



Status Survey and Conservation Action Plan for the Bats of Prespa

**Elena Papadatou, Xavier Grémillet, Ferdinand Bego,
Svetozar Petkovski, Emilija Stojkoska,
Oliver Avramoski & Yannis Kazoglou**

SOCIETY FOR
THE PROTECTION
OF PRESPA



for Man and Nature

SOCIETY FOR
THE PROTECTION
OF PRESPA



for Man and Nature

Status Survey and Conservation Action Plan for the Bats of Prespa

Elena Papadatou, Xavier Grémillet, Ferdinand Bego,
Svetozar Petkovski, Emilija Stojkoska,
Oliver Avramoski & Yannis Kazoglou



Prespa May 2011

Copyright:	© 2011 Society for the Protection of Prespa (SPP)
	ISBN: 978-960-85811-8-0
	Reproduction of this publication for educational or other purposes is authorised without prior written permission from the copyright holder provided the source is fully acknowledged.
Citation:	Papadatou E, Grémillet X, Bego F, Petkovski S, Stojkoska E, Avramoski O, Kazoglou Y (2011) Status survey and conservation action plan for the bats of Prespa. Society for the Protection of Prespa, Agios Germanos, pp 170
Cover photo:	Medium sized <i>Rhinolophus</i> bat emerging from its cave roost. Philippos Katsiyiannis.
Photo credits in document:	Christian Dietz, Torsten Pröhl, Xavier Grémillet/GMB, Ferdinand Bego, Emilija Stojkoska, Yannis Kazoglou, Thomas Dubos, Aggela Georganda, Philippos Katsiyiannis, Sébastien Puechmille, John D. Altringham, E. Papadatou
Produced by:	Society for the Protection of Prespa (SPP)
Design:	Defrost design
Printed by:	Technograph
Available from:	Society for the Protection of Prespa Ag. Germanos 53077, Greece E-mail: spp@line.gr http://www.spp.gr

CONTENTS

Foreword	6
Acknowledgements	7
List of acronyms	9
Executive summary	12
Introduction	13
 PART I. Background: bats in Europe	17
1. Classification, diversity and distribution	19
2. Biology and ecology of European bats	19
3. Threats and conservation considerations	26
4. Legal protection and conservation	31
5. Education	33
 PART II. Background: Bats in Greece	37
6. Species diversity, distribution and population status	39
7. Ecology	39
8. Threats, legal protection and conservation	40
 PART III. Bats in Prespa	43
9. Study area – The Prespa Lakes basin	45
10. History of bat research at Prespa	57
11. Data collection: field techniques and analysis methods	59
12. Bats on the Greek side of Prespa	61
13. Bats on the Albanian side of Prespa	98
14. Bats on the side of the FYR of Macedonia	102
15. Synthesis: bats in the Transboundary Prespa Park and its surroundings	109
 PART IV. Research, survey and conservation recommendations	113
16. Recommended research and survey actions	115
17. Recommended conservation actions	118
18. Advisory, communication, public awareness and training	133
19. Cooperation at the transboundary level	136
20. Useful websites	137
References	139
Appendices	145

Foreword

It was over four years ago when SPP received one of Xavier's most enthusiastic e-mail messages informing that he had succeeded in gathering a group of French volunteers to work for the bats in Prespa, following a similar voluntary expedition in 2004. The results were surprisingly good, new species were found, unknown roosting and hunting places were placed on the map and this encouraged SPP to launch an almost two-year project aiming at the completion of a Bat Action Plan at the transboundary level. The group of people involved increased from year to year; first there was Xavier and the French colleagues and volunteers with Yannis in 2004, then came Elena, followed by Svetozar, Oliver, Emilija, Ferdinand, and Panayotis along with many others. Bat work continued and expanded to the wider Prespa region. They embarked on a journey with quite harsh conditions entering into sometimes deep caves and spending many nights out in the field trying to detect new species or pinpoint threats and propose mitigation measures.

Through these long efforts and rather difficult endeavour, an exemplary Action Plan has been produced, which has significantly increased our – until now – limited knowledge on bats in the Transboundary Prespa Park. For the countries sharing the Prespa Basin, this work is an exam-

ple not only of the importance and wealth of the Prespa area but also of the high quality results that good cooperation among different partners and scientists can produce.

Besides giving us new scientific data on these largely unknown species, this Action Plan also provides important information on conservation activities and mitigation measures that should be taken to preserve bats and their habitats. Obviously, these activities cannot be confined within the Greek Prespa borders. Cooperation among the three countries and implementation of specific conservation activities in the field are needed in order to ensure that this excellent production will be put to use.

Finally, and above all, it should be stressed that, reading between the lines in this Action Plan, you feel the enthusiasm and dedication of all participants to their field of expertise and to Prespa. Let's hope that this work and spirit will inspire all of us towards the protection of our little, silent, night-flying friends, which bear a heavy share of responsibility for keeping a balance in nature for us and for our children.

Myrsini Malakou

Managing Director of the Society for the Protection of Prespa

Acknowledgements

This work would have never been achieved without the help of numerous field assistants and we are grateful to all of them: V. Arabatzis, J. Boireau, T. Cheyrezy, S. Declercq, N. Deguines, F. Doleson, J. L. Dubois, T. Dubos, N. Galand, P. Georgiakakis, T. Le Campion, M. C. Navet, S. Puechmaille, V. Papadopoulos, A. Trasias, J. Vernusse, N. Xega, A. Bojadzi, P. Katsiyiannis, S. Bilonis, many inhabitants of Prespa who willingly opened their buildings to see bats (especially E. Chatzaras) or gave useful information on bat sites (esp. D. Pitoulis), as well as volunteers from the SPP and WWF Greece. J. Boireau, T. Cheyrezy, S. Declercq, N. Deguines, T. Dubos, N. Galand, P. Georgiakakis, T. Le Campion and S. Puechmaille assisted with echolocation call recordings and species identification. We thank F. Mayer (Natural History Museum, Berlin, Germany), and the genetics laboratory of the Natural History Museum of Crete for analyzing genetics samples that helped confirm the identification of

Myotis brandtii and *Plecotus austriacus* respectively. We thank Zoran Velickov for providing free of charge the GIS background for the bat distribution maps. The authors and the SPP are grateful to the Elliniki Etairia (Hellenic Society for the Protection of the Environment and the Cultural Heritage) for providing accommodation to the French team of bat researchers in 2009 and 2010 at the Biological Station at Mikrolimni. We thank P. Katsiyiannis for providing the wonderful cover photo and Irene Koutseri for reading through the entire manuscript to make final comments and corrections. The present work was funded by the SPP through its programs titled “Conservation-oriented research on Priority Species and Habitats in the Transboundary Prespa Park” and “Development of a Transboundary Monitoring System for the Prespa Park Area”. However, it should not be forgotten that a large part of the data was collected through activities and expeditions on a voluntary basis.



List of acronyms

EIA	Environmental Impact Assessment Study
GNP	Galicica National Park
GEF/SGP	Global Environment Facility/Small Grants Program
GMB	Groupe Mammalogique Breton
IR cameras	Infrared cameras
m a.s.l.	Meters above sea level
NGO	Non Governmental Organisation
NP	National Park
PelNP	Pelister National Park
PNP-AL	Prespa National Park in Albania
PNP-GR	Prespa National Park in Greece
SPP	Society for the Protection of Prespa
TMS	Transboundary Monitoring System
TPP	Transboundary Prespa Park
VWT	Vincent Wildlife Trust



“There is a persistent and widely held, homocentric view of the world, that if an animal has no apparent economic value then it is not worth preserving, and if it is perceived to be a pest, then it can be eradicated. A more enlightened view is becoming more prevalent, as is an appreciation of the importance of intact, functional ecosystems to human survival. Sadly, despite widespread acceptance of the concepts of ecosystem services and the economic value of natural habitats, this homocentric view of the world is still widespread and bats, like many other animals, continue to be persecuted” ~ J. D. Altringham, 2011.

Executive Summary

In the last years, researchers and naturalists in collaboration with the Society for the Protection of Prespa (SPP) have conducted bat surveys in the area of Prespa to determine the distribution and status of bat species, and to identify conservation and research needs. Surveys originally took place in the Greek part of Prespa but later expanded to include all three countries surrounding the Prespa Basin, namely Greece, Albania and the FYR of Macedonia, in the Transboundary Prespa Park as well as at sites to the north and south of the park and in the Ohrid Lake basin. This document summarises the results of these expeditions and defines a list of conservation and research priorities to ensure a favourable conservation status for Prespa bats.

Expeditions revealed that more than half of the European bat species roost and hunt in the Prespa Basin and the surrounding areas in habitats varying from the lakes and associated wetlands to broad-leaf woodlands and subalpine meadows. Bats roost in caves and rock crevices along the shores of the lakes, in old or abandoned traditional buildings and presumably in trees. Many commuting bats cross mountain passes at high altitudes up to 2000 m a.s.l., flying above subalpine meadows and forests near the tree line where they may also forage. Bats appear to commute from areas outside the Prespa Basin such as the Florina plain and the Pisoderi valley to forage in the rich in habitats and insect prey Prespa area. Prespa and the surrounding areas host a uniquely large population of the Lesser horseshoe bat *Rhinolophus hipposideros*, one of the most threatened European bats already extinct in some areas of Europe. The high bat diversity and abundance presumably reflect the highly heterogeneous environment, the lakes and their associated wetlands, offering a wide variety of habitat types both for roosting and for foraging, coupled with the unique geomorphology and the climate of the area.

