (1983) all of whom made limnological-hydrobiological investigations; Popovska-Stanković (1972) who studied Cyprinus carpio L. in Lake Megali Prespa; Tzekakis and Papanikolaou (1977) who examined the noise situation in the park, Fish et al. (1979) who prepared an evaluative study of Lake Prespa National Park and Crivelli (1980) who appraised the area with respect to the breeding of pelicans. The Byzantine monuments of Prespa were studied by Pelecanides (1960), Moutsopoulos (1969) and Poulianos (1972). Pyrovetsi et al. (1983) elaborated on the development options and the conservation problems of Mikri Prespa National Park.

Until now there has been no attempt to make an integrated ecological study of the area. Similarly, no effort was made to confront the conservation of bird-habitats or to analyze and resolve the conflicts

between preservation and exploitation.

The problem of conservation of Prespa is a complicated one. It involves an undeveloped part of the country, a marginal land with limited resources, a land where human impact dates from ancient times.

Chapter I

STATUS OF PRESPA NATIONAL PARK

Biophysical Status

Geology

The area of Prespa is geologically part of the Pelagonic mass of Adriatica (Cvijić, 1911). The lakes Mikri Prespa, Megali Prespa, Ochrid and Malik (Figure 3) are remnants of the ancient Lake Dassaritis formed during the Tertiary Period (Jakovljević, 1935). In 1938 Lake Malik was drained and is now agricultural land. South of these lakes and close to one another are five other lakes, namely Kastoria, Zazari, Himaditis, Vegoritis and Petron (Figure 3). That part of the country may be called the Lake District of Greece.

Both Mikri Prespa and Megali Prespa are carstic lakes (Cvijić, 1911). Lakeshores on the western side of Lake Mikri Prespa are steep with frequent rock outcrops mainly of Cretetaceous limestone. The soils formed from the weathering products of these rocks are mostly fairly shallow and poor in plant nutrients. The shallowness of the soil, coupled with the steep slopes, prevents these soils from holding sufficient moisture during the months of low rainfall.

Half the length of the eastern shore also slopes steeply. The rocks there are predominantly granites and gneisses. The overlaying soils are rich in feldspars and micas and are considered quite productive in terms of natural vegetation (Forest Service of Greece, 1975). Land on the other half of the eastern side is mostly smoothly sloping or flat. It is formed of

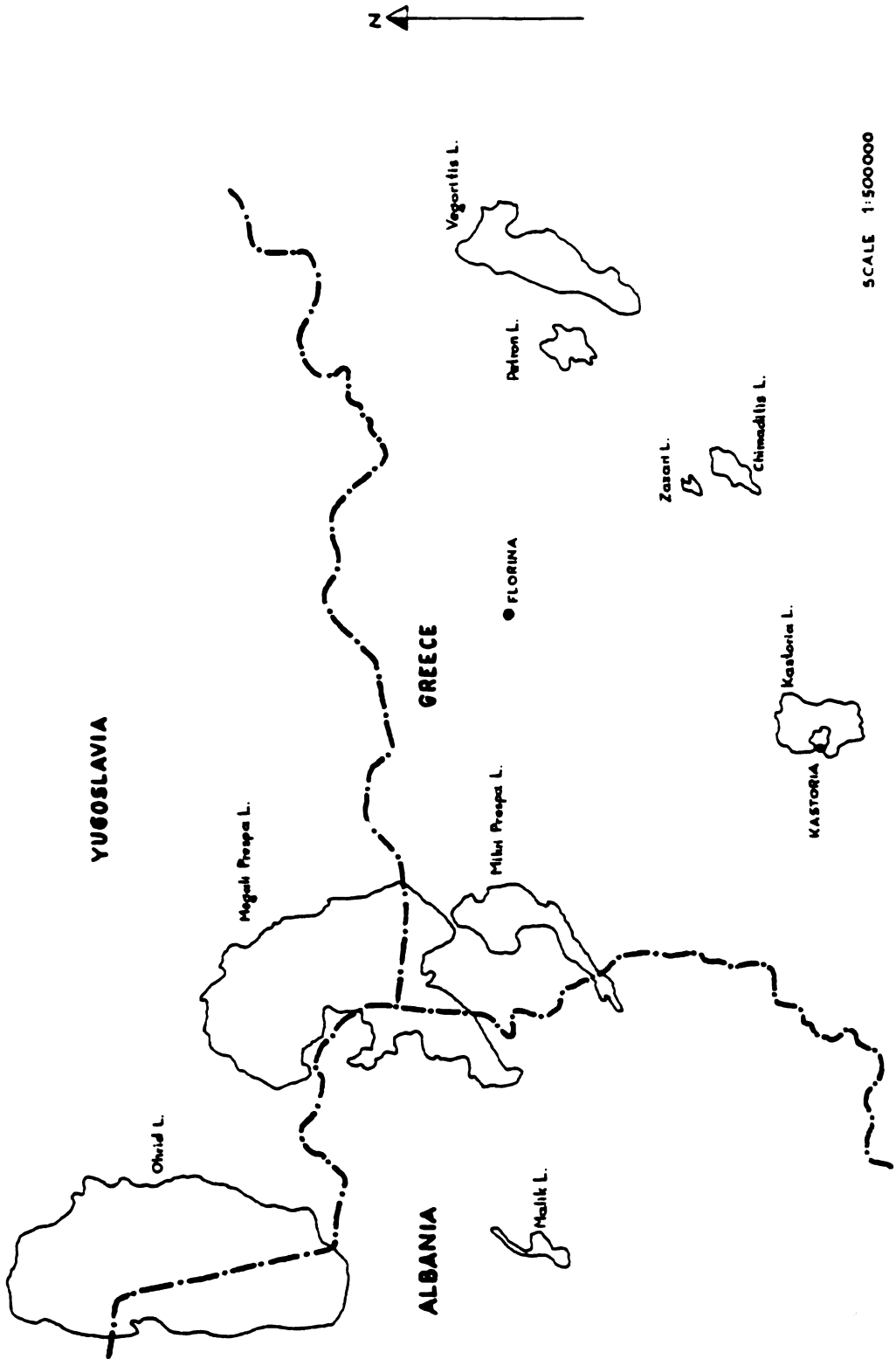


Figure 3. Regional geography of Prespa.

recent alluvial deposits with a high content of quartz. It is in this part, that most of the area's wetland is situated. The alluvial deposits are weathering products of the granite mountains which stand 100 m to 2200 m to the east. At the northern shores of the lake, another important part of the wetland is formed of flat alluvial deposits. This land is virtually an isthmus, less than 350 m wide, separating lakes Mikri from Megali Prespa.

The water level of Mikri Prespa is higher than that of Megali Prespa throughout most of the year. Water flows from the former to the latter through a narrow canal situated at the north-western corner of the lake. The discharge varies and becomes almost nil from August to January when the difference in the water level between the two lakes reaches zero. The two lakes have no outlet but there is an underground flow from Megali Prespa to Lake Ochrid. The former is 160 m higher in altitude (Broussalis, 1975; Koussouris and Diapoulis, 1983).

There are two distinct inputs of surface water to Lake Mikri Prespa. Two small rivers flow on the eastern slopes and several other streams run only during the spring snow melt. In addition to these sources, however, it is believed that underground waters flow into the lake from limestone rocks of the western areas.

Climate

The climate of the greater area of Florina has no clearly defined dry season. It has low temperatures during the winter months. It has been characterized, according to Koeppen's classification as intermediate between mediterranean (Cfa) and continental (Cfb) climates (Balafoutis, 1977).

Climatic data of the metereological station at Florina for a 24-year period (1950-1973) show that the mean annual air temperature is 12.6^{o} C and

correspond to the mean temperature of April and October. January is the coldest month with a mean value of 0.8° C; July is the warmest (23.6° C) differing very slightly from August (23.2°C) (Figure 4).

The mean annual rainfall for the same period is 752.1 mm and characterizes the climate of the area as humid continental with warm summers. The maximum is in December followed by November and October while the minimum is in August.

The growing season for vegetation is about 200 days, from April to October (Forest Service of Greece, 1975). During that period the mean maximum air temperature is 18.4° C.

In general, the climate shows the characteristics of the hot and dry Mediterranean type during the summer and of the Mid-European type during the winter with long periods of high rainfall, snow, increased cloudiness and low temperature.

In spite of the fact that the distance between Florina and the lakes is short, the climate described above must differ from that of the lowlands around the two lakes which are surrounded by high mountains. No data are available on air temperatures in the lakes area. If the higher altitudes of the lakes is considered only, then the values should be expected to be lower than at Florina. Most likely, however, the thermal capacity of the lakes is such as to cause somewhat higher temperatures during the cold months than would occur in open country.

As regards rainfall, observations at the Prespa lakes cover only 13 years (Figure 5). Nevertheless, they provide indications of considerable microclimatic differences between Florina and Prespa. According to those observations, the mean annual rainfall at Prespa is about 600 mm. The driest month has 30 mm less rainfall while the wettest has three times more

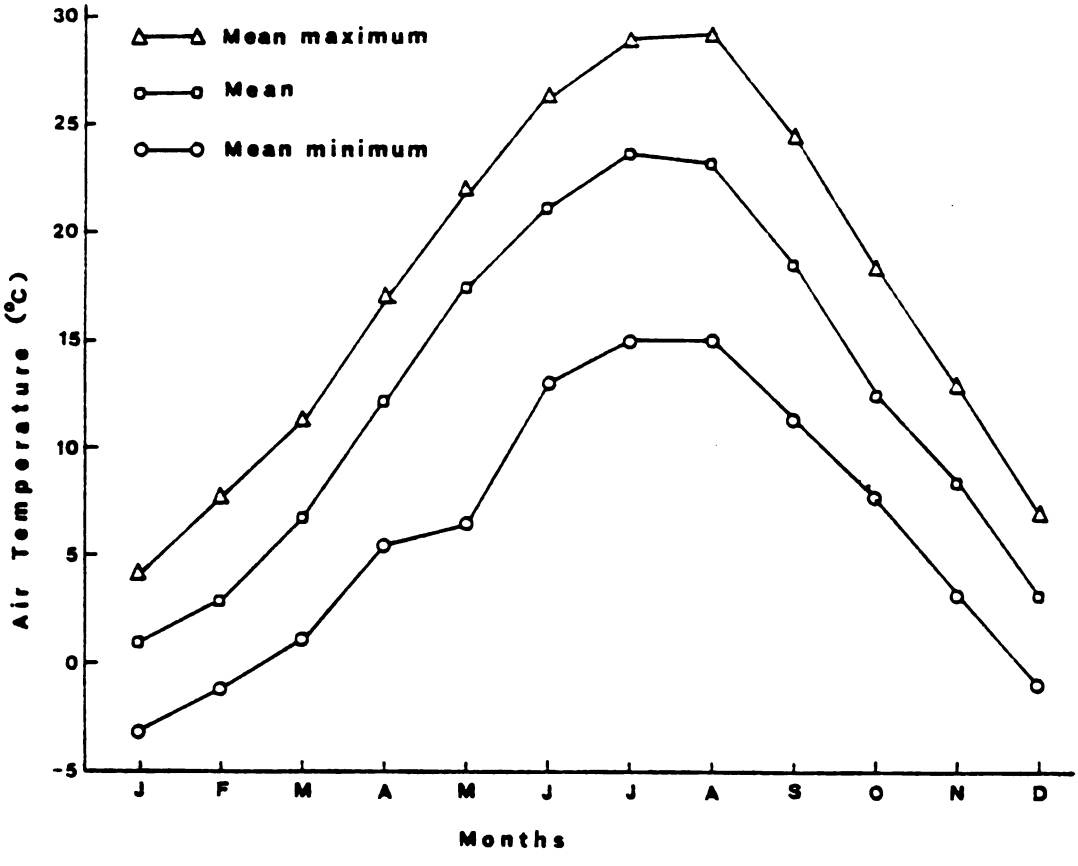


Figure 4. Air temperature data for Florina, Greece (1950-1973).

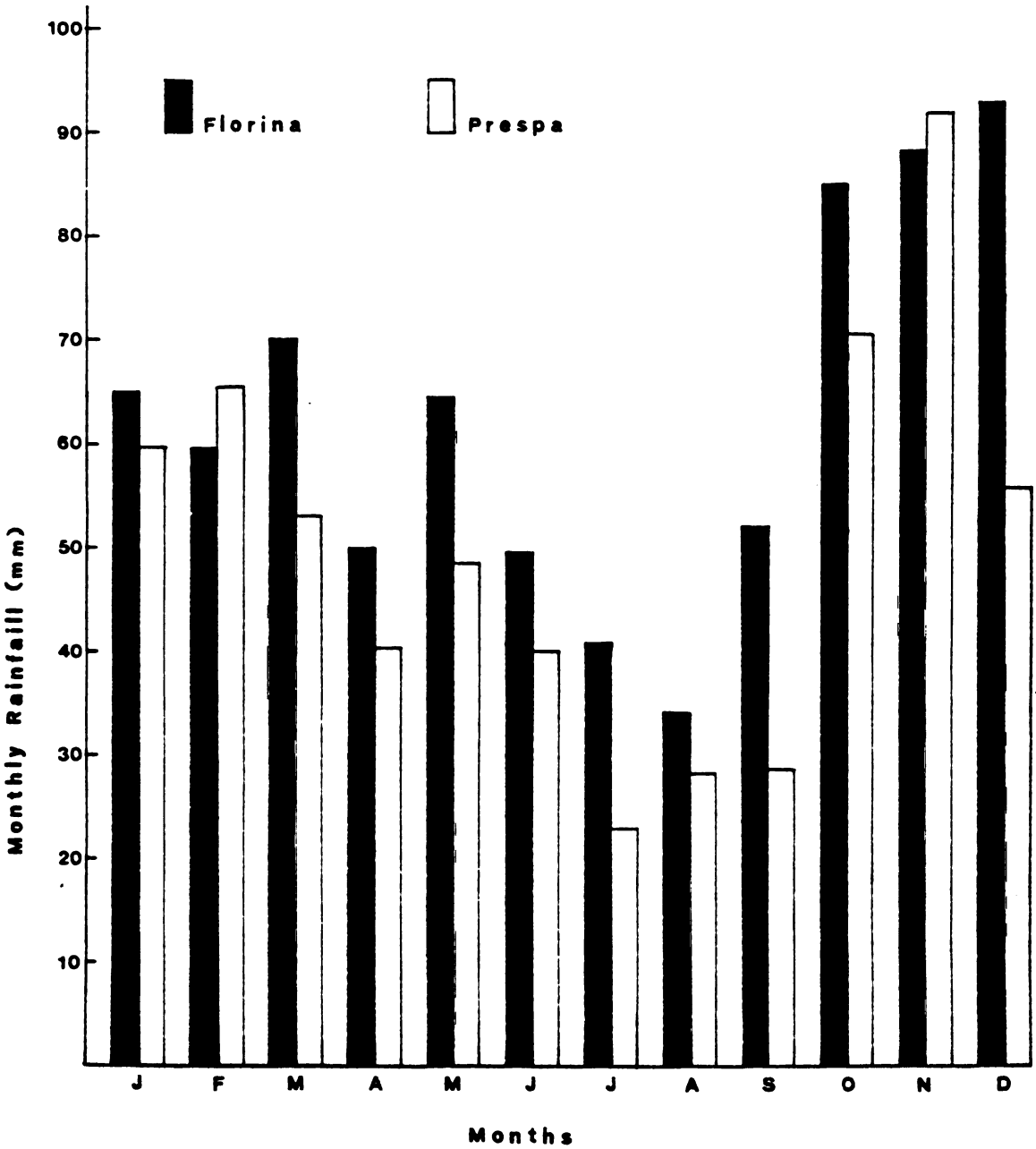


Figure 5. Comparison between mean annual rainfalls at Florina and Prespa. For Florina, the data are means of 24 consecutive years (1950-1973). For Prespa, the data are means of 13 years only. These were not consecutive years, although they were within the same period as above, i.e. 1953-1970.

rainfall than the respective months for Florina. This characteristic indicates (Pennas, pers. com.) that the climate of the Prespa area may differ in the distribution of rainfall in showing clearly-defined dry and wet periods (Csa and Csb in Koeppen's classification).

Lakes Mikri Prespa and Megali Prespa

Lake Megali Prespa has a total surface area of 28600 ha. It is shared between Yugoslavia, Albania and Greece as follows: Yugoslavia 19000 ha, Albania 5600 ha and Greece 4000 ha (Karvounaris, 1979). The southeastern part of the lake belongs to Greece.

The maximum depth of the lake in its Greek portion is 55 meters. The maximum length and width of Lake Megali Prespa is 26 km and 20 km respectively. The lake basin from the shoreline to the center is more even in its eastern part than in the south-central area, where the basin is very steep and presents maximum depths (National Statistical Service of Greece, 1963 - Map). Lake Megali Prespa seldom freezes. During the summer, the lake shows thermal stratification with its thermocline at depths of 11-12 m or 12-13 m (June, July respectively). Mourkides et al. (1978) found that oxygen was 7.5 ppm at the bottom of the lake in June; during January the lake's mean water temperature was 3^{o} C and its dissolved oxygen concentration 12 ppm. According to the above data and its location, it can be classified as a warm monomictic lake (Wetzel, 1975). Mourkides et al. (1978) characterized it an oligotrophic lake, due to the high dissolved oxygen content, the high Secchi disc value, the low values of chlorophyll-a and the low content in inorganic nitrogen.

Contrary to the above characteristics of Megali Prespa, Lake Mikri Prespa has a shallow carstic basin with a maximum depth of 7.7 m. It has a

total surface area of 4850 ha (Koussouris and Diapoulis, 1983) of which 4350 ha belong to Greece and 500 ha to Albania. The maximum length of the lake is 13.0 km and its maximum width 6.0 km. Two small islands, Agios Achillios and Vitrinetsi (the latter uninhabited) have a total surface area of 1 km^2.

In the northern part of the lake, close to the isthmus which separates Mikri from Megali Prespa, there is an opening in the extensive reedbeds which forms a small lake bordered by a strip of land on the south. It is called Vromolimni and its water is continuous with that of Mikri Prespa. Vromolimni is shallow with a maximum depth of 3 m. Five small floating islets (of dead reeds, other aquatic vegetation and bird feces) are within Vromolimni and comprise the pelicans' major nesting areas.

Mikri Prespa often freezes for a few days during winter. Mourkides et al. (1978) found that the lake showed thermal stratification during summer with the thermocline at 4-6 m, and a dissolved oxygen level of 6 ppm and above. In the hypolimnion the dissolved oxygen was only 2 ppm. Inverse thermal stratification was noticed in January with a temperature of 1.7° C at the bottom. Similar results were found by Koussouris and Diapoulis (1983) with even lower dissolved oxygen (0.5-4.8 ppm). Close to the bottom basin in the summer months, they found anoxic conditions. All the above findings together with the location of the lake caused it to be classified as a dimictic lake (Wetzel, 1975; Mourkides et al., 1978; Koussouris and Diapoulis, 1983).

The waters of Mikri Prespa also show low Secchi disc values, a mean hardness, a mean to high alkalinity value and a rather a high chlorophyll-a content. They are high in phosphates and low in nitrates (Mourkides et al., 1978; Koussouris and Diapoulis, 1983). Koussouris and Diapoulis (1983) observed exceptionally high nitrate concentrations during April 1979,

probably due to agricultural runoffs. Based on its alkalinity, chloride content, and nutrient concentrations, Mourkides et al. (1978) and Koussouris and Diapoulis (1983) classed Mikri Prespa as an oligomesotrophic lake (using the standards of Thomas (1969).

Yet due to the scattered data as well as the absence of some essential information, the trophic state of Lake Mikri Prespa is really unclear. If we consider the data presented by the above studies with respect to pH value, turbidity, hypolimnetic oxygen, the phytoplankton species - mainly diatoms and blue-green algae - the lake may be classified as eutrophic.

The water level of Mikri Prespa drops about 70-80 cm during late summer and fall. This is mainly due to evaporation plus the outflow into Megali Prespa and summer irrigation of the agricultural fields. As described earlier, the levels of the two lakes become equal in August.

The banks of Mikri Prespa have a rich aquatic vegetation, especially of reeds. Extensive reedbeds cover the northern and eastern shores of the lake where the slopes are gentle. The organic matter which is accumulated in excess of degradation accelerates ecological succession in the hydrosere. As will be shown beyond, there can be little doubt that eutrophication is proceeding at an all-too-rapid rate.

Flora

Prespa National Park maintains a valuable and impressive flora with over 1200 plant species of ferns and seed plants. This is mainly due to the geomorphological and climatic characteristics of the park and the interface of two basic ecosystems, the aquatic and terrestrial. The structure and physiognomy of the vegetation as well as the quantitative and qualitative characteristics of the floristic elements present sub-mediterranean,

continental, and mid-European types (Pavlides, pers. com.). The species Centaurea prespana, first described at Prespa by Rechinger (1974), is endemic. The scientific names of the plant species follow Tutin et al. (1964) while those of plant communities are named after the Braun-Blanquet (1951) method.

The various vegetative types of the park occur in zones of altitudinal stratification (Pavlides, pers. com). These strata are especially observable in the eastern part of the park, with the sequence of zones from lake to mountain top (Figure 6).

1. Wetland vegetation
2. Hilly/cultivated areas.
3. Mixed deciduous-evergreen shrubs (Ostryo-Carpinion plant community, sub-mediterranean type)
4. Mixed broad-leaved forest (Quercion frainetto plant community, continental type)
5. Beech forest (Fagion moesiacae plant community, (mid-European type).
6. Alpine grassland

The wetland vegetation is characterized by three communities which appear from open water inland:

a) Floating plants of the class Lemnetea. Dominant species which have been identified are: Spirodela polyrrhiza, Lemna minor and Salvinia natans. These are most often supplemented by Ceratophyllum demersum, Myriophyllum spicatum and Hydrocharis morsus-ranae, contributing to the stabilization of this free-floating plant community (Turtin et al. 1964).

Figure 6. Sequence of the major vegetation types from the lake surface to the mountaintop, Prespa National Park, Greece.

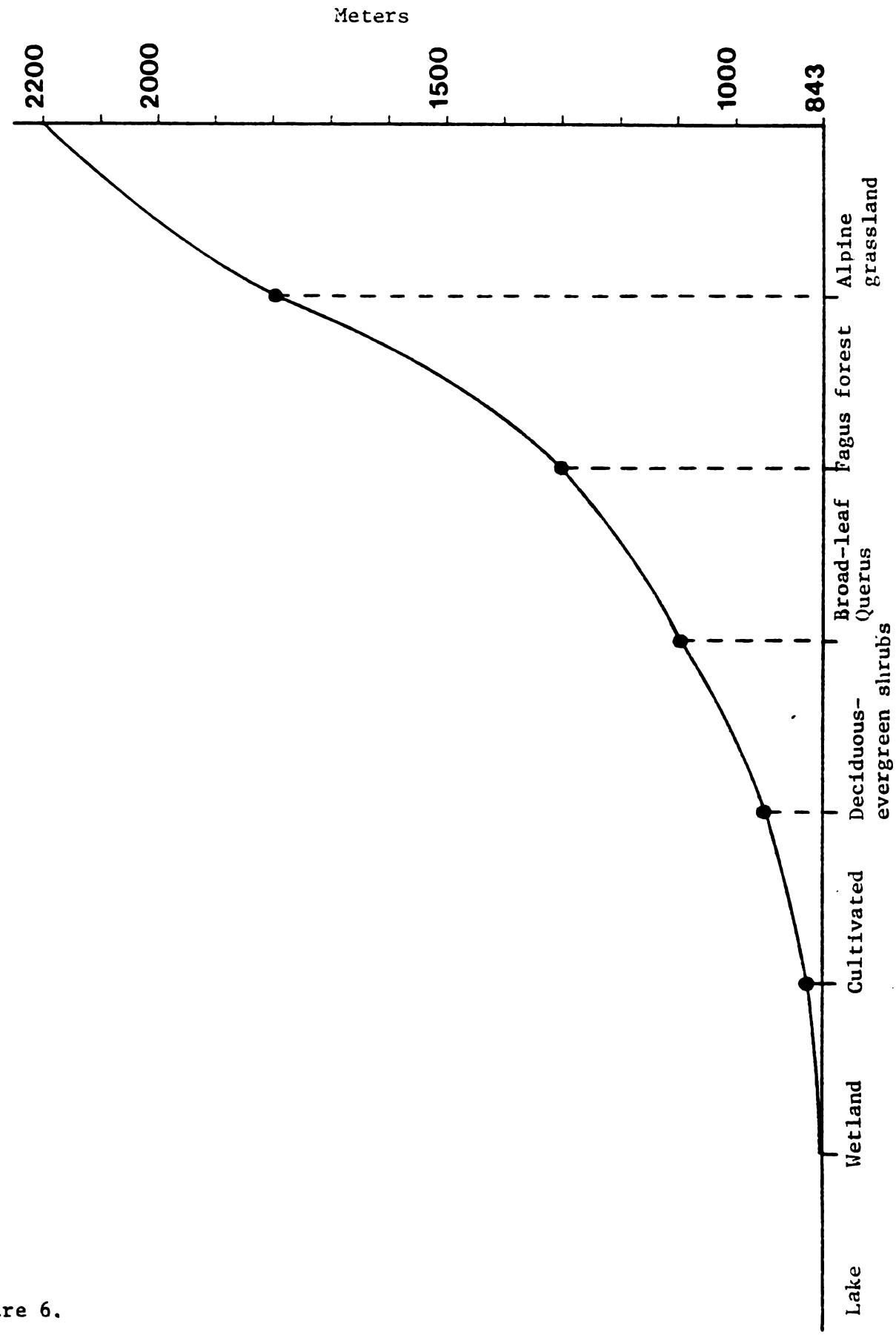

Meters
2200
2000
1500
1000
843
Alpine grassland
Fagus forest
Broad-leaf Querus
Deciduous-evergreen shrubs
Cultivated
Wetland
Lake

Figure 6.

b) Submerged plants of the class Potametea characterized by Ceratophyllum submersum, Potamogeton natans, P. perfoliatum, and P. crispus. Other plants of this community are rooted, with floating stems and leaves: Nymphaea alba, Nuphar luteum, Ranunculus aquatilis, R. trichophyllus, Polygonum amphibium and Sparganium emersum.

c) Reed-swamps of the class Phragmitetea grow on the periphery of the lake. This vegetation type is the most dominant and important on the wetland in Prespa. It is characterized by Phragmites australis, Typha angustifolia, Scirpus lacustris and Iris pseudacorus. Found in smaller numbers are Scirpus holoschoenus, Cyperus fuscus and Calamogrostis pseudophragmites. In the sedge-meadow areas of the wetland the genera Rumex, Carex, Juncus, Ranunculus and Elaeocharis were identified.

Cultivated areas occur in the eastern part of the park, where slopes are gentle. Plant composition in the area has been influenced by livestock grazing, wood-cutting, farming and other human activities. The most important vegetation in this zone are cultivated crops in the lower wet areas. The following wild species also have been identified as components: Trifolium repens, T. tragiferum, Plantago lanceolata, Prunella vulgaris, Poa pretensis, and Cynosurus cristatus.

The mixed deciduous-evergreen shrub zone is characterized by the Ostryo-Carpinion plant community which extends around the lake and up to 110 m above lake level. On the rocky shores of the southern and western part, this zone reaches the lake level while on the east and north agricultural land intervenes between it and the lake. This vegetation has submediterranean characteristics with Carpinus orientalis and Ostrya carpinifolia dominant. Other deciduous shrubs present are Quercus pubescens, Acer campestre, Crataegus monogyna, Ligustrum vulgare, Coronilla

emerus, and Rosa canina. Scattered among the broad-leaved shrubs are the evergreens Juniperus oxycedrus, Phillyrea latyfolia and Buxus sempervirens plus, on the western shores, Juniperus foetidissima, J. excelsa, J. communis and Buxus sempervirens. These may be mixed with Quercus pubescens, Prunus mahaleb and Fraxinus ornus. The height of the vegetation in this zone is generally under 3 m, with the exception of Juniperus foetidissima and J. excelsa which reach 12-15 m.

Mixed broad-leaved forests of the Quercion frainetto plant community extend above the previous one to an altitude of 1000 to 1300 m. These forests are of the continental xerothermic type. Dominant trees (growing to more than 4 m) are Quercus frainetto, Q. sessiliflora, Q. pubesceus, Q. conferta and Q. macedonica. Other associated species are Pyrus communis, Ulmus minor, and Ostrya carpinifolia which reach 7 m in height. Low shrubs include Sorbus tormindis, Juniperus oxycedrus, and Buxus sempervivens. Grasses and herbs also are present.

The beech forest (Fagion moesiacae plant community) occurs between 1200 and 1800 m. Fagus sylvatica beech grows in pure stands with a rich understory vegetation. These stands present a mid-European character with the dominant species occurring with a decreased coverage of F. moesiacae. Interspersed among these beeches are Populus tremula, Carpinus betulus, Acer pseudoplatanus and Ulmus glabra.

On the higher hills, alpine grasslands extend in the park from 1800 to 2200 m above sea level. Of the class Daphno-Festucetea the plant community has Festuca valesiaca, F. varia, F. circummediterranea, Stipa pulcherrima, Poa cenisia and Melica ciliata as representative species.

Wetland

Since a classification system for wetlands does not exist in Greece, the present study modified the U.S. Fish and Wildlife Service Circular 39 (Cowardin, et al. 1979) in combination with Shaw and Fredine's (1956) classification system in order to describe the wetland at Prespa.

The wetland types present at Prespa are types I to V of Cowardin, et al. (1979). These occur successively from inland to the lake (Table 1 Figure 7).

Wildlife

Birds

The ornithological value of Mikri Prespa was the main reason for its declaration as a national park (Hoffmann et al., 1971). One of the primary values of the Prespa wetland is that it functions as a genetic reservoir for a significant number of waterfowl species, some of which are threatened with extinction. The word 'waterfowl' is used here as it was defined by the Ramsar Convention (1971) as 'birds ecologically dependent on wetlands'.

Thorpe et al. (1936), Terrasse et al. (1969), Broussalis (1974), Kempf and Wersinger (1974), Biber and Crivelli (1978) and Makatsch (1980) recorded a total of 188 bird species for the park, most of which bred there. Present observations added 4 more park species: Anas querquedula, Anas penelope, Aythya nyroca and Cygnus olor.

The International Council of Bird Preservation European Community Working Group (ICBP-EC) has prepared a list of 74 avian species which need protection. Some of these are rare or endangered in the countries of the European Community. This list is Annex I of the Directive on the Conservation of Wild Birds (79/409/EEC: Article 1-4 and relevant

Table 1. Wetland classification system for Prespa National Park, Greece. Adapted from several sources. Original source: Cowardin et al., 1979.

Type	Descriptive name	Classes	Water regime	Typical vegetation
I	Seasonally flooded basins or flats Wet meadow (Stewart and Kantrud 1972)	Emergent wetland	Soil covered with water or water-logged in spring, well drained most of the year	Elaeocharis sp, Juncus sp., Plantago sp. Achillea, Trifolium sp
Il	Inland fresh meadows	Emergent wetland	Soils saturated with water	Juncus sp., Carex sp. Rumex sp.
III	Inland shallow fresh marshes Shallow marsh (Stewart and Kantrud 1972; Golet and Larson 1974)	Emergent wetland	Soil covered with 15 cm or more water until mid-summer; seasonally flooded.	Scirpus sp., Iris sp., Typha sp., Polygonum sp.
IV	Inland deep fresh marshes Deep marsh (Stewart and Kantrud 1972; Golet and Larson 1974)	Emergent wetland	Soil covered with 15 cm to 90 cm of water; permanently flooded	Typha sp., Scirpus sp., Phragmites sp.
V	Inland open fresh water Open water (Golet and Larson 1974) Submerged aquatic (Curtis 1959)	Aquatic bed unconsolidated bottom	Water less than 90 cm deep, bordered by emergent vegetation; permanently flooded	Ceratophyllum sp, Myriophyllum sp., Phragmites sp., Potamogeton sp., Nymphaea sp., Ranunculus sp.

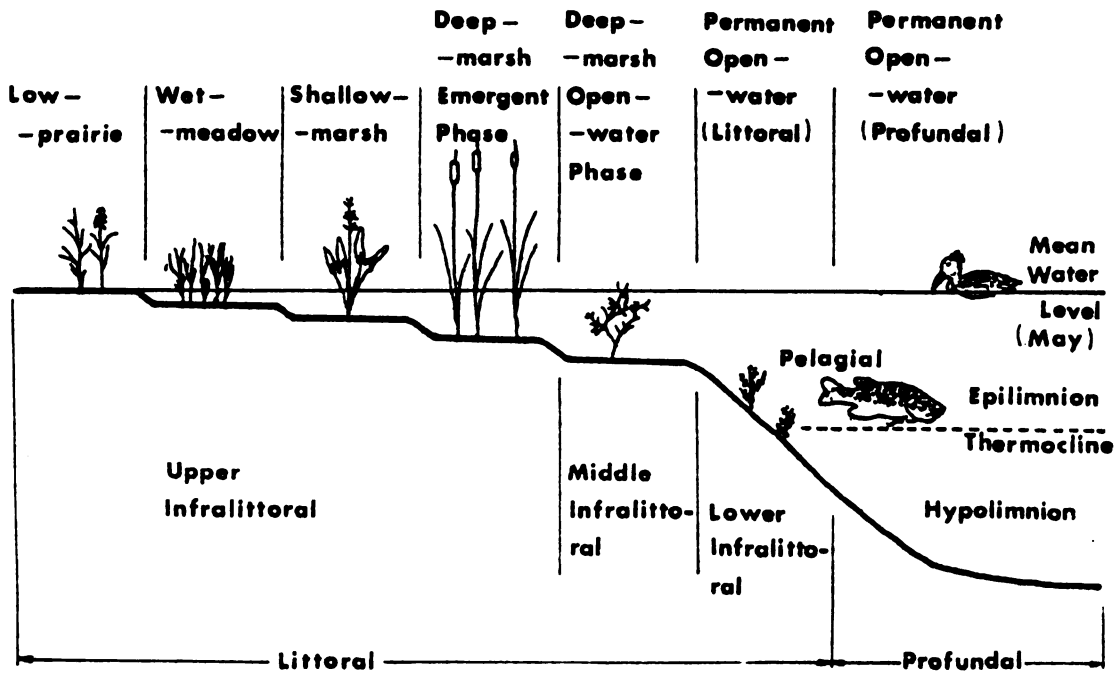


Figure 7. Wetland zonation in Prespa National Park, Greece. Modified from Stewart and Kantrud (1981).

considerations), which was adopted by EEC on April 2, 1979 (O.J.C.E.C., 1979). Tenty-two of the species mentioned in Annex I, have been recorded breeding in Prespa.