Despite the generally well preserved condition of the Prespa area, a number of factors are threats to the bats and their habitats. The degradation, destruction and loss of roosting and hunting habitats is the most significant threat to bats worldwide. In

Prespa, threats include current forest management practices, intensive agricultural practices, including monocultures and uncontrolled use of pesticides and fertilisers, the partial abandonment of the traditional agro-pastoral and agro-forestry systems, the disturbance of roosts through uncontrolled public access, the collapse or restoration practices of old traditional houses and the development of wind farms on surrounding mountain ridges. Currently, it is internationally recognised that wind farms pose a more significant threat to bats than to birds, killing hundreds or even thousands of bats every year especially when built within or close to sensitive areas. The lack of enforcement of existing legislation protecting bats is an additional problem. It is therefore crucial to preserve the Prespa habitats and improve the conditions at certain locations.

To allow for appropriate regionally adapted conservation management recommendations and for targeted use of resources, we need to have a solid understanding of the bats' ecological requirements and threats they face. Because details of the distribution and status of many species are currently unclear, and little is known on their ecology, we first recommend research and survey actions to increase our knowledge and understanding of bats in the area of Prespa. However, accumulating knowledge is a long-term procedure, we therefore further recommend appropriate conservation management actions based on currently available knowledge and experience. The results of these actions should be monitored and conservation recommendations be adapted to monitoring and research results. We finally provide recommendations on the development of education programmes and the dissemination of information to increase public awareness and support towards the conservation of Prespa bats. Because bats know no borders, research and survey work, conservation management actions and education projects ideally should be done on a transboundary level and with the participation of local people. All recommendations will need financial support and political will to be implemented.

Introduction

The Prespa Basin has long been known for its biodiversity value. Although bats comprise an important component of biodiversity, only few attempts to study the bats of the area had been made until recently (see PART III, chapter 10), one of the main reasons being the inherent difficulties that the study of these cryptic animals present.

Between 2004 and 2011, a number of intensive expeditions in the area were conducted by researchers and naturalists in collaboration with the Society for the Protection of Prespa aiming at the development of the bat species inventory, the mapping of their distribution, the identification of important roosts, the establishment of basic biological knowledge with regards to annual use of bat roosts and hunting habitats, and the identification of research and conservation needs and priorities. In the first years, expeditions were only run in the Prespa National Park of Greece (PNP-GR) by Greek and French researchers and naturalists, but as it is natural and expected bats move across the three countries and so should research expeditions. In 2009 some important caves in the Albanian Prespa National Park (PNP-AL) were therefore included in the expeditions. In 2010 and 2011, expeditions expanded to include other important roosts in Albania and in the FYR of Macedonia, within the boundaries of the Transboundary Prespa Park and in adjacent areas, including some key sites in the basin of Ohrid Lake, in collaboration with local scientists and Galicica National Park (GNP). Until 2009, expeditions were conducted in summer, while the first autumn and winter roost surveys were carried out in late 2010 – early 2011. These expeditions revealed a unique and highly diverse bat fauna in Prespa, comprising 26 species (27 including the Ladopotamos valley which is adjacent to the south of the Prespa Basin in Greece), i.e. almost 65% of species occurring in Europe, with a wide range of roosting and foraging requirements. This document provides the results of all expeditions to date: it is the first comprehensive review of the status and distribution of bat species in the area of Prespa and provides a list of research and conservation priorities and recommendations

for the preservation of a favourable conservation status for them to ensure their long-term survival.

The document is structured in four different parts. In PART I, background information is given, including a brief account of the classification and diversity of bats in general, and of the distribution and ecology of European bats in particular. Conservation concerns and considerations, threats, legal protection and education issues are presented. This information is essential for the reader to understand why conservation of bats is an imperative need on a global and on a local scale, especially in areas supporting high species diversity such as the Transboundary Prespa Park and its adjacent areas. PART II provides further background information dealing with the same issues as applied in Greece in particular, since this work was initially established in the Greek part of Prespa, later involving Albania and the FYR of Macedonia. PART III provides all currently available information on the bats of Prespa separately for each country associated with the Prespa basin, including the description and ecology of species present, their known distribution and status at Prespa, important roosts and feeding areas, threats and legal protection issues. PART III ends with a synthesis of information from the 3 countries linking it with the fourth and final part, PART IV, where research, survey, and conservation recommendations including advisory, communication and education actions for the bats of Prespa are listed and discussed. Research, survey and monitoring actions underlie conservation recommendations and are much needed, since details of the status and ecological requirements of many species are unclear. Education is among the key tools in conservation and therefore forms an essential part of the recommendations. Many of the recommended actions are applicable in each of the three countries separately but most should ideally be applied on a transboundary level.

Overall, this document summarises all currently available information on the bats of Prespa and provides a framework for the development of further more specific actions for the study and protection of particular bat species, assemblages, and habitats.





Part I

Background:
Bats in Europe



T. CHEYREZY

Lesser Horseshoe bats, *Rhinolophus hipposideros*

1. Classification, diversity and distribution

1.1 Classification and diversity

Bats are included in the order Chiroptera, the second largest mammalian order in the world following rodents. They are the only mammals that have developed powered flight and only one of three mammalian orders (the others being cetaceans and insectivores) that use ultrasound. Until recently, they were traditionally divided into the suborders Megachiroptera (megabats) and Microchiroptera (microbats). However, according to new molecular phylogenies, two new suborders have emerged and are now replacing the traditional ones: the Yangochiroptera and the Yinpterochiroptera. Some microbat families are now included along with the megabats in the same suborder, the Yinpterochiroptera (Teeling *et al.* 2005, Eick *et al.* 2005)

To date, over 1100 bat species have been recorded worldwide and almost 80% are found in the tropics. The megabats all belong to the same family, the Pteropodidae, the fruit bats or flying foxes that are only found in the Old World tropics. All remaining bat species fall into the old sub-order Microchiroptera (microbats), a large, very diverse and widespread group distributed in 18 families, most of which are also tropical. In Europe there are four microbat families: the Vespertilionidae (8 genera, ~ 33 species), the Rhinolophidae (1 genus, 5 species), the recently defined family Miniopteridae (1 genus, 1 species) and the Molossidae (1 genus, 1 species). The Vespertilionidae is one of the largest families in the world and the number of European species is still being revised given the rapid evolution of molecular studies that keep revealing new species (e.g. Mayer *et al.* 2007).

European microbats weigh anything between approximately 3 and 60 g and their forearm length (a typical measure of their skeletal size) ranges from 28 to 70 mm. All species have the ability to navigate, orientate and hunt by echolocation (see section 2.1). However, they are not blind and even though they generally have small eyes, their visual capability is good. Some species often locate their prey by listening for prey generated sounds and/or by using vision; these species usually have large

ears (e.g. *Plecotus* species and *Myotis bechsteinii*, Vespertilionidae). Wing and tail membranes vary in shape and size, and with echolocation characteristics, they are related to prey type, foraging strategy and habitat (Altringham 2011).

1.2 Distribution

In Europe, the number of species decreases with latitude. In countries in the north of the continent, such as the U.K. or Scandinavian countries, fewer than 20 species are found on average. As we move to the south, the number of species increases. For example, Spain hosts 33 and Greece 34 species. Some species are confined to the south of Europe (e.g. *Myotis capaccinii* and *Tadarida teniotis*) whereas some other bats are only distributed or are more widespread in central and northern Europe (e.g. *Myotis brandtii*) or are comparatively less abundant in the Mediterranean part of the continent (e.g. *Myotis daubentonii*) (Dietz *et al.* 2009). In overlap zones, these species may be found in sympatry (e.g. *Myotis capaccinii* and *M. daubentonii* in the National Parks of Prespa and of Dardia-Lefkimi-Soufli, Galand *et al.* 2010 and Papadatou 2010 respectively). Some endemic island species have recently been described, such as *Plecotus sardus* in Sardinia (Dietz *et al.* 2009), whereas species occurring in the north of Africa have recently been identified in Europe, such as *Eptesicus isabellinus* (García-Mударra *et al.* 2009).

2. Biology and ecology of European bats

2.1 Echolocation and other senses

Perhaps the most important feature of microbats distinguishing them from megabats is the use of laryngeal echolocation. Only members of the genus *Rousettus* (Pteropodidae) have the ability to echolocate but sound is not produced in the larynx and it is less complex (Holland *et al.* 2004). Echolocation is the analysis by an animal of the echoes of its own emitted sounds, by which it builds a sound-picture of its immediate environment. Bats use echolocation for orientation and short-range navigation between roosts



Fig. 2.1 a) A Mehelyi's horseshoe bat, *Rhinolophus mehelyi*, b) a brown-long eared bat, *Plecotus auritus*

and foraging sites and for hunting their prey. They emit echolocation sounds in pulses (calls) from their open mouth or their nostrils. Species emitting sound through the nostrils often have complex folds of skin and cartilage extending around their nose, a formation called the nose-leaf. In Europe, only members of the family Rhinolophidae have a nose-leaf (Fig. 2.1a). All other species have a plain muzzle.