Phalacrocorax carbo sinensis	Neophron percnopterus
Nycticorax nycticorax	Gyps fulvus
Ardeola ralloides	Cirvus aeruginosus
Egretta garzetta	Himantopus himantopus
Egretta alba*	Glareola pranticola
Ardea purpurea	Tringa glareola
Plegadis falcinellus*	Gelochelidon nilotica
Platalea leucorodia*	Sterna sandvicensis
Aythya nyroca	Sterna hirundo
Milvus migrans	Sterna albifrons
Haliaeetus albicilla*	Chlidonias niger

* rare and endangered species in Europe

A supplementary report for Greece (Hallmann, 1982) added 19 more rare and/or endangered species to Annex I, 10 of which breed in Prespa:

Pelecanus crispus	Aquilla heliaca
Pelecanus onocrotalus	Larus melanocephalus
Mergus merganser	Chlidonias hybrida
Buteo rufinus	Chlidonias leucopterus
Aquilla pomarina	Phalacrocorax pygmeus

In addition, 4 more species which need special protection within the European Community have been recorded at Prespa and are considered for inclusion in Annex I:

Falco naumanni
Acrocephalus melanopogon
Porzana parva
Ixobrychus minutus

Of all migratory bird species which either breed or visit Prespa, 14 have been declared as rare or endangered species in Europe. Of these, Pelecanus crispus and Haliaeetus albicilla are listed in the Red Data Book (IUCN/ICBP, 1981) as species vulnerable to extinction.

In recognition of its important bird habitats, Mikri Prespa appears on the European Community List of Important Bird Areas. It is also named in the List of Wetlands of International Importance for Waterfowl prepared by

the Ramsar Convention. In this list, Mikri Prespa was selected as a site which incorporates feeding, roosting and breeding areas for the waterfowl concerned (Scott, 1980).

Following Drury (1974), Adamus and Clough (1978) grouped rare species into three types according to their abundance and distribution: (1) species with a few individuals in a few places, (2) species with many individuals in many places, and (3) species with many individuals in a few places. Species characterized by distributions of types (1) and (3) should be given higher priorities for protection because they are more likely to become endangered if one of their breeding sites is destroyed. Mikri Prespa provides breeding habitat to a number of rare bird species of the above two spatial distribution types. The general status of some of these rare species, whose position at Prespa will be reviewed in more detail later, is as follows:

Pelecanus crispus (Dalmatian Pelican) is listed in the IUCN/ICBP Red Data Book (1981) as a species vulnerable to extinction. The world population is estimated at only 650 to 1000 pairs and decreasing (Scott, 1980). The decline is a result of wetland drainage and dessication and also of direct persecution by fishermen, who view this pelican as a competitor. Crivelli (1978) estimated the population of P. crispus in Europe (omitting the USSR) and Turkey to be 500-600 pairs which breed at 8 different nesting sites. Greece has lost 7 out of the 9 breeding colonies once present. Mikri Prespa now comprises the major breeding site of the species in Greece, with another site at Amvrakikos Gulf. The breeding population at Mikri Prespa was 110 pairs in 1983 and about 140 pairs in 1984. Other nesting sites in Europe are in Lake Skadar, Yugoslavia, with 15 nesting pairs (Crivelli, pers. com.), Lake Srebana, Bulgaria, with 70-90 pairs reported in 1978 (Vizi and Crivelli, 1981) and the Danube Delta, Rumania, with about 60

pairs in 1971 (Cramp, 1977). The importance of Prespa is increased when it is considered that it is the only place besides Rumania in all of Europe where both Pelecanus crispus and P. onocrotalus breed in mixed colonies.

Pelecanus onocrotalus (White Pelican), as a breeding population at Prespa, involved 60-70 pairs in 1983. Mikri Prespa is the only nesting site for the species in Greece. The Danube Delta population of the species was reported (Cramp, 1977) to be 1200 pairs in 1969. The total population breeding throughout southeast Europe, Black Sea and western Turkey was estimated (Scott, 1980) at about 7500 pairs. Crivelli (1978) estimated the Europe (outside the USSR)and Turkey nesting population of P. onocrotalus as 5500-6000 pairs at six different nesting sites. Although P. crispus seems to be more threatened because of its lower worldwide numbers of nesting pairs, P. onocrotalus is in equally critical condition because it occupies fewer nesting sites though with more numerous pairs. If even one site were to be disturbed the population of P. onocrotalus might diminish considerably (Crivelli, pers. com.) Both pelican species are strictly protected by law in Greece.

Egretta alba (Great White Egret) is also an endangered species in Europe. Scott (1980) estimated the population of the nominate race breeding in southeast Europe, Black Sea area and western Turkey to be about 500 pairs. Greece is the only country where the species is found within the European Community. A total of only 10 pairs (Hallmann, 1982) is known for Greece, with six pairs breeding at Mikri Prespa where they are protected by law. Other areas in Europe where the species breeds are in Lake Srebana, Bulgaria, with 4-5 pairs (Cramp, 1977), in Rumania, with 30-40 pairs in all (Vasiliu, 1968) and in the USSR (where no counts have been published.

Phalacrocorax pygmeus (Pygmy Cormorant) population numbers have decreased recently throughout Europe. Greece, with approximately 250 pairs, is the only breeding area for the species within the European Community countries (Hallmann, 1982). The majority of Greek birds nest at Mikri Prespa. The species population breeding in southeast Europe, Black Sea and Turkey is estimated at about 5000 pairs (Scott, 1980).

Another important breeding population at Mikri Prespa, despite its small numbers, is that of Platalea leucorodia (Spoonbill) with 6-8 nesting pairs. Spoonbills breeding elsewhere in Greece are estimated to comprise 310 pairs. The Prespa population of the species has declined considerably in recent years.

Plegadis falcinellus (Glossy Ibis), which was reported breeding at Mikri Prespa until 1970 (Terrasse and Terrasse, 1970), does not nest in the area any more. Every spring, however, 10-30 individuals appear in the western meadows of Mikri Prespa for about 10 days.

Phalocrocorax carbo (Cormorant) populations everywhere have suffered major losses during the last 100 years from persecution by fishermen, habitat changes and destruction of nesting trees by the birds' droppings. Some colonies still exist with a limited number of breeding pairs: France 630 pairs (Cruon and Vielliard, 1975), Denmark 600 pairs (Cramp 1977), Sweden 150-200 pairs (Cramp 1977), West Germany 25 pairs (Cramp 1977), Hungary 149 pairs (Bauer and Glutz, 1966). The total number of breeding pairs in the European Community is estimated to be 5600 pairs (Hallmann, 1982). In Greece, there are only two colonies with a total of 180 breeding pairs (Hallmann, 1982). Of these, Prespa is the major breeding site.

Egretta garzetta (Little Egret) nesting populations in the European Community are estimated at about 8300 pairs (Hallmann, 1982). Of these, 1500 pairs breed in Greece in 9 large and several small colonies (Cramp, 1977). Present Prespa population ranges between 30-50 nesting pairs. Other countries where the species breeds are: Yugoslavia, Italy with 4000-4500 pairs (Cramp, 1977), and France with 1700 pairs (Hafner, 1977). Hungary and USSR have a limited number of pairs (Cramp, 1977).

Ardea purpurea (Purple Heron) breeds in Netherlands, France, West Germany, Switzerland, Czechoslovakia, Hungary, Italy, Spain, Yugoslavia, Rumania with a total population of about 3800 breeding pairs (Cramp, 1977). The colony at Prespa has decreased sharply in recent years to about 10-15 pairs.

Nycticorax nycticorax (Night Heron) colonies have decreased everywhere in Europe. In the Camargue, France, there has been a decline of nearly 50% since 1968 (Hafner, 1977). The species still breeds in Spain, West Germany, Czechoslovakia, Hungary, Yugoslavia, USSR (Cramp, 1977). In Greece, there are about 1100 breeding pairs, 27 of which nest at Mikri Prespa. The Mikri Prespa population has declined considerably, however, in recent years.

Podiceps cristatus (Great Crested Grebe) is widely distributed in most of Europe. Increases recently were assisted by the construction of reservoirs and the increasing eutrophication of waters. Decreases in some areas have been due to disturbances from water sports (Cramp, 1977).

Of the above species, none winter in Prespa except Phalacrocorax pygmeus. It was recorded there during the winters of 1982, 1983 and 1984. All other waterbird species winter in Africa, the Middle East or in other

wetlands in Greece, such as those at Kerkini, Porto Lago and the Amvrakikos Gulf.

Mammals

The most important mammals in the area of Prespa are the carnivores Canis aureus (jackal), C. lupus (wolf), Vulpes vulpes (fox), Ursus arctos (brown bear), Felis lynx (lynx), Lutra lutra (otter), Mustela nivalis (weasel), Martes foina (beech marten) and Meles meles (Badger). Among the larger herbivores, there is Sus scrofa (wild boar) and Oryctolagus caniculus (rabbit). Several of the above mammals are threatened with extinction in Europe and are considered legally protected either under E.E.C. Directives or the Bern Convention on Conservation of European Wildlife and Nature Habitats.

Felis lynx is very close to extinction in Europe. Only a few individuals are found locally in Germany, France, Greece, Spain, USSR, Poland, Czechoslovakia, Yugoslavia, Bulgaria and Scandinavia. Prespa is one of the few places in Greece where remnants of the lynx population still live. Lynxes must have been quite numerous at Prespa hundreds of years ago, since the ancient name of the whole area is Lyngistis. An unknown number of individuals still live in the park, mainly in its western part. Habitat destruction and hunting must have been the main causes of lynx decline. In Greece lynx is not protected by law except in the national parks, although it is fully protected in the two European Community countries, France and Germany, where it is still found (Nowak, 1981).

Canis lupus is included in the list of protected animals of the Bern Convention and is also protected by Greek Law 1335/14-3-1983. The European

population of the species consists of only a few individuals in Italy, Greece, the Scandinavian countries, USSR, Poland, Yugoslavia and Bulgaria. In most of these countries the wolf is a protected animal. Despite legal protection, the wolf suffers considerable losses in the Prespa area being considered officially by the Forest Service to be a "harmful predator" on livestock. Unclear ordinances issued by the local government (prefecture), wolf hunting is organized when animals appear close to villages or livestock. Until recently, people legally used poison baits to kill wolves under a bounty system.

The IUCN in 1939 advocated that predator control not be practiced in national parks. They advised that "no native predator shall be destroyed on account of its utilization of any other park animal...When control is necessary it shall be accomplished by transplanting or, if necessary, by killing offending individuals, not by campaigns to reduce the general population of the species.." (Ise, 1961).

Vulpes vulpes in Prespa also suffers severely from predator control. The animal has been hunted since 1950 under the bounty system because it preys on poultry. During the 1980-1981 fox-hunting season, 74,500 individuals were shot throughout Greece and the Government paid 3,000,000 drachmas ($30,000) in bounty payments. Yet Papageorgiou et al. (1981) in a study of the feeding habits of the foxes in Greece found that mammals and poultry were minimal in stomach contents as compared to plant materials. In the same study it was concluded that the benefits of foxes to agriculture, because of their role in controlling mice and grasshoppers, more than compensated for any negative impact. Foxes are found in all European countries but are rarely protected by national laws, even during their breeding season (Nowak, 1981).

In Greece, Ursus arctos is found only in northern Greece. Yet few brown bears live in Prespa and they, despite their rarity, suffer from predator control because of the damage they sometimes cause to the crops. In all other European countries where it still occurs (France, Italy, Spain, Yugoslavia, USSR and the Scandinavian countries), the species is protected by law.

Canis aureus occurs nowhere in the countries of the European Community except in Greece, yet it is not protected by law (Nowak, 1981).

Lutra lutra is found in most European countries in very small populations and is fully protected by national laws. The otter population in Greece has been legally protected since 1968, but nevertheless a large number is killed by fishermen every year.

In 1971, Myocastor coypu (coypu) was introduced into the Vromolimni portion of Lake Mikri Prespa. It is believed locally that the introduction of this exotic species had severe negative impacts on the lake fisheries and few individuals remain. This is despite their full protection under Greek Law.

Fish

Thirteen species of fishes have been reported (Agricultural Service, 1983; Crivelli, 1977; Koussouris and Diapoulis, 1983; Crivelli, pers. com.) from Lakes Mikri and Megali Prespa: Family Cyprinidae: Cyprinus carpio, Alburnus albidus belvica, Barbus prespensis, Chondrostoma nasus, Leuciscus caephalus albus, Paraphoxinus epiroticus prespensis, Rutilus rubilio prespensis, Scardinius erythropthalmus, Carassius auratus, Alburnoides

bipunctatus ohridanus. Family Cobitidae: Cobitis taenia meridionalis. Family Siluridae: Silurus glanis. Family Anquillidae: Anguilla anguilla. Of these, Barbus prespensis is an endemic species found only in the Prespa lakes. Carassius auratus was introduced into their part of Mikri Prespa by the Albanians in the 1970s (pers. com. with local fishermen). Since then, the population has rapidly increased both in Mikri and Megali Prespa (Iliopoulos, pers. com.) It seems that this species competes to the detriment of Cyprinus carpio (carp), as both are benthic feeders.

During the present study, a new species for the area was identified (Economides, pers. com.) as Parabramis pecquinensis. Since 1982, it has been caught in small numbers during the winter months by local fishermen in waters close to the Albanian border. Common in China, this fish is not listed as living in Europe or the western world. It is assumed that during the period of Albanian-Chinese economic-political relationships of the 1970s, this exotic was introduced or escaped into Lake Mikri Prespa. This new population as yet has not become numerous or spread widely.

The introduction of both Carassius auratus and Parabramis pecquinensis has all the implications for danger that exotic species may bring to a natural ecosystem and especially to a national park. The exotic species may carry parasites and diseases, prey upon or be highly competitive with native species or otherwise affect native species and communities (Petrides, 1968). It is suspected that an unforeseen result of the introduction of Carassius auratus was a reduction of the carp population. Carassius auratus reproduces by gynogenesis, having only female individuals after mating with male carp and other Cyprinids (Economides and Voyadjis, 1981).

Commercial fishing at Prespa is based mainly on carp. The decline of that species has caused fishermen to increase their efforts to catch other

species. Despite a resultant intensive fishing effort, however, the total catch from the two lakes has decreased. (Figure 8). The decline of carp population started in 1969 with a contagious disease. Ill individuals showed red bloody spots on the dorsal and abdominal parts of their bodies, especially concentrated near the genital openings. Although the carp disease diminished during 1972-1973 the population did not recover.

Though fisheries data are of uncertain validity they show that the carp catch has declined sharply since 1973 (Figure 9). That decline may be due to an enhanced rate of eutrophication of the lake resulting from the prohibition of reed-burning (see chapter on Land Use: Reed-beds) and to increased inflows of nutrients from newly-irrigated and fertilized agricultural fields. It may be too, that at the same time carp were overfished and did not survive to breed.

Fishing regulations at Prespa are not based on reliable statistics or on adequate scientific knowledge of the fisheries populations and ecological conditions. No statistics on the fish populations or of the catch are available for the years before 1964; even the catch statistics from 1964 to date are unreliable due to the methods of reporting and collection used. These statistics are the only ones available, however, to indicate the status of the lakes' fisheries resources.

The lack of basic fishing regulations may be analyzed as follows: There are no limitations on the fishing effort, on the number of fishermen in the lake, on the mesh-size of the nets used, or on the size of fishes caught. No fishing licenses are required. Fishing is prohibited only for 30-40 days during the spawning season. Furthermore, nets of small mesh, 22 mm or even 12 mm, are used. And in June and July, they regularly use nets of 2 mm mesh size so as to catch the small Alburnus sp. (Chironi). This last practice

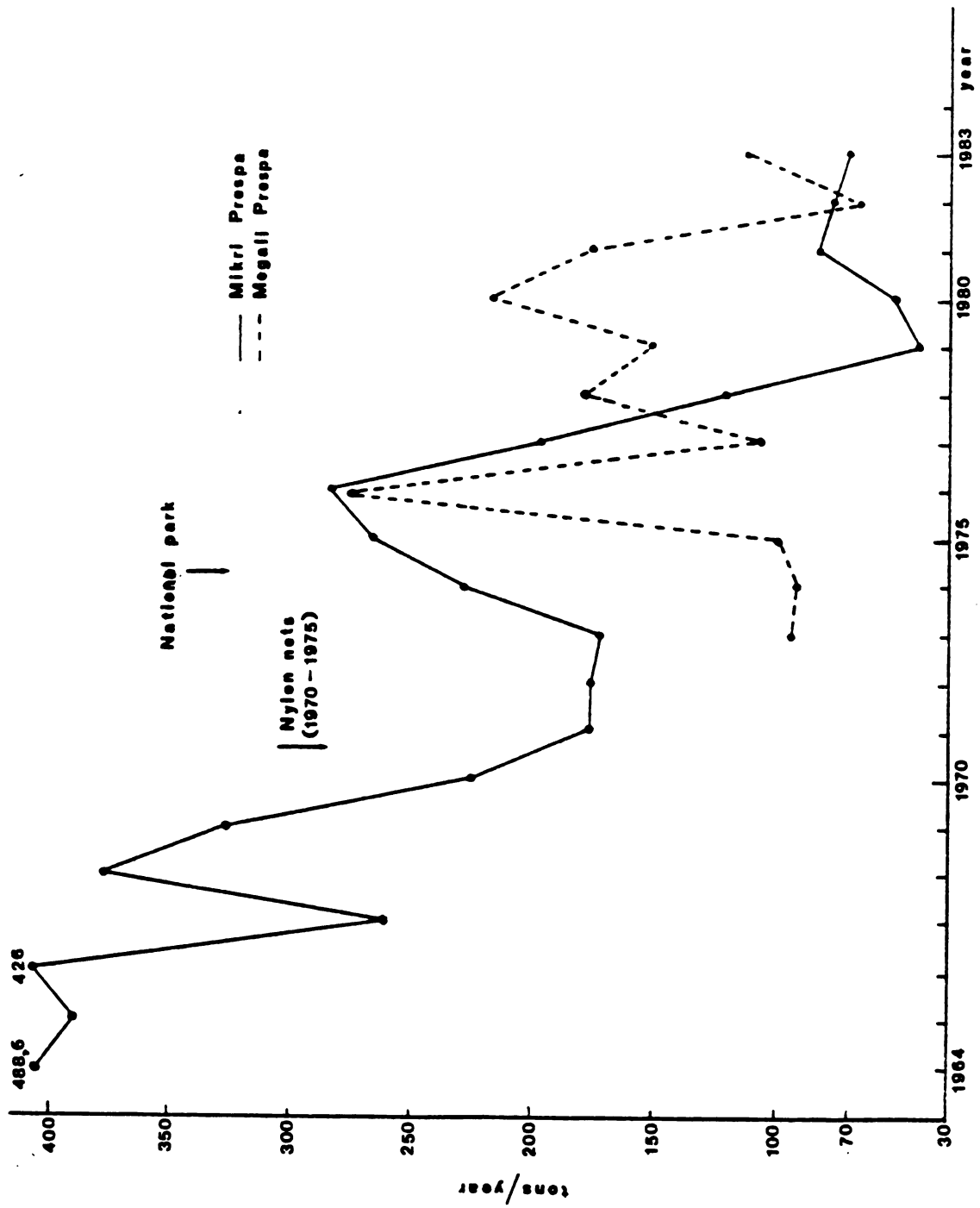


Figure 8. Total catch of fish (tons/year) from Prespa Lakes, Greece (based on data of Ministry of Agriculture).

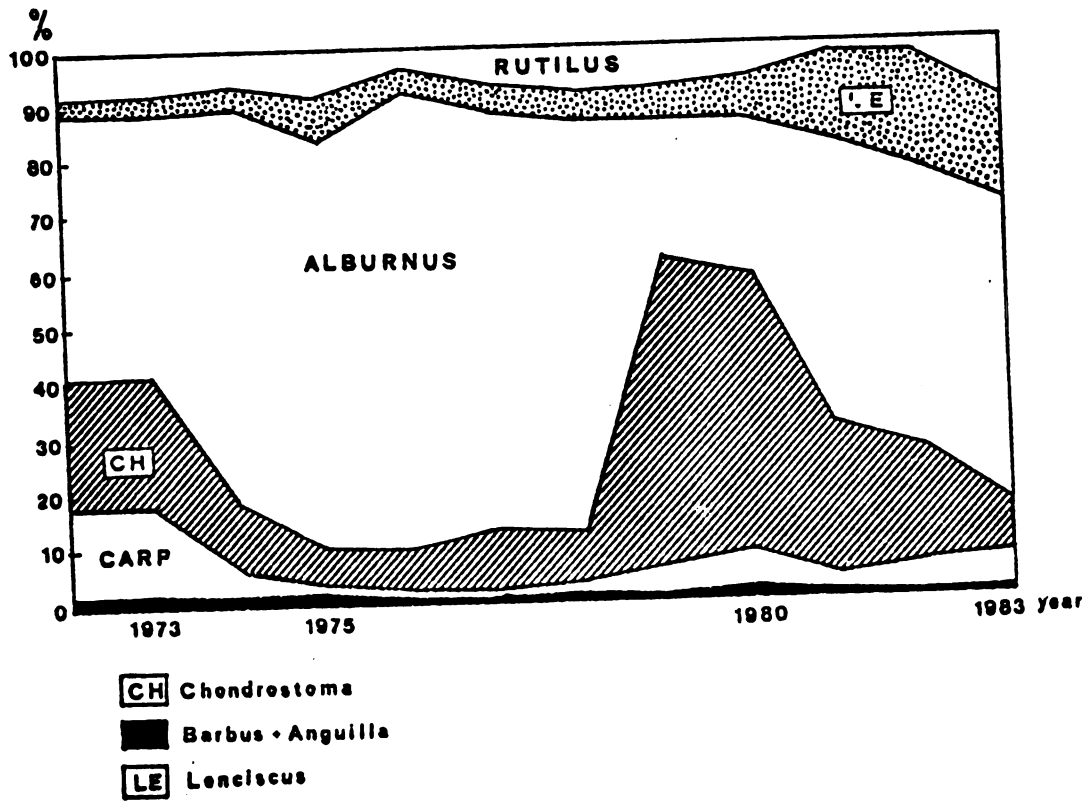


Figure 9. Species composition of total commercial catch from Lake Mikri Prespa, Greece (based on data of Ministry of Agriculture - Crivelli, pers. com.).

may be detrimental to all other newly-hatched fishes, especially young carp.

The introduction of Carassius auratus in the late 1970's and its probable competition with carp may have played a significant part in causing carp to come close to extinction in Lakes Megali Prespa and Mikri Prespa. An attempt made on April 1983 to re-introduce carp into Mikri Prespa proved a failure. At least there was no increase on the catch of carp. It is indeed doubtful whether the introduced carp survived to spawn. This unsuccessful effort is an additional indication of the unfavorable ecological conditions that exist in the lake. Further limnological investigations certainly are desirable.

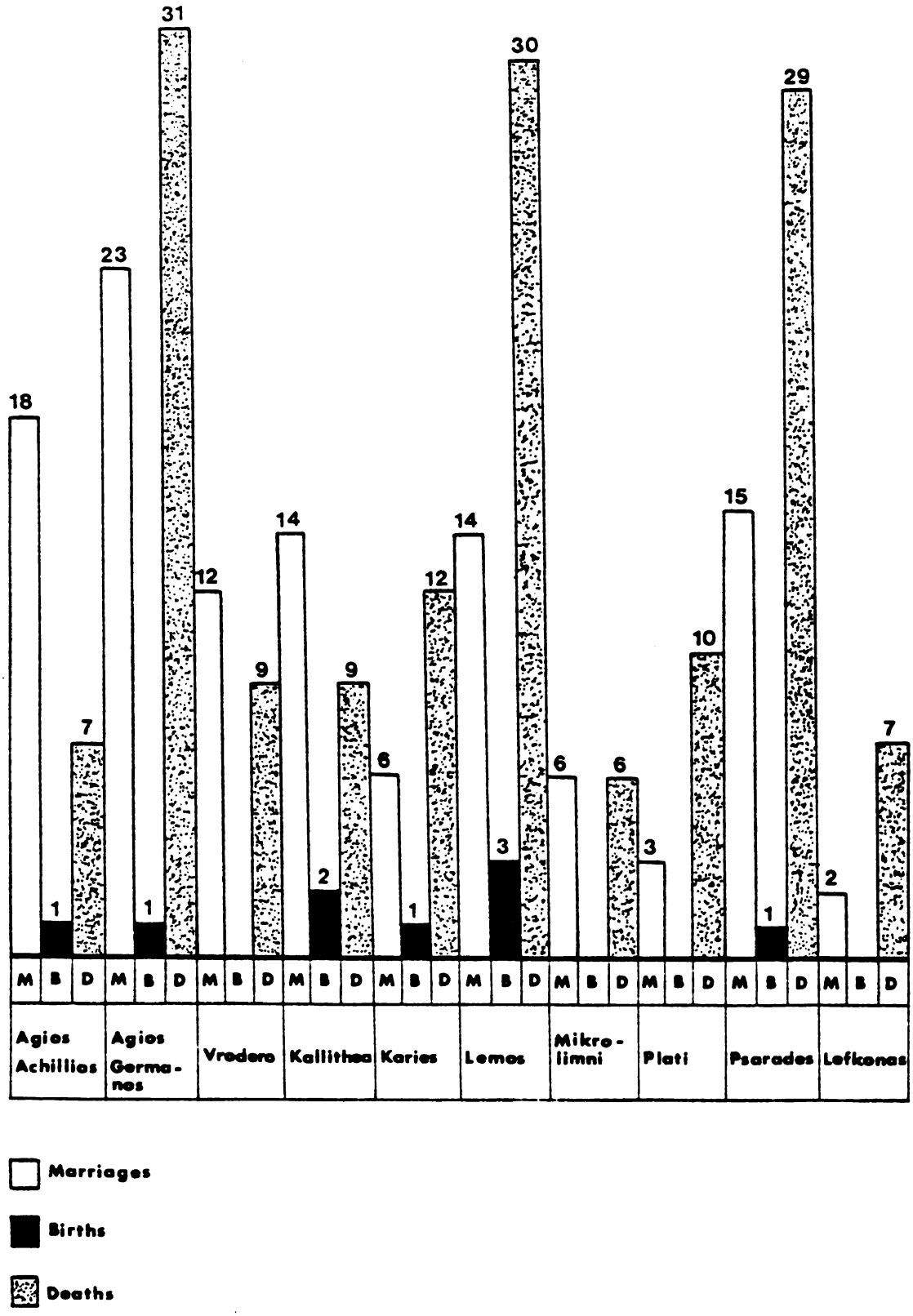
Human Population

Demographic Status

Twelve small villages are located within the national park boundaries: Vrontero, Pili, Agios Achillios, Psarades, Lemos, Milionas, Plati, Kallithea, Lefkonas, Karies, Oxia and Mikrolimni. The ruins of 5 abandoned villages are also present.

The population census of 1981 (National Statistical Service of Greece, 1982) showed that the park area was inhabited by 1545 persons distributed in 13 residential communities. Village size range between 60 and 180 persons, with one settlement (Milionas) having only 7 inhabitants (Pyrovetsi et al., 1983). There were two villages with more than 200 residents, two with less than 100 and the remaining with 100-200 residents. There were low numbers of couples getting married, children being born and a larger number of deaths (Figure 10) during the ten-year period 1973-1982 in the area (National Statistical Service of Greece, 1982). The low numbers of

Figure 10. Totals of marriages, births and deaths in the villages of Prespa National Park, Greece, 1973-1982. Data from National Statistical Service of Greece (1982).


18
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Agios Achillios
Agios Germanos
Vrodero
Kallithea
Karies
Lemos
Mikro-limni
Plati
Psarades
Lefkonas
Marriages
Births
Deaths

Figure 10.

residents per village resulted in a lack of social and other services. There was a mean population density of 5.5 residents per km^2.

The present investigation showed that in 1983 the permanent residents of Prespa were fewer than 1000 persons. The larger number in 1981 may have been caused by people moving into the area on the census day in order to retain residency rights.

During the last forty years a continuous population decline has been recorded (annual reports of the National Statistical Service of Greece) for the area. The total resident loss between 1940 and 1981 was 5335 persons, or a 77.5% reduction (Figure 11). Most of this reduction was due to the Civil War of 1945-1949 which followed the Second World War. Both wars, and particularly the Civil War, had a severe adverse effect on the demography of the district. During this period, each of the villages at Prespa lost residents. Families were split and dispersed to every corner of the world. Those who remained at their birthplace were fearful of the future. Some villages were completely abandoned and these turned to ruins. Large houses sometimes deteriorated and collapsed with old residents living in them. In addition from 1949 to 1960, there were military restrictions against non-residents visiting the area. This period of wartime uncertainty probably determined not only the demographic future of the area but also affected its natural ecological condition to a high degree.

In the early 1960s there was an effort made by the central government to repopulate the area by transferring nomads (Vlahi) from other places in Greece. Housing and land to cultivate was provided. The project, however, proved unsuccessful and the population again began a decline. There was a 52.5% population reduction between 1961 and 1981. Today, in Prespa's villages one can see old people living alone (a condition which is unusual

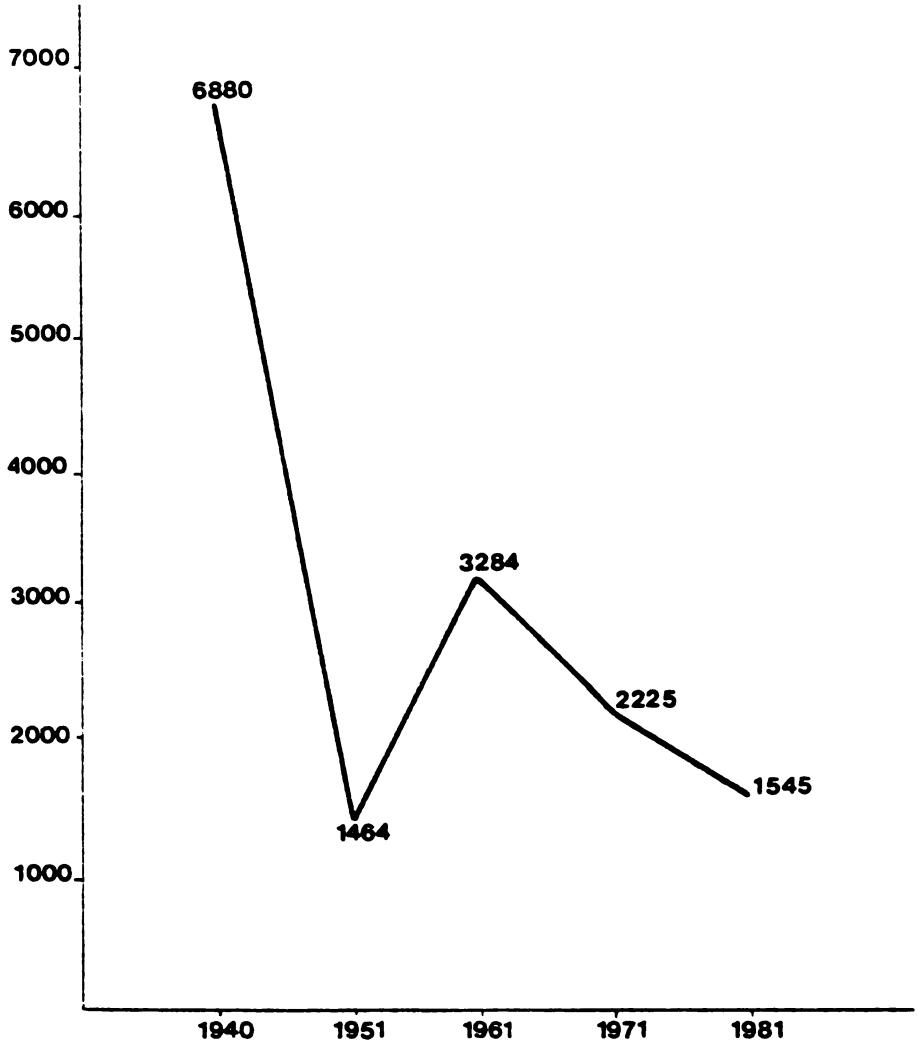

Figure 11. Total human population in Prespa National Park, Greece. Data from National Statistical Service of Greece.

for Greece), their children having migrated to various eastern and western countries.

Current trends of the population show a continuing rapid decline, leading to an alarmingly high average age and "demographic death" for the area. A population age pyramid (Figure 12) reveals the minimum number of young adults and children present.

Residents' Occupation

Economic exploitation of the land and water resources within the park is the main occupation of its residents. Farming, irrigation using lake water, clearing lands for cultivation, lumbering, livestock grazing, hunting, fishing are all practices conducted within the national park.