Bats show considerable variation in their call design, both between and within species, which most likely reflects adaptations to the wide range of ecological niches they occupy (Kalko and Schnitzler 1993). Because of these differences, echolocation calls have been widely used for species identification (e.g. Papadatou *et al.* 2008a). Calls are usually described as being frequency modulated (FM) or constant frequency (CF), but most species of bat use

combinations of the two (Fig. 2.2). The terms broadband (for mostly FM calls) and narrowband (for mostly CF calls) are often used instead (Altringham 2011). Broadband calls are short and cover a broad range of frequencies whereas narrowband calls are longer, they cover a short range of frequencies and usually most of their energy is concentrated in a single frequency. These and other features are closely associated with hunting habitat and prey type.

Microbats may use other senses except echolocation to navigate, orientate and hunt (Altringham 2011). Species such as the gleaning bats (e.g. genus *Plecotus*) and the sibling mouse-eared bats *Myotis myotis* and *M. blythii* rely largely on prey-generated sounds to forage (Anderson and Racey 1991, Arlettaz *et al.* 2001). This is aided by their large external ears (Fig. 2.1b). A number of bats such as *Plecotus auritus* may also use vision when hunting. Sight may even be more important than echolocation in navigation over long journeys, since many insectivorous bats have good low light eyesight and echolocation works only over short ranges. Very recently, evidence has been found for a magnetic navigational sense in bats (Holland *et al.* 2006).

2.2 Torpor and hibernation

Bats fly out of their roosts at night to forage and spend most of the daylight hours in their roosts in torpor and/or in various social activities including grooming, care of young and mating. **Torpor** is an energy-saving strategy used by bats on a daily basis or for longer periods in the winter when they may stay mostly inactive (see section 2.3). It is an important and integral component of the life history strategy of bats in temperate regions including Europe, where it is used by members of the families Vespertilionidae, Rhinolophidae and Miniopteriidae. When in torpor, animals reduce their body temperature and slow down their metabolism.

Hibernation is an extended form of torpor, which may last for many days, weeks or months and occurs on a seasonal basis, in winter, in response to a prolonged fall in ambient temperature or reduction in food supply. Bats do not usually spend their entire time in continuous hibernation and they may arouse to feed or drink when the weather conditions

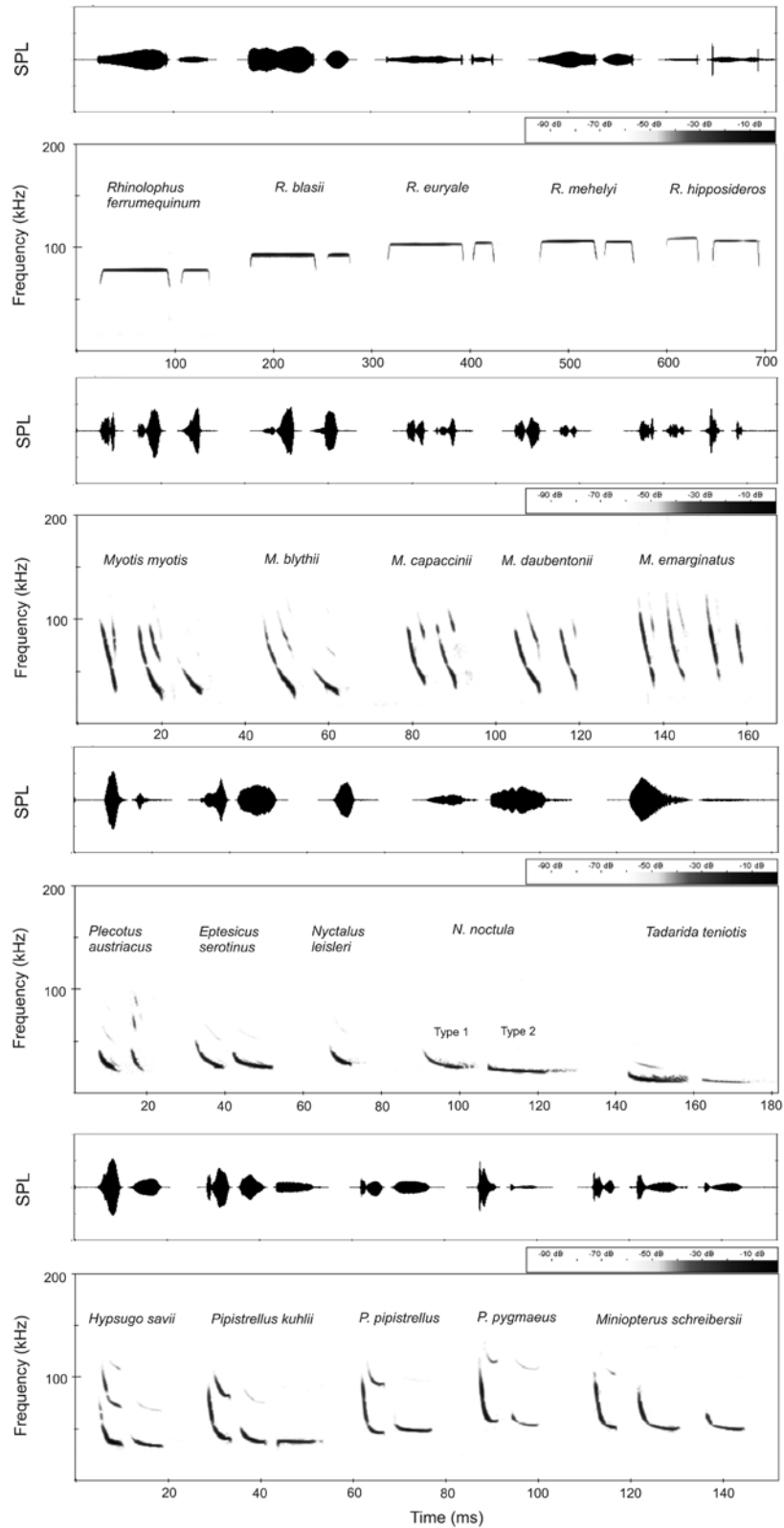


Fig. 2.2 Oscillograms (SPL = relative Sound Pressure Level) and sonograms (time versus frequency plots) of one to four echolocation calls per species from 20 species recorded in Dadia National Park, Greece (from Papadatou *et al.* 2008a). Gaps between calls are not true inter-pulse intervals.

are favourable for insects; in a maritime climate they may be active in a mild winter (Altringham 2011). Bats usually require hibernation sites with a limited range of temperature and humidity but with a temperature low enough to allow them to drop their body temperature at ambient levels (usually < 6-10°C, depending on the species).

2.3 Life cycle

Bats have an unusual life cycle compared to other terrestrial mammals of similarly small size. They have a relatively long life-span (at least 30 years for some bats) with multiple reproductive events and low reproductive rates with long gestation periods (Barclay and Harder 2003). Most European bats typically produce one pup per litter, once a year, but they do not give birth every year. Only in the Vespertilionidae are multiple births at all common: some species such as *Nyctalus noctula* and *Hypsugo savii* may produce twins (Dietz *et al.* 2009). Figure 2.3 shows the typical annual cycle of a European temperate bat. In the Mediterranean part of Europe however, the annual cycle may slightly differ. The year of a typical temperate bat comprises three main phases: a) wintering, b) parturition and lactation, and c) mating (Fig. 2.3).

Most temperate bats hibernate in winter usually in mixed-sex colonies. At the end of hibernation, nursery colonies (pregnant females, future mothers) form between April and May, and females give birth to young at the end of spring or early summer that are weaned by late summer. Females are usually highly philopatric, returning to their natal roost or roost area of birth every year to breed. Males usually roost separately during summer in most European bats and disperse away from their natal roost. They produce sperm from early to late summer, and when nursery colonies (mothers and young) disperse around August, mating begins. Males store sperm for several months after spermatogenesis, so that they are capable of mating from late summer through to autumn and possibly winter (Figure 2.3) or even spring (Crichton 2000). Females store sperm until ovulation, which takes place on arousal from hibernation in the spring when they become pregnant (Crichton 2000) with the exception of *Miniopterus schreibersii* (de-

layed implantation). Late summer and autumn mating involves swarming behaviour at underground sites for several bat species mainly of the genera *Myotis* and *Plecotus*: large, transient, male-biased populations arrive at swarming sites often from considerable distances during the night and their behaviour is characterised by intense chasing and emission of social calls (Altringham 2011).

Bats face increased energy demands during specific stages of their life cycle. Prior to hibernation, i.e. over late summer and in the autumn months, they deposit fat reserves for consumption during hibernation. Fat depletion and starvation at the end of hibernation may be the most important cause of mortality. Mating may be energetically demanding for males that seek to mate with as many females as possible and may limit their ability to lay down fat (Senior *et al.* 2005). In the female life cycle, pregnancy and lactation are the most energetically expensive stages (Racey and Entwistle 2000). Energetically demanding life stages are generally the most important for the survival of adult bats. However, mortality is highest in young individuals that are less experienced compared to adults and may not deposit enough fat reserves to survive the winter. The selection of optimal roosting and foraging habitats throughout their cycle is therefore crucial to their survival and welfare.