Agriculture is the predominant form of land use with animal husbandry and fishing as supplementary and subsistence occupations. Lumbering is a rather limited source of income.

A marble quarry is also active within the nucleus of the park. Operation of a small canned-food factory in the same area stopped in 1980, but there are persistent efforts to renew operations.

Organized tourism does not exist in the park. There are no sleeping accommodations, except for a few rooms which can be rented in the villages, neither are there campgrounds. There are no hotels or restaurants either to support touristic development in the region. Tourism is mainly restricted to one-day visits, providing no significant income to the natives.

Figure 12. Population age pyramid of Prespa National Park, Greece, 1983.

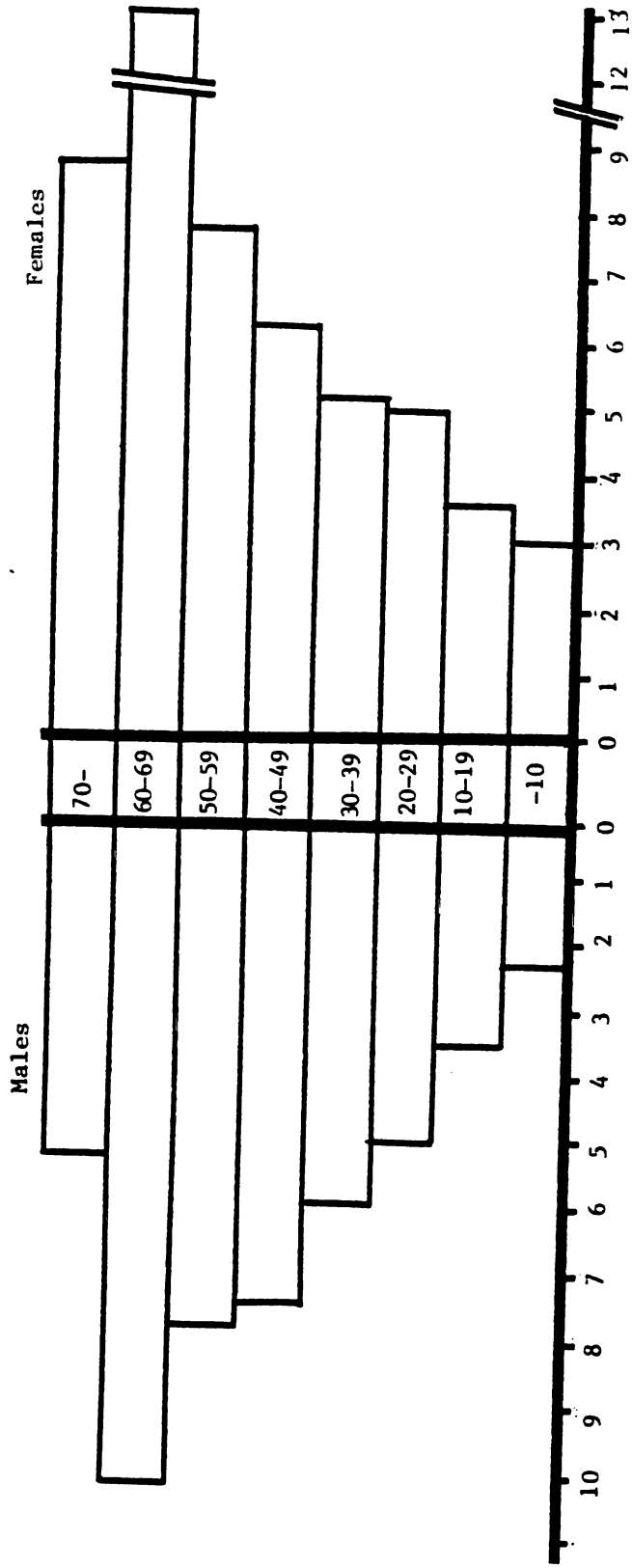
Females
Males
70-
60-69
50-59
40-49
30-39
20-29
10-19
-10
0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 1 2 3 4 5 6 7 8 9 10

Figure 12.

Legal Status

Prespa National Park

Prespa was declared a national park by Presidential Decree 46/14-1-1974 (State Gazette 13 of 25-1-74). As stated in Article 1 of the decree, the objectives[1] of the Prespa National Park(1) are: "...to preserve the wetland with its special fauna of rare bird species and its flora, especially that of the botanically interesting Juniperus foetidissima stand, the geomorphological formations of the lake and the natural environment, along with the esthetic and cultural characteristics which should also be preserved for the scientific value and the economic development of the region."

Article 2 of the same decree defines the Nucleus of the National Park. It states: "The nucleus consists of 2 separate regions. The first comprises a total area of 4900 ha of which 4735 ha is lake and 165 ha is land. The second, of 12 ha, is located close to Psarades Village and consists of a Juniperus foetidissima stand. The whole area of the national park, including the nucleus, totals 19470 ha, of which 11,085 ha is land and 8,375 ha is lake. Of the 8375 ha of water surface, 4735 ha belong to Lake Mikri Prespa included within the borders of the national park. The execution of the action of the Decree is required to be organized under specific regulations of the Ministry of Agriculture."

To date no legally-established set of regulations has been established for the operation of the national park. The Ministry of Agriculture (Forest Service) has only issued general restrictive rules. Ordinance No. 9130/24-4-1970 prohibits hunting, egg collection and nest destruction for a 5-year

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[1] Unofficial translation of the decree by the author.

period. The order was extended with order No. 954/10-4-1975 for 5 more years, and with order No. 1206/26-3-1980 for another 5-year period. Ordinance No. 1667/4-6-1975 prohibits the use of motor boats on the lake. Ordinance No. 416/31-1-1976 prohibits the burning of reeds. Contrary to this, order no. E/522/21-1-1978 contravenes the previous order, permitting the burning of aquatic reeds "for improvement of its fisheries." Ordinance No. 3999/17-10-1979 prohibits the uprooting, cutting, etc. of the willow trees at the Opagia site near the lake. Ordinance No. 4476/27-11-79 protects the Juniperus excelsa stand near Psarades Village from lumbering, grazing and cutting of vegetation.

An official report (No. 1155/24-4-1975) issued by the District Forest Service to the National Park Administration of the Ministry of Agriculture states: "... the Prespa National Park is not actually operating as such due to the lack of regulations for its operation in accordance with Article 5 Paragraph 2 of the Legisl. Decree 996/1971 (this decree refers to the National Park organization). Another official report (No. 2394/28-6-1978) issued by the same District Forest Service Office states that the prohibition orders referring to grazing, cutting, uprooting and the approach of people to the lakeshores are not applicable because these lands are privately owned. In the same report it is suggested that the burning of reeds should be practiced in certain areas in order to improve the lake fisheries. The lack of Park personnel is also mentioned in this report.

Legal Framework for National Parks in Greece

Legislative Decree L.D. 996/1971 stands as the legal base for national parks in Greece. Quoting from Article 78, a national park is described as[2]

[2] Official translation of the decree.

"a forested area that shows a special interest from the point of preservation of their wild flora and fauna, of the geomorphological formations, the soil, the atmosphere, the waters and the general natural environment, and whose protection, preservance and amelioration is considered important, as well as their aspect and their natural beauties of the aesthetical, psychological and healthy enjoyment and the development of tourism, and also for the procedure of every kind of scientific research."

Article 79 of the same decree describes the synthesis, extension and regulation of the national parks. According to these: "Each national park is composed a) from the nucleus an area of absolute protection, not less than 1500 ha, b) from the area around the nucleus (regional zone) of a corresponding extension, at least equivalent to the nucleus, the exploitation of which is organized in a way assisting the accomplishment of the purposes aimed by the nucleus of the National Park."

Prohibitions within the nucleus of the national parks are described in Article 80:

1. ...it is prohibited on the penalty of absolute invalidity, that in the nucleus of the national park any kinds of concessions take place by natural or legal persons of public or private law, as well as by state services for the accomplishment of any purpose whatsoever.
2. The following activities are also forbidden within the nucleus of the national park:
   a) The excavation and exploitation of mines and quarries ... and in general the execution of every similar work or construction of relative installation.
   b) The digging, earthing, taking samples, etc.

c) The placement of advertising, signs, tablets and announcements.

d) Any industrial activity.

e) The installation of housing, houses, huts ... and any kind of construction, with the exception of buildings indispensable to the protection and function of the national park...

f) The logging, cutting, digging, destruction, collection or transportation of plants and forest products.

g) The pasturing (grazing) of any kind of animal... and the construction of any kind of installation for animal breeding.

h) The hunting of any animal with exception of those that are dangerous, the hunting of which is allowed at the decision of the Prefect.

i) Fishing throughout the whole year in lakes and mountain streams."

The National Park Administration in Greece is under the Forestry Service, a part of the Ministry of Agriculture.

National Parks as Protected Areas in the European Community

The Commission of European Communities (CEC Environment and Consumer Protection Service ENV/311/80) defines a national park as a large natural or semi-natural area of at least 1000 ha, with high landscape and biological values whose central organization is under the auspices of the highest national authority. The Commission considers that few or no settlements should be included in the park, and that agricultural activities should be restricted to traditional ones.

Forestry, game control and fishing may be practices "in order to preserve values". Recreation may be permitted in a park only on a day-by-day, with no accommodation or other amenities. Transportation within a park

is not allowed; motor-vehicles and road networks should be located outside the reserves. An additional objective of national parks is to promote research and education/information for the public.

IUCN Criteria for National Parks

An internationally applicable definition of a national park was endorsed and adopted by the International Union for the Conservation of Nature and Natural Resources (IUCN) during its Tenth General Assembly in New Delphi, 1969:

"A national park is a relatively large area: 1) where one or several ecosystems are not materially altered by human exploitation and occupation, where plant and animal species, geomorphological sites and habitats are of specific scientific, educational and recreational interest or which contain a natural landscape of great beauty, and 2) where the highest competent authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation of the whole area and to enforce effectively the respect of ecological, geomorphological or aesthetic features which have led to its establishment; and 3) where visitors are allowed to enter, under special considerations, for inspirational, educational, cultural and recreational purposes" (IUCN, 1969).

The definition and the criteria adopted by the international assemblies attempted to define clearly and to restrict the use and meaning of the term, national park, which varied widely throughout the world, reflecting the broad spectrum of preservation philosophies, ownership patterns, size and suitability of areas for national park classification. The criteria formed a framework capable of being used for a selective classification and also as basic standards, guidelines and principles for the designation of a national

park. Any departures from these principles should be exceptional and always treated as exceptions (Harroy, 1971). Based upon all previous work and experience, the International Commission on National Parks (ICNP) during the Eleventh General Assembly of IUCN in Banff, Canada, in 1972 approved the following criteria:

1. A legal status which establishes it as a permanently-protected area. This legal protection must be given by the highest competent authority having jurisdiction over the area.
2. Enjoy adequate de facto protection along with de jure protection. According to this, the park must have a minimum size, budget and personnel to manage the area in accordance with the objectives of the park. Correlations with the population density of the country were taken into consideration:

   Size: If the population of the country is less than 50 inhabitants to the square kilometer, minimum size 2,000 ha. If the population is more than 50 inhabitants per square kilometer, minimum size 500 ha.

   Personnel: If the population is less than 50 inhabitants per square kilometer, a minimum of 1 person working full time at the management and supervision of 10,000 ha. If the population density is higher than 50 inhabitants per square kilometer, a minimum of 1 person working full time at the management and supervision per 4,000 ha.

   Budget: If the population is less than 50 inhabitants per square kilometer, a minimum of U.S. $50 spent annually for the management and supervision of 1,000 ha. If the population is more than 50 inhabitants per square kilometer, a minimum of U.S.

$100 spent annually for the management and supervision of 500 ha.

3. Within the park a minimum surface area of 1,000 contiguous ha must be dedicated to conservation of a representative sample of a biotic unit in its natural state.

4. Exploitation of natural resources is prohibited. Exploitation is considered to include the removal of mineral resources, timber, vegetation, animals, or the development of dams or other structures for irrigation and hydroelectric power. Also to be prohibited are agricultural and pastoral activities, hunting, fishing, lumbering, mining, residential, commercial or industrial occupation. Some exceptions to these criteria are contemplated such as villages of historical interest which form an integral part of the area and should be protected as cultural heritage. Similarly, private rights for agricultural, pastoral or mining activities may be allowed to continue where they occupy a small part of the whole area and where they do not disturb the effective protection of other portions of the park.

5. Certain activities which are considered necessary for the management and administration of the area and for its development in relation to the objectives of the park are permitted. These activities include road network construction, areas for public accommodation, offices and essential flora and fauna management (U.N. List of National Parks and Equivalent Reserves, 1974; Meganck, 1975; Miller, 1978).

Nature Conservation Policies in Greece

Greece participated at the Eighth General Assembly of the ICUN in Delphi, Greece, 1958, (IUCN, 1958) where the International Commission on National Parks (ICNP) was proposed, decided and established. In the first edition of the United Nations List of National Parks (IUCN, 1967), Greece was included as a member-country accepting the ICNP criteria for national parks.

The Greek Government was one of the first to ratify the 1971 Convention on Wetlands of International Importance especially as waterfowl habitat, the Ramsar Convention.* It will soon ratify the Bonn Convention on Migratory Species. Greece is also a signatory of the Bern Convention on the Conservation of European Wildlife and Nature Habitats and the Protocol on Mediterranean Specially-protected Areas (O.E.C.D., 1983). As a member of the European Communities, Greece has accepted the Directive on Bird Conservation, which forms a legal basis for community policy (O.J.C.E.C., 1979). Along the same line it has accepted the Washington Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Greece is also party to the World Cultural and Natural Heritage Convention held in Paris in 1972. Greece is a party, or is in the process of becoming a party to a number of international conventions for nature conservation.

As a member country of IUCN, Greece supported the proposed World Conservation Strategy in 1982 and has agreed to establish a national conservation strategy.

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* If there is a Proceedings for this Conference, it could not be found.

In the Constitution of the Democracy of Greece (1975), Article 24, par. 1, it is clearly stated that "the protection of the natural and cultural environment of the country is the obligation of the nation."

Mikri Prespa in Relation to International Conventions and EEC Directives

Lake Mikri Prespa is one of the eleven wetlands in Greece which is listed under the Ramsar Convention of Wetlands, 1971. It is also in the inventory of "Important Bird Areas of the European Community" which was prepared by the International Council of Bird Preservation - European Community Working Group for the Environment and Consumer Protection Service of the Commission. This inventory concerns areas of particular importance for the conservation of birds and wetlands of international importance (EC-ICBP, 1982).

Conclusions

If we consider Lake Mikri Prespa within the frames of nature conservation policies, it is an area with values which have been recognized both on the national and international levels. As a national park the area is subject to the highest degree (level) of legal and administrative protection within the nation. Its nomination (designation) as a wetland of international importance and as an Important Bird Area in the European Communities adds further to its significance. In accordance with the prestige which the area enjoys at an international level, the Government of Greece has undertaken the responsibility to establish all measures required in order to protect Prespa's natural environment, to conserve the native wildlife and habitats and to perpetuate its natural wetland functions and processes.

Despite the recognized values of Mikri Prespa, there are weaknesses in achieving the nature preservation goals set for the area. These points may be observed even in the official documents.

The Presidential Decree (46/14-1-1974) for the declaration of Mikri Prespa National Park includes in itself two opposite and conflicting viewpoints. It mentions that the area is established both for "preservation of the natural environment... and for the economic development of the region." The pressure of economic development within a national park is a threat to its natural resources, however, and to its biological and ecological existence (except as tourism, public recreation and education, scientific observations, and cultural benefits accrue (Pyrovetsi, 1983b). It is very possible that in the future the economic development goal of the park in a commercial sense may lead to environmental degradation, resource depletion and mismanagement.

The Presidential decree, as well as the decree referring to national parks in Greece (L.D. 996/1971) did not plan for the creation of a buffer zone around the park.

Ten years after the declaration of the area as a national park, the park is still functioning without an Operational Regulation. The Forest Service orders which forbid certain activities in the area are only temporary: they are not laws in accordance with the decree (L.D. 996/1971) for national parks and have no permanent basis. They may be altered at any time by administrative personnel. For example, order No. 416/31-1-1976 which prohibits burning of reeds was superceded by order No IE/522/21-1-1978 which permits this activity. These conflicting orders create confusion and are not effective toward the preservation objectives of the park.

The Presidential Decree of the declaration of the National Park was not followed by any law or decision which would settle the private ownership of land, especially of areas within the nucleus of the park. Thus the constitutional ownership rights of land holders prevail over the decree. The Greek Government has not issued any law or decision to compensate owners for losses of property rights even in the strictly-protected areas. Settlement of this problem is a matter of simple justice which would avoid conflict with any negative implications on the conservation objectives of various areas in the park. The official report of the Forest Service (No. 2394/28-6-2978) refers to this problem, adding that on these private lands actually no restrictive order is in effect.

A part of the previous problem is the presence of villages in the park. The Presidential Decree ignores the fact that human settlements occupy a considerable area of the park and that people exploit its natural resources for living. IUCN's standards for National Parks make it clear that the exploitation of natural resources should be prohibited and that a negative position prevails toward the human settlement.

A well-defined and accepted policy of conservation performance in the national park does not appear in the legal documents. This probably reflects the absence of a national conservation strategy for Greece. The need and the model for such a strategy was set out in the World Conservation Strategy proposed by the IUCN and supported by many governments including the Government of Greece (IUCN, 1982). A national conservation strategy would provide a framework within which the objectives of the various agencies which contribute to or impact upon nature conservation could be assessed and harmonized. It would also provide a basis for establishing the priorities for action that the limited resources for nature conservation in

Greece make necessary.

There is a complete lack of environmental planning in the Park. The only plans existing for the area are the so-called "Five Year Economic Development Plans" (Koroni, 1979); these plans follow the same lines as similar ones for other regions of the country. Present plans are limited and ignore the special characteristics of the national park and the objectives of its conservation.

There is no zoning and management plan for the park. Mikri Prespa National Park is not a self-regulating system. It is subject to human impacts such as agricultural, pastoral, settlement and fishing activities within its boundaries. Zoning of the park might control activities in the various areas according to their values and relations to natural area conservation. Together with zoning, the need of management is of high priority. Wise management of the park's resources would minimize the problems caused by human presence and would maintain and promote the biological and ecological diversity of the area. This kind of park management should base its decision on a continuous flow of research, assessment and monitoring.

The visitor of Mikri Prespa has no chance of attending an education program or receiving any information about the Park. Such programs addressed to visitors and to local people increase public awareness on the benefits of conservation. This is particularly important in rural areas such as Prespa and in their development (Pyrovetri, 1983b). On several occasions when an informal illustrated lecture was offered to the local population in Mikrolimni's cafe, the results were very interesting. People accepted these presentations with enthusiasm. They "discovered" through the slides the place where they had lived a lifetime, having failed to observe

or even notice its special characteristics, its ecological harmony, its uniqueness. Many people were impressed by the architectural features of their own houses, the simple small details in the balcony or the windows which personalized them. Then they started to observe the birds which lived so close in a loving way, no longer as competitors for the area's resources. They saw how beautiful and important was the lakeshore, where they used to throw their home garbage, and they cleaned it up the next day, without any external instruction or ordinance. Once the local people understood that it is in their own interest not to deplete the natural resources and to safeguard the ecological features of their area, they lost their antagonism to the park's idea and objectives.

The need of an adequate number of park personnel is indicated in an official report. The Greek law for national parks and Prespa's decree omitted to foresee any special arrangement for personnel and budgets in accordance with IUCN's standards for national parks. According to international standards a minimum of 5 persons should be working full time in the management and supervision of Mikri Prespa National Park.

The boundaries of the national park are not marked in the field. The park area appears to be of different size in various documents: The Presidential Decree of its declaration defines it as 19,470 ha, total area. The forest Service document states that the national park comprises an area of 25,750 ha of which 17,370.75 ha is land and 8,000 ha water. The EC-ICBP (1983) report on Important Areas of the European Community lists Mikri Prespa National Park as 30,000 ha. A similar confusion exists for the exact size of the nucleus. An official document reports the nucleus as 4,650 ha instead of 4,900 ha, in accordance with the Presidential Decree. A clarification of the Park's exact size and boundaries is required.

Although Prespa lakes are shared between Yugoslavia, Albania and Greece, only the Greek part has been declared a national park. Now, before serious problems and conflicts arise with the neighbor countries, is the time to establish agreements on the protection and equitable management of these lakes by these nations. It is of high priority to strengthen bilateral and multilateral cooperation with a view to reach agreements on similar protection policies and, if compatible with conservation principles, use of area resources. Each lake requires the integrated management of its water and also its watershed, if it is intended to preserve them in perpetuity. A future role for Mikri Prespa National Park could be to become an International Park for Yugoslavia, Albania, Greece and the world.

Chapter II

LAND COVER/USE OF PRESPA NATIONAL PARK

Rational planning and efficient management of national park resources requires basic information on the present cover and use of the park land and water. This information for the Prespa area is either lacking or of low reliability because existing maps are not sufficiently accurate and updated to enable detailed investigations. Aspects of this information include the identification of major (habitat) vegetation types and their relationships with ekistic and agricultural activities, the water regime of the wetlands, the delineation of areas vulnerable to human perturbations expected to result from present and imminent development schemes, etc. It was considered essential to collect the necessary material and data and to prepare an updated land cover/use map suitable for the park's needs.

Ground survey using a common topographical map is the conventional way of collecting land cover/use information. This, however, has been shown to be costly, time consuming, of low accuracy, and frequently lacking equal scale of detail unless remote-sensing techniques also are incorporated into the mapping procedure (Draeger et al., 1981). Interpretation of spatial relationships among land use types, comparisons of areas with their surroundings, monitoring of dynamic phenomena such as vegetative succession and/or degradation, past changes in land use and future trends, can only be accomplished by remotely-sensed images. Remote-sensing has been used for years and has proven to be an indispensable tool in assessing and managing natural resources (Lins, 1982). A mapping procedure was followed based on remotely-sensed information supported by ground surveys to verify the

interpretations.

The objectives of this section of the study were:

1. To prepare an accurate, up-to-date land cover/use map.
2. To detect the land cover/use changes which occurred in the area during the last 40 years.
3. To determine present and probable future trends of land cover/use and to determine the points of conflict within the region; to designate these areas which are more susceptible to human alterations thus affecting park values.

Landsat photographic images often provide a rapid, effective tool for mapping general vegetation and land cover patterns over large areas. In the case of Prespa, however, the available images proved unsuitable because their scale was small and they did not display detailed information on the national park's natural resources. Moreover, the image resolution was poor for the intended purpose and the first images were not collected until after 1972 which made comparisons with past conditions impossible.

Aerial photographs, though, did satisfy park planning and inventory needs, and were valuable as a source of information on past conditions (Schmid-Haas, 1980; Avery, 1965; Smit, 1978; Richter, 1969; Adeniyi, 1980).

Materials and Methods

Aerial photographs of the Prespa area were acquired from the Greek Army Geographic Service for the years 1945 and 1969-1970. Special clearance had to be obtained to secure these photographs and some portions of them were blacked out because of military requirements. These same reasons prevented acquisition of the most recent photographs of 1975, 1980 and 1983. The 1945 and 1969-1970 sets however, were useful to assess and present land cover/use

conditions, respectively. The photographs were all black and white panchromatic with scales of 1:45,000 to 1:40,000.

Base topographic maps of the study area, scale 1:20,000, were provided by the Forest Service. The boundaries of the National Park were outlined on these maps, after enlarging them from a 1:20,000 to a 1:14,100 scale. The aerial photographs of 1945 and 1969-1970 were interpreted using standard techniques; these interpretations were traced directly onto the 1:14,100 topographic map. Ten land cover/use categories (Table 2) were identified and delineated to a 0.2485125 ha level of detail from the aerial photographs.

In mapping the area's land use the entire national park was first divided into aquatic and terrestrial sections. The aquatic portion involved only Lakes Mikri Prespa and Megali Prespa. In this section, only open water and reedbeds categories were represented. The terrestrial section was divided into eastern and western parts of Lake Mikri Prespa.

The boundaries of each land use type were mapped (Appendix A) and measured with respect to its ownership. The main road network and trigonometric and altimetric points are also shown.

Using field data, ground verification was undertaken so that each area closely represented the condition occurring in 1984. Land use maps prepared from the 1945 and 1969-1970 aerial photographs as updated to 1984 were compared and boundary changes between 1945 and 1984 were measured. The changes were designated by two numbers, ranging between 0 and 10. The first number represented the type of land use in 1945, while the second represented condition in 1984. The location, type and extent of each land use change which occurred between 1945 and 1984 was plotted (Appendix B). The areas which had no land cover/use change during the above time interval were mapped without digits.

Table 2. The land cover/use classification scheme for Prespa National Park, Greece.

F	Forestland: land covered by trees and/or bush.
R	Rangeland: land covered by natural vegetation, predominantly grasses and grass-like herbs and forbs that could be used for grazing.
A	Agricultural land non-irrigated: land used only for rainfed crop production
Ai	Agricultural land irrigated: land presently irrigated and/or planned to be irrigated (irrigation facilities are under construction.
Aa	Abandoned agricultural land: land previously covered by crops but now fallow.
Wm	Wet meadow-marshland: areas periodically inundated which are characterized by vegetation that requires saturated soils for growth.
E	Barren-eroded land: soils devoid of any significant vegetative cover and including streambed canals, ditches, dikes and roads.
U	Urban areas: land covered by human buildings and settlement
W	Water: area covered by water the year-around; lakes.
Re	Reedbeds: submerged areas covered by reeds (Phragmitetea community).

Measurements of the areas of each land use category were made by means of a dot grid system. Each dot was centered on an area equal to 0.24185125 ha on the map scale of 1:14100. A transparency overlay (with dots arranged to equal about 4 dots per hectare) was used to assist in the measurement process. The standard deviation of the binomial distribution $e = \sqrt{\frac{P(100-P)}{N}}$ was employed to calculate the error of the areas measured by the dot grid (Snedecor and Cochran, 1978). In the formula P = proportion of the total area in a particular land use category; N = total number of dots counted over the entire study area; e = percentage error.

When photographs from two time periods are being compared it is imperative that the photography for both periods be consistent with regard to contrast, scale, ground resolution and time period (Lins and Milazzo, 1972). Although the photographs we obtained had no information as to the season of the year that they were taken, it was concluded, based largely on the limited flood waters, that the 1945 photos must have been taken during the dry season, possibly late summer or fall.

Results and Discussion

The total area of the Park (Table 3) according to present measurements is 25689.9 ha (256.9 km^2). Official measurements of the Presidential Decree show it to be only 19470 ha (194.7 km^2). Presumably the difference between the two numbers is due to inaccuracies in the original measurements.

Of the total park area, 66.51% is land and the remaining water (Table 3). The aquatic section includes the reedbeds (Table 4). About 47% of the land is in the eastern sector, and 53% is in the western portion (Tables 5 and 6).

Table 3. Area of the sections of Prespa National Park in hectares as of 1984.

Land cover/use section	Area (ha)	Percent of the National Park
Aquatic	8,604.8	33.49
Terrestrial	17,085.1	66.51
Total area of National Park	25,689.9	100.0

Table 4. Area of land cover/use categories of the aquatic section of Prespa National Park in hectares.

Land cover/use category	Aquatic Section				Total area of N. P.
	Lake Mikri Prespa		Lake Megali Prespa		
	Area (Ha)	Error (%)	Area (Ha)	Error (%)	
Water	4235.2	0.24	3749.8	0.24	7,985.0
Reedbeds	605.9	0.05	13.9	0.05	619.8
Total	4841.1		3763.7		8,604.8

Table 5. Hectares of land cover/use categories in eastern and western sections of Prespa National Park, Greece, January, 1984.

Land cover/use category	East		West		Total		Percentage of total area
	Area	Error (%)	Area	Error (%)	Area	Error (%)	
Forestland (F)	3287.0	0.28	7594.8	0.20	10881.8	0.18	63.69
Rangeland (R)	2308.9	0.25	623.8	0.13	2932.7	0.14	17.17
Wet meadows-marshland (Wm)	83.8	0.06	5.2	0.01	89.0	0.03	0.52
Agricultural land (A)	590.5	0.15	763.4	0.14	353.9	0.10	7.92
Agricultural land irrigated (Ai)	1395.6	0.21	55.2	0.04	1450.8	0.11	8.49
Agricultural land abandoned (Aa)	157.5	0.08	57.4	0.04	214.9	0.04	1.26
Barren-eroded land (E)	79.5	0.06	7.2	0.01	86.7	0.03	0.51
Urban area (U)	50.2	0.04	25.1	0.02	75.3	0.02	0.44
Totals	7953.0		9132.1		17085.1		100.00

Table 6. Land use in Prespa National Park, Greece, by community ownership, January, 1984.

Village/land use category*	F	R	Wm	A	Ai	Aa	E	U	Total
Eastern Section									
Mikrolimni	1402.2	197.6	7.2	7.7	168.2	64.1	9.4	7.7	1864.1
Karies	1074.8	196.3	-	137.7	190.1	67.1	30.3	8.0	1701.3
Lefkonas	296.3	52.7	10.2	69.1	348.4	18.1	13.4	7.2	815.4
Kallithea	390.7	704.2	5.0	152.5	133.2	-	5.5	6.2	1377.3
Plati	98.9	267.8	61.4	84.2	238.8	5.2	2.5	4	765.0
Lemos	21.1	895.4	-	165.3	316.9	-	18.9	14.9	
Total	3281.0	2314.1	83.8	596.5	1395.6	154.5	79.5	48	7953.0
Percentages	41.25	29.10	1.05	7.50	17.55	1.94	1.00	0.60	100
Western Section									
Psarades	1978.9	83.9	-	20.1	-	-	2.2	7.0	2072.1
Pili	1375.6	230.4	5.2	74.2	55.2	-	5.0	6.0	1771.6
Agathoto**	535.6	30.6	-	0.2	-	25.6	-	-	592.0
Daseri**	430.9	5.7	-	47.0	-	1.2	-	-	484.8
Pixos**	1780.4	153.3	-	419.0	-	-	-	-	2352.7
Vrontero	1493.4	144.6	-	182.9	-	30.6	-	-	1858.9
Total	7594.8	628.5	5.2	763.4	55.2	37.4	7.2	20.4	9132.1
Percentages	83.17	6.88	0.06	8.36	0.6	0.63	0.08	0.22	100
Total Land Area	10875.8	2942.6	89.0	1359.9	1450.9	211.9	86.7	68.4	17085.1
Percentages	63.66	17.22	0.52	7.96	8.49	1.24	0.51	0.40	100

*F=forestland; R=rangeland; A=agricultural land non-irrigated; Ai= agricultural land irrigated; Aa=abandoned agricultural land; Wm=wet meadow-marshland; E=barren-erroded land; U=urban areas

**Abandoned villages

Each land cover/use category is interpreted as follows, with a discussion of its ecological significance:

Water (W)

The main permanent water bodies are Lake Mikri Prespa in the south of the park and Lake Megali Prespa to the north, only partly in the park. These water bodies comprise 33.5% (Table 5) of the park and supply the basic resources supporting the park's fishing industry (see Chapter I: Lakes and Fishes).

Reedbeds (Re)

Dense stands of Phragmites australis reeds occur on the shores of Lake Mikri Prespa and, to a lesser extent, in Lake Megali Prespa. Overall, Phragmites covers 619.8 ha (Table 4). In Lake Mikri Prespa, the reedbeds are found primarily on the northern and eastern shores with only a small area in the west. On the northern part of Mikri Prespa, extensive reedbeds cover an area over 2 km long and 1 km wide. Within the latter marsh there is a lake-like water-body called Vromolimni. With its surrounding reedbeds, Vromolimni is the core of Prespa's wetlands and is one of the two major biotopes for waterbirds of the area.

The reedbeds of the eastern shore grow on gentle slopes and are rather extensive. They have a rather limited width, however, where the lakeshore is steep. On the Greek-Albanian border to the south, the reedbeds also are widespread. There, they are interspersed with a number of inner lagoons. These openings are surrounded by reedbeds and Salix trees. They comprise the major breeding habitats for many waterbird species (see Chapter III).

The extensive reedbeds in Lake Mikri Prespa are very important as a wildlife and fisheries habitat. Phragmites has a strong capacity for vegetative reproduction through rhizomes. It has invaded large areas, forming natural monocultures. In the autumn, the above-ground parts of the plants die and the leaves are shed. The tall dead stems may remain standing during the winter but eventually lodge and decay. Decomposition of these large and enriching quantities of reed biomass is a slow process and decayed materials accumulate on the lake bottom. An anaerobic hypolimnion is created, near the lake bottom and in the areas of the reedbeds. Pieczyńska and Szczepański (1974) estimated the average standing crop of dead reeds collected in late November from Polish lakes to be 740 g/m^2. Koussouris and Diapoulis (1983) found low levels of dissolved oxygen near the bottom of Lake Mikri Prespa during summer. The anaerobic hypolimnion has a negative impact for the carp and other fish populations in the lake.

These conditions accelerate aging and succession (eutrophication) in the lake. At present there is no management nor any use made of the reedbeds. Although fish usually are not harvested commercially within a national park, the fishery at Prespa has to be maintained for the local population. The fish population also supports the fish-eating birds of the park and management which would enhance the fishery has positive values. Such management would be best if it could slow down the accelerating eutrophication of the lake caused by the dead reeds. Restoring a former practice of the villagers, controlled burning of the reeds could be practiced in early autumn when the ground is quite dry and before the rainy season starts. Improving on what once were perhaps too-frequent annual burns, a 3-year rotational burning system could be tested with the same plots burned every third year with care taken so that fires are not of high intensity (Linde, 1969).