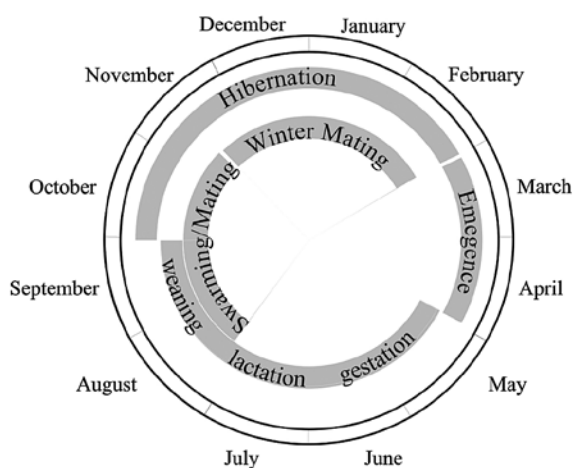


Fig. 2.3 The typical annual life cycle of European insectivorous bats (from Altringham 2003). The figure is only an approximation, because the cycle depends on species, weather, geographical location and the physiological status of bats.

2.4 Habitat use: roosts and food

Microbats use a variety of habitats for roosting and foraging, but arguably, forests are key habitats for both. Aquatic habitats (e.g. rivers, streams, lakes and canals) are important feeding areas as they are typically rich in insect prey. Some species have adapted well to urban environments and bats can feed and roost within urban areas too (Hutson *et al.* 2001).

2.4.1 Roosts

Bats spend over half of their lives in their roosts. A roost is a physical structure or location but sometimes it refers to the group of roosting bats themselves (Altringham 2011). A group of roosting bats behaviourally and/or genetically related to each other that share one or more roosting sites over a long period are defined as a colony. Colonies vary in space and time (seasonally) in terms of sex and age ratios, size and composition depending on the stage of their life cycle, and they can be anything between small, cohesive groups and large, fluid assemblages.

Roosts generally provide bats with shelter from adverse weather conditions and predation, and an appropriate microclimate for their physiological and energetic requirements, and facilitate social interactions and information transfer (Altringham 2011, Kunz 1982, Kunz and Lumsden 2003). Bats generally use roost sites for hibernation, rearing young, mating and as transitional sites during migration (section 2.5). They may also use roosts during the night, for consumption and digestion of food, as feeding perches and as resting places between foraging bouts.

The physical structure and the microclimate in the roost are significant factors in roost selection. Some species are morphologically adapted to roost in crevices, while others are better suited to hang in more open spaces. Bats also select roosts that reduce their energy expenditure for thermoregulation: in summer, they roost in warm sites, while in winter they prefer sites with cool, relatively stable temperatures and humidity.

A wide variety of both natural and artificial structures are used as roost sites (Altringham 2011, Kunz 1982, Kunz and Lumsden 2003). Artificial sites most

often substitute for natural roosts, especially in areas where natural sites have decreased because of expanding human activities (see section 3.2). Natural roost structures include underground sites (caves), rock crevices, tree cavities and places under exfoliating bark of tree trunks and branches. Bats may use tree cavities created naturally or through the activities of other animals such as woodpeckers or through the traditional pruning (pollard trees in W Europe). Gales, storms, lightning, rains and strong frost make different kinds of holes or injuries on the trunk or the main branches and these may be used by the bats. Mature trees, including standing dead trees or “snags”, typically have more available cavities and are of greater importance for bats (Hutson *et al.* 2001). Bats may use a wide variety of artificial structures through the year (as summer roosts, autumn shelter, and/or hibernacula) including buildings (e.g. abandoned or used houses, churches, barns, stone walls, historical castles, etc.), underground sites (e.g. tunnels, mines, cellars, quarries, bunkers etc.) and bridges. Within buildings they may use crevices in walls, attic spaces, chimneys, or spaces under roofing materials such as tiles, reeds or thatch. Underground sites, some rock crevices and buildings provide permanent roost locations, but they are often less abundant and patchily distributed. Bats are therefore typically faithful to these roost sites, whereas tree-roosting bats are faithful rather to particular roost-tree areas. Some bats use only one roost type (e.g. *Myotis capaccinii* is a strict cave-dweller using both natural and artificial underground sites), while others may vary their roost type seasonally (e.g. *Plecotus auritus* roosting in trees/attic spaces in summer and in trees/underground sites in winter).

Many species change roost site frequently within seasons and although roost switching is most commonly seen in tree-roosting bats, e.g. in *Myotis bechsteinii* (Kerth *et al.* 2006) and *Nyctalus lasiopterus* (Popa-Lisseanu *et al.* 2008), it is probably not uncommon in cave-roosting bats that form larger roosting groups (e.g. *Myotis capaccinii*, Papadatou *et al.* 2008b, 2009). Roost switching may be related to changes in roost microclimate, avoidance of ectoparasites, abundance and permanency of roost type, the bats' life cycle stage, social organization, mating systems, the proximity of the roost to for-

aging habitat, predator pressure and disturbance. As bats move from roost to roost, roosting groups frequently fragment and reform many times within seasons moving around a set of shared roost sites (Altringham 2011). Also, members of a colony may use alternative day roosts in the vicinity of the main roost, known as “satellite” roosts.

Not all underground sites can provide bats with a suitable microclimate, physical dimensions and structure. The distribution and availability of suitable caves for roosting thus affects the distribution of cave-dwelling bats (Kunz 1982). In temperate and Mediterranean climates, many caves may be unsuitable as bat roosts, e.g. they may be too cold

for nursery colonies or too warm for hibernation. Bats in high latitudes use caves to hibernate but in warmer climates such as in the Mediterranean, bats may use caves all-year round. Caves and sometimes other underground sites usually host the largest aggregations of bats counting from a few hundred up to tens of thousands of animals.

2.4.2 Food

After leaving their roost at dusk, bats commute to their foraging areas where they may feed until dawn. Usually, commuting and foraging are separate behaviours, with most bats leaving their roost



Treni Cave, Albania

and flying rapidly and almost directly to their foraging sites (Altringham 2003), though they may occasionally feed while commuting. Bats frequently commute along linear features in the landscape, including hedgerows, woodland edges, tree lines, tracks and waterways such as streams. These are followed as a predator-avoidance strategy, as an aid to orientation and navigation, as protection from adverse weather and as sources of food (particularly over windy, rainy or cool nights). Linear landscape elements therefore provide vital links between roosting and feeding habitat (Hutson *et al.* 2001).

Feeding habitats include open space (e.g. at high altitudes, above tree canopy or in large forest clearings), spaces between vegetation (e.g. woodland edge and openings), within and around vegetation, and high above or just over water surfaces (Schnitzler and Kalko 1998). Insects may be caught in flight (aerial hawking), taken from foliage or the ground (gleaning) or from water surfaces (trawling). Food may be eaten on the wing or taken to a perch to be consumed. Feeding perches may be regularly used and rejected food remains such as moth wings discarded beneath the site often reveal the presence of bats (Hutson *et al.* 2001). Although bat species are adapted to particular foraging strategies associated with their diet, wing morphology and echolocation patterns, they may nevertheless be flexible in their foraging strategy depending on habitat type and availability of insect prey. Most species use a mosaic of habitats but some are restricted to specific habitat types, e.g. *Myotis capaccinii* that forages low over water surfaces (see PART III, section 12.1.5). The quality of feeding habitats near breeding colonies is important to their success and survival, since lactating females need to regularly return to the roost through the night to feed their young and young bats feed close to the roost during their first flights.

Insects are the dominant component of European bats' diet, but other arthropods such as spiders and crustacean are also eaten. Most insectivorous bats are small (the term insectivorous hereafter includes other arthropods) and catch their food on the wing. Their small size enables them to catch flying insects detected by their short-range echo-

location system (Barclay and Brigham 1991). Most European species are exclusively insectivorous with the exception of *Nyctalus lasiopterus*, a species that also feeds on nocturnal migrating birds (Popa-Lisseanu *et al.* 2007) and *Myotis capaccinii*, an insectivorous trawler that may occasionally take fish (Aihartza *et al.* 2003).

2.5 Seasonal movements and migration

Bats may switch roosts between a number of favoured roosts in their home range within seasons, but they may also move on a seasonal basis on a larger scale between warm summer roosts and cool hibernation sites. Migration in bats can be defined as these twice-annual, seasonal movements in response to changes in climate and food abundance. The driving force for migration is strong, because at a time when the bats' energy demands increase due to lower environmental temperatures, prey becomes scarce (Altringham 2011). In Europe, some bats hibernate locally, but many migrate at short or longer distances to find suitable hibernation sites. Fleming and Eby (2003) define three categories of bats according to the scale of their migratory movements. These are: (a) sedentary bats, (b) regional (short-distance), and (c) long-distance migrants. Sedentary species typically move less than 50 km between their summer and winter roosts (e.g. *Rhinolophus*, *Plecotus* and some *Myotis* species). Regional migrants are bats that travel over moderate distances, on average between 100 and 500 km (e.g. *Miniopterus schreibersii* and *Myotis capaccinii*). Long-distance migrants may travel over 1000 km (e.g. *Nyctalus noctula* and *Pipistrellus nathusii*). Long-range migration is most commonly seen in tree roosting bats, whereas regional migrants and sedentary species typically hibernate in underground sites such as caves, mines, or tunnels, at least at higher latitudes (Fleming and Eby 2003, Strelkov 1969). Migrants usually show a high degree of fidelity to both their summer and winter habitats and even to specific roosts.