Careful controlled burning should cause (1) a decrease of the density of Phragmites, (2) an earlier green-up of the reedbed area in the spring, (3) nutrients to be recycled faster, (4) a mineralization of organic material to reduce the rate of lake eutrophication, and (5) small openings to be created among the reedbeds, with some grasses invading to increase habitat diversity for wildlife.

Mowing is another management technique which could be combined with use of the reeds for energy needs. Amphibious machines have been used regularly for winter cutting in many places (Bjork and Graneli, 1978). In order to get long stems, the reeds should be harvested when the water level is low, but it is important not to damage rhizomes and new shoots. Fuel reeds could be harvested in winter, preferably over the ice or the frozen bottom of the lake. By properly managing the reedbed communities of Prespa these areas could be improved as wildlife habitats and the aging-rate of the lake would be retarded.

Forestland (F)

This is the major land cover/use category in the national park. Its area is 63.7% of the total land area (Tables 5 and 6). Forestland is found almost entirely outside the borders of the national park nucleus, extending mainly toward the periphery of the park. It occurs mainly on the mountainous areas and steep slopes in both western and eastern areas and often reaching the lake shore. Forests are often interspersed with brush and patches of rangeland.

Approximately 45% of the forestland is classified as partly-forested, because the existing vegetation does not meet the minimum requirements in

terms of timber stocking and productivity (Karteris, pers. com.). Present conditions of the forest clearly indicate the effects of previous overgrazing, overbrowsing, clearcutting and uncontrolled logging.

The overall picture of the forestland is one of land degradation and retrogression (Whittaker, 1975) of plant communities. Many openings within the forestland, especially on steep slopes, display extensive soil erosion and loss of topsoil. In contrast to the major problem on most Greek coniferous forestlands, the Prespa area does not have a forest fire history; this is mainly due to climate but also to the fact that the dominant hardwoods are not highly inflammable.

The most abundant forest is the deciduous broad-leaved type (Figure 13). Quercus spp. are the dominant tree species and comprise the climax natural vegetation (see Chapter I: Flora). They are found in pure stands or mixed with other hardwoods like Fagus spp., Ostrya spp., Carpinus, spp. Juniperus spp., etc. Oak occurs only as a coppice forest. In many areas it produces thickets that are difficult to penetrate. The stands have poorly formed trees and are used mainly for fuelwood. Clearcutting is usual even in the national park. Recently, management plans of the Forest Service propose the conversion of coppice stands to tall trees by selective cutting after the period of vigorous sprouting.

The next most abundant tree, Fagus sylvatica, is found in the highest forested areas of the eastern part, either in pure stands or in mixed stands with oak and other hardwoods. Beech trees occur either as uneven-aged forest (271 ha) or as coppice even-aged stands. The coppice stands consist of poorly-formed trees and are in as equally-degraded a condition as the oak stands. The beech forest consists of trees which are mainly used for industrial wood. Mature beech trees have a larger diameter, over 22 cm dbh

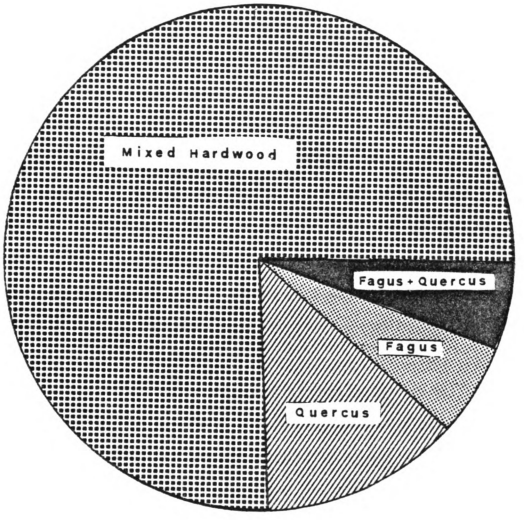


Figure 13. Relative abundance of forest types in Prespa National Park, Greece. Data from Forest Service of Greece.

(breast high diameter), than local oaks and other species.

The only forestland included in the nucleus of the park is a Juniperus spp. stand on the western shores of the lakes. Part of this forest, covering an area of 12 ha, and consisting mainly of Juniperus foetidissima, J. communis, J. oxycedrus and J. excelsa, is under strict legal protection. A few trees are older than 300 years. The whole juniper forest seems to be a regressional succession stage of an earlier oak-mixed hardwood forest on limestone outcroppings. Human activities, such as fire, clearcutting, overlogging, grazing, etc., evidently years ago, converted a climax oak forest to an earlier successional stage (Pavlides, pers. com.). The production of topsoil over limestone bed-rock is slow and junipers are the only species able to withstand low moisture conditions, shallow soils and extensive soil erosion. In the ravines of the most inaccessible areas where human interference was minimal, oaks and other broad-leaved trees also are somewhat larger than elsewhere.

At present, there is no management of the juniper forest or of its protected area. On the contrary, the construction of a paved asphalt road through this protected area has had a negative impact on the trees. No measures were taken to prevent erosion of the roadsides. The same problem exists over all the road network in the forestland of the National Park.

No forestland in the whole area has been managed for recreational use or esthetic purposes. Forest management, on the other hand, is directed towards increasing timber production on a purely economic basis.

Rangeland (R)

The second most important category in terms of acreage, rangeland cover, about 18% of the park's terrestrial area (Tables 5 and 6). Most

(79%) rangelands are interspersed with forestland in the eastern part of the park, primarily in the mountainous areas. There is evidence that this type of vegetation often is a result of clearcuts in the forestland. In addition, however, alpine rangelands occupy the nonforested zone at altitudes above 1800 m. Only a small amount of alpine rangeland, however, is within the national park boundaries.

Natural rangeland vegetation is the primary source of forage for sheep and goats whose ranching is one of the most important economic activities of the region. Yet over most of the rangelands, particularly in the mountains, sheet erosion and often rill and gully erosion are obvious. Such serious erosion is indicative of grazing which exceeds the range carrying capacity of the land.

Excessive grazing causes a reduction in vegetative cover, especially of those forage species with the highest food-preference ratings (Petrides, 1976). The reduction of heavily-cropped range plants is followed by an invasion of less-palatable thorny or distasteful species. This is the process of "desertification" and it has occurred in some Prespa rangeland areas. Artificial droughts result from increased soil compaction and rainfall runoff, with reduced soil tilth and soil moisture. Such conditions are especially evident close to the villages on the southern slopes in the eastern part of the park.

According to 1982 census data, the main livestock population of the entire Prespa area (Table 7) consisted of sheep and goats and all of these forage in the national park. All areas of rangeland are open to grazing as are some portions of the forestland and also the agricultural land. The Forest Service reports that the total grazing capacity of the park is 15157 animals. The Service, however, does not specify whether this is an annual

Table 7. Number of livestock in Prespa by categories of animals, in 1982.

Animals	On farms	Wild-grazing flocks
Sheep	-	8633
Goats	53	2790
Sows	201	-
Cattle (cows)	-	227
Cattle (bulls)	-	79
Poultry	6560	-
TOTAL	6814	11,729

or more seasonal range carrying capacity and does not indicate that this figure would vary depending on the livestock species involved.

The livestock present in the park during the study (Table 7) was equivalent to 13259 sheep, (based on 6.0 sheep to 1.0 cow (Stoddard and Smith, 1943)) which is close to the carrying capacity estimate given by the Service. Judging from the condition of the landscape, however, livestock grazing is excessive in many localities.

Ideally, livestock grazing should not occur in national parks. Even according to the Greek law for national parks (L.D. 996/1971) the grazing of livestock now seen in the nucleus is prohibited there. Since livestock breeding has been a major source of income to the residents of the area for centuries, however, and since people do live within the park, some provision may have to be made for continuation of the practice. In time, it is hoped that livestock grazing can be phased out. In the meantime, frequency and intensity of grazing needs to be controlled.

The range livestock operator should take into account that his primary crop is forage rather than animal products (Petrides, 1976) and once forage is diminished the overall impact of grazing will negatively affect the whole ecosystem. The development of a range management plan should be established and practiced in a way which would ensure that:

1. continuous directional change in plant composition and productivity does not result.
2. the soil does not become increasingly eroded, compacted and of low water-holding capacity.
3. a network of meadows representative of each major grassland type is protected from all stock use so that they remain as near to naturally-functioning ecosystems as possible.

Wet Meadows - Marshland (Wm)

The wet meadow-marshland together with the reedbeds comprise Prespa's wetland. It is the smallest (0.52%) land cover/use category within the national park (Table 5). Of the park's vegetation types, this least abundant one is the most important to wildlife (see Chapter III). Fortunately, it is wholly included in the nucleus of the national park and therefore is favored by legal protection. Most (94%) of the wet meadows are located on the northeast shores of Mikri Prespa, between the agricultural fields and the lake reedbeds.

This land, periodically inundated, is characterized by hydrophylic vegetation that requires saturated soils for growth and reproduction. Periodic fluctuations in water level is the major factor regulating the dynamics of the wet meadows-marshland area of Prespa. Drying, reflooding and other cyclic changes induce periodic nutrient releases which are reflected in periodic "boom and bust" population responses. This area, therefore, is highly productive for vegetation, invertebrate fauna, and a wide array of vertebrates including fishes (see Chapter I: Flora, Wildlife and Fish). The value of the wet meadow-marshland area as a bird habitat, especially for colonial waterbirds is enormous (see Chapter III). In contrast to non-colonial nesters (Wiens, 1975, 1977; Wiens and Dyer, 1975; Sturges et al., 1974), colonial species contribute substantially to local energy and nutrient budgets (Kroodsma, 1978).

Larger, but unmeasured, values of wet meadow-marshland cover/use category are found in the other natural functions they perform. These include storm water runoff control, floodwater retention, water purification through nutrient uptake, sediment trap maintenance, groundwater recharge, and wave-erosion control. These are benefits which contribute to the

welfare of the whole national park.

A direct land use of Prespa's wet meadows is to provide livestock grazing. Especially on the wet meadows of Mikrolimni, the overgrazing impact on the soil and vegetation is obvious. In these areas, large mudbelts border the shoreline. The consumption of reeds by sheep and goats has reduced these plants to stalks about 30 cm high. In the remaining wet meadows, particularly on the northeast part of the park, grazing under less-intensive conditions had rather the effect of retarding succession. There, although not following any scientifically-based plan to a degree, the wet meadows were grazed in a rotational manner so that utilization did not exceed forage production.

Adverse impacts on wet meadow-marshland functions and production also occur as a result of agricultural drainage and irrigation networks constructed in the area(e.g. Darnell, 1976; Barber et al., 1978, etc.). These activities have reduced the wet meadow category to its present 89 ha.

The wet meadow-marshland should be a focal point if land management is practiced in the national park. A first step toward any management procedure should be to recognize that this land cover/use category comprises a valuable national resource. Any management plan to achieve national park objectives should release the area from human pressures and allow natural processes to prevail.

Agricultural land, non-irrigated and irrigated (A, Ai)

The total cultivated area within the national park boundaries is 2,804.7 ha, representing 16.4% of the land area. Over 70% of cultivated fields are located in the eastern part of the national park (Table 5 and 6). Of these, 110 ha of irrigated fields are located within the nucleus of the

national park. Potential irrigated land is all agricultural fields within the perimeter of the irrigation network. The potentially-irrigated land was measured as 1450.8 ha. Only 4% of this was in the western part of the park, at Pili. All the remaining was along the eastern shores of Lake Mikri Prespa, from Lemos to Mikrolimni. All other cultivated areas outside this network constitute non-irrigated agricultural land (Appendix A).

Most (57%) non-irrigated agricultural land is on the western mountainous plateau at Vrontero. The same land cover/use category in eastern areas is located at a considerable distance from the lakeshores and outside the nucleus of the national park. Most such areas lie close to the villages of Plati, Kallithea, Lefkonas and Karies. A portion of non-irrigated agricultural land, however, is on the isthmus and within the nucleus of the park.

At Prespa, insufficient summer rainfall prevents any substantial commercial crop production of rainfed crops. Irrigation is required for spring crops which could provide a substantial income. Irrigated crops primarily are beans, potatoes, vegetables and secondarily maize (corn) and alfalfa. Winter cereals, primarily barley, but also wheat and rye, cover more than two-thirds of the non-irrigated fields. The yields of all crops, except beans, are medium to low. While beans and potatoes are high-income cash crops, they are not cultivated to the extent permitted by the soil and water resources of the area mainly because of labor deficiencies caused by the high average age of local farmers. The percentage of fallow fields also is high when compared to that of other parts of Greece (Gerakis, pers. com.) and reflects the aging characteristics of the local population.

At present, agriculture is practiced at Prespa on relatively low inputs of inorganic fertilizers. Although the amounts of fertilizers applied per

hectare are in many cases higher than needed, the total amounts of fertilizers used are low. Surveys of Agricultural Service personnel indicated that in some cases farmers used twice as much fertilizer per hectare as recommended by the agricultural specialists. The types of fertilizer applied as well as the application techniques used also are not selected with any consideration for broader environmental protection.

The amounts of pesticides used in the area are low in keeping with the generally non-intensive exploitation of the cropland. The selection of the particular type of pesticide, the mode of usage and the precautionary measures for human safety adopted are a matter of personal judgement by each farmer. Discussions with local farmers showed that no consideration exists, nor control measures of any kind imposed concerning the broader environmental consequences of pesticides. In general, the environmental awareness of the farmers is low to nil, as is certainly also the case with farmers in other parts of Greece.

Irrigation/drainage network

The irrigation/drainage network (Lemos to Mikrolimni) is coupled, as in all such networks, with its drainage network. Although the area of this combined irrigation/drainage network is larger, only about 860 ha (59%) can be irrigated at present. The remaining portions of the network are not yet completely constructed. Even so, of the 860 ha which can now be irrigated, only 20.2% (174 ha) are actually used.

Despite the high construction costs of the network, the existing irrigation facilities are presently not fully utilized. The reasons for this low usage of the existing irrigation system are both social and economic. One of the main constraints is the land ownership problem which is more difficult and complex in Prespa than in other parts of Greece

(Pyrovetsi et al., 1983). Related to this is the high average age of the farmer-landowners which does not permit intensive farming.

Despite the small area of land actually irrigated, the Government plans are not only to complete irrigation facilities over the whole area of the network but also to encourage the increased usage of existing irrigation water. Construction of the irrigation/drainage network in the national park began in 1965. Among the first works carried out were alterations in the natural stream beds and the construction of a related drainage network. The objective of these works was to regulate stream flow and drain wet meadows-marshland areas. This drainage objective was reached. According to Zisopoulos (1982) these works turned the area from a place of thick natural vegetation and "useless" marshes to one of high crop productivity. This viewpoint displays an untrained level of environmental awareness and national park objectives on the part of the land reclamation specialists who planned and supervised the irrigation/drainage project at Prespa National Park.

The development of agricultural land (both irrigated and non-irrigated) is in direct conflict with the functions of the wet meadow-marshland and lake ecosystems which are essential to the objectives of the National Park. Because earlier data are lacking, the total losses of wildlife and its habitat cannot be assessed precisely. Those losses, however, must be considerable since the drained areas are part of the major wetlands of the national park (see Chapter III). The "invasion" of the agricultural land and farm activities into the marshland and its proximity to existing wildlife habitats introduces disturbance and indirect negative impact into those habitats.

Another conflict between agricultural land on one hand and the wetland-lake on the other is a functional one. The development of the irrigation/drainage network enables the introduction of agro-ecosystems requiring large inputs of chemical fertilizers and pesticides, which drain into and pollute the water body either from point sources or from non-point sources or from both (Rogers et al., 1977; Marsh and Borton, 1975). Although detailed analysis of the potential impact of these sources is not within the scope of this study a few salient points may be discussed.

The main threat of pollution to Lake Mikri Prespa today is by nonpoint pollution from the agricultural land (Gerakis, pers. com.). The pollutants of particular concern are pesticides, chemical plant nutrients, organic detritus and soil particles which may be transported to the lake mainly through surface runoff.

Surface runoff from rainwater is a natural process on all watersheds. Cultivated lands situated on steep slopes are especially liable to intense runoff with consequent transport of soil particles and mineral nutrients to the lower-lying water body. In modern agriculture, nutrient transport is increased due to the intensive use of chemical fertilizers. Irrigated lands in addition to runoff occurring from rain, release much irrigation water rich in nutrients. Some of the tillage systems applied also leave the land with only sparse vegetative protection during the rainy season (October-April). In this way, too. runoff and erosion is increased. From the soil conservation aspect, winter cereals provide better soil cover than spring row-crops such as beans and maize.

As runoff and drainage waters flow directly into the lake without treatment, its impact on the lake ecosystem is direct and can be serious. The increased use of fertilizers, especially of phosphorus, (Vollenweider

and Kerekes, 1982), accelerates the rate of lake eutrophication, indications of which have already been observed in Prespa (see Chapter I: Lakes). Also, introduced pesticides may cause toxic effects to plant and animal species of the wetland and lake. These effects will originate from the normal use of pesticides but they will certainly also occur from airdrift because of accidental spills with consequent runoff. In addition to the danger to wildlife from pesticides and other chemicals, the direct exposure of local residents to dangerous chemicals seems certain if they continue to use lake fishes as food.

If proper control measures are not taken, the use of both irrigated and non-irrigated agricultural lands will have deleterious effects on both the wetland and the lake systems of Prespa. This deterioration and degradation will destroy the park along with its goals and objectives.

Abandoned agricultural land (Aa)

Abandoned fields comprise 1.26% of the terrestrial park land, mainly (73.3%) in the southeast (Table 6). Most abandoned farms are interspersed throughout the forestland or are located in the valleys south of Mikrolimni. There are indications that clearcutting of forests occurred in the past and created fields which had no road access and were isolated from the closest villages. It is probable that most such farmland was developed by residents of the abandoned village Krania which is in ruins today. Agricultural produce was transported to other areas only by boat. This land is of little economic or social value today.

Abandoned fields also have been identified on the slopes of the eastern hills close to the villages of Plati, Milionas and Lefkonas. As soon as the Land Reclamation Service drained lowlands on the eastern lake shore (about

1967) to provide high-quality farmland, the hilly fields of low soil fertility were abandoned.

The abandonment of farms in the western part of the park resulted from the considerable population decline in the area. According to the national census data of 1981 there were 172 residents in Vrontero while in 1941 there were only 591 (a 71% population decline). Agathoto and Daseri have been completely abandoned.

Urban areas (U)

Village areas comprise 0.44% of the total land within the national park (Tables 5 and 6) and are distributed in 12 villages on the periphery of Lake Mikri Prespa, except for Psarades which is located on the shores of Megali Prespa (see Chapter I: Human Population). Most of the villages are outside the nucleus of the Park with the exception of Ag. Achillios. Mikrolimni is on the nucleus' border. At the time that these villages were developing, man had little control over natural processes and forms of nature and the villages grew in harmony with nature. None of the villages was built on a predesigned urban plan.

The villages of Prespa are, for the most part, visually unobtrusive and complementary to the landscape (Fish et al., 1979). Lemos and Psarades have been declared by law as architecturally-valuable preserved villages within the National Park.

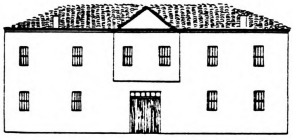
Each village has a main square located in its center around which the houses are built. The village square is a kind of community center with cafes and village shops. In each village, there is at least one church placed in a position of significance, either in its center or on a hill overlooking the village. There is one schoolhouse in each village, but not

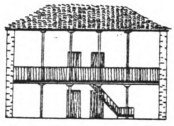
all of them are still in operation. The roads within the villages are dirt or paved with stones (as at Psarades) and usually follow the contour. They are thus unobtrusive and help to prevent soil erosion.

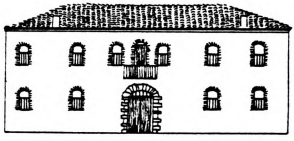
Houses in these villages, as well as in all the villages of Prespa, are 50 to 100 years old with very few new buildings. Each house is a closed unit with its yard, furnace and barn enclosed by a stone wall (Figure 14). The form and structural details of many buildings characterize them as valuable remnants of the traditional local architecture. Stone is the major construction material. Especially in the case of Psarades, these stone houses fit perfectly with the natural landscape. Some houses are constructed with mud bricks which also blend well with the soils of eastern Prespa (at Milionas).

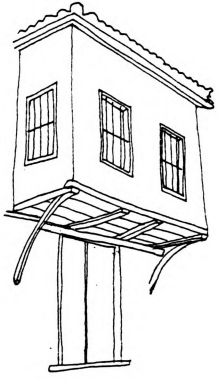
Historical Monuments

Prespa National Park has values as a place of historical interest. Many ruins, mainly of Byzantine churches, are present within the Park. On the island of Agios Achillios as a major monument is a church dedicated to that saint. It is one of the largest Byzantine basilicas, and was built in the 10th century. It is a three-aisled basilica with several stone tombs along its southern aisle. One of the tombstones, illustrating a hawk, a heron and a juniper tree as the major symbols of the area, is of great value. Unfortunately, efforts to preserve this valuable relic have not been made. On the same island there are three other churches and one Byzantine monastery (16th century) with interesting frescoes. On the cliffs opposite Psarades, over Lake Megali Prespa, there are frescoes which decorated old cave-hermitages painted on the rocks. These archaeological ruins have great value and can be viewed from boats by park visitors. Only limited









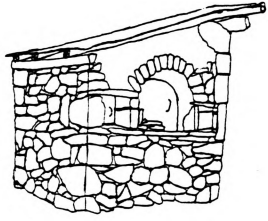


Figure 14. Examples of local architecture in Prespa National Park, Greece.

restoration work has been done on these monuments.

Barren-eroded land (E)

The barren-eroded land cover/use category involves 0.51% of the terrestrial part of the national park (Tables 5 and 6). This percentage is comparable to that of the wet meadow-marshland. The actual total area of this category is by far larger than the stated value, however, because only the barren-eroded patches large enough as to be identified in the aerial photographs were measured. Streams, canals and ditches have also been included in this category. Nearly 92% of this land type is located in the eastern part of the park interspersed as patches in the forestland.

The parent soil materials in the eastern areas of the park are granites and gneisses which develop into productive soils. Most of this land cover/use category, therefore, is the result of erosion and land misuse. The land is not naturally barren. The western limestone mountains in contrast, have shallow top-soils and are more liable to have naturally-barren areas, despite the small area (8%). The eroded land there has mainly resulted from overgrazing by livestock or from clearcutting and farming activities in the forestland.

The mapping of the barren-eroded land in the Park is useful for providing an indication of the misuse of park resources. Also, however, it provided an insight into the potential dangers of accelerating the eutrophication of the lakes through the transport of sediments, nutrients and organic detritus.

Quarry

Another land cover/use category which due to their small size, was not found through interpretation of the aerial photographs is that of quarries which may be considered as point sources of pollution. Two such areas are within the national park, both bordering the nucleus. The stone quarry (and concrete gravel bin) at Mikrolimni was abandoned many years ago and no reclamation work done. Today from anywhere on the northern half of the lake, the quarry is seen as an unattractive cavity in the otherwise green hills.

The second quarry is at Pili and it actively extracts marble. A marble finishing plant is located in the same area. This quarry centers on the edge of the lake and has a direct impact on it. Quarrying is a "use" totally unacceptable in a national park (L.D. 996/1971, Article 80) and incompatible with its objectives.

This quarry is located within the park's protected zone and its operations should be forbidden. It damages the landscape along a whole section of the shore. Reeds are continually being crushed and destroyed by rocks being dumped on them. The wet meadow has been completely covered. There is a pond filled with muddy water, a gravel bin and an area with haphazardly stacked marble; all having a negative impact on lake turbidity and other qualities. The noise from dynamite explosions has a further negative impact on the tranquility expected in a national park. And, as a result of the explosions, there are gaping holes visible and large piles of rubble scattered along the road. In Greece, quarries are now subject to control under various laws (Laws 386/1976, 669/1977, 998/1979, Ministerial Resolution 19/8/1980) and it is intended that areas not in national parks and appropriate in other regions will be designated for quarrying.

Canned food plant

A food processing plant for canning fish and vegetables is located on the western shore of the lake, within the nucleus of the Park. It is not operating presently but the temporary closure is due to economic and not to ecological causes. Legal and ecological arguments exist which are strong enough to ask for its permanent closure.

During its several years of operation in the early 1970s the plant disposed of all of its wastes directly into the lake, an illegal and ecologically destructive practice.

Land Cover/use changes

One of the major geophysical feature changes which occurred after 1945 was the man-made alteration of the bed of the perennial stream originating from the alpine northeastern mountains and now flowing into Lake Megali Prespa. In the 1945 aerial photographs, that stream was divided into two sections near Lemos. While a small part flowed into Lake Megali Prespa, the main tributary emptied into Vromolimni of Mikri Prespa, and a delta was formed between the two stream units. Probably the sediments carried by the stream decreased the water depth of Mikri Prespa and enhanced the formation of the Vromolimni "inner" lake. The plant litter and other organic material exported into the lake by the stream enhanced the productivity of the lake system in the delta area. The wetland, with its rich flora and fauna, may be a result of this nutrient input.

The stream also brought large quantities of water to the area, particularly during the snow-melt season. Doubtless the water quality of the lake, and particularly of the wetland was improved as the highly-oxygenated stream entered the lake. When the streambed toward Vromolimni

ceased to exist during the construction of the irrigation/drainage network, it caused water levels to fluctuate less. Now, less dynamic conditions prevail, and the wetland contains different vegetation than in the past.

The changes since 1945 extended throughout the eastern part of the park and involved decreases in forestland, rangeland, wet meadow-marshland, in non-irrigated agricultural lands and urban areas (Table 8). The land cover/use categories which increased (Table 9) were primarily the barren-eroded land (by 337.9%) and the reedbeds (by 25%). Irrigated agricultural land and abandoned agricultural land are categories which were present in 1984 but did not appear in the 1945 aerial photographs at all. They are entirely new.

Each land cover/use category has exhibited changes in area (Figure 15). Non-irrigated agricultural land suffered most of the losses, decreasing by 37.6% (817.2 ha) (Table 9). Most (56.9%) of this land was located in the lower zone of the eastern park area and was transformed into irrigated agricultural land. Other large portions were abandoned (21%) or converted into rangeland (18.5%). Old farms abandoned between 1945 and 1984 were mainly south of Mikrolimni and close to the ruined village Krania, or in the western section close to the ruined villages Agathoto and Pixos, both near the Albanian border. Other agricultural land which has changed since 1945 included patches on the steeper slopes of the eastern mountains, close to Kallithea and Lefkona.

Terraces had been built on those slopes and crops had been cultivated there for many years. Traditional farming was ecologically sound and terracing was successful in reducing erosion while providing farmland close to the villages. Evidently it was when new more-fertile agricultural land with irrigation facilities was made available to the farmers that the above

Table 8. Land cover/use changes between 1945-1984 in Prespa National Park, Greece (in hectares).

1945	1984	1 F*	2 R	3 Wm	4 A	5 Ai	6 Aa	7 E	8 W	9 Re	Total reduction
1**	East		51.4		22.6	3.2		5.5			
F	West		-		-	-		-			
	Total		51.4		22.6	3.2		5.5			82.7
2	East	30.8		11.7	160.09	818.4		40.3			
R	West	12.7		-	21.9	13.2		-			
	Total	43.5		11.7	182.0	831.6		40.3			1109.1
3	East				0.5	30.6		1.7		3.0	
Wm	West				-	4.2		-		-	
	Total				0.5	34.8		1.7		3.0	40.0
4	East	17.4	160.3			560.8	151.6	19.4			
A	West	-	29.1			20.4	63.3	-			
	Total	17.4	189.4			581.2	214.9	19.4			1022.3
8	East									105.6	
W	West									30.8	
	Total									136.4	136.4
9	East								13.4		
Re	West								2.0		
	Total								15.4		15.4
10	East		1.0								
U	West		5.2								
	Total		6.2								6.2
											6.2
Total Gains		60.9	247.0	11.7	205.1	1450.8	214.9	66.9	15.4	139.4	2412.1

*F = forestland; R = rangeland; Wm = wet meadow-marshland; A = agriculture, non-irrigated; E = barren-eroded land; W = water surface; Re = reedbeds; U = urban (village) areas; Ai = agriculture, irrigated

Note: Categories Ai, Aa, and E were absent in 1945; category U showed no gain by 1984

** = code numbers as shown on Map 2.

To read the table: 51.4 under R and opposite F(East) indicates a 51.4 hectare change from forestland in 1945 to rangeland in 1984.

Table 9. Percent changes in land use since 1945, Prespa National Park, Greece, January 1984.

		Area 1945 (Ha)	Area 1984 (Ha)	Percentage change total loss
Forestland	F	10903.6	10881.8	-0.2
Rangeland	R	3794.8	2932.7	-22.7
Wet meadows-marshland	Wm	117.3	89.0	-24.1
Agricultural land	A	2171.1	1353.9	-37.6
Agricultural land-irrigated	Ai	-	1450.8	+
Agricultural land-abandoned	Aa	-	214.9	+
Barren-eroded land	E	19.8	86.7	+337.9
Water	W	8106.0	7985.0	-1.5
Reedbeds	Re	495.8	619.8	+25.0
Urban areas	U	81.5	75.3	7.6
Total Park Area		25689.9	25689.9	

Figure 15. Percent changes in land use, 1945-1984, in Prespa National Park, Greece.

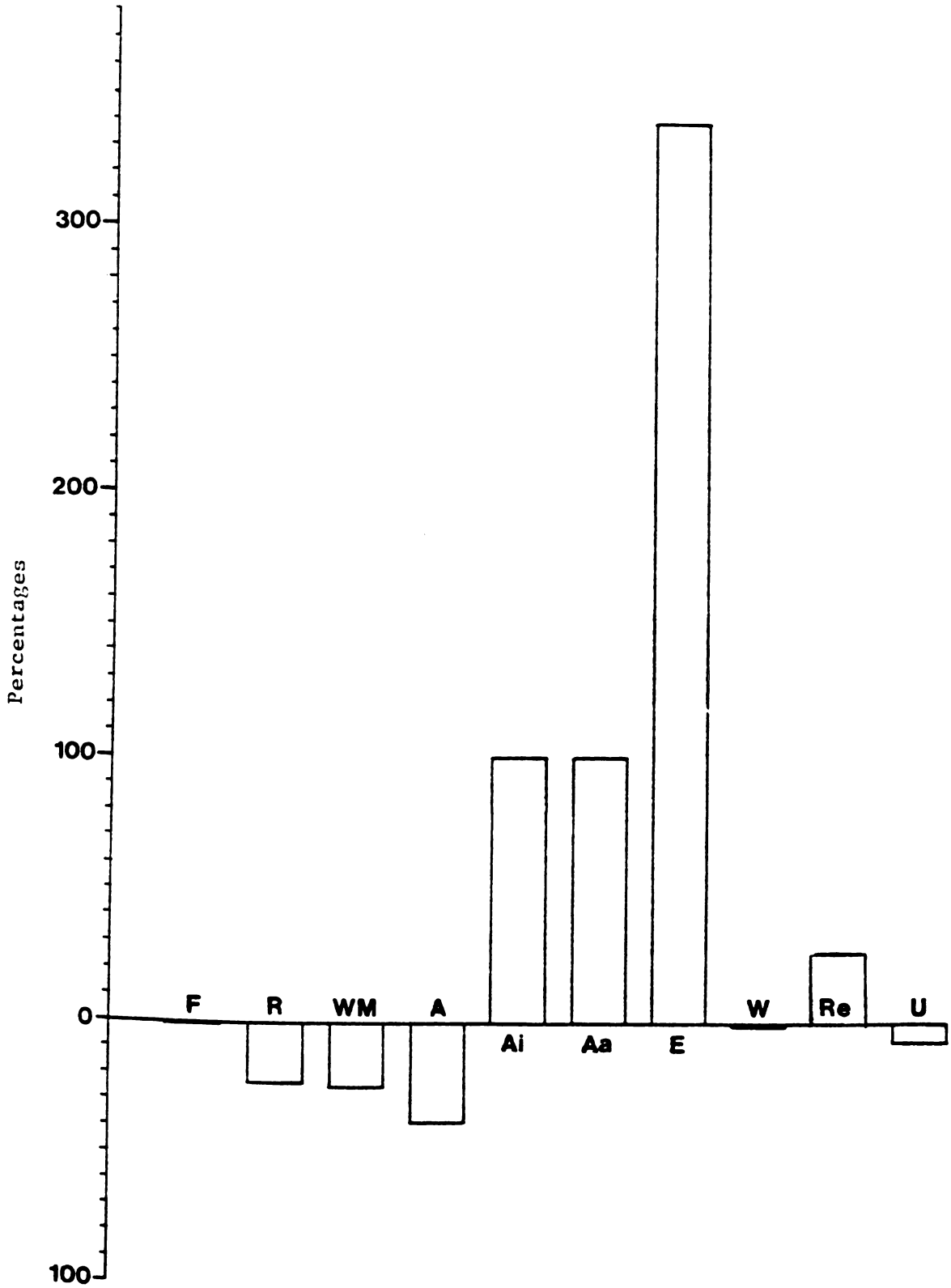


Figure 15.

farmed terraces and farm-fields in the forestland were abandoned. These areas are now classified as rangelands, presenting signs of grazing, while others are categorized as abandoned agricultural lands. Some smaller portions have become forests in early successional stages while other parts display signs of advanced soil erosion and degradation.

The wet meadows-marshland in the east has been subjected to considerable losses (40 ha) since 1945 (Table 9). Nearly a quarter (24.1%) has been drained and transformed to farmland. All of the lost wetlands, though located within the nucleus of the park and favored with strict protection by law, is within the irrigation/drainage network.