Long-range migrants in the genera *Nyctalus*, *Pipistrellus* and *Vespertilio* may migrate seasonally

over 1000 km in a generally north-south direction (Fleming and Eby 2003). These bats may hibernate in tree cavities. Tree cavities however may be too cold for hibernation in the longer and more extreme winters at high latitudes and hence the bats look for areas with relatively milder winters. Other bats, such as members of the genus *Myotis*, usually migrate over shorter distances, probably because “local” caves offer suitable hibernation conditions: caves are better buffered than tree-cavities against environmental extremes. The movements of short-range migrants are not necessarily north-south, but may be in random directions, probably depending on the local availability of suitable caves for hibernation (Strelkov 1969, Altringham 2011). Migratory distance may also depend on the availability of suitable hibernation sites and is probably something of a continuum, with considerable variation even within species (Altringham 2011). Not all bats in a particular population migrate, and they often disperse to different locations. Migrating bats will often stopover to refuel and rest using transitional roosts.

2.6 Predators: bats as prey

There are relatively few observations of animals that feed on bats. Their main predators include birds of prey such as owls (e.g. Tawny Owls, *Strix aluco* and Barn Owls, *Tyto alba*), hawks and falcons (e.g. Peregrine Falcon, *Falco peregrinus*), but other birds such as Magpies, *Pica pica*, have also been observed feeding on bats. Snakes and a few mammals such as Stone Martens (*Martes foina*) may include bats in their diet. Remains of bats can be found in owl pellets. Predators of bats are not generally considered to have significant impacts on bat populations unless they are introduced (see section 3.2.5). However, in the U.K. and in Brittany, France, Barn Owls have been reported to have a strong impact on some of the nursery colonies of *Rhinolophus ferrumequinum* roosting in the attics of churches and castles: several of the main colonies (up to 600 bats) have disappeared because of barn owl predation. To protect bats at these sites, bat conservationists place special grilles (45° angle, round large section bars).

3. Threats and conservation considerations

3.1 Why conserve bats?

Bats are part of the global ecosystem, along with all other organisms, with a significant part to play in its continuing evolution (Altringham 2011). Their role in ecosystems functioning is crucial (e.g. control of insect populations), considering their diversity and widespread distribution. Bats can further be effective indicators of the health of biodiversity and the natural environment, because of their widespread distribution, high ecological diversity and because they can be sensitive to environmental change through changes in their prey. However, in common with all threatened animals and plants, bats face numerous pressures resulting by the continuously expanding human activities. A number of overlapping mechanisms of loss apply not just to bats, but to biodiversity in general (Altringham 2011). Bats are therefore subject to the same threats and conservation concerns as other animals, but they also face some unique conservation problems. In recent decades, several European bat species have experienced dramatic population declines leading to the contraction of their ranges.

3.2 Threats

3.2.1 Habitat degradation, fragmentation and loss

Arguably, the primary cause of threat to bats and biodiversity in general is the reduction in size and quality degradation of their vital habitat for shelter, food and reproduction because of human activities expanding at an alarming pace. Forests are the most important source of roosts and food for many (if not most) bat species, and one of the most threatened habitats. Most European forests are managed/exploited, often containing many young immature trees densely structured with only a few, if any, old trees, whereas natural pristine forests are rare. Some harvesting techniques can be particularly damaging to the forest structure. This leads to the loss of both roosting

and foraging habitat. In Western Europe, natural tree cavities have been reduced by extensive deforestation and misguided forest management practices (Kunz and Lumsden 2003). This has led many bat species into manmade structures such as attic spaces in buildings, whereas bat boxes are a common practice to attract forest bats otherwise unable to find suitable sites for roosting, for example in Germany and the UK. Extensive forest clearance, road construction (see section 3.2.4) and other activities often result in forest fragmentation. However, small forest fragments support small bat population sizes and fewer species. If, further, forest fragments are isolated (e.g. surrounded by urbanised or intensive single-crop agricultural areas), their connection with other source populations may be limited (no population exchange possible) and hence these small populations risk to die out. In general, the smaller and the more isolated are forest fragments, the smaller and less viable are bat populations and the lower the species diversity they can support. In particular, bats adapted to cluttered environments such as *Plecotus* species and *Myotis bechsteinii* are rather confined in forested areas and largely excluded from urban and intensely cultivated agricultural environments (e.g. Safi and Kerth 2004). Forest cover is therefore critical to these and other bat species and forest should be mature and structurally diverse. Forest management practices should clearly account for bat requirements.

Many other bats depend on rich and structurally diverse agricultural landscapes for foraging. The extensive use of pesticides, herbicides and fertilisers, as well as the pollution from industrial animal farms, the removal of hedges and the homogenisation of the landscape through intensification of agriculture damage habitat diversity and quality and clearly affect bats among other animals. Bats use tree lines and hedges to commute and often forage (see section 2.4.2), hence the removal of these features from the landscape may have detrimental effects on their use of habitat. Chemical pollution by herbicides and pesticides is specifically dealt with in section 3.2.3.

3.2.2 Disturbance and destruction of roosts

Underground sites. Cave roosts may be under threat from tourist exploitation turning them into show caves, frequent uncontrolled random visits of the public or from being used as dumps in areas where they are not strictly protected. Caves opened up for tourism have their entrances or even interiors modified, sometimes destructively. Walkways, railing and lighting often installed and the exposure to a constant stream of people constitute major disturbance if bats are present (Altringham 2011). Several very important hibernacula have already been lost or damaged and others are under threat from tourism. For example, none of the biologically rich caves of Turkey which are used as hibernacula and summer roosts have adequate protection and some are under serious threat (Furman and Ozgul 2002, 2004), with two of them having tourist walkways directly under hibernation and nursery sites. Frequent visits by anyone making noise and using lights without respecting bat roosts also constitute disturbance that may even lead to roost abandonment. Abandoned mines used by bats may collapse as old timber props decay, or be sealed for safety reasons or be re-used (Altringham 2011). Recently, in France, the state mining authorities destroyed many of the abandoned mines and quarries by sealing or bombing the entrances despite their known use as bat roosts, using as an official reason the liability. The French state did not accept alternative ways proposed by wildlife conservation groups at the time such as special grilles, strong safety fences, etc. Finally, through the different EC conservation directives, the use of alternative security grilles against disturbance by humans was promoted, favouring bat conservation, although it is still difficult to implement this measure in practice.

In the south of Europe, bats use underground sites year round (see section 2.4.1). Bats are particularly vulnerable during both hibernation and breeding, first because they often form very large aggregations over these periods. This means that large numbers of bats can be exposed to potential sources of disturbance or the risk of destruction. Second, during hibernation in particular, bats are in deep torpor and therefore helpless until fully aroused, and they have little or no opportunity to replenish fat reserves if disturbed (Altringham 2011). Some

population declines because of disturbance at hibernacula have been well documented (e.g. Wegiel and Wegiel 1998). In France, cave explorers have dramatically disturbed underground roosts in the past. In the 1950s, some of the main large bat colonies declined or even disappeared because of intensive uncontrolled ringing in the winter. Third, large nursery colonies especially in underground sites are vulnerable: if seriously disturbed or if their roost is damaged, they risk dropping their young or even abandoning the site. However, failure to reproduce will have severe consequences to their populations because of their low reproductive rates.

Buildings. Many bats may form colonies in buildings. Older buildings may be more frequently used, probably because of the traditional architecture and building materials which provide a greater number of potential roosting places (cracks on walls, attic spaces, spaces underneath the tiles, etc.). Currently, the changes in the way of life, the building materials and technology including for example the use of concrete walls and floors, the use of insecticides and fungicides to preserve timber, the absence of attic spaces, etc., make modern buildings much less suitable as bat roosts. Bats in houses may cause problems such as smell, noise, and accumulation of guano and cause concerns to homeowners. However, homeowners may want to get rid of bats as a result of their misconception (see section 3.2.6). If bats do need to be excluded from properties, there are various non-destructive methods that can be used but many owners prefer to kill bats. Abandoned houses used for roosting may collapse, or be demolished. Houses may be renovated without considering their bat-inhabitants, often trapping them in the interior or poisoning them through the use of chemical substances.

Bridges. The restoration of old stone bridges may inadvertently affect bats through blocking off crevices and other openings that serve as bat roosts.