The change which appears on Table 9 from wet meadow-marshland to barren-eroded land include by definition, all the canals, dikes, ditches and other engineering features of the irrigation network.

The difference between the seasons at which the photographs of 1945 and 1970 were taken seems to be the reason for the 3 ha change from wet meadow - marshland to reedbeds. This changed area is at the isthmus, on the northeast corner of Vromolimni, and because of the low water level in the dry season the reedbeds appear as wet meadow-marshland in 1945 photos.

Rangelands also lost considerable(862.1 ha or 22.7%) since 1945 (Tables 8 and 9). Most such land, located on the eastern lowlands, has been transformed mainly into irrigated (75%) and non-irrigated (16.4%) agricultural land. Some patches of rangeland, dispersed among the forestland slopes, changed to forest.

The rangelands which changed to the barren-eroded type were either a result of overgrazing or involve the canals and other engineering construction.

Even though 11 ha of the 1945 rangelands appear according to the photographs and later survey to have been changed to the wet meadow-marshland category in 1984, this evidently merely was caused by seasonal change. Wetland areas which were naturally flooded in spring and summer evidently appeared as grassland in the 1945 photographs. It seems unlikely that there was an actual gain in the wet meadows category in the time interval under consideration.

The changes (7.6%) which occurred is the urban areas of Perspa are due to the complete abandonment of five villages; Daseri, Agathoto and Pixos in the western section, and Krania and Opagia were on the eastern shore. Ruins of the old houses were included in areas later used as rangeland.

The evacuation of the villages like all other Prespa's villages occurred during the Civil War (1946-1949) when the whole area was a battlefield. After the war, the few people who returned to the area concentrated in the present villages which were accessible by roads. The villages Daseri, Pixos, Agathoto and Krania were accessible only by mountain paths or boats which possibly has discouraged return. Opagia, though close to the main road of Prespa, was not preferred for residential use any more because it was within the wetland and malaria was a continuous threat to the villagers at that time. Also, the dirt roads were flooded during winter and Opagia was not easily accessible.

Only minor changes (21.8 ha or 0.2%) occurred on forestland (Tables 8 and 9). All such changes occurred on the eastern slopes and turned the forest mainly into rangeland and secondarily into both irrigated and non-irrigated agricultural lands. Some new rangeland is located at the south outskirts of Lefkonas, on the mountain, as a result of clearcutting. The forest area converted to farmland occurs close to Karies and is planned to

be irrigated.

The water area of the Park has decreased since 1945, 121 ha has been lost with a comparable increase in the extent of reedbeds (Table 8). Interpretation of the aerial photos showed that new reedbeds are extending along both eastern and western shores from the Albanian border to Vromolimni with great changes around Vromolimni. In 1945, Vromolimni appeared to have had much more open water with small patches of reedbeds forming a continuous mass with the mainland. The "inner lake" described previously evidently did not exist in the 1945 photos. This may be related to the presence of the stream which then flowed into Vromolimni, increasing local water volume and lake-depth and preventing the spread of reeds.

The earlier absence of reedbeds along the shoreline of the eastern and western shorelines may be partially a result of reed use by the local people. Discussion with older local people brought up that in the past villagers used the reeds and managed the reedbed ecosystem in a way similar to suggested modern management methods. During early summer, they cut the new reeds and used them for animal feed. In the early fall, they would cut the dry stems for heating, cooking and construction material. Fences in the farm plots and thatched roofs were made of reeds. Later in the fall, before the rainy season, they used to burn in situ the remaining dead stems and stubble; they did this, they said, "in order to have better spawning of the carp the coming spring." Evidently, mineralization of the organic material induced a better-oxygenated habitat suitable for fish spawning. Although many other national park activities inconsistent with the law are overlooked, these methods have not been allowed to be practiced in Prespa since the establishment of the National Park.

Since the 1945 photos were most probably taken in the late summer-early fall, the period when the reedbeds would be at a minimum because they had been cut and/or burned. Nevertheless, the present extent of the reedbeds is far larger than might have been caused by any management practice in 1945.

The only explanation for the difference still remaining to be examined is the trophic level of the lake during 1945 as compared with today. There are clear indications that eutrophication of the lake has recently increased substantially with a consequent increase of phytoplankton and emergent-submergent vegetation. Until the late 1960s, villagers used the water of the lake for drinking and washing. Today this water is neither drinkable nor of household use. It has become "greenish, with many tiny particles and is not clear the way it used to be", testimonies of old villagers say. It is interesting to note that this change coincides, considering the expected time lag, with the operation of the irrigation/drainage network and the transfer of farming activities to the lowland. It seems most probable that agricultural activities combined with the lack of reedbed-cutting has increased the level of eutrophication of the lake and has caused fisheries spawning habitat to deteriorate.

The increase (337.9%) (Table 9) of barren-eroded land in the eastern part of the National Park since 1945 is also quite impressive and merits special examination. The recently eroded land has mainly resulted from grazing and secondarily from agricultural practices during years past. Overgrazing by livestock in the steep slopes of the eastern rangeland, close to Karies and Kallithea, has caused erosion conditions of considerable seriousness. Areas of gully erosion were observed during the field survey, particularly on the southern slopes of the eastern mountains. Adverse agricultural practices on steep slopes and uncontrolled clearcutting in the

forestland have contributed considerably to the overall increase of eroded land. The construction of the irrigation/drainage network also contributed to an extension of eroded lands.

In general, the aerial photographs give the impression of more extensive human activities/disturbances (such as logging, grazing, farming on steep slopes, terracing, etc.) over the whole area of Prespa and particularly on the uplands, around and/or close to the villages in 1945. The extent of these activities is compatible with the population of the area in 1945 which was more than 6000 people. The intensity of some of these activities resulted in the deterioration of forest vegetation. Some forest areas in 1945 seem to have been less dense than in 1984, although the general structure of the forest was the same. Since the irrigation/drainage network was constructed, there is a general trend of concentrating land use in the lowlands, close to the lake. In this area, which happens to be in the nucleus of the National Park or in great proximity to it, land use activities are continuously becoming more concentrated and more intense with increased inputs of fertilizers and energy. These activities strongly conflict with the legally defined objectives of the National Park.

As matters now stand (1) fertilizers and silt flow into the lake and wetland ecosystem, (2) the concentration of agricultural activities is eroding the soil and destroying the natural vegetation in the nucleus of the park. Land cover/use trends as they appear in 1984 are endangering the values of the National Park, in general, and more directly of its wetland areas and require urgent conservation measures to be taken.

Chapter III

HABITAT USE BY BIRDS

There is a concentration of human activities in the wetland of Prespa (see Chapter II) and an accelerated destruction of essential natural habitats there. These matters deserve immediate attention.

Although the entire nucleus of the national park, including the wetlands, has been given legal protection from human use, those laws are disregarded in its present land use and, furthermore, in its prospective development. The waterbirds which are the park's most important component are also threatened by these land uses.

It is of high priority to design a conservation policy based on ecological evaluation and assessment of the bird use of these areas. Conservation goals in areas of national significance include the preservation of rare species and unique environments, the maintenance of diversity and the protection of representative ecosystems.

A goal of the present study was to assess the ecological values of the various wetland biotopes in Prespa. The conservation potential of each of the several waterbird habitats was appraised through measurements of population use. Changes and potential shifts in bird populations also were evaluated with reference to present land use patterns and habitat destruction.

It is not the intention of the present study to designate certain habitat types which need to be preserved for wildlife by leaving others to destruction. It is necessary, however, to stress the functional importance of the most valuable habitats.

To date, there have been no studies made to determine how birds use the various biotopes at Prespa or in any other wetland in Greece. In order to assess bird use of their habitats and to determine the environmental stimuli to which birds respond, a complete range of biotic and abiotic aspects should be investigated. Because identification of such stimuli is made difficult by man's incapability to understand the perception system of the animal (Klopfer, 1969), a holistic approach is necessary in identifying those factors and the stimuli which regulate animal populations (Kroodsma, 1978). An attempt was made toward this approach by using quantitative and qualitative data in a complementary manner.

Many authors have documented a correlation between the complexity of habitat structure and the number of bird species present (Hutchinson, 1957, 1959; MacArthur and MacArthur, 1961). MacArthur (1964) also showed that habitats with wet areas have a higher bird species diversity than those without water. In these wetland habitats, the most important key features to which birds respond is the amount of open water (White and James, 1978; Burger et al., 1982), the ratio between emergent vegetation and open water (Weller and Spatcher, 1965; Weller and Fredrickson, 1974), the plant life form (Beecher, 1942), the complex zonation and layers of vegetation (Patterson, 1976) and the diversity or heterogeneity of the wetland (Weller, 1978). These features and their combinations are the main factors which determine bird abundance and species richness in a wetland habitat.

Margules and Usher (1981) reviewed the criteria used by various authors in assessing a habitat's wildlife conservation potential. Commonly-used criteria included those which had a scientific basis such as species diversity, rarity, area size and naturalness. This last item involving the threat of human interference is of great significance in national parks. In

evaluating biotopes for conservation purposes, UNESCO (1974) used the criteria of representativeness, diversity, naturalness and potential effectiveness as a conservation unit.

Species diversity, species richness and species abundance have been used extensively in ecological evaluations of wildlife habitats (Ratcliffe, 1977; Wright, 1977; van der Plöeg and Vlijm, 1978; Burger et al. 1982). These criteria help to describe community structure and provide values which enable comparisons between habitats. Species diversity involves the number of different species present in a habitat and their relative abundance, while species richness merely refers to the number of species in a community.

Sparrowe and Wright (1975) in developing the American endangered species program, devised a system to protect the rare species which contribute significantly to the diversity of the biological gene pool. Protecting rare species from extinction is a major role of conservation.

In order to assess the commonness or rarity of species for conservation it is necessary first to know the distribution and abundance of the species within the concerned geographic area (Margules and Usher, 1981). The rarity criterion has been considered by Adamus and Clough(1978); Ratcliffe (1977); Usher (1980), to be an important element in evaluating habitats for conservation.

When evaluating habitats for birds, site tenacity also is significant. McNicholl (1975) has defined this as the tenacity of a species to nest, feed, roost or conduct other activities repeatedly on or close to a particular site. The habitat of a highly tenacious species is more vulnerable to human impact than the habitat of a species which easily moves from one site to another.

A common further criterion important to the success of habitat conservation is human interference, especially through competing land uses.

In addition to environmental factors it is of great value to know how interactions between species and individuals in the community may set limits to their numbers. Colonial birds present different social behaviors than species with much larger territories to defend. Their behavioral population limitations may be important in habitat analysis.

Methods and Materials

Field data were collected on the use of eight different habitat types by 12 aquatic bird species between September 1982 and May 1984. The species were selected from the complete list of local aquatic birds on the basis of their rarity. 'Rarity' and 'danger of extinction' have been used extensively as criteria of the need for ecological evaluation and nature conservation (Adriani and Van der Maarel, 1968; Volthe-De Lutte Studiegroep, 1971; Kromme Rijn Projekt, 1974; Gehlbach, 1975; Goldsmith, 1975; Kalkhoven et al., 1976; Ratcliffe, 1977; Van der Ploeg and Vlijm, 1978).

The 'rare species' evaluation procedure used was based on the characteristics applicable in natural areas supplied by Drury (1974) and Adamus and Clough (1978). The criteria which were used involved: site tenacity for breeding, feeding and nesting; spatial distribution of the species over its geographic range; population trend, and endemicity of the species. The last characteristic was with respect to whether a species is endemic to Prespa, to Greece, to the European Community countries, to the whole of Europe or to the whole world. Among the species studied, Podiceps cristatus was quite common. The others were rare to varying degrees:

Phalacrocorax pygmeus (Pygmy Cormorant)

Phalacrocorax carbo (Cormorant)

Pelecanus crispus (Dalmatian Pelican)

Pelecanus onocrotalus (White Pelican)

Podiceps cristatus (Great Crested Grebe)

Nycticorax nycticorax (Night Heron)

Ardeola ralloides (Squacco Heron)

Egretta garzetta (Little Egret)

Ardea cinerea (Grey Heron)

Egretta alba (Great White Egret)

Ardea purpurea (Purple Heron)

Platalea leucorodia (Spoonbill)

The distributions of these species are listed in Chapter I: Birds.

Study Area

Eight sampling areas were established in the several habitats to determine their use by bird species. Two of these areas were the major breeding habitats of the colonial aquatic birds in Prespa. The remaining six were typical feeding and loafing habitats of the species studied (Table 10).

The sampling areas selected represented structurally-different biotopes and had varying degrees of human interference. The structural features of the habitats and the physiognomy of the vegetation are recognized as playing a major role in bird response (Odum, 1945; Kendeigh, 1954; Wiens, 1969) Other factors important to to the animals such as water level, are also appraised:

Table 10. Study site characteristics in Prespa National Park, Greece, 1982-1984.

Sampling area	Major use	Habitat type	Major vegetation type	Water level* fluctuation	Human[1] disturbance
Vromolimni	Breeding	Floating islets in open water	Phragmites sp.	Vertical, low	None
Albanian border	Breeding	Lagoons in the lake among reeds	Phragmites, Salix, Juncus, Typha, Nymphaea	Vertical, low	None
Mikrolimni lake	Feeding/ resting	Open water	-	Vertical, low	Fishing (d)
Mikrolimni wet meadow	Feeding/ resting	Wet meadow open to the lake	Phragmites, Plantago, Trifolium, Poa, Rubus, Scripus, Elaeocharis, Ranunculus	Horizontal, high	Grazing (d), agriculture (d)
Biological Station lakeshore	Feeding/ resting	Rocky lake-shore	Phragmites	Horizontal, high	Livestock (d) damp area (d)
Biological Station lake	Feeding/ resting	Open water	-	Vertical, low	Fishing (d)
Koula wet meadow	Feeding/ resting	Wet meadow inland	Phragmites, Scirpus, Typha, Nymphaea, Ranuculus, Potamogeton, Plantago, Poa	Vertical, high. horizontal, high	Grazing (d) agriculture (in) traffic (in)

[1]Human Disturbance: d = direct
in = indirect

*Water level fluctuation: vertical = water level fluctuates vertically
horizontal = water level fluctuates gradual, without obvious vertical changes
high = fluctuations considerable, observed easily, significant effects on habitat structure
low = fluctuations not evident day-by-day, observed easily, not affecting bird use.

Mikrolimni Lake consists of about 1 km^2 of open water surface facing the observation tower at Mikrolimni wet meadow. It extends between Mikrolimni and Vitrinetsi Island (see also Chapter I: Lakes). The bottom of the lake is rich in dead organic plant materials from the nearby reedbeds. As judged by the greater catch by local fishermen, fish here seem to be more abundant than at other nearby sites. A drainage canal from the agricultural fields ends at the site.

Mikrolimni wet meadow: Located northeast of the village of Mikrolimni, this meadow consists of flat alluvial deposits and is largely open to the lake. This site adjoins drained areas and an irrigated agricultural field. A drainage canal crosses the meadow on its southern part. The meadow shows signs of intensive grazing pressure and of the nearby farming activities.

The wet meadow vegetation reaches a maximum height of 10-20 cm during the high-water season and is composed of the forbs Plantago laceolata, Achillea millefolium, Bellis perennis, Taraxacum officinale, Prunella vulgaris, Ranunculus marginatus, Trifolium repens, Mentha microphylla, Anchusa officinalis, Centaurea jacea, Verbascum sinuatum, Sisymbricus orientale, and Veronia arvensis. Of the grasses which dominate the area during the summer, the most important are Poa pratensis, P. annua, Alopecurus pratensis, Cynosurus cristatus and Anthoxanthum odoratesus. Occasionally Rubus canescens appears, randomly interspersed in the meadow with Utrica dioica, Sonchus oleraceus, Stellaria neglecta, Galium sp. and Cirsium sp. In depressions the grasses are replaced by Scirpus holoschoenus, Elaeocharis acicularis, E. uniglumis, Cyperus fuscus, Juncus effusus, Ranunculus aquatilis, R. trichophyllus, Trifolium fragiferum, and Poa annua.

Phragmites australis reedbeds 30-40 m wide, extend northward between the meadow and the lake. Other important species there, are Scirpus lacustris, Iris pseudocorus and Typha angustifolia distributed equally. From late February until June, depending on rainfall, the lake covers most of the meadow. During this period, the floristic associations in the area are those of the wet meadows plant community of the class Molimio Arrhanatheretea, mixed with a marshy plant community of the class Phragmitetea. From July on, the lake water level drops, and the area dries out. During the winter months, the area most of the time is either covered by snow or ice.

Biological Station Lakeshore: This rocky steep lakeshore has no vegetation except the reedbeds which are about 20-30 m wide and extend into the lake about 3-5 m. This pure stand of Phragmites australis is 150 m or so long. During the summer in the shallow outskirts of the reedbed, Solanum dulcamara, Scirpus holoschoenus, Glyceria plicata and Juncus effusus grow. In deeper areas, submerged Myriophyllum spicatum, Potamogeton scirpus and Ceratophyllum submersum are found. During the spring season of high water, the lake extends 7-10 m inshore from the reedbed. When the water level drops in late summer and fall, the water withdraws to the outer edge of the reeds. The shoreline vegetation, which is near Mikrolimni village, presents signs of human disturbance, since it is often used a dumping site for household garbage and barn manure. Flocks of sheep and goats also stay overnight at the site during summer.

Biological Station Lake: This open water area of 1 km^2 is located between the Biological Station at Mikrolimni and Vitrinetsi Island (see Chapter I:

Lakes). The lake bottom is rocky like the adjacent lakeshore. The lake there is quite deep.

Koula Wet Meadow: This site of waterlogged soils is representative of the marsh - wet meadows of the north and northeast shores of Lake Mikri Prespa. It is located at the isthmus and is part of the major wetland at Vromolimni. The site is not open to the lake but rather is a continuation of the Vromolimni wetland. In the broader area of Vromolimni, open water and reedbeds are interspersed in a ratio of 1:3 to 1:2. The marsh - wet meadow biotopes here have suffered severe changes from drainage to create agricultural fields. One of the few natural meadows still remaining is the site used for bird observations. The area adjoins drained fields (planted to barley), a drainage canal and a Phragmites marsh. A wooden fence at the edge of the reedbeds prevented livestock from entering the wetland.

On this site, water level fluctuations determine the composition of vegetation. Water reaches 75 cm during the wet season and decreases to 10-15 cm during the dry season (Figure 16).

The floristic composition on the study area is a Scirpo-Phragmitetum association with dominant species (in a gradient of decreasing importance) Phragmites australis, Scirpus lacustris, Typha angustifolia, T. latifolia, Sparganium emersum, S. erectum, Iris pseudacorus, Sagittaria sagitifolia. Phragmites australis grows mainly on the periphery of the site, separating it from the main wetland at Vromolimni. In late spring, primarily Nymphaea alba, Nuphar luteum, Nyphoides peltata, Ranunculus aquatilis and Hydrocharis morsus and secondarily, Myriophyllum sp., Ceratophyllum sp., and Potamogeton sp. densely are submerged over most of the deep water areas. On a slight elevation of the meadow, Trifolium repens, Ranuculus marginatus, Plantago

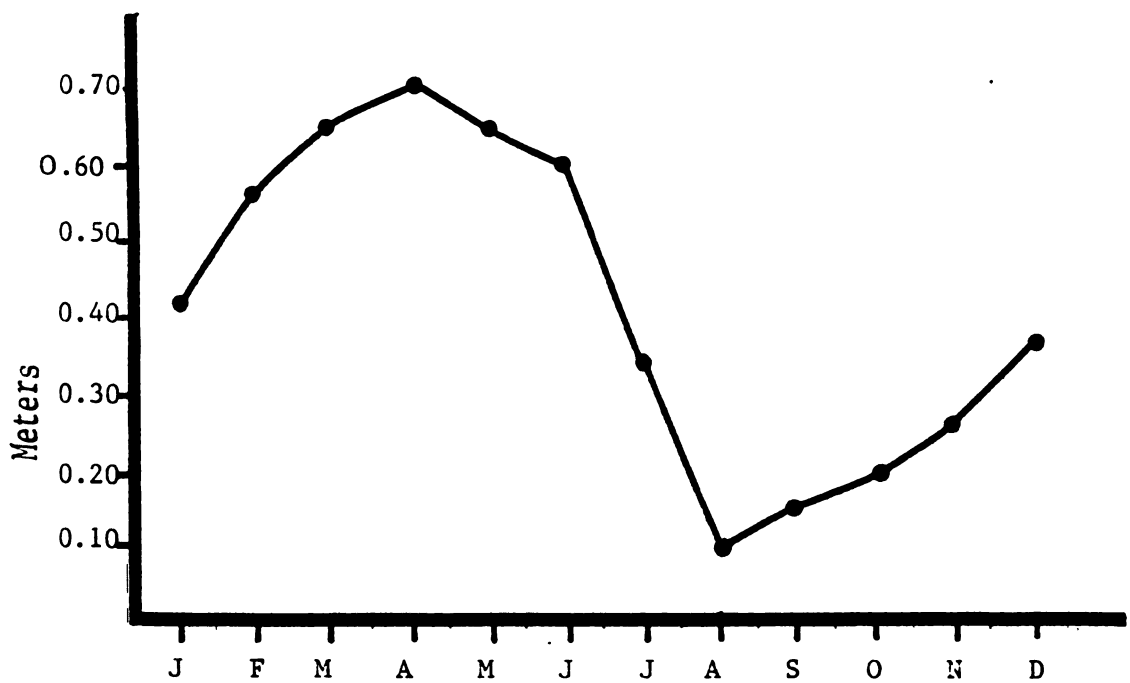


Figure 16. Fluctuations in water depth at Koula wet meadow, Prespa National Park, Greece, 1983.

lanceollata, Achillea millefolium, Poa annua and P. pratensis are found.

Human impacts at the site were estimated as high because of herdsmen and livestock grazing. Tractors operating in adjacent fields also invaded the meadow on occasion while turning, making ruts and disturbing vegetation and birds. Traffic on the adjacent road was quite high during summer as compared to other areas of Prespa.

Stream: Initially a sampling site was established at a stream which flows from the northeastern mountains into Megali Prespa. An observation tower was constructed within the streambed, close to its delta.

The site had been bulldozed and had hardly any vegetation on the alluvial sandy bottom. Observations of birds from the hide provided insignificant results concering bird use of the habitat. This site finally was abandoned. Although the stream has a rich stream fauna, we may conclude that the effects of human impact on it has degraded it as a bird feeding-nesting habitat. Data from these sites were few and will not be considered further, yet their very paucity indicates the serious environmental effects of even simple but thoughtless engineering activities.

Greek-Albanian border area: This portion of Lake Mikri Prespa has exceptional natural values. It is the area least disturbed or altered by man in all of Prespa. While human influences may have occurred earlier, for the last 34 years it has suffered no deterioration because of its borderline location. No access to this national border area was allowed until 1969 because of strict military restrictions. Presently the area is inaccessible to the public, being declared a bird sanctuary. The natural succession of the vegetation in this wetland has been undisturbed.

The marshes and other wetlands in this southern part of Mikri Prespa extend approximately 1 km across the entire width of the lake. The lakeshores are steep, with 50-70% slopes covered by mixed deciduous-evergreen shrubs. In shallow parts of the lake the bottom is rich in decomposing organic materials. There, especially as seen in summer, Elaeocharis sp., Juncus sp., Pulicana dysenterica and Polygonum amphibium are abundant. In water depths from 30-40 cm to about 2 m is a zone, parallel to the shoreline, with Phragmites australis as the dominant species. Other aquatic plants there, are Typha angustifolia, T. latifolia, and Scirpus lacustris which form extensive reedbeds.

Interspersed among the reeds in mean depths of 1-2 m, Salix cinerea reaches a maximum height of 3 m. The trees are coated with bird guano which seems to cause their death. Small stands of these trees have their lower branches intermingled to form islets of vegetation, dead plant materials, accumulated silt and guano. The edges of these islets supported Solanum dulcamara, Leonurus cardiaca, Lycopus europaeus and Elaeocharis palustris.

Scattered throughout the emergent vegetation are lagoons free of vegetation. In these openings, submerged and floating plants include Nymphaea alba, Nuphar luteum, Myriophyllum verticulatum, Ceratophyllum demersum, Potamogeton crispus, P. natans and Ranunculus aquatilis.

Vromolimni: This is a large lake opening in the extensive reedbeds at the northern part of Mikri Prespa. It is approximately 1000 m long and 250 m wide, with a maximum depth of 3 m. (see Chapter I: Lakes, and Chapter II: Reedbeds). Phragmites australis is dominant and grows in depths up to 2 m. The lake bottom in this area has a thick layer of gradually-decomposing organic materials. Five small floating islets, the largest of which is 13 m

long and 4 m wide, are located at the periphery of Vromolimni. These islets are composed of dead reeds, decomposed blackish organic material, mud, bird feces and aquatic vegetation. On the biggest of these floating islets, living Phragmites australis and Typha spp. plants cover a small portion.

There is no direct access to Vromolimni either from the lake or the land. The reedbeds which surround it are 200-1000 m wide and extend for 2000 m along the shore. Passage by boat through the dense growth is impossible. Vromolimni is protected legally from use by people but, more importantly, is favored by isolation which prevents human intrusion.

Field Methods

Observations were made from blinds built on observation towers, 2 m high. These were constructed for this study on three of the sampling sites to serve four areas at Koula wet meadow, Mikrolimni wet meadow, Mikrolimni lake area and the canalized stream. Observations of bird use on the lake and also on the lakeshore in front of the Biological Station were made from the balcony of the Station. Observation into Vromolimni breeding habitats were made from a nearby hill (960 m) in the eastern part of the park, and also from the road along the western mountains, depending on the position of the sun. From these locations, counts of nesting birds repeated from opposite sides during the same day, enhanced the accuracy of data collection. Visits to Vromolimni observation points were limited to avoid undue disturbance of the nesting birds. For the same reason, visits to the Albanian border nesting habitats were made only once a month.

Precise censuses of birds nesting at the Albanian border lagoons were not possible because of the brevity of the visits. Indicative counts, however, were made. Entrance to the lagoons was only possible in the spring

when the reeds were dry, before the new growth inhibited boat passage. The boat used in the study was a locally made narrow flat-bottom one propelled by poling.

A Bushnell Sportview 10x50 binoculars and a Weso-Target 4 25-45 zoom telescope were used to observe birds in the field. Observations at each sampling site were made once a month, over an entire day. The observer entered in the tower at 8:00 a.m. or 9:00 a.m., depending on the season, and stayed until darkness prevented further observations. During observations, counts were made at half-hour intervals of the numbers of birds of each species using the habitat. Time was recorded as Greek daylight time (-3 hours GMT).

Analysis of Data: Feeding/Resting

As a measure of bird use, for each species the mean number present in each habitat per half-hour sampling period was calculated as a percentage of all birds of the same species observed on all sites during the month. Thus, the intensities of habitat use per month, per species were established. In addition, the percentages of all birds seen at one site per sampling period per month were calculated to show how each habitat was used by all species combined.

The most valuable overall comparisons between habitats can be made when the species diversity index of each habitat is compared by months. This, along with species richness in each habitat throughout the study period indicates the relative importance of the habitat conditions to which the species responded. One simple measure of diversity is the number of species occurring per unit area. This, however, is an unweighted measure since it fails to count the relative abundance of the several species present and

also depends on sample size (Schemnitz, 1980). To arrive at a measure that takes account of the relative quantities of the 12 species, some appropriate function of the proportion P_i $(i = 1, 2, \ldots s)$, is required whre P_i is the proportion of the community belonging to the ith species (Pielou, 1975).

The most appropriate function is the Shannon diversity index where: $H' = -\sum_{i=1}^{s} P_i \log P_i$. This index is based on the information theory, (Shannon and Weaver, 1949) where P_i is the proportion of the total number of individuals of the ith species and s is the number of species. In the present study P_i is the proportin of birds of species i observed per sampling period in a habitat; s equals the 12 species studied. One of the merits of the Shannon index is its independence of sample size (Poole, 1974). Species richness was measured as the number of species observed in each habitat per month.

For comparative purposes, the several bird species were grouped in two guilds according to their feeding habits: the strictly fish-eating species (Phalacrocorax pygmeus, Phalacrocorax carbo, Pelecanus crispus, P. onocrotalus, Podiceps cristatus) and the generalist carnivores (Nycticorax nycticorax, Ardeola ralloides, Egretta garzetta, E. alba, Ardea cinerea, A. purpurea and Platalea leucorodia).

Results

Feeding/Resting

The arrival of birds in spring migration started in March, depending on species and weather conditions. Reverse movements to the wintering grounds began early in September and ended by October 20. No birds of the species

studied were observed at the sampling sites between late October and the end of February (Figure 17). The only species wintering at Prespa was Phalacrocorax pygmeus.

All species were distributed along a habitat cline which extended from open water to waterlogged soils, all with abundant emergent vegetation. Subgroups of the waterbird community were separated by habitat along the cline according to their ecological characteristics of feeding and resting. Some species were never observed in certain habitats, i.e. species from the family Heronidae never used the open lake. Even within the same subgroup, each species exhibited preferences regarding the habitats it occupied. Within the same guild, for example, Pelecanus onocrotalus although a fish-eating open-water bird like P. crispus, was never recorded feeding or resting in the open lake.

During September and October, no bird used the Biological Station shore (Figure 17). The Mikrolimni meadow also was not used in October of either year. The Koula meadow was not occupied during October 1982 and was only occasionally used in October 1983. Yet this latter meadow presented maximum usage as a feeding habitat during the spring months. In contrast to the considerable fluctuations of birds in the meadows and the shore, the open water was used rather regularly throughout the study period. Results for each species taken separately provide information on how habitats were used throughout the year:

Phalacrocorax pygmeus used all sampling habitats but to varying extents throughout the year (Figure 18). The Mikrolimni and especially the Koula meadows yielded maximum usage in March, April and May. In the meadows, the birds were mostly observed perched on a pole, dried reeds or on the wooden

Figure 17. Monthly use of study sites by all species of waterbirds in Prespa National Park, Greece, 1982-1984.

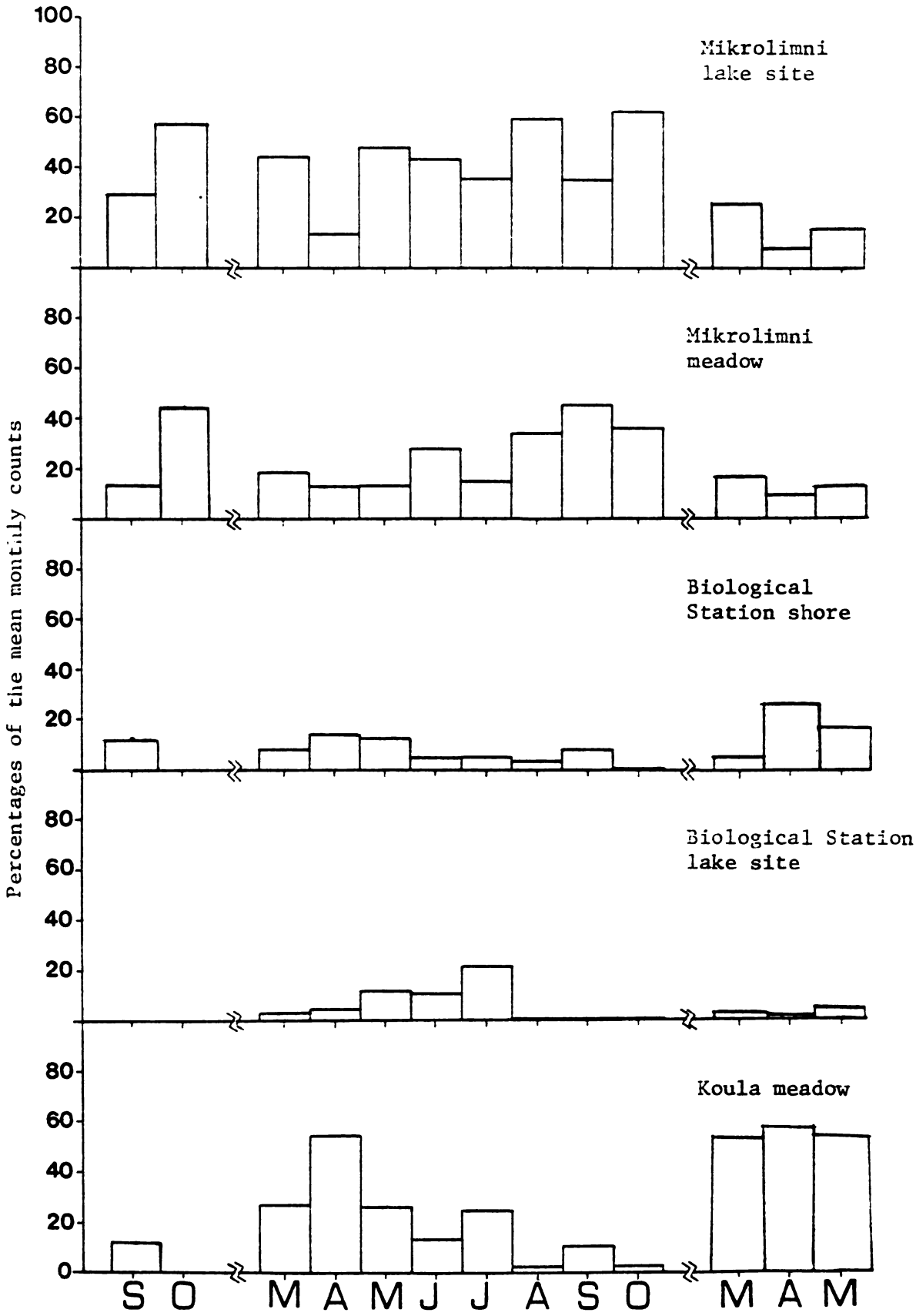

Percentages of the mean monthly counts
Mikrolimni lake site
Mikrolimni meadow
Biological Station shore
Biological Station lake site
Koula meadow
100
80
60
40
20
0
S O M A M J J A S O M A M

Figure 17.

Figure 18. Monthly use of study sites by Phalacrocorax pygmeus in Prespa National Park, Greece, 1982-1984.

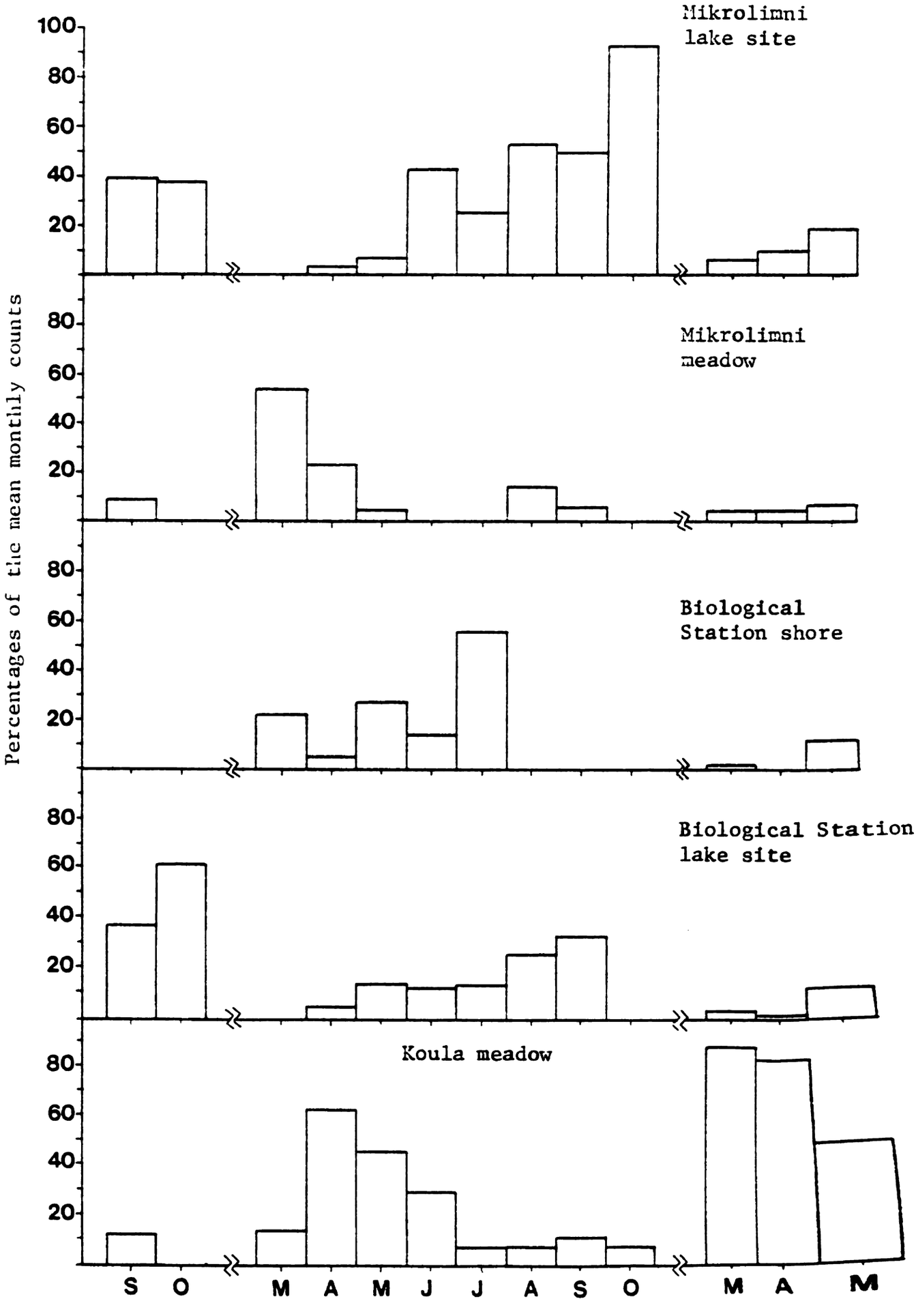

Mikrolimni lake site
Mikrolimni meadow
Biological Station shore
Biological Station lake site
Koula meadow
Percentages of the mean monthly counts
100
80
60
40
20
S O M A M J J A S O M A M

Figure 18.

fence at Koula. While perched, they usually held their wings open spread-eagled to dry. Heavy use shifted to the Biological Station shore in June and then to the open water from July to October. This occurred after water levels on the previous sites had dropped considerably. The bigger rocks at the Biological Station shore were often used for resting after they had dived several times to feed in the shallow waters close to shore.

Phalacrocorax pygmeus was never observed feeding at Mikrolimni meadow. It seemed that the water in the depressions of this meadow was too shallow. Koula meadow, however, was used by the birds both for feeding and resting, especially in March, April and May when the area was flooded and its deeper areas held 50-65 cm water. The birds fed singly by diving repeatedly. They fed close to each other, but did not seem to be organized as a group. Feeding was most often accomplished either early in the morning or in the late afternoons. From 11 am to 1 pm the birds rested, most often roosting on the rocks or fence. Often they were then in groups of 9-13 individuals, sitting close to one another with only 50 cm or less between them. While on the rocks, resting Phalacrocorax pygmeus was often in evidently-harmonious association with Ardeola ralloides and Egretta garzetta.

Though wintering at Prespa, the species did not use the habitats sampled. During winter months it occupied the canal joining the two lakes and the shallow waters of Megali Prespa at Psarades. These areas, in contrast to Mikri Prespa, seldom froze and the birds could find fish on which to feed.

Phalacrocorax carbo was never observed at the Mikrolimni meadow or on the Biological Station shore (Figure 19). During March and April the species carried part of its feeding and most of its resting (drying, oiling,

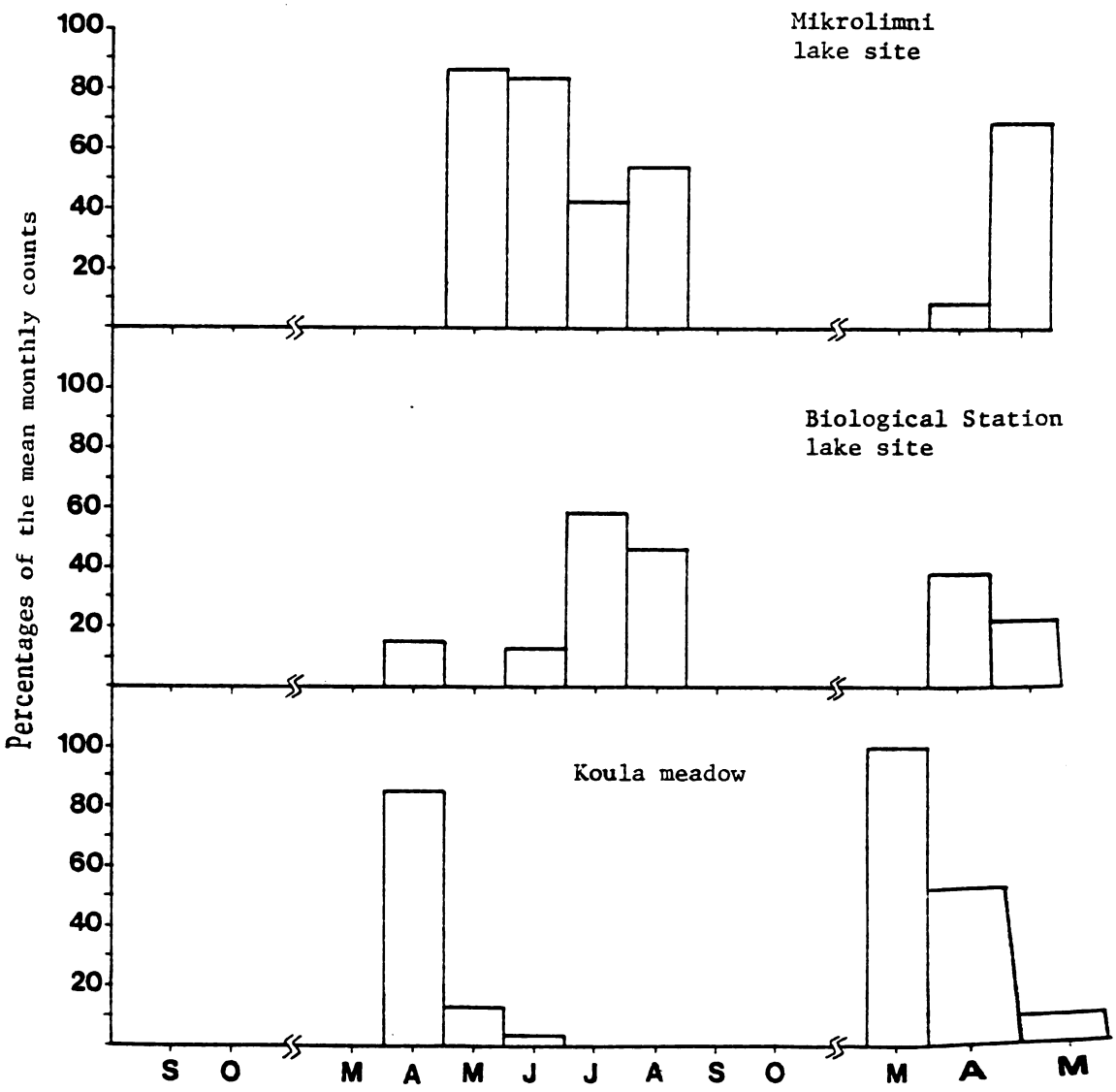


Figure 19. Monthly use of study sites by Phalacrocorax carbo in Prespa National Park, Greece, 1982-1984.

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preening) activities in Koula meadow. There in early March and April, before vegetation had yet appeared, the birds dived repeatedly in the deepest waters. Following such fishing they perched on the fence, often close to one another. Perching Phalacrocorax carbo were usually in spacial association with Phalacrocorax pygmeus. Birds of the first species were seen to fly in from Vromolimni or Megali Prespa where they had fed. Although not a site included in the sampling, flocks of up to 70-80 Phalacrocorax carbo were counted on the rocky cliffs of Vitrinetsi Island, where they rested for hours, especially in late afternoon. Beginning in May, the species spent its time on the open lake. Mikrolimni lake site was preferred to the Biological Station portion of the lake. The birds disappeared from all study areas by the end of August. Feeding was by diving in open water far from shore. Flocks were formed as temporary aggregations when feeding, usually following the swimming Pelecanus crispus. Terrasse and Terrasse (1961) and Crivelli and Vizi (1981) described this close association of the two species when feeding.

Pelecanus crispus was observed to be one of the first species in spring to arrive at Prespa and was one of the last to migrate in the fall. Birds of this species fed exclusively in the open deep waters of the lake. The occurrence of the species at Koula meadow in April, 1982, was believed to be unusual or accidental. The two sampled lake sites were used alternately with a higher preference shown for the lake at Mikrolimni (Figure 20).

P. crispus were seen to swim in the lake for many hours during the day. The birds had a rather strong site tenacity in feeding and resting; they swam in the same spot for hours. They fed by probing in the water with the bill open and fish were caught with the gular sac acting as a scoop. The

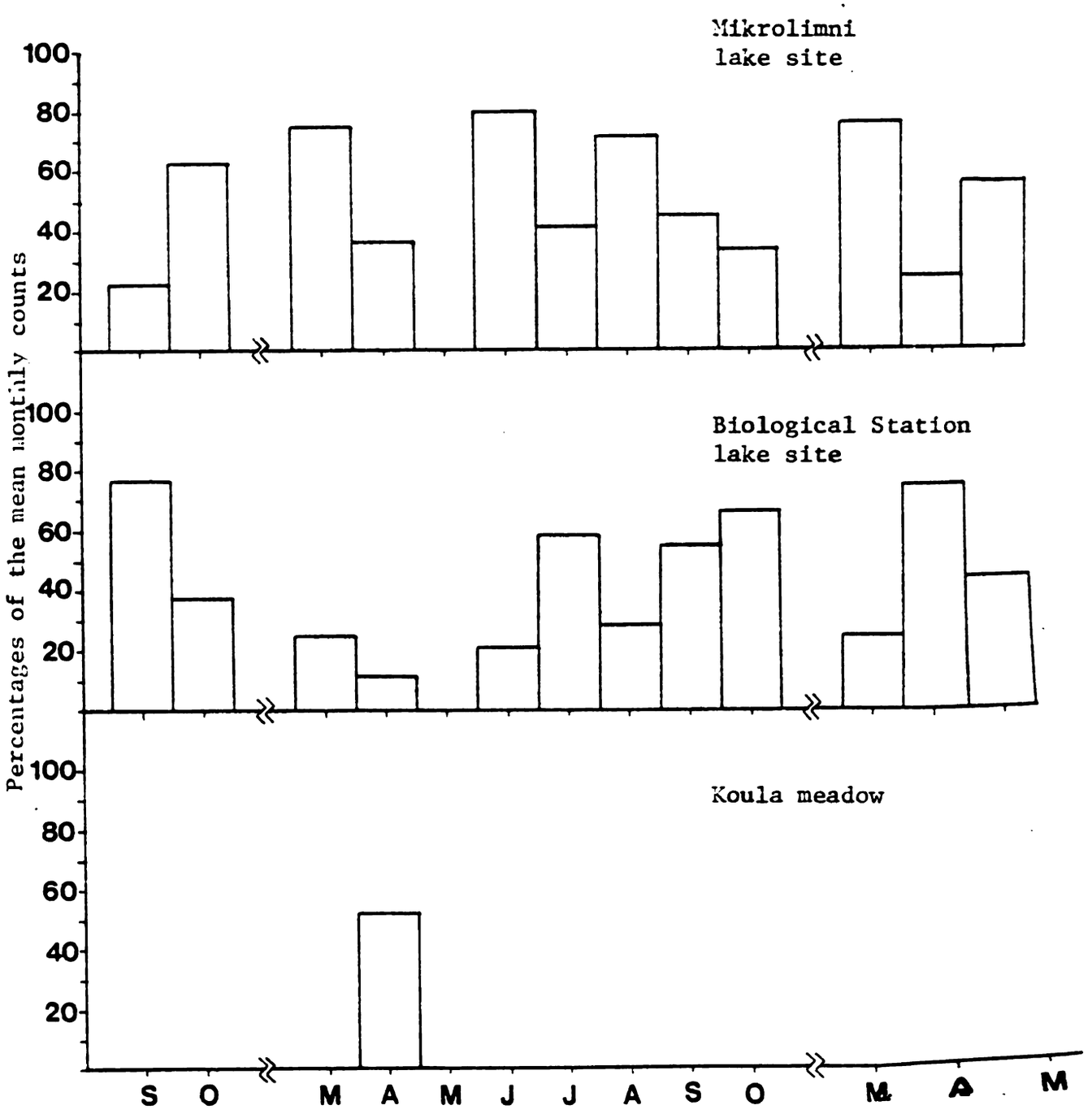

Figure 20. Monthly use of study sites by Pelecanus crispus in Prespa National Park, Greece, 1982-1984.

birds fed solitarily or in small (3-5) groups. Feeding was often carried on with Phalacrocorax carbo in a cooperative manner. Many individuals were observed feeding in Megali Prespa or along the Albanian border of Mikri Prespa. Groups of 8-12 birds occasionally were seen resting on big rocks in front of the Biological Station.

Pelecanus onocrotalus, in contrast to P. crispus, never used lakes Mikri Prespa or Megali Prespa for feeding. Instead, they chose the temporary ponds at the Koula meadow (Figure 21). These were averaged about 0.15 ha in area and 60-70 cm deep. Thirty-three P. onocrotalus were observed feeding there in May. The individuals of the group were in close association with each other, maintaining a tight social structure. These ponds held an abundance of submerged but no emergent vegetation. On one occasion when P. onocrotalus arrived at the site, several E. alba and E. garzetta at the edge of the marsh flew away.

Each bird's position in the group was well-defined; there was a rather obvious hierarchy among them. The top bird would probe its bill in the water and simultaneously all others would do the same thing. When they became close to the edge of the pond, all birds turned backwards forming a "skirmish line" swimming together in the same direction while feeding. They probed constantly, 19 scoops per minute, sweeping the area. The whole feeding procedure gave the impression of being pre-planned. Occasionally 3-4 birds flew out of the group, being replaced by others which flew in. The pond must have been rich in fish because the birds were observed scooping up fish continuously. Presumably, it was a fish-spawning area.

At all other times, flocks of P. onocrotalus were observed flying away from their nesting sites at Prespa to feed. This behavior of traveling for

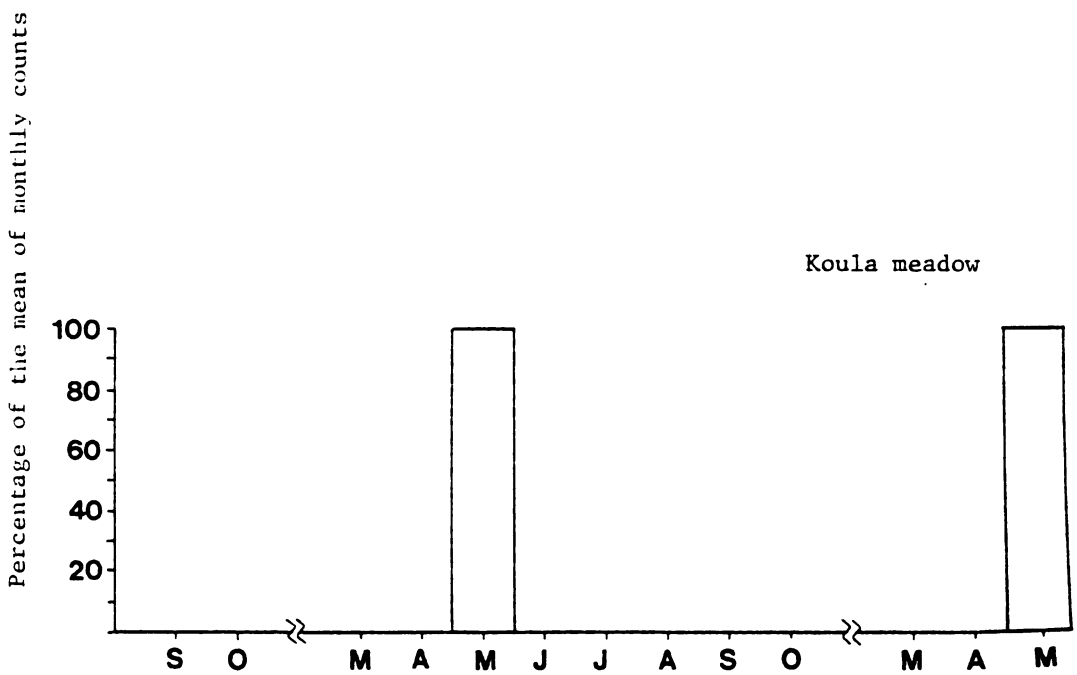

Figure 21. Monthly use of studysites by Pelecanus onocrotdius in Prespa National Park, Greece, 1982-1984.

feeding has been observed by Geroudet (1973), Kempf and Wersinger (1974) and Crivelli (pers. com.). The birds flew daily to areas which have not yet been identified. They travelled in groups which varied in size with season and hour of departure and returned with fish for their chicks. In preparing for these flights a number of birds would take off from one or more breeding islets at Vromolimni and circle upwards with the thermals. They soared together in circles, keeping regular distances between them while gaining altitude. Upon reaching a height of several hundred meters above Prespa they would all head in one direction, most often southeast, over Mount Triklarion.

In April, P. onocrotalus did not depart from Vromolimni before 10:00-10:30 am, presumably because the air currents were not yet warm enough to rise. During this month, groups of only 4-7 birds would depart in the morning. In the early afternoon, groups of 10-12 birds took flight. Groups took off from Vromolimni at infrequent intervals until about noon when the intervals between group departures became only 10-15 minutes long. At that hour, the birds flew most often south and very seldom southeast. Individuals were back at their nests by 5:00-6:00 pm.

Since the first birds of the day returned at about noon, the distances that these early birds travelled must have been quite short. The only possible feeding grounds relatively nearby and in the birds' flying direction are Kastoria Lake and possibly Zazari or Chimaditis Lakes. Information from Kastoria indicated that the species occurred on that lake only for a few days in the spring. During the present study, 3 birds were observed at mid-day at Lake Zazari and 4 at Chimaditis. Nevertheless on 27 April, 4 P. onocrotalus were observed about 100 km from Prespa while flying over Agra at Edessa and going toward Prespa.

In June, the birds started their daily feeding trips earlier, by 9:30 am and in larger groups. Thirty-one birds were counted on 30 May 1983, heading mostly southeast.

Departing groups were smaller and more frequent than arriving ones. On 15 July 1983, 88 P. onocrotalus landed in Vromolimni at 2:20 pm from the southeast. It seemed that the birds had changed their flock formation while on their feeding grounds. When the arriving flock appeared from over the mountains, each bird directed itself quickly toward its nesting islet. No time was lost before landing. Each arriving bird went directly to its nest and fed its chicks for 3-6 minutes. Within 10 minutes of arrival, a group of adults again was seen to take off from the same islet. It is a question whether the same individuals made feeding trips twice a day or alternated with adults which remained at the nest site during the morning.

Later in August, travel flocks were even larger: 46 birds departed with 92 arriving on one occasion. Time intervals between departures also were longer. The latest arrival time observed was 8:10 pm. Two occasions were observed wherein a group arrived at about 9:00 am, without having departed earlier the same morning. Perhaps these birds stayed away overnight with their feeding groups, but this is uncertain.

Podiceps cristatus were seen at both lake sites, using the areas continuously and in a regular manner throughout the study period (Figure 22). A few individuals used the Koula meadow in April 1982, an unusual visit. The species fed in pairs, the male and female close together or accompanied by 2-3 chicks. The adults caught fish during dives of about 30 seconds duration. The fish were carried at once to the young, which they visited often during the day. Depending on its size, the fish would be

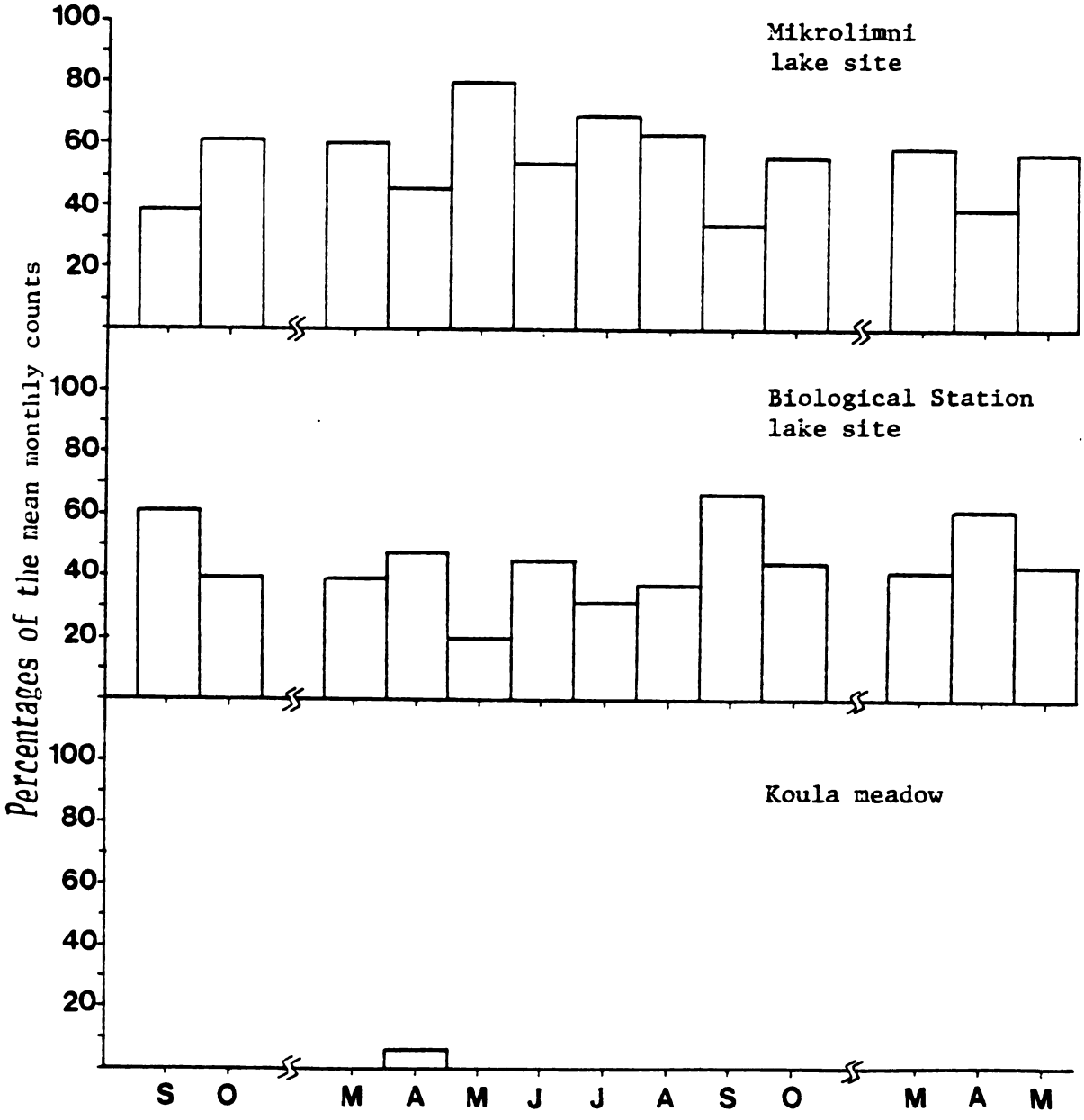

Figure 22. Monthly use of study sites by Podiceps cristatus in Prespa National Park, Greece, 1982-1984.

broken in two and given to the chicks while held in the tip of the bill. Adult Podiceps cristatus often would play with the catch. A bird would toss the fish high, catch it in the open bill, then release it in the water for a few seconds and toss it again. The procedure sometimes was repeated 4-5 times. The bird would then either break the fish and swallow it or release it into the lake. Release was most often observed after the bird had caught several fish and had fed itself and its young.

Adults feeding each other during courtship were observed. Young were often carried on a parent's back while swimming.

During nesting, the feeding territory was close to the shore, where the nest was located. Later in the summer, feeding was mainly done in deeper waters at a distance from the shore. Phalacrocorax pygmeus often dived close to Podiceps cristatus but no aggressive interaction was observe between the two species.

Nycticorax nycticorax, though a nocturnal and crepuscular feeder, used the Koula meadow for a few daylight hours from March to July (Figure 23). This area was the most preferred feeding ground of the species. In June, individuals mostly used the Biological Station shore in the evening. In August, however, this heron was only observed in the Mikrolimni meadow at dusk. N. nycticorax disappeared from the feeding grounds by the end of September.

The birds fed alone, stalking in shallow water or from a stationary posture. During daytime hours, individuals were observed standing still, waiting for prey to approach. At the meadow, the species occupied shallow water, remaining immobile among dense aquatic vegetation and sometimes being hidden behind it. Along shorelines, the birds also mostly stalked in the shallow water. Ardeola ralloides sometimes fed nearby but the two species

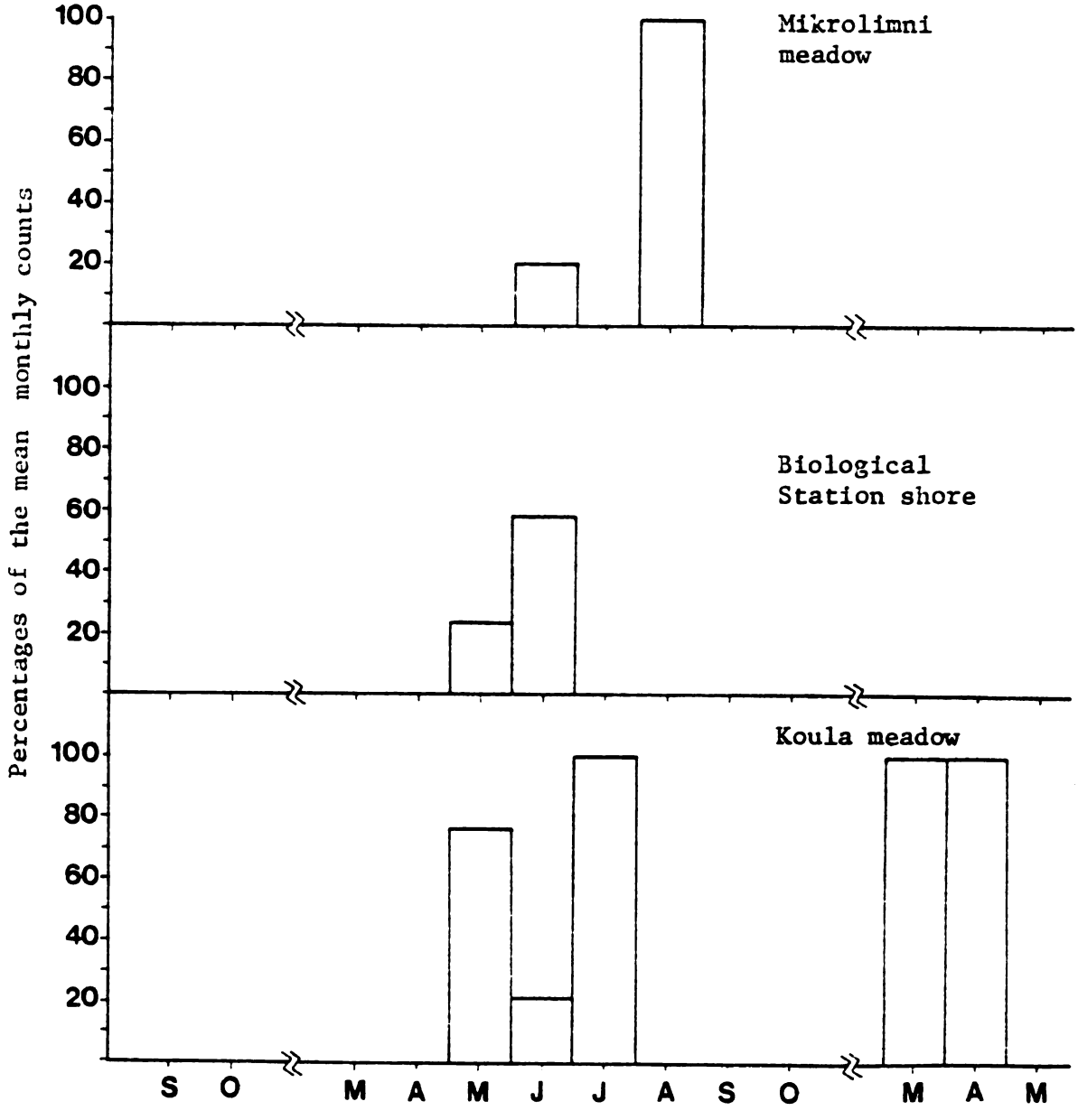

Figure 23. Monthly use of study sites by Nycticorax nycticorax in Prespa National Park, Greece, 1982-1984.

did not interact. When a slight distance from one another, N. nycticorax would have its feet in the water while A. ralloides remained on shore.

Ardeola ralloides arrived at the feeding grounds in April, later than most other waterbirds (Figure 24). They used the Koula meadow intensively until they departed at the end of September. A few individuals visited the Mikrolimni meadow during that period. A small portion of the population also used the Biological Station shore in June and July, mainly in the evening. Birds were seldom observed wading. They would stay immobile in the same spot for hours, being hidden among dense aquatic vegetation. Individuals were often close to conspecifics, but well-spaced from them. A small feeding territory was established by each, rejecting conspecifics with aggressive postures.

Egretta garzetta used the Koula meadow as its prime habitat (Figure 25). In August when the water level dropped considerably and this meadow dried out, the species moved to the Mikrolimni meadow. There, the birds fed individually on the sandy shore. Several E. garzetta used the same meadow throughout the study period. The Biological Station shore also was visited from March to July, with maximum usage beginning in June. It seemed that the same individuals spent many hours of the day in the same area. They favored generally open areas with sparse aquatic vegetation. When they were close to the lake they mostly used the shore. Occasionally they were observed in the cultivated alfalfa field by the wet meadow.