3.2.3 Chemical and light pollution

Chemical pollution. There are forms of chemical pollution that can affect bats directly, while others contribute to habitat degradation and can affect them indirectly. Pesticides and herbicides are chemical pollutants that may directly poison bats by poison-

ing their prey or indirectly by killing and hence reducing invertebrate prey. In conventional farming, the quantities of chemicals applied may still be excessive and many chemicals persist in the environment. Indirectly, pesticides may reduce insect abundance and diversity, and herbicides the abundance and diversity of plants that insects rely on. Organic farms have been found to have higher insect species richness and abundance, as well as higher bat activity and bat species richness compared to conventional farms (Wickramasinghe *et al.* 2003, 2004). For example, in organic farms where moth diversity and abundance was higher, more bats feeding on moths such as *Rhinolophus ferrumequinum* and *R. hipposideros* were present. Overall, insects important in the diet of bats were more abundant on organic farms. Chemical pollutants may kill or weaken bats, or impair reproduction, as they accumulate in their bodies. Unless the use of pesticides and herbicides is very carefully targeted and strictly controlled and reduced there is an inevitable loss of biodiversity including bats. Anti-parasite treatment of livestock may make animals' faeces toxic to dung-feeding insects to the detriment of bat species foraging upon them. In particular the avermectin-based wormers remain active in the dung, preventing colonisation by dung-beetles (English Nature 2003).

Light pollution. Villages, towns, cities, transport systems, industrial areas and other human constructions are illuminated at night. Artificial light may have significant effects on bats among other animals, especially in highly urbanised areas. Light avoidance may exclude bats from roosting and foraging habitats and may prevent them from travelling freely about their home range (Altringham 2011). For example, it has been shown that street lights lead to a major reduction in the activity of *Rhinolophus hipposideros* (Stone *et al.* 2009), which avoid light and are thus probably led to longer commuting journeys wasting time and energy and may lose suitable foraging habitat. A large colony of bats did not use the main entrance to emerge at a cave in NE Greece when the entrance was artificially lit; however, they did use it over a period when the lights had been damaged (Papadatou, unpublished data). Floodlighting on church roofs may have disastrous impacts on the bat colonies (Grémillet/GMB, unpublished data). Artificial light is likely to increase

the risk of predation and to interfere with the navigation system of migrating bats, since vision is used in navigation (Altringham 2011). Some bat species feed on insects attracted by artificial light but these are not many. Insects attracted by artificial lights may also benefit a few species at a cost to other bats, because insect abundance away from lights may be reduced. It has been suggested that increased competition for food due to the population expansion of *Pipistrellus pipistrellus* which forage upon insects attracted by street lights may have contributed to the decline of *R. hipposideros* in Western Europe (Arletaz *et al.* 2000).

3.2.4 Infrastructure: wind turbines and roads

Wind turbines. Wind turbines, a technology with real potential for sustainable, environmentally-friendly energy generation, have become highly controversial because increasing evidence shows that they kill high numbers of birds and bats. Bats are killed through direct collision with wind turbines or barotrauma (rapid expansion of the air in the lungs that leads to internal injuries and eventual death caused by air pressure changes around the rotating blades). Barotrauma is a significant cause of death because of the bats' highly sensitive respiratory system (Baerwald *et al.* 2008). Blades may rotate even at low wind speeds (< 5 m/s), but it has now been widely documented that it is at those wind speeds that bats are most likely to be killed (e.g. Rodrigues *et al.* 2008). Extensive literature from around Europe mostly in the form of unpublished reports increasingly shows that hundreds or even thousands of bats are killed every year at wind turbines. Not all turbines are equally responsible for the death of bats (e.g. Georgiakakis and Papadatou 2011), but the likely causes are currently under investigation.

Roads. Longer, wider, faster and more complex road systems are currently being built around the world, despite the acknowledged conservation concerns and the need to make better use of public transport and reduce fossil fuel use (Altringham 2011). In Germany, only 2% is made up of landscape fragments greater than 100 km² (Jaeger *et al.* 2007). Roads can affect bats in different ways: they may act as barriers between their roosts and foraging sites,

between different foraging sites or between summer and mating roosts, and hibernacula, preventing bats from accessing parts of their vital habitat or forcing them to make longer journeys needing more time and energy; they may directly kill animals through collision with moving vehicles; and they may lead to degradation and loss of vital bat habitat. Many bats are vulnerable to collision because they fly at low speeds (< 20 km/h) and close to the ground (0-4 m), in particular when they cross open spaces including roads. Annual mortality due to collision with passing vehicles has been estimated to 5% of bats at a local roost in the UK (Altringham 2011). Road construction further reduces natural habitat (e.g. removal of trees, water bodies etc.).

3.2.5 Introduced predators: cats

Cats are among the most numerous introduced predators in many parts of the world including Europe and are widely acknowledged as a serious conservation concern. For instance, 10.3 million pet cats and about two million feral cats were estimated in the UK in 2007 (Altringham 2011). Many island populations of animals outside Europe have been extinct because of introduced predators including cats. There is good evidence that this predation extends to bats (e.g. Woods *et al.* 2003) and that the effects can be significant. Cats may kill thousands of bats every year (Altringham 2003).

3.2.6 Persecution and the negative image of bats

Bats may be killed by humans because they are perceived as pests, as a threat or even because of ignorance and prejudice. For example, bats are associated with the devil in Roman Catholicism (Fig. 3.1); books, comic strips and the film industry have associated bats with blood and the Dracula. Humans often think that bats are vermin, carriers of disease or that they destroy buildings. Bats may indeed transmit a small number of diseases, most seriously rabies, but in reality their impact on humans is very small and does not justify their persecution. Rabies is no more prevalent in bats than in other animal-eating mammals and humans are far more likely to catch rabies from domestic or wild carnivores



Fig. 3.1 Bats are associated with the devil in the Roman Catholicism ("Tableau de Mission", Archives of Boshop Palace, Quimper, France).



Fig. 3.2 In Europe, WNS has not yet been proven to kill bats.

(Altringham 2011). Increasing human populations, ignorance and the ease with which wild animals can now be killed have put enormous pressure on bats. Bats form large aggregations and by using buildings as roosts, they come into close proximity to humans. They are therefore particularly vulnerable to human misconception. Although they do not cause any significant problems and their droppings do not constitute a major health hazard, their roosts are often excluded by buildings or bats can even be killed.

3.2.7 White Nose Syndrome

White Nose Syndrome (WNS) is an emerging disease with real conservation concern in the United States, but not yet well understood. WNS was first revealed in a show cave in New York State in the north-eastern US in 2006 (Turner and Reeder 2009) and it is suspected that it got there through a human carrier from Europe. It is caused by a fungus, *Geomyces destructans*, forming a conspicuous growth on the face, ears and wings of six cave-hibernating bat species (genera *Eptesicus*, *Myotis* and *Perimyotis*) and is typically found in individuals with minimal fat reserves. WNS has killed over one million bats in the US since 2006 and has now been discovered in five species of cave-hibernating *Myotis* species in four European countries (France, Germany, Switzerland and Hungary, Puechmaille *et al.* 2010). However, in Europe the infection does not appear to cause death to bats that may be resistant to it (Fig. 3.2).

3.2.8 Climate change

Climate change is expected to affect bat populations. Other flying animals, such as birds and butterflies, are already changing their distributions in response to climate change. There is still not much evidence on the effects of climate change on bats and even good past and present distribution data are lacking. As temperatures rise, bats may expand their ranges to higher latitudes and altitudes, and may be forced out of their habitats at lower latitudes and altitudes. Consequences of climate change will most possibly be more complex than this, since changes in temperature will probably be accompanied by changes in rainfall and in extreme

weather events (Altringham 2011). Further, species may not have the same ability to move and adapt to climate change. Potential new habitats may be fragmented and key resources such as hibernacula may not become available. Rebelo *et al.* (2010) modelled future distributions of 28 European bat species based on current distributions and climatic data and found that any climate change model resulted in a decline in species richness.

4. Legal protection and conservation

European bats are protected by a number of national and international laws, conventions and agreements. International legislation includes:

- **The Convention on the Conservation of European Wildlife and Natural Habitats** (Bern, 1982).

- **The Convention on the Conservation of Migratory Species of Wild Animals** (Bonn, 1983). Under the Bonn Convention, the Agreement on the Conservation of Populations of European Bats, known as **EUROBATS**, came into force in 1994. To date, 33 countries have signed the agreement. The EUROBATS secretariat has been set up to help European governments fulfil their obligations under the agreement, promoting information exchange, co-ordinating research and monitoring initiatives, and stimulating public awareness. Through these actions, a series of publications have been produced dealing with various aspects of bat conservation, e.g. guidelines for surveillance and monitoring of bats, for management and protection of underground and overground roosts, and for considering bats in wind farm projects.

- **EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora** (1992, known as the **Habitats Directive**). Many bat species are included in Annex II (Animal and plant species of community interest whose conservation requires the designation of special areas of conservation) and all in Annex IV (Animal and plant species of community interest in need of strict protection) of the Habitats Directive. Hence, Natura 2000

sites may be defined on the basis of important bat populations present in any area.