These birds were very active when feeding, sometimes running or jumping in the shallow water with wings raised. They fed solitarily or in small groups. When one individual of the group flew to a nearby site, the others usually followed but these seemed to form temporary aggregations rather than

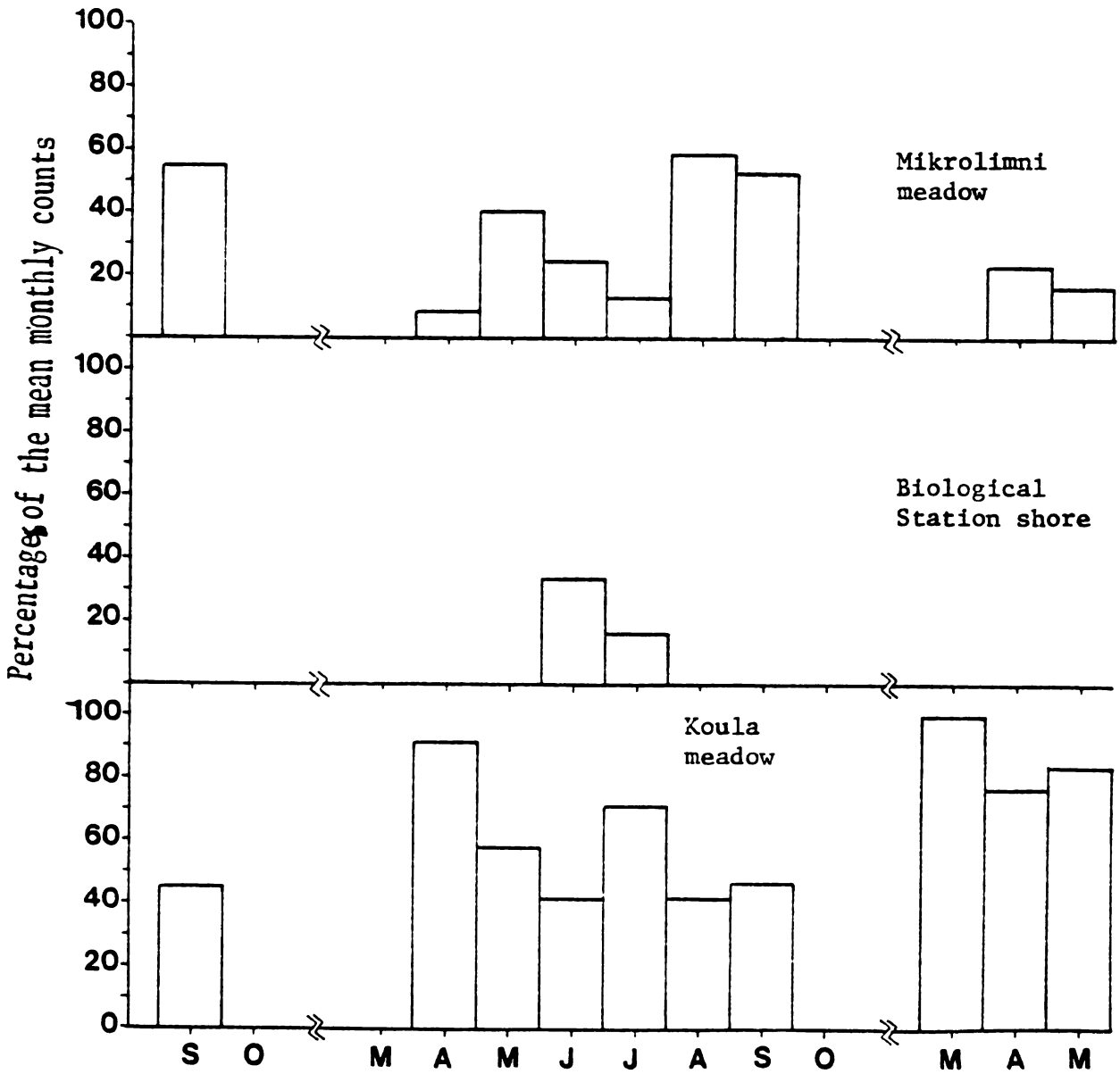

Figure 24. Monthly use of study sites by Ardeola ralloides in Prespa National Park, Greece, 1982-1984.

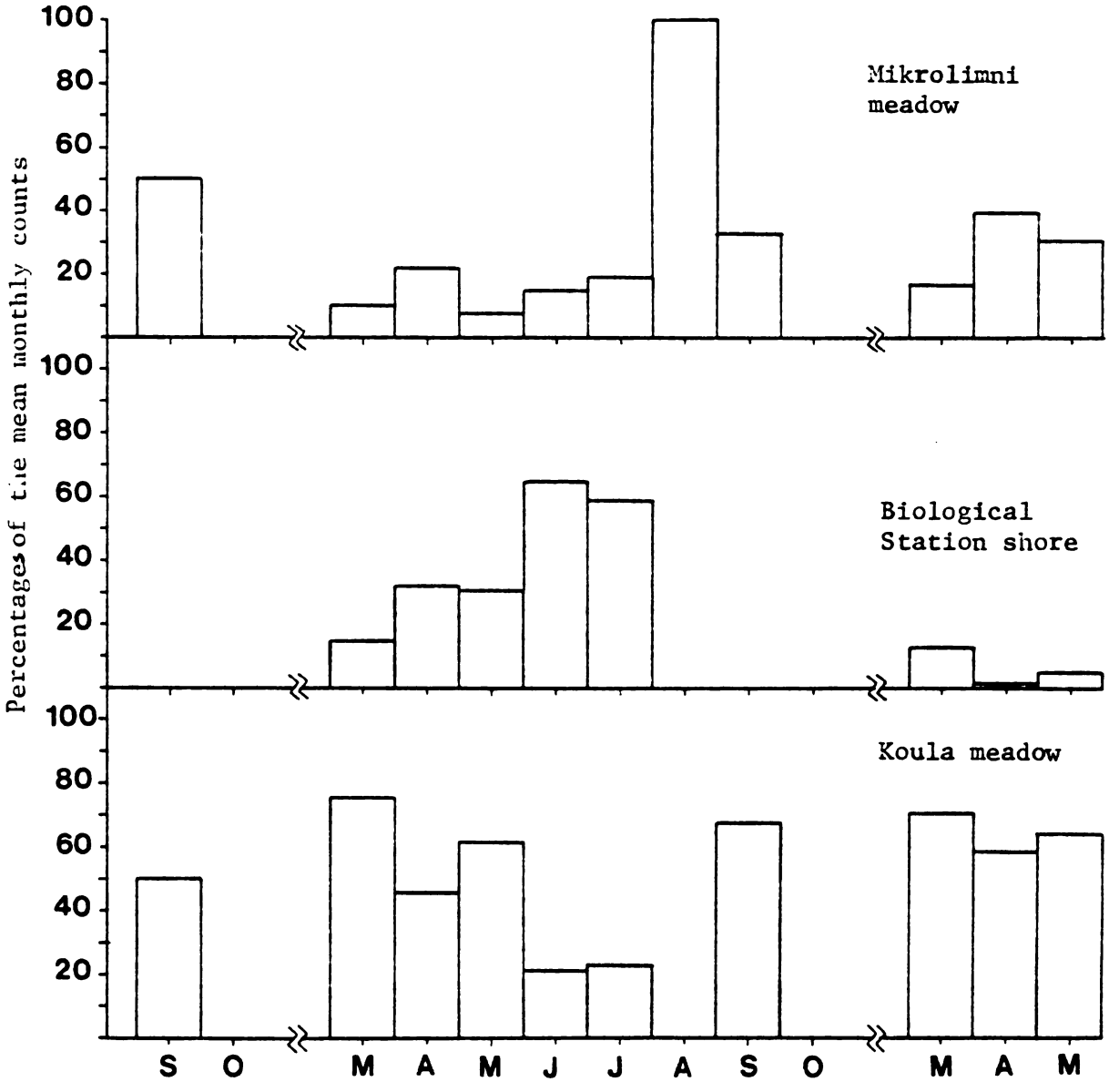

Figure 25. Monthly use of study sites by Egretta garzetta in Prespa National Park, Greece, 1982-1984.

true flocks. Among con-specifics, antagonistic interactions were often observed. Brief chases, threat-calls and sometimes direct attacks were made. The winner would establish itself at the site, but invariably soon abandoned it. Although other Ardeinae sometimes also were present, no interspecific aggressive interactions were observed.

Ardea cinerea's main feeding habitat was the Koula meadow (Figure 26). Most of the species population used this site from March until August, when it disappeared from the study areas. The Mikrolimni meadow was used for feeding to a lesser extent. The birds using the Mikrolimni meadow nested in the nearby reedbeds.

Along the Biological Station shore, the species appeared only twice, probably accidentally. It seemed that the water was too shallow for this long-legged bird. The species preferred shallow water, but deeper than that used by E. garzetta and without much vegetation. The species was often observed in the field by the road at Koula meadow, undisturbed by passing cars.

The birds fed especially in the morning and late afternoon, wading or standing in the water. Up to 13 A. cinerea were observed at the Koula meadow in an area of less than 400 m^2, each feeding alone and spaced widely from conspecifics. Sometimes, birds of this species foraged in loose flocks with E. alba and A. purpurea. No interspecific interactions were observed.

Egretta alba population at Prespa (6 pairs) used the Koula meadow almost exclusively for feeding (Figure 27). The Mikrolimni meadow and the Biological Station shore were of minimal use. In August, the birds were not seen anywhere on the study areas.

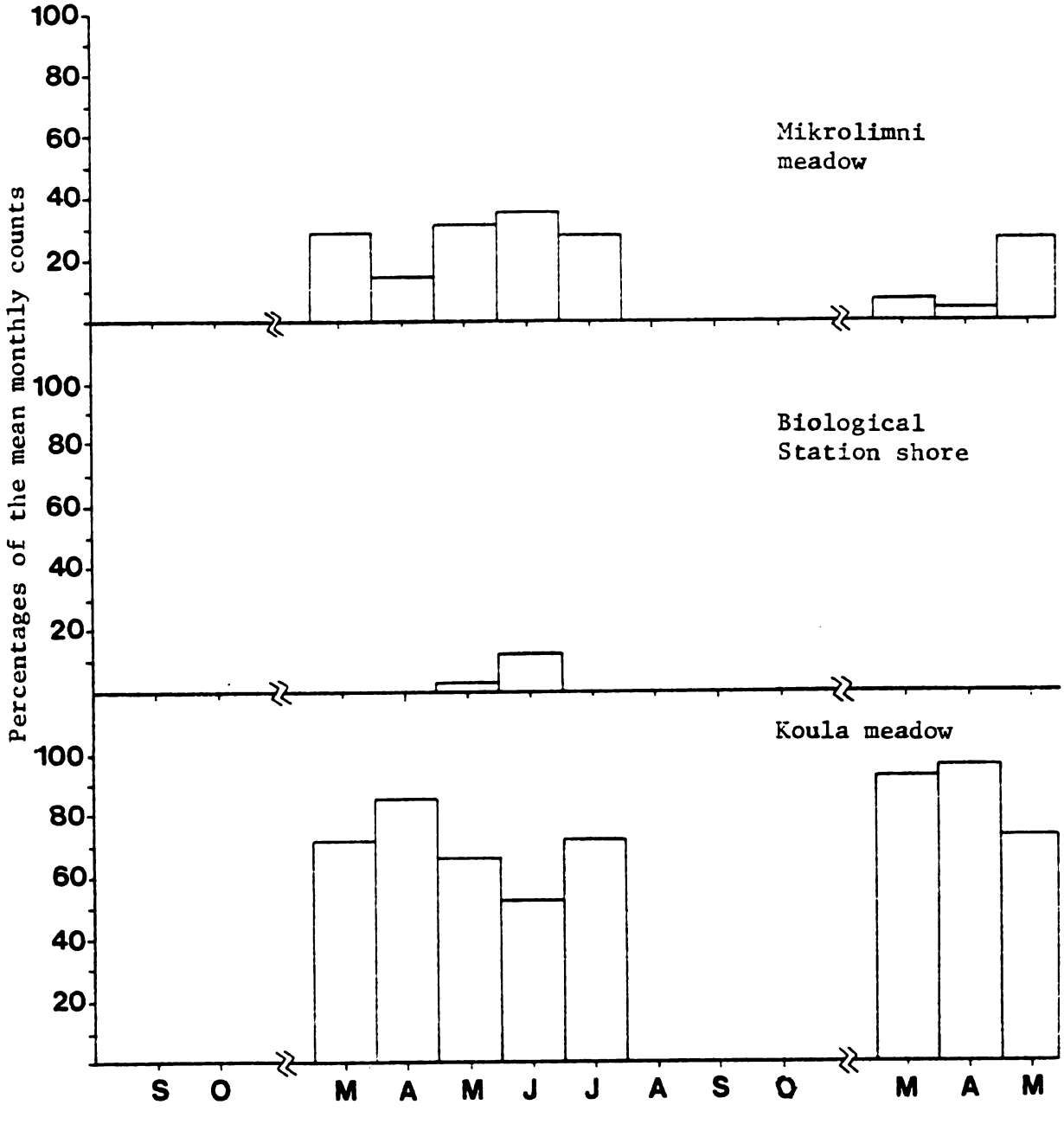

Figure 26. Monthly use of study site by Ardea cinerea in Prespa National Park, Greece, 1982-1984.

Percentages of the mean monthly counts

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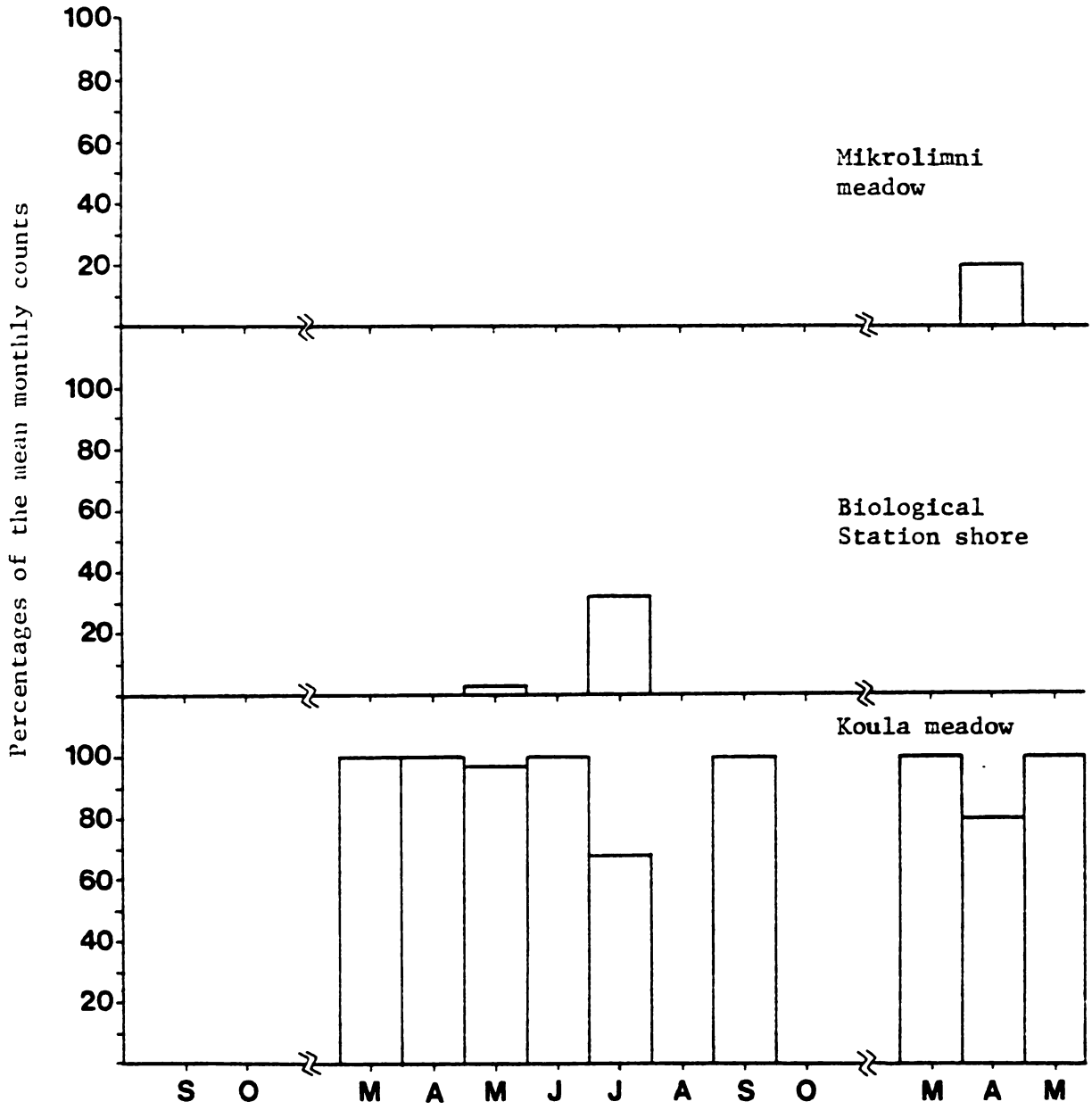

Figure 27. Monthly use of study sites by Egretta alba in Prespa National Park, Greece, 1982-1984.

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In foraging, the species hunted both in shallow and deep waters, and even on fields which supported dense aquatic vegetation. They fed alone, spaced widely from other individuals, or in loose flocks. The species seemed to be quite sensitive to human disturbance, although passing cars did not seem often to affect it.

Ardea purpurea arrived quite late at the feeding grounds and left the area by the end of August. From April to July, the species mainly used the Koula meadow, but in August moved to the Mikrolimni meadow (Figure 28). The Biological Station shore was of minimum importance.

These birds fed singly, in water 30-40 cm deep, among dense aquatic vegetation and nearly hidden in it. They hunted while standing still or wading slowly with the beak held horizontally and close to the water. When other aquatic species were foraging close to it, no aggressive interactions were seen. Neither was it affected when approached by cows. Although Cramp (1977) considered this species to be intolerant of human disturbance, in this study it seemed to be the least wary of all the waterbird species.

Platalea leucorodia appeared on the feeding grounds in April and disappeared by the end of July. In 1983, the species nested near the Albanian border. At that time they frequented the Koula meadow and secondarily the Mikrolimni meadow even though these areas were not close by (Figure 29). In contrast in 1984, this species was mainly observed to feed in the Mikrolimni meadow. Pairs of the species seemed to have moved not only to different feeding grounds but to new nesting sites as well. One or 2 pairs of Platalea leucorodia nested in the reedbeds at Mikrolimni meadow in 1984. No other study area was visited by the species.

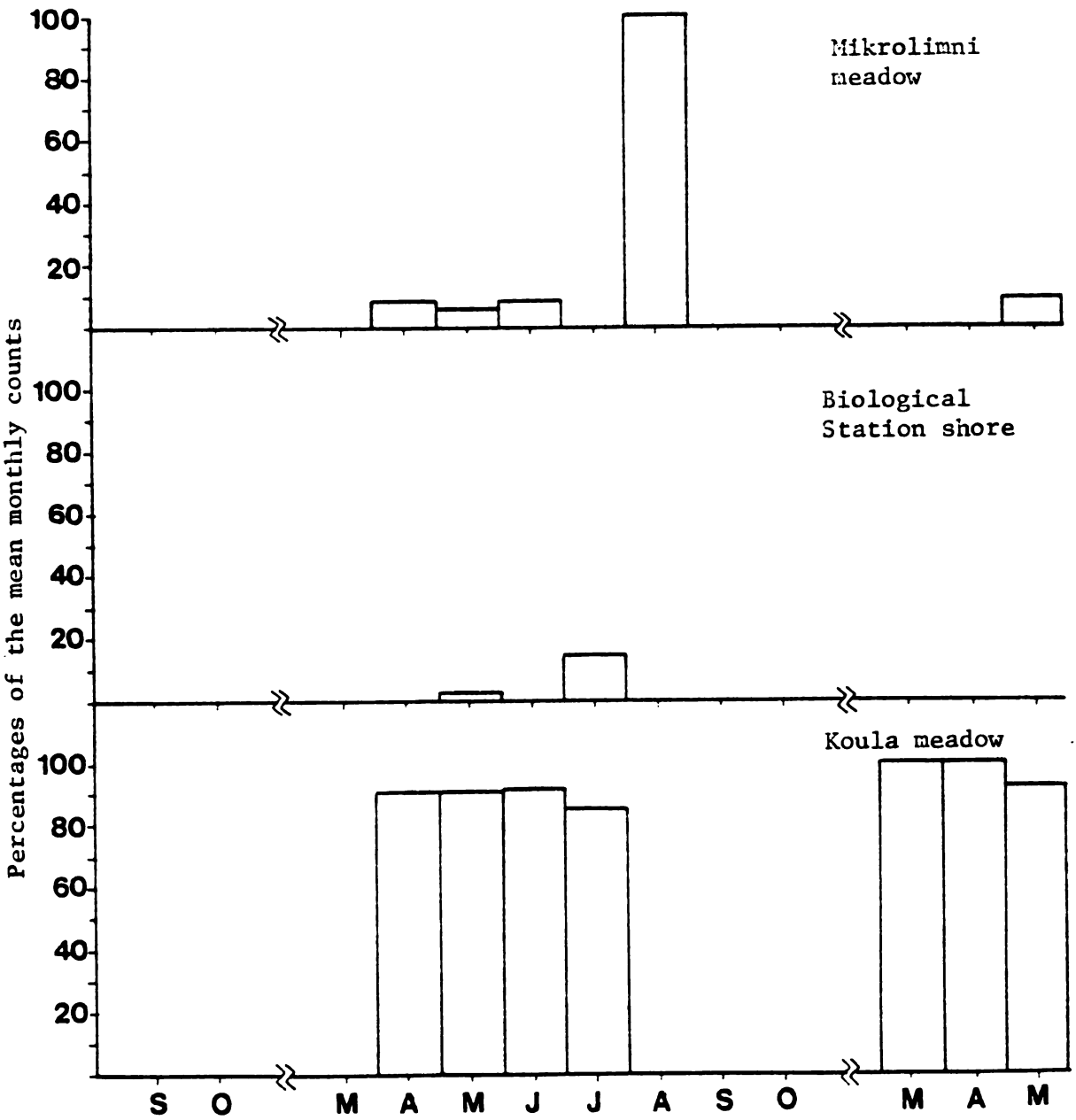

Figure 28. Monthly use of study sites by Ardea purpurea in Prespa National Park, Greece, 1982-1984.

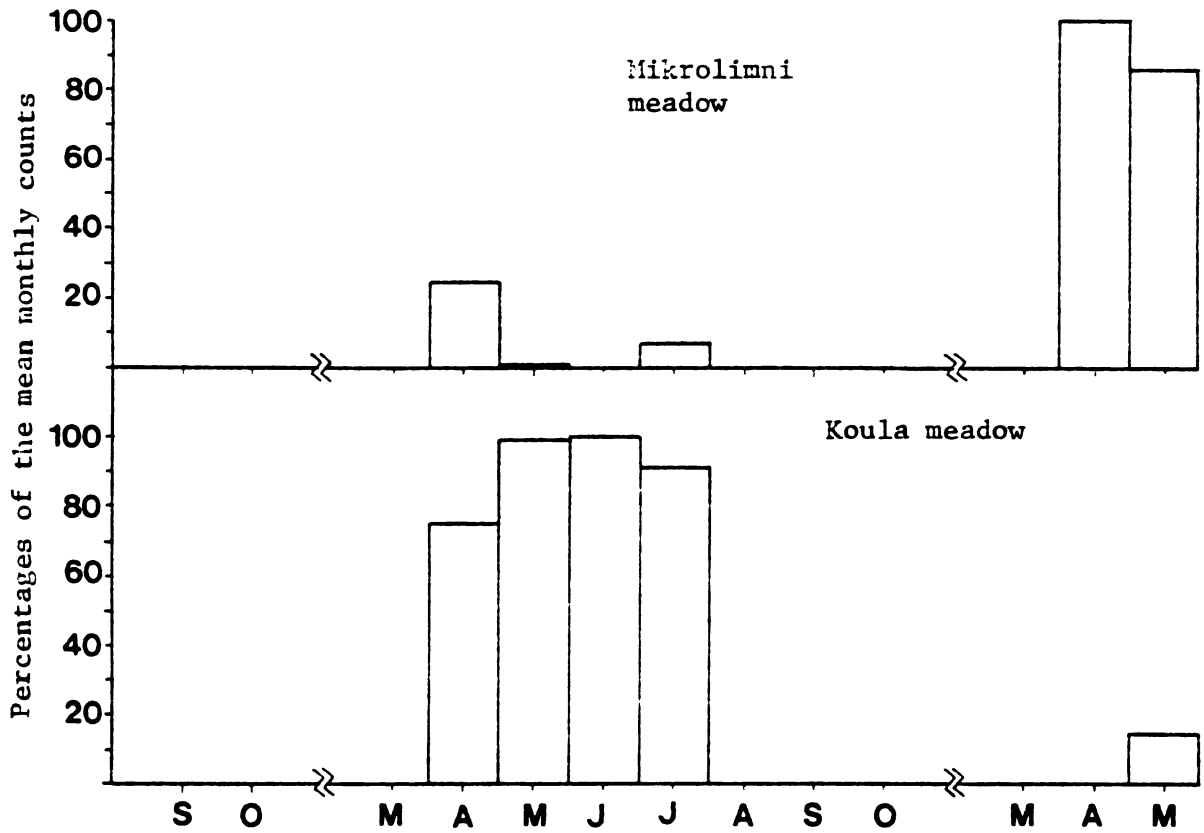

Figure 29. Monthly use of study sites by Platalea leucorodia in Prespa National Park, Greece, 1982-1984.

Spoonbills are filter-feeders. They foraged in shallow water over mud bottoms and among low aquatic vegetation. They always fed while in a group and were seldom solitary. The group stayed close together; if one individual flew, the others followed it. They did not have strict feeding territories, although a space of about 1 m was maintained between them. They frequented the same feeding site for days. In foraging, they were very active, probing constantly and nervously in the water with head held low.

The species was very intolerant of disturbance; even camera clicks caused them to abandon the feeding ground.

Species Diversity and Species Richness

The Shannon index to species diversity indicated that the highest value occurred in May 1983 at the Koula meadow (Table 11, Figure 30). This meadow also showed higher diversities than any other site during April and March 1983 and in April and May 1984. Species diversity at Mikrolimni meadow in April 1983 was next highest. In general, the Mikrolimni meadow showed reduced species diversity indices as compared with the Koula meadow, while indices for the Biological Station shore were even lower. By October 1983 at the Koula meadow, only one species remained.

Of the 12 species studied, 10 were present on the same day at the Koula meadow in April and again in May 1983. That meadow had the highest species richness values in June and July of 1983 and also in March, April and May 1984. The Biological Station shore had a comparatively higher value than the Mikrolimni meadow in May 1983, although it fluctuated to a greater extent.

Species richness indices ranged from 2 to 4 on the lake, without much difference between sites. Of the birds studied the maximum number of

Table 11. Species diversity and richness values at feeding/resting sites in Prespa National Park, Greece, 1982-1984.

	Mikrolimni Lake site		Mikrolimni Meadow		Biological Station Shore		Biological Station Lake		Koula Meadow	
	H'	sp. richness	H'	sp. richness	H'	sp. richness	H'	sp. richness	H'	sp. richness
1982										
September	0.92	3	0.95	3	-	-	0.99	3	1.01	3
October	0.92	3	-	-	-	-	1.00	3	-	-
1983										
March	0.50	2	1.08	3	0.62	2	0.68	2	0.94	4
April	0.54	3	1.26	6	0.63	2	0.46	4	1.77	10
May	0.30	3	0.98	6	1.02	7	0.31	2	1.90	10
June	0.94	3	1.08	6	1.10	5	0.44	4	1.80	9
July	1.06	4	0.94	4	1.10	5	1.25	4	1.21	7
August	0.46	4	1.16	5	-	-	0.83	4	0.18	2
September	1.03	3	0.96	3	-	-	0.97	3	1.25	4
October	0.76	3	-	-	-	-	0.37	2	-	1
1984										
March	0.43	3	1.09	3	0.61	2	0.17	3	1.39	8
April	0.94	4	0.58	6	0.24	2	0.52	4	1.34	8
May	0.77	4	1.06	6	0.66	2	0.52	4	1.46	9

Figure 30. Species diversity index and species richness values at feeding/resting sites in Prespa National Park, Greece, 1982-1984.

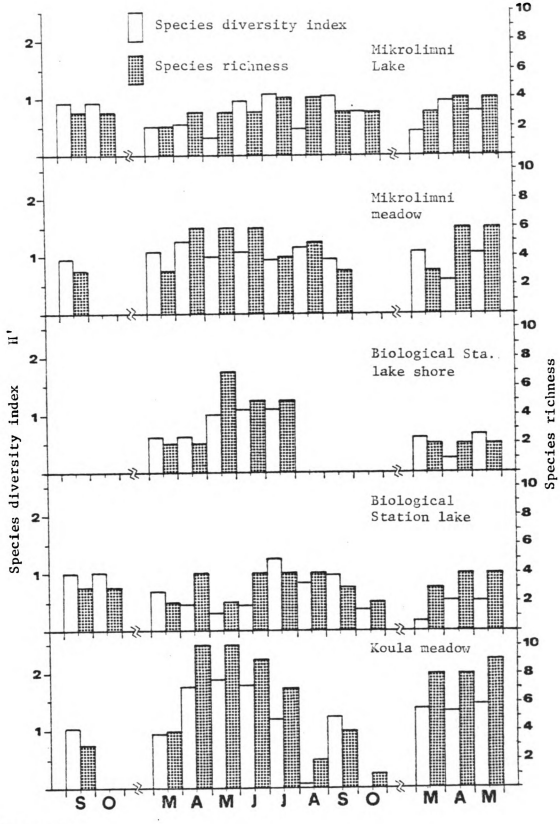
Species diversity index
Species richness
Mikrolimni Lake
Mikrolimni meadow
Biological Sta. lake shore
Biological Station lake
Koula meadow
Species diversity index H'
Species richness
S O M A M J J A S O M A M

Figure 30.

species which actually were adapted to use the open lake was only 4. This maximum often was attained.

In a general overview of all sampled feeding sites, both species diversity and species richness were highest on the meadows but fluctuated to a much greater extent there where the habitat was more diverse, than on the lake where conditions were more uniform throughout the year.

Relating the above findings to water level fluctuations (Figure 16), a close relationship existed between the species diversity index and water level at the 2 sampled meadows and, to a lesser degree, at the shore. When water level reached its peak in April and May, the corresponding species diversities at those sites were at their highest points. When the water level started dropping, between June and September, the index also dropped. This close relationship between bird community structure and water level was especially obvious at the Koula meadow, because of its isolation from the lake.

September rainfall did not affect the lake water level at the shoreline sites but only at the meadows, and particularly in their depressions. There, although there was no lake level to rise nearby, rainfall filled depressions and enabled the continuing use of the habitats.

Breeding Sites

In both nesting sites, colonial breeding occurred. At the Albanian border, most of the birds studied nested in mixed colonies. Nests of *Phalacrocorax pygmeus*, *Phalacrocorax carbo*, *Pelecanus crispus*, *Nycticora nycticorax*, *Ardeola ralloides*, *Egretta garzetta*, *Ardea cinerea*, *E. alba*, *A. purpurea* and *Platalea leucorodia* were found in the branches of *Salix cinerea* trees in the lagoons (Table 12). Exceptions were the nests of *P.*

Table 12. Minimum numbers of nesting pairs of aquatic birds in the Greek-Albanian area 1983-1984, Prespa National Park, Greece.

Breeding pair Species	1983	1984
Phalacrocorax pygmeus	120+	120+
Phalacrocorax carbo	80+	100+
P. crispus	17	14
N. nycticorax	17+	28+
Ardeola ralloides	25	10+
E. garzetta	50+	30+
Ardea cinerea	3	4
E. alba	1	-
A. purpurea	5	-
P. leucorodia	5	3
	323+	295+

crispus and Platalea leucorodia which were built closer to the water. All nests were constructed near each other. There was an average distance of about 50 cm between most of them, but others sometimes touched one another.

In one lagoon, 207 nests were counted on the branches of about 20 Salix trees. Although the trees were intermingled and difficult to distinguish individually, there was an average of over 10 nests per tree.

Phalacrocorax carbo nests were placed highest in the trees in branches free of leaves. In similarly high positions, E. alba, A. purpurea and A. cinerea also nested. The middle tree stratum was occupied by E. garzetta and Ardeola ralloides nests. Phalacrocorax pygmeus nests occurred in dense vegetation both in the lowest stratum and also in high branches.

All nests were made of twigs, branches and reeds and were lined with finer materials. Diameters of the nests varied from 17 cm (Ardeola ralloides) to 90 cm (E. alba), depending on the species. All nests were situated on branches oriented toward the center of the lagoon.

One nest of Platalea leucorodia was found in a Salix tree, 2 m above the water. Four others, however, were in a different setting in another lagoon. That lagoon was quite open with few trees and surrounded by reeds. There the Platalea leucorodia nests were 60 cm in diameter and on floating mats of reeds. The nests were completely separated from each other 1-2 m apart. Three eggs, completely exposed, were found in each. No other species nested nearby.

P. crispus nests at that site were built on a floating mat of dead Salix branches, dry reeds and other vegetation held together by decomposed organic material, silt, mud and bird guano. That islet, 3 m wide and 10 m long, was not firm and would not support the observer. Five or six nests were placed in a close circle on a common base, of twigs, branches and reeds

which were longer than those used in the nests. Each nest was built up to about 20 cm above the mat and separate from the adjacent one. In April 1983, 27 nests of P. crispus were found, 14 of these each held 1-2 eggs and/or nestlings. The remaining 13 had not been used. The first eggs of P. crispus were laid on 18 March 1983.

Vromolimni was the major nesting site for both P. onocrotalus and P. crispus. The two pelican species nested on the islets in mixed colonies (Table 13). Three main islets were used from late February until October for both nesting and roosting by these species and also by Phalacrocorax carbo. Two smaller islets, each about 3 m^2, were each occupied by 3 single nests from March until June and then abandoned. As these sites seemed marginal in quality, late migrants or submissive individuals may have been forced to use them. Two other very small islets, close to the main islets, were used as resting and roosting sites. In 1984, 2 other similarly-inferior sites seemed to be used by P. crispus.

Table 13. Minimum numbers of nesting pairs of aquatic birds in Vromolimni, spring 1983-1984, Prespa National Park, Greece.

Nesting Pair Species	1983	1984
P. crispus	90-100	130-140
P. onocrotalus	70	80-90

On the biggest of the main islets, in the southeastern portion of Vromolimni, both P. crispus and P. onocrotalus nested together. This islet was occupied by 12 nesting circles with 5-8 nests placed in the center of each. Phalacrocorax carbo nests also were present there but either at the

edge of the islet or in more-elevated positions. The other two main islets held 18 and 7 nests, arranged in 3 circles and 1 circle, respectively.