The Species Survival Commission of IUCN (World Conservation Union) has a Chiroptera Specialist Group, a network of bat authorities. The group deals with bat conservation issues and prepares broad policies and strategies for bat conservation. Within this framework, the Chiroptera Specialist Group produced an action plan for all microbat species of the world including Europe's bats (Hutson *et al.* 2001). This action plan examined particular conservation issues and recommended actions for species and habitats, aiming at key decision makers at the governmental level and at those promoting bat conservation at international, regional and national levels (Mickleburgh *et al.* 2002). Species-specific action plans have also been produced for a number of bat species in Europe, e.g. the pond bat, *Myotis dacycneme* (Limpens *et al.* 2000) or the greater horseshoe bat, *Rhinolophus ferrumequinum* (Ransome and Hutson 2000). Finally, species specific action plans have been produced on a local scale, often within the framework of European funded projects, focusing on particular bat species; e.g. a guide recommending specific conservation and habitat management actions was published in 2008 on three rare cave-dwelling bats in the south of France (*Rhinolophus euryale*, *Myotis capaccinii* and *Miniopterus schreibersii*) following an extensive 3-year study within the framework of a LIFE-Nature project (Némoz and Brisorgueil 2008).

The legal protection and conservation status of bats have led many countries to include them in the designation of protected areas (e.g. national parks, nature reserves etc.). In many countries, impacts on bat populations are considered in environmental impact assessments (EIAs). However, post-construction monitoring for the evaluation of the proposed mitigation measures is often lacking.

In many countries, organisations and volunteer groups have been set up specifically to promote bat conservation and they are usually a mixture of amateur and professionals. Their activities include practical conservation, survey and monitoring, research, education that promotes a more informed and publicly acceptable image for bats,

professional guidance to encourage good practice, policy, lobbying and consultations. They may produce reports in specific projects, conservation plans, newsletters, handbooks, brochures, project reports, guides to survey techniques, manuals for bat house construction and installation, and even educational and professional guides to bats. They may also run public and professional courses, and training seminars and workshops.

4.1 Examples of bat conservation in practice

Examples come from W and N Europe. Non governmental conservation organisations (e.g. the Bat Conservation Trust or the Vincent Wildlife Trust in the U.K.) and volunteer groups (e.g. the Groupe Mammalogique Breton in Brittany, France) lead many small or large-scale projects for the protection and the conservation of bats and their habitats. These projects may be financed by private, governmental or local authority funds, sponsorships or European funds. Project design and implementation strategies vary depending on the local conditions.

4.2.1. SOS bat helplines

Bat groups and NGOs often run bat telephone helplines. For example, the Groupe Mammalogique Breton (GMB) in France and the Bat Conservation Trust (BCT) in the U.K. run bat helplines where a network of local bat workers answer to the general public or professionals that may need advice, information, help or intervention. People most frequently call in the warm summer months when bats are mostly active. Often, a gentle talk may be enough to soothe people concerned by the presence of bats in their house, but in other cases, bat workers visit the place to find a solution on site.

4.2.2. Bat refuges

Bat groups and NGOs may propose to private or public owners a “bat refuge” project through a free agreement to manage lands and buildings in favour of bats using their property, estate or town. First, bat groups inform owners on bat biology and behaviour. Sec-

ond they survey the site and write an expert’s report. They also assess possible damages by bats. Third they propose technical solutions to stop or prevent these damages and the best solutions to preserve or restore the bat colonies without inconvenience to the owners. Public owners (e.g. schools, city councils, museums, historical castles, churches, etc.) may implement officially more ambitious projects, such as the ecological management of the properties concerned (buildings, gardens, etc.), school education programs, events about bats in summer, and even a bat museum with infrared (IR) cameras showing bats in their roost to the public (see section 5.1).

4.2.3. Restoration of artificial roosts

Bat groups and NGOs may purchase ruins or abandoned sites or ask other partners such as the city council to purchase them in order to create new alternative bat roosts. Sites may be suitable as hibernacula, summer roosts, autumn shelters or simple night roosts, whereas some may be used throughout the year. Enhancement works are site-specific, but the general rule is that the bat workers should be able to understand the behaviour and requirements of the bats (see Box 17.5 in PART IV, section 17).

Creating artificial bat roosts depends on the local availability: traditional rural buildings, disused bunkers, tunnels or mines, bridges, drainage pipes, abandoned shepherd shelters, private castles, cellars or attics may be used to create new alternative roosts. Often, bat roosts are created in ruined or disused buildings, but currently bat refuges may even be created in used or new buildings in countries such as the U.K., France, Belgium and Germany without inconvenience or disturbance to the people. A number of publications provide useful guidelines and relevant case studies (e.g. EUROBATs Publications No. 4 and The Bat Workers’ Manual, section 20, or the Bat Refuge guide of GMB, <http://www.refugespourleschauves-souris.com/>).

4.2.4 Bats and rabies

Recently in France, bat workers have been incorporated in the official bat rabies network of the Health Department of the state. Bat workers should get an official agreement and they need a valid annual



Roti Cave, Greece

license card and control of their rabies serology. Appropriate solutions are sought when a colony is found infected with rabies to avoid the destruction of the colony.

5. Education

Education programmes lie in the heart of effective bat conservation. Education can dispel the negative human perception of bats, stress the bats' key roles in natural ecosystems and address conservation concerns. Where educational programmes have been applied, views of bats have often changed dramatically (Mickleburgh *et al.* 2002). Targeted audiences need to include all people whose activities may im-

pact bats both in the natural and urban environments: the general public, investors, professionals such as foresters, miners, archaeologists, architects, farmers, the building industry, carpenters and roofers, cave explorers, policy and decision makers, the local and national governments, even other conservationists, and of course children and their teachers. Each audience should be approached in different and appropriate ways. Education can thus help overcome prejudice, ignorance and conflicts of interest.

In many European countries, bat NGOs and groups design and implement bat training and education programs for the general public, schools, professionals, and authorities, often with input from bat scientists. Some examples are given in the following sections.

5.1 The general public

It is possible to show bats to the public without disturbing them and at low cost. For example, during events such as the European Bat Nights organised by bat workers for the local inhabitants, bats may be watched while they emerge from their roosts in churches, historical castles, private properties hosting “bat refuges” and caves. Bats may simultaneously be heard on bat detectors. The public and especially the children become very enthusiastic during night walks where they discover the foraging flight paths of bats through the bat detectors.

Information centres help dispel the myths about bats not only through relevant exhibitions but also through activities. Activities may include bat watching in the dusk, observing bats in their roosts through IR cameras (everyday behaviour in the colonies, birth of young, etc.). Some examples are the abbey St Maurice and the “Maison de la Chauves-souris” in Brittany, France (see section 20). Information centres may include shops with bat related objects (e.g. toys, games, puppets, videos, books, clothes, etc.).

Mass media such as the radio, television, newspapers and more recently the internet are very efficient ways to inform the public and promote bat conservation, e.g. through regular columns in the local newspapers or spots on the local radio or TV stations. Sometimes, however, it is difficult to find journalists able to understand the difference between bats and the Dracula!

5.2 School programs

There are many possibilities at low cost but they depend on the national and local legislation which may be different among countries. In the school and during day time, bat workers may use videos, drawings, puppet or theatre shows, and other forms of teaching with or without the participation of the teachers. Activities depend on the available budget, age of children, time, and official teaching programs. Currently many ideas are available on the internet. Because bats are nocturnal animals, outdoor activities for schools may be difficult to implement. Nevertheless, children are very attracted by listening to bats through bat detectors.

Therefore, outdoor activities for children may be organised outside school programs (e.g. nature clubs for children).

5.3 Professionals and local authorities

5.3.1 Forestry

Forest management practices should account for bats roosting and foraging in forests. It is therefore important to inform public and private owners, forest managers, workers and engineers on bat biology, behaviour and ecological requirements, tree roosts, legal protection and conservation, and to provide them with appropriate guidelines. Information and guidelines may be diffused through various forms of material such as leaflets (e.g. Bats and Forestry), forest biodiversity booklets (e.g. the French Forestry Commission, Biodiversité n°3- 2010, ONF, www.onf.fr), and bat and forestry training courses for lumberjacks and forest engineers (e.g. ONF, www.onf.fr; GMB, www.gmb.asso.fr).

5.2.2 Roads and bridges

Many bat species roost in crevices of old stone bridges and some even in the joints of modern bridges. The maintenance or strengthening works of bridges may therefore destroy these bat roosts. New roads may act as barriers between roosts and foraging sites cutting tree lines, hedges or other bat corridors (see section 3.2.4). Therefore, partners involved in the maintenance of bridges, and the road construction and management should be informed and provided with appropriate guidelines. For this purpose, a number of reports and other material have been published including leaflets, e.g. “Bats and Bridges” (GMB, www.gmb.asso.fr) (for other material see examples in section 20).

5.2.3 The building industry

Treatments for the preservation of timber (organochlorine insecticides, fungicides, etc.) have a strong impact on bat roosts in buildings. Although

the building industry should be informed and provided with appropriate guidelines, this is not easy because many people are involved, there is not an adequate amount of time to talk on site, and many builders are not interested in bat conservation. Information diffusion specifically on this issue is still not very widespread – even in W and N Europe where there is a relatively long tradition in bat conservation – and there is a lack of technical leaflets, booklets, and training. Some good examples come from the Joint Nature Conservation Committee (<http://www.jncc.gov.uk>) and the Bat Conservation Trust (<http://www.bats.org.uk>) in the U.K., and the GMB (<http://www.gmb.asso.fr>) in France who provide information for the construction industry on bat conservation issues in building construction and maintenance. Conservation actions may include alternative and safe remedial timber treatments, timber quality, and the conservation of bat roosts in buildings, avoiding damage, smell, or noise by the bats. A very useful textbook with specific guidelines and practical advice for surveying, enhancing or constructing *Rhinolophus hipposideros* roosts was recently published (Schofield 2010).

5.2.4 Pest control in buildings

Often there are large wasp or hornet colonies in attics that may also be used by bat colonies. Pest control companies are usually not aware of bats and often use very toxic pesticides. Bat workers inform pest control companies and other people involved.

5.2.5 Farming

In some European countries, organic farming is promoted through farming courses. Some very motivated teachers may include information on bats. Examples of bat and other biodiversity-friendly farming practices include:

- The use of alternative less toxic wormers in livestock (e.g. moxidectin is less toxic than avermectin to non-target insects such as Diptera and Coleoptera).
- The use of bat and bird boxes in orchards that may help increase bat populations, therefore controlling insect pests through an alternative more natural way. This practice has been successfully used in organic arboriculture (e.g. Apple tree farm, P. Mercier, Aude, France. <http://www.agrienviroment.org/ae/fiches/04.htm>).

5.2.6 Local authorities

It is important to regularly meet with and inform policy and decision makers, the local and regional politicians, and the main planning departments and management authorities to promote alternative solutions in favour of bats and prevent potential detrimental effects on bat colonies. Annual meetings are an opportunity to inform these partners on bat-friendly practices, works and plans. In Brittany, France, each year the GMB invite the local, regional and state administrations and politicians for a one-day outdoor trip to show the new achievements and bat projects in progress. In this way, the authorities discover an unknown world! These bat trips are an opportunity to plan with them the future projects and policy for bat conservation.

Part II

Background:
Bats in Greece



T. CHEVREZY

Savi's Pipistrelle, *Hypsugo savii*

6. Species diversity, distribution and population status

Greece is located at the southernmost tip of the Balkan Peninsula, being on the crossroads of three continents: Europe to the North, Asia to the east and Africa to the south. European, Anatolian and Mediterranean African species may therefore have the southern, western and northern limit of their distributions in Greece, e.g. *Myotis brandtii* (von Helversen, Papadatou-SPP and Georgiakakis, unpublished data), *Eptesicus anatolicus* (Dietz *et al.* 2009, *E. bottae* in von Helversen 1998) and *Pipistrellus hanaki* (Benda *et al.* 2008) respectively. The country hosts all four European bat families and 34 out of the approximately 40 bat species occurring in the European continent (Dietz *et al.* 2009), i.e. almost 85% of all European bats. In addition, 1 in 3 “land” mammals in Greece are bats. Even relatively small areas may host over half of the species encountered in the country: e.g. the National Park of Tzoumerka, at least 18 species (Papadatou & von Helversen 2007), the National Park of Dadia-Lefkimi-Soufli, 24 species (Papadatou 2010), and the National Park of Prespa, 26 species (Galand *et al.* 2010, this document).

Despite its high bat diversity, Greece remains among the parts of the world where even basic data on the species distributional ranges and population status are limited. Even the number of species keeps increasing, including newly discovered species on a global scale. In the last decade, the following bat species have been added in the list: *Myotis brandtii* (von Helversen, Papadatou-SPP and Georgiakakis, unpublished data), *Myotis alcathoe* (von Helversen *et al.* 2001), *Plecotus kolombatovici*, *P. macrobullaris* and *Pipistrellus hanaki*, the latter being found only on the island of Crete (Benda *et al.* 2008). In 2001, Hanák *et al.* published the most comprehensive compilation of distributional and taxonomical data on Greek bats available at the time. Until recently, such data were mostly collected by foreign researchers on an occasional basis. In the last decade, studies on a more systematic basis both by local and foreign researchers have allowed increasingly more comprehensive species inventories at several locations in the country, for example the island of Zakynthos (Davy *et al.*

2007), the National Park of Tzoumerka (Papadatou & von Helversen 2007), the island of Crete (Benda *et al.* 2008, Georgiakakis 2009), the National Park of Dadia-Lefkimi-Soufli (Papadatou 2010) and the National Park of Prespa (Grémillet and Dubos 2008, Grémillet *et al.* 2010, this document). Much information had been collected by Professor O. von Helversen (University of Erlangen, Germany, deceased in 2009) over the course of many years, but most of this information remains unpublished with few exceptions (e.g. von Helversen and Weid 1990). Available but sparse distributional data of all species were more recently revised in the latest version of the Greek Red Data Book of Threatened Animals (Legakis and Maragou 2009).

The population status of bat species in Greece is mostly unknown, though we do have some idea of the relative abundance across species. For example, *Barbastella barbastellus* and *Hypsugo savii* are among the rarest and most frequently encountered bats in the country respectively. Also, the population status of colonial animals aggregating in buildings or underground sites is easier to assess relatively to those that are widely dispersed and roost in less accessible sites such as trees. Therefore, we have some idea on the number of bats inhabiting underground sites or buildings at certain locations: e.g. less than 5000 *M. capaccinii* and up to several hundred *Rhinolophus euryale* inhabit caves and mines in and around the National Park of Dadia-Lefkimi-Soufli throughout the year (Papadatou *et al.* 2008b, 2009 and unpublished data), and several hundred of *Rhinolophus hipposideros* inhabit mostly abandoned or not frequently used buildings and some rock cavities and caves in the area of Mt Grammos (Papadatou, unpublished data) and the National Park of Prespa (Grémillet and Dubos 2008, Grémillet *et al.* 2010, this document).

7. Ecology

The ecology of most Greek bats, whether with a largely European or Mediterranean distribution, has generally been poorly documented. We know little on their annual cycle, roosting behaviour, feeding ecology, habitat use, migration and population biology. Until recently, most information on

the ecology and habitat use of temperate bat species came from western, northern and central Europe, but their ecology may differ in the warmer south. In the last decade, published information on bats from the south of Europe has been increasing, including Italy and the Mediterranean parts of France and Spain, as well as Greece. In Greece, the ecology and habitat use of a few species has been recently studied in a systematic manner at certain areas, for example Thrace (*Myotis capaccinii*, Papadatou *et al.* 2008b, 2009), the island of Crete (Georgiakakis 2008, Georgiakakis *et al.* 2010), and the island of Zakynthos (Davy *et al.* 2007). Some earlier studies have focused on particular features of bat ecology related to echolocation, e.g songflights and display behaviour in *Vespertilio murinus* (Weid 1988) and in *Nyctalus leisleri* (von Helversen and von Helversen 1994). The systematic inventory of bat species in the National Park of Prespa (see PART III) has provided some valuable information on the habitat use by bats in the area.

Some ecological features of Greek bats. In central and northern Europe, bats only hibernate in caves but in Greece and the Mediterranean parts of Europe in general, many species use underground sites all year round throughout their life cycle. However, they may not use the same sites but may switch between different winter and summer underground roosts. Some bats may spend part of their annual cycle in Greece; for example *Myotis capaccinii* appears to migrate between summer sites in Greece and Turkey, and winter sites in Bulgaria (Papadatou *et al.* 2009). A few thousand *Myotis emarginatus* females only appear in spring time at some underground sites in Thrace and it is unknown where they spend the rest of the year (Papadatou, unpublished data). Primarily males of *Nyctalus noctula*, *N. leisleri*, *Vespertilio murinus* and *Pipistrellus nathusii* have been found in summer in Greece with the exception of areas in the NE, suggesting that these bats rather reproduce in northern areas and migrate through Greece, where they may also hibernate. There is some evidence that bats do not remain in deep torpor for long through the winter at least in the lowlands and in the south of the country: they appear to emerge and feed on warm nights and they may remain mostly active through mild winters. Females appear to give birth

earlier in the south of Greece compared to bats in northern and central Europe (Georgiakakis 2009, Papadatou, unpublished data).

Clearly, there is more need for bat research, survey and monitoring in the country. An upcoming monitoring project for the reporting on the Habitats Directive (92/43/EEC)/Natura 2000 sites will take place in the next few years and is expected to form the basis for more systematic bat surveys and research in a relatively large part of the territory of Greece.

8. Threats, legal protection and conservation

8.1 Threats

We know very little on the specific threats bats face in Greece, although they are not expected to be very different from those European bats are facing in general. The effects of the most important threat worldwide, habitat degradation and loss, have not been sufficiently documented apart from some scarce information, but as a developed country, Greece must not be an exception to the rule. For example, chemicals have been used in agricultural lands over many years without strict control by the government and there is a tendency for further intensification of farming in many areas. Forest management practices do not account for bats. In earlier years, some caves hosting important bat colonies in the Peloponnese and in the north of Greece were exploited to attract tourists without accounting for bats, resulting in the loss of these colonies. There is currently a tendency in the country to exploit more caves some of which host large colonies of many bat species (e.g. Maronia Cave, Thrace, Paragamian *et al.* 2004). Although these bats and caves are strictly protected under the European legislation