Discussion

Vromolimni and the Albanian border area are highly significant nesting areas for the colonial birds. A major characteristic of both sites is their isolation from direct human disturbance. All rare species of the families Pelecanidae, Phalacrocoracidae, Ardeinae and Threskiornithidae used one of these two sites for breeding. Although the Albanian border site was utilized by more nesting species, the value of Vromolimni was equally great because it supported nearly all Pelecanidae nesting at Prespa.

The habitat structure of the Albanian breeding site was more complex than the one at Vromolimni, with various vegetative strata utilized by the several species of nesting birds. This is in accordance with MacArthur's (1964, 1965) and correlations between the number of bird species present and foliage height diversity.

The internal structure of the Albanian border habitat consisted of a mosaic of horizontal and vertical patches which enhanced the overall vegetation complexity and diversity. In contrast to this, the Vromolimni site consisted only of a mosaic of vegetation types arranged on a horizontal plane.

Habitat diversity in the Albanian border site varied between microhabitats there. One of the lagoons at this site seemed to have reached its maximal sustainable density of nesting birds, yet adjacent ones were not used at all. A comparison of vegetation structure, habitat diversity and the amount of water between these two habitats showed no differences. This

led to the conclusion that social factors may have played an important role in determining the structure and the exact location of the nesting community. Social stimulation probably has been the cause for this. Predation (Tenaza, 1971) did not seem to be the explanation. And Tenaza (1971) observed that among colonial birds reproductive success is higher in large colonies than in smaller ones. Although these observations were made on a single species colonies (penguins), an extension of this theory to multi-species nest sites may be reasonable. The concentration of nests of the various species there, may support the hypothesis. that a minimal nest density is required to insure bird colony establishment.

The birds which arrived first at Vromolimni built their nests in colonies on the larger islet until no space was left. Then, the other islets were occupied. This sequence of site occupation and other observations made during the study indicated that social interactions and bonds between colonial birds to a great extent may determine their breeding success. Construction of the nests in a circle, for example, gave the impression of a tight, closely-associated community. It is for further investigation, however, to determine the social bonds which exist between the members of the same circle (cooperation, altruism, etc.). The question that arises is what might happen if one or more parts (species) of this community chain are lost. How crucial are those social bonds for the whole community's existence?

Feeding-resting habitats of waterbirds at Prespa differed most clearly in the density of vegetation and the amount of water present. Some were a series of habitats with equal amounts of water and land, while others had sparse low vegetation and low water level or dense low vegetation and higher water level. Of all these, the last one was the most favorable for feeding.

The wet meadow at Koula, at one time or another, supported the feeding requirements of all studied species (Table 14). This site, although the smallest in size of all sampled areas presented the highest species diversity and species richness, as well as the highest abundance of all during the breeding season. Although there was a temporal shift of maximum species diversity and a dispersal of birds to different areas after the breeding season, the Koula's maximum was not reached at any other site.

This wet meadow during March, April and May was rather in a "semimarsh" stage, with a ratio of about 2:1 cover/water interspersion. MacArthur (1964) found that vegetation density and the amount of water may be key determinants of community organization. Weller and Fredrickson (1974) also noted a positive correlation between bird species and the percentage of open pools in emergent cover. They found that the greatest species richness and highest density for different species ranged from 1:1 to 1:2 cover/water interspersion. Although their results referred to nests, the present study indicated that these may be applied equally to feeding birds.

Within the wet meadow/semimarsh habitat at Koula, resources were divided between species at a much finer level. Food resource partitioning was made possible by the birds being organized into subgroups which occupied different niches in the same habitat. Niche variation involved different patterns of foraging, different food uses and feeding at different time of the day (Pianka, 1978). Schoener (1974) reviewed patterns of resource partitioning in natural communities and concluded that habitat dimensions are generally more important in separating niches than food type dimensions. Weller and Spatcher (1965) also showed that habitat variation and niche segregation were involved in waterbirds of an emergent wetland in Iowa. Wiens (1969), too, observed that although all the grassland birds he studied

Table 14 . Aquatic bird species seen in the different habitats in Prespa National Park, Greece, 1982-1984.

Bird species	Mikrolimni Lake site	Mikrolimni Meadow	Biological Station shore	Biological Station Lake site	Koula Meadow	Albanian border	Vromolimni
Phalacrocorax pygmeus	+	+	+	+	+	+	
Phalacrocorax carbo	+			+	+	+	+
Pelecanus crispus	+			+	+	+	+
P. onocrotalus					+		+
Podiceps cristatus	+			+	+		
Nycticorax nycticorax		+	+		+	+	
Ardeola ralloides		+	+		+	+	
Egretta garzetta		+	+		+	+	
Ardea cinerea		+	+		+	+	
Egretta alba		+	+		+	+	
Ardea purpurea		+	+		+	+	
Platalea leucorodia		+			+	+	

obtained their food in the grass, there were basic differences in their patterns of foraging. Although the present study did not estimate food abundance or food selection by birds at the sampling sites, it seemed that the Koula meadow had abundant food during the breeding season of the birds. That was concluded from 1) the density of birds feeding there, and 2) from the manner they would forage, i.e. the spoonbills and pelicans fed constantly "sweeping" the area either by filtering food intensively or by scooping in fish. The fact that P. onocrotalus used this site, as a unique feeding site at Prespa during May, instead of making the daily long distance trip seen at other times, supports this hypothesis. Furthermore, there were no inter- or intra-specific competitive interactions observed among species using this meadow which also indicated an abundance of food. Brown (1975) stated that areas with richer food supplies attract a greater density of birds, who then defend small exclusive areas because of pressure from their numerous neighbors. The available space is divided among the number of territory aspirants and there is minimum individual distance between territories. This hypothesis was more striking when comparison was made between the rich Koula meadow and the relatively sterile habitat at the Biological Station shore. The interspecific or intraspecific aggressive interactions of E. garzetta and A. ralloides were often observed at the Biological Station but were never seen at the Koula meadow. These species with identical foraging patterns and food habits, evidently found it more difficult to coexist at the shore while succeeding at the meadow.

The abundance of food at the Koula meadow might be related to a good interspersion of aquatic vegetation and water. It could also be, however, that water level determined the use of the area by the birds. When the water level dropped in July and the meadow dried out, it was not used by

birds. While vegetation remained at the site, it was mostly dried. Water level fluctuation had a similar effect on birds feeding at other feeding sites as well. At the Biological Station shore when the water extended 5 m inland from the reedbeds during spring, birds used the site. Egretta garzetta which is more a fish-eating bird than the other Ardeinae then showed a high preference for this site. In August, however, when that the water withdrew to the edge of the reeds and there was no open shore on which to feed, the birds abandoned the site. Disturbance from sheep or fishermen, however, also was seen to prevent birds from using the shoreline at that time.

In March and April, there also was limited use of the shoreline even though the water level was high. This probably was a result of better and richer feeding habitats being available elsewhere, such as at the Koula meadow. Yet in March, could also be that not all birds had arrived at Prespa or that they were busy with nesting and spent little time feeding.

The use of the Mikrolimni meadow was more stable than the other two sites, probably because the open lakeshore with the continuous presence of lake water was available even when the meadows became dried out in July and August.

Although the vegetative physiognomy was the same as at the Koula meadow, its structure and complexity at Mikrolimni was inferior. Nevertheless it is believed that if the Mikrolimni wet meadow was placed under less pressure from human activities and not drained, it would be a habitat used as heavily for feeding throughout spring and summer as the Koula meadow. The proximity of the Mikrolimni meadow to the reedbeds which also provided nest sites possibilities for Ardea cinerea, Platalea leucorodia and Egretta alba should add to the attractiveness of this site.

The open lake sites were used by only 4 bird species. A comparison, between the two lake sites showed that although the abundance of birds using the Mikrolimni site was higher than at the lake in front of the Biological Station and species richness was the same at both places, the species diversity index was higher at the Biological Station. That was the number of species in relation to their relative abundance reached higher values at the Biological Station than at the Mikrolimni lake site. Since interviews with fishermen revealed that their catches at Mikrolimni lake site were usually larger than at the Biological Station, it seemed that this was the probable cause of higher numbers of fish-eating birds being present at the Mikrolimni lake site.

Pelecanus onocrotalus was the only species which bred but did not normally feed at Prespa. The frequency of departures and arrivals of groups of these birds indicated that the daily trips were certainly a significant part of their activities. When the birds were incubating, they seemed to spend less time on these feeding trips than later in the season. Their trips were shorter and the departing groups were smaller. Yet the southern direction of departing pelicans seemed to indicate that they were going to Kastoria, one of the regional lakes, closest to the Prespa wetland. The lakes in the region are smaller than Mikri Prespa and their structure is such that they can satisfy feeding needs of only a portion of the P. onocrotalus population. If the birds did indeed feed at Kastoria, a reason for these shorter trips may be that they needed to take turns incubating.

When habitat conditions were favorable at Prespa, the birds fed there. Later in the season, when they had to feed their nestlings too, the trips became longer - to more productive wetlands, located at a distance from Prespa. While longer day lengths aided distant flights, also larger group

departures and consequent feeding in larger groups probably increased the catch, or made it more efficient. Before migration, when the individual bird's needs for food increased, birds remained on the feeding grounds overnight and probably roosted there.

Further investigation of the feeding behavior and movements of the colonial species is required. It is crucial for the species' continued and successful breeding that: (1) feeding opportunities for P. onocrotalus increase at Prespa by improving habitat conditions favorable to the birds, (2) the species feeding grounds outside Prespa be identified, (3) these feeding grounds be protected from drainage and other human disturbance, and (4) they be managed so as to enhance the breeding population of the species at Prespa.

Resting birds were accommodated in all sites. An important component of the habitat used for resting was the wooden fence in front of the reeds at Koula. The rocks on the shore of the Biological Station were occupied most of the day by various loafing birds. The dried reeds at Mikrolimni meadow were also sometimes used for perching. Although there was often species overlap in the utilization of these sites, it did not appear to lead to excessive competition. Questions of use were usually resolved with minimum conflict through a hierarchy of species dominance at such perches. Most often there was a temporal segregation during the day of the species involved.

Human disturbance had negative impacts on all species using a habitat. This was particularly obvious at the stream sampling site. There, habitat modification by man destroyed nearly all the natural components and degraded the area for any bird use. Agricultural activities and livestock grazing also had negative impacts on birds using meadow habitats. No birds (not

even herons) were ever observed, in the meadow biotope when cows were present. On the other hand, automobile traffic did not drive birds from their foraging or resting sites. When cars stopped on the road nearby or entered the biotope, however, they did abandon the site. Recovery after disturbance was sometimes delayed for hours for Platalea leucorodia, Pelecanus onocrotalus, and Egretta alba. In contrast, E. garzetta, Ardeola ralloides, and Phalacrocorax pygmeus returned to the site soon after the disturbance was over.

The most severe effect on the habitats was water loss largely due to the existing drainage system. Moisture losses were sometimes so drastic in the summer that within less than a week, if there was no rain, all meadow vegetation would dry out. The habitat then would be of no use to the waterbirds.

Chapter IV

CONFLICTS BETWEEN LAND USE AND BIRD HABITAT

As stated in the Presidential Decree which declared Prespa a national park, the main objective of this action was "to preserve the wetland with its fauna of rare bird species and its flora..." To achieve this, the lake and wetland combined were to comprise the nucleus of the park.

According to Legislative Decree L.D. 996/1971 article 80 par. 2, fishing, hunting, grazing, mining, construction of any type, destruction of natural vegetation, industrial activities, etc. are forbidden completely within the nucleus of the park (see Chapter I: Legal Status). Nevertheless, in the nucleus of Prespa National Park most of the above prohibited activities still occur to various degrees (see Chapter on Land Use). Although it is necessary that these legal provisions be followed to safeguard the values of the park, it is important to examine the dangers that present land uses cause these values. Even if the legal aspects are set aside, other conflicts exist between human land use and wetland preservation. Only after analysis of these conflicts can realistic decisions be made regarding the future of the park.

Land cover/use analysis of the national park showed that there is a general trend to concentrate existing commercial land use in lowland areas close to or within the nucleus of the park. In 1945, the Prespa population was about 6000 people as compared to 1000 nowadays. In comparison with recent aerial photographs, those of 1945 showed that land use then was dispersed throughout the park, particularly on the uplands where most of the villages were located. Local people used the land extensively rather than

intensively, applying traditional rather than mechanized methods of farming, logging and grazing. These methods seemed to have been practiced in a sustainable and ecologically-sound manner. At that time, Prespa was in many ways a closed system without many economic inputs from the outside. There was not much trade of products with the outside world. The civil war and especially the years which came thereafter, however, hit the local population hard and determined the ecological future of Prespa.

After the war, all Greece was struggling for quick economic development and a strong need arose to develop the marginal area of Prespa. With its population declining rapidly and recolonizing efforts of the government failing, the economic goals of development were raised with increased objectives for stabilizing the population. Furthermore, it is still strongly believed by the administration that economic investment will stop population declines and benefit the local people. The construction of a drainage/irrigation network was the first major step toward this goal. But the pattern of economic development followed, was not based on sound ecological considerations.

Despite the relatively few people who remain in the area, some land use has become relatively intensive. Land which was marginal until the construction of the irrigation project in the late 1960s became the focal point of agricultural activities. One-quarter of the park's wet meadows-marshland was transformed to agricultural land. By altering the water balance, the entire area close to the nucleus changed drastically.

The former ecotone between reedbeds and cultivated lands disappeared and farmland reached the edge of the reeds. The new agricultural ventures also put heavy pressure on the remaining wetlands.

The importance of wet meadows to Prespa's unique bird life was recognized by the government when the park was established (see also Chapter III: Habitat Use by Birds). The small wet meadow at Koula, for example, is important as a feeding and loafing ground for all the rare species (Table 13). The high species diversity at that site during the breeding season indicates particularly that these feeding grounds are necessary during the critical nesting period. Even though biotopes such as the Koula meadow do not exceed a total of 20 ha in the whole of Prespa, they determine the breeding success of several of the bird populations which are declining world-wide.

What would be the impact of the loss of these wet meadows on the bird populations breeding at Prespa? Such effects can be inferred from observations on the year-to-year dynamics of the waterbird population in the area. A census made by Terrasse et al. (1969) showed that the breeding populations at Prespa then were: Phalacrocorax pygmeus 70-90 pairs; Phalacrocorax carbo 300 pairs; Pelecanus crispus 50-70 pairs; P. onocrotalus 40-50 pairs; Nycticorax nycticorax 50 pairs; Ardeola ralloides 30 pairs; Egretta garzetta 250 pairs; Ardea cinerea 50-100 pairs; E. alba 10 pairs; A. purpurea 300 pairs; Platalea leucorodia 100 pairs. A comparison of these numbers with those of presently-nesting populations (Tables 12 and 13) is striking. Although reference is made only to nesting pairs at the two major breeding sites, the birds nesting at other sites in Prespa are very few and would not increase the total breeding population significantly by more than 5%. The decline of populations of the above species is most disturbing. And as a further sign of what the future may hold, Plegadis falcinellus, which was reported by Terrasse et al. (1969) to have had a breeding population of 10-15 pairs in 1969, is now extinct in Prespa.

Critical population sizes, where extinction becomes a danger, are not known. It is also difficult to assess those factors which limit the size of a breeding population. Long-term studies should involve various approaches and attempt to identify all possible factors which could regulate waterbird populations. Even lacking some data, however, present knowledge of Prespa conditions allows us to relate some population decreases with losses of feeding grounds.

The diminished populations are all wading birds of the order Ciconiiformes. For most of these species, the size and quality of feeding areas which are required to sustain breeding populations in the Mediterranean region is poorly understood (ICBP/IWRB,). For N. nycticorax, however, Fasola et al. (1981) have demonstrated that there is a clear relationship between the size of the feeding area and the consequent population size. Furthermore, the worldwide contraction in range and reduction in numbers of these species have been related to the drainage of wetlands (Cramp 1977). The Prespa population decline may be a similar case.

Juxtaposition of new farms adjacent to and within the remaining wetlands will have an increasingly negative impact on the already-reduced waterbird population at Prespa. If intensive agriculture is extended in the area, there will be increasing disturbance to the birds and habitat quality will be diminished. Disturbances to birds involve direct interference, as tractors are operated close to or within the meadows. As for habitats, the probably-increasing use of chemical fertilizers and pesticides is of special interest. The marsh must absorb the impact of the chemical fluxes which are characteristic of modern farming procedures. Marsh wetlands are a sink for nutrients, especially nitrogen (Good et al., 1978; Tilton et al., 1976). It

is difficult to predict the behavior of the wetland when the nutrient load is applied as a nonpoint source in space but as a point source in time (Barber et al. 1978). For example, after a fertilizer is applied anywhere in the watershed, the wetland must react to a pulse of the chemical run-off.

Although existing scientific data are scarce, the increase in lake eutrophication may be interpreted from aerial photographs (1945, 1984) (see chapter II) and from the testimonies of local people. The area covered by the reedbeds has increased and the water quality has deteriorated through the years. It is difficult to determine what portion of the increased eutrophication is due to natural causes and what part was caused by agricultural activities or the prohibitions of reed cutting and burning. Runoff from the increasingly-eroded land over the whole watershed of the park also certainly played a role in the rapid aging of the lake.

The use of pesticides in agriculture had direct effects on the birds and their habitats, too. Mendenhall (1978), monitoring Pelecanus occidentalis, found that reductions in breeding success were correlated with increases in organochlorine pesticide residues in the egg whites. The current effects of pesticide use on the birds of Prespa is unknown, and may still be low, since there is at present a low, use of these toxic substances in the area. The threat increases, however, as agriculture becomes more intensive and oriented toward the application of more chemicals.

Hurlbert (1975) in his review of the secondary effects of pesticides on aquatic systems, found changes in food-web structure and alterations of population dynamics through selective reductions of predators and changes in relationships with competitors. Livingston and Loucks (1978) concluded that the effects of toxic agents on wetland systems can be much more significant

in an ecological sense than just simple mortality within individual populations.

The concentration of pesticides on such top carnivores as the fish-eating waterbirds may reflect deleterious effects on the whole ecosystem. The relative abundance of those top species reflects the health of the entire community.

As meadows and rangelands surrounding the lake were transformed for crop production, grazing by livestock increased on the remaining meadows. At the Mikrolimni meadow, the change in vegetative composition toward species unpalatable to cattle and the formation of mudbelts at the shoreline was indicative of overgrazing. Waterbirds there also abandoned their feeding ground when disturbed by invading cattle. Despite the disturbance, however, the possibilities for management of wet meadows through controlled grazing should not be ignored. Such practices could keep the vegetation at a favorable successional stage and improve the feeding grounds for the rare birds.

The most significant nesting biotopes for the waterbirds in Prespa are at Vromolimni and in the Albanian border lagoons. Since nearly all breeding populations of the colonial species are concentrated in these two areas, entire populations are vulnerable even to simple disturbances there. The thoughtless destruction of habitat features essential to colony life could decimate whole colonies (Kroodsma, 1978). Even altering what appear to be insignificant features of their habitats may have profound influences on bird populations. Visits by people at critical times, too, could have detrimental effects on nesting birds.

Shifts in the pelican nesting sites observed at Prespa is an example of their vulnerability to disturbance. Until 1972, Vromolimni was extensively

used by local fishermen for fishing and for the breeding of Lutra lutra which was introduced to the area for commercial development. There were passages through the reeds then and accessibility to the Vromolimni pond was easy. Terrasse et al. (1969) found numerous pelican nests, including eggs, destroyed by fishermen at Vromolimni.

Despite the stated governmental objectives to preserve the pelicans at Prespa, the order for the destruction of the pelican colonies was given by a local government agency. Individual testimonies from many local people, though not certified officially, stated that during the mid-1960s the administration informed the people that the fish catch would increase if pelicans were exterminated from the lake. By 1968, the colony had been completely exterminated and no pelicans nested there for several years.

The same agency placed pelicans under a bounty, paying 50 drachmas per adult pelican killed and 5 drachmas per destroyed egg. Pelican shooting was even organized by groups coming from Florina to Prespa for this purpose. The operation was terminated soon, however, because the colonies at Vromolimni were quickly decimated. Fortunately, there was no access to the Albanian border nesting sites because of military restrictions. During that time, the populations nesting at the Albanian border were more numerous than today, with 50 pairs of P. crispus and 40 pairs of P. onocrotalus reported (Terrasse et al., 1969; Terrasse and Terrasse, 1970).

In 1971, an ordinance issued by the Forest Service prohibited fishing at Vromolimni, "in order to protect the potential pelican nesting habitats." Gradually, the passages through the reedbeds closed and Vromolimni became isolated from human penetration. After several years (Crivelli, 1977), the pelican colony reestablished itself at this site. By then, however, fishing was allowed for Greeks close to the Albanian border and it is believed that

fishermen who lived and fished there disturbed those nesting colonies and somewhat "guided" the return of pelicans to the Vromolimni site. The Albanians, furthermore, also opened this areas to their use.

Presently, the burning of reeds, fishing, explosions for mining purposes, and intensive agriculture with terracing are all common practices on the Albanian side of Lake Mikri Prespa. Even during the study, nesting colonies were observed to shift closer to the Greek zone, abandoning sites within the disturbed Albanian territories. The numbers of birds nesting along the border have decreased considerably, as compared with earlier censuses (Terrasse and Terrasse, 1970; Geroudet, 1973; Kempf and Wersinger, 1974). Presently, the nesting colony on the Albanian border site is the smallest ever recorded. Fortunately, the pelican colony at Vromolimni in contrast, has shown an increase. Both Vromolimni and the lagoons at the borders should be accpted as bird sanctuaries and no visits should be allowed. Binational agreements with the Albanian government should begin in order to prevent the decimation of the colonies there.

Although fishing is prohibited by Presidential Decree in Lake Mikri Prespa, it is practiced throughout the whole lake except at Vromolimni and in the lagoons close to the Albanian border. Recently, fishing pressure seems to have increased as the lake's fish population has decreased (Agricultural Service, 1983). Although the fisheries problem is complex and needs further investigation, the present study found enough evidence to hypothesize that the spawning habitats of many fishes, have deteriorated due to eutrophication of the lake. Competition between carp and Carassius auratus may be a related cause.

The absence of reedbed management and the infiltration of agricultural fertilizers may also be key factors in the reduction of water quality.

Sites dominated by organic decay of the reeds are relatively low in oxygen and high in acidity. This may prevent successful fish spawning. It is crucial for the birds, and especially the exclusively fish-eating pelicans and cormorants, that management be undertaken to increase fishes in the lake. Fishing by local residents should be controlled, with commercial activities confined to areas of the lake away from bird habitats. The introduction of additional exotic fishes should be avoided.

It is important, too, to emphasize the value of those other lake wetlands of the region which serve as the principal feeding grounds for the P. onocrotalus which breed at Prespa.

If the objective of Prespa National Park is to maintain and enhance breeding populations of waterbirds, especially the rare species, it is important to protect both their nesting and feeding habitats from further damage by human use. All evidence at Prespa indicates that it is the wetlands which give it a unique character. These areas must be considered to be the heart of the park. They must be given strict protection and, at least at present, adequate management.

Chapter V

RECOMMENDATIONS FOR THE ECODEVELOPMENT OF PRESPA NATIONAL PARK

1. Organization of the National Park

- An Operational Regulation for the park is required. This will describe necessary administrative needs and determine all human activities and the appropriate environmental regulations.
- Administration - Personnel. A minimum of 5 persons working full time in management and supervision of the park is required, according to IUCN criteria for national parks.
- The boundaries of the park should be marked in the field.

2. Environmental Monitoring Research and Program

The existing Biological Station should undertake cooperation with recognized biologists, limnologists, agriculturalists, foresters. They should monitor biological and environmental conditions in the park, organize studies of threatened habitats and species and suggest management needs to officials of the national park.

3. Educational - Interpretation Program.

a. A mobile conservation educational unit with slides, films and other presentations should be organized to increase the knowledge of local villagers regarding the varied values of their lands and waters and the need to conserve them.

b. A visitor information-interpretation center should be made available with programs on conservation education and the park's scientific, cultural and economic values. It should be a nucleus around which to build a museum of local history and culture.

4. Zoning of the park

a. Nucleus: A zone at least 200 m wide around the lake shores of Mikri Prespa should be fully protected from any exploitative activities such as agriculture, grazing, logging or mining. To give impetus to a more active program to preserve the rare waterbirds of Prespa, the expropriation of an irrigated area of about 110 ha is required for return to its natural status as a wet meadow. Changes from private ownership in the nucleus and buffer zone (see beyond) should be negotiated and villagers compensated for the loss of their land. Three types of land use should be designated within the nucleus:
i. Restricted areas: Vromolimni and the Albanian border lagoons which are of critical importance as the major waterbird nesting habitats at Prespa should be closed to visitors, with such closure strictly enforced. ii. Areas of limited use by visitors: A controlled number of visitors may use the wet meadows for bird watching and nature photography. Birds should be seen, however, mostly from blinds on observation towers built at various feeding sites. Care must be taken that visitors do not cause disturbance to the birds. Mikrolimni, which is in the designated nucleus of the park, may include the park's administration center.

b. Buffer Zone: An area around the nucleus should be designated, for limited agriculture and livestock grazing under permit. All activities there should be under the strict control of park personnel so as to

protect the nucleus. The width of the buffer zone could vary, depending on the importance of adjacent nucleus sites (i.e. it may be 50 m wide on the steep southeast and southwest slopes, but at least 200 m wide on the eastern, northern and western sides where the topography is less sheltering). The isthmus portion of the park, which does not now belong to the nucleus, should be in the buffer zone. A drainage canal and pollution control system should be constructed in the buffer zone to cause all runoff from agricultural fields to be collected and pollutants removed prior to waste-water release into the lake.

c. Extensive-use Zone: Most of the prospective regional development plans may be implemented in this zone. Villages may be included. Cultivation and livestock grazing may be practiced, using traditional methods which follow conservation principles. Methods of agriculture using only organic natural fertilizers, such as livestock manure, should be used on farms. In the villages, handicraft production could be encouraged to enhance local culture and skills, while providing extra income. Tourist accommodations should be established in this zone, particularly in the existing villages. It is suggested that new hotels should not be constructed in the area, rather houses in the villages should be restored to their original style and serve as small-scale home-motels. Such actions could bring extra income to a large number of local residents but would not change the character of the present residential areas or natural environment. It would also protect the local architecture and help to upgrade presently-deserted houses.

The abandoned village Mileonas could become a scientific center for the park, affiliated with the University of Thessaloniki. In restored houses of the village, students in such disciplines as biology,

agriculture, forestry and architecture, may be accommodated while they acquire training and conduct field research. The wetland resources, lake, fauna, flora, forests, agriculture and architecture of the park all could be subjects of their studies. The village also could serve as the site of scientific seminars, conferences and professional meetings (Pyrovetsi et al., 1983).

Restoration of the local cultural heritage also is required. The churches, the frescoes on the cliffs and all buildings of architectural value should be restored and preserved.

The beauty of the landscape and the tranquility of the area should be protected. Reclamation work must be done on the quarries. Road construction should not create visual scars on the landscape. Care should be taken so that any new buildings constructed in the park are not visually obtrusive and that they follow local architectural materials and patterns.

A detailed touristic-recreation plan for the park must be designed, including suggestions for potential visitor activities. Birdwatching, hiking, nature photography, mountain climbing, natural sports in Lake Megali Prespa such as canoeing, fishing and swimming could be encouraged. Sports which require landscape modification, such as golf and tennis, however, should not be planned. Tours to the Byzantine monuments also should be organized. Ski facilities on the eastern alpine areas outside the park might be considered for the winter months, but only if maintained so as not to damage national park views and other values.

5. General Suggestions for Administration and Management

Hunting should be prohibited within the national park on a year-around basis. No exotic plants or animals should be introduced into the park. New crop species also should be appraised as to their potential impacts on the

natural environment before being used on the farms. The quarry definitely should be closed. The canned food plant also should be closed permanently. The plant building, perhaps, could be transformed into an interpretation-education center.

Lake waters should continuously be monitored both for chemical and physical characteristics. The mass flow of nutrients from the watershed and food-web structures are among the topics which must be studied. Management procedures should be established, after adequate research, to restore lake conditions to their former natural levels of productivity.

6. Land Use and Resource Management

In this national park, it is believed that rural development should be a major objective of ecodevelopment so as to prevent a decline in the local population (Pyrovetri, 1983b). Health, educational facilities and employment opportunities should be provided to the villagers in Perspa.

Fisheries: Research on fish population dynamics and the basic limnology of the lake is required. Food web relations and interactions between species should be investigated. The current impacts of the introduced exotic species should be evaluated and probably reduced. Research results must be integrated with proper management practices. Fishing on Lake Mikri Prespa should be regulated and restricted to certain seasons and areas. During the fish spawning and breeding period, fishing should be prohibited. The administration should monitor the catch on a long-term basis.

Wetlands: Research on wetland fauna, flora and edaptic conditions and on the consequences of the watershed modifications which affect the wetlands is required. Burning the Phragmites (reeds) of the wetland on a 3-year

rotational cycle could be tested, with one/third of the plots burned every third year. Controlled burning should be attempted with the objective of assuring that fires are not of high intensity. Unless research indicates otherwise, fall burning, before the rainy season starts, may be best. The harvesting of reeds also could be practiced in winter, preferably on the ice. Appropriate machinery could be used for this harvesting. Results of these 2 management methods (burning vs. cutting) should be compared and decisions made which would help the meadow vegetation return to its natural conditions. In all meadows, grazing by livestock should be managed to retard the natural succession of the vegetation.

Agriculture: As a first step, it is necessary that the land ownership problem be resolved so that the number of active farmers increases at Prespa. An agricultural extension program is necessary to train and educate farmers on traditional methods of crop production and especially on applying conservation methods in land management. These should be used wherever possible, providing another source of interest for park visitors. The existing irrigation/drainage network needs modification. Sprinkler, or possibly trickle, irrigation may reduce surface runoff and loss of moisture. Also to prevent erosion, the irrigated fields must be leveled. Soil conservation measures should be practiced in tillage during harvests and while land is lying fallow. No drainage water from the farms should enter the wetland before such waters are adequately treated.

Rangeland: Grazing by livestock should be practiced only on upland openings and, if carefully practiced, on the alpine meadows. Rangeland management objectives should assure that: 1) continuous directional change in plant composition and productivity does not result, 2) soils maintain their water-holding capacities and do not become eroded, compacted or unduly

exposed to rain and wind, and 3) representative samples of the major grassland types are protected from grazing so that they remain as naturally functioning ecosystems and as standards against which to measure the effects of grazing (Petrides, 1970).

Forestry: The juniper forest and other representative samples of the major vegetative types should be protected from exploitation and be managed for their esthetic and recreational values. On some few forestland areas, management toward timber production on a sustained yield basis might be justified, but should be undertaken only under adequate conservation measures for watershed protection.

A Prespa International Peace Park: International cooperation with Albania and Yugoslavia is required if values from the park's assets are to be maximized. Agreements should be reached between the three countries for applying conservation principles toward attaining mutual benefits from use of the area's resources. Integrated management of the lake and its watersheds would be useful to all three countries.

Dedicated to peace and friendship, a Prespa International Peace Park could be organized which would offer benefits to the several nations involved and stand as a monument to the coexistence of man and nature.

Chapter VI

PROSPECTS FOR THE FUTURE

In the previous chapters it was shown that economic pressures were the motivating power for the decision makers and planners who have dealt with Prespa National Park and its development processes. It was also recognized that this economic pressure which exists for all development throughout Greece, has been affected by its troubled and difficult recent past, including a civil war which had a totally negative impact on its human and natural resources. As a result of economic pressures and necessities, the biological diversity and ecological well-being of the area's natural resources have been sacrificed.

The declaration of the area as a National Park did little toward conservation. Economic revenues and expenditures were the ultimate criteria and determinants of human administrative action which were misdirected to the degree that the living world had no significance. Local residents, natural resources and national treasures have all suffered. Governmental actions were so inappropriate at Prespa that they even failed to stop Prespa's population decline, much less to make its residents prosperous. As time passes, the ecological consequences of thoughtless development are becoming increasingly evident. The ecological damage caused has also invoked economic and social damage. Its results are environmental degradation, resource depletion and biological death.

It is not too late for Prespa to save its unique living resources. It is not too late to integrate conservation into all its developing processes. Development can and should occur in harmony with the environment, so that it

conserves resources, respects the diversity of natural and human cultures and employs technologies that do not abuse natural systems.

Prespa can play a much larger role than just being a museum of nature. It can provide a basis from which people can learn to better understand and maintain the biosphere. It can be used as a pattern for the whole nation providing a sounder basis for decision-making toward ecodevelopment. Thoughtful development toward maximizing the total values of Greece's natural wealth is essential.

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LAND COVER/USE
CHANGES of
PRESPA NATIONAL PARK
(1945-1983)
SCALE: 0 05 10 15 20 KM
Psarades
Koula
Lemos
Milionas
Plati
Kallithea
Lefkonas
Pili
Daseri
Karies
Pixos
Mikrolimni
Oxia
Agathoto
LEGEND
Boundary of countries
Boundary of National Park
Boundary of land cover/use categories
Boundary of land area
Roads
Streams
1 (F) Forest land
2 (R) Rangeland
3 (Wm) Wet meadow
4 (A) Agricultural land not irrigated
5 (Ai) Agricultural land irrigated
6 (Aa) Agricultural land abandoned
7 (E) Barren Eroded land
8 (W) Water
9 (Re) Reedbeds
10 (U) Urban
(Note Coding 4 5 means that agricultural land not irrigated in 1945 has changed to agricultural land irrigated in 1983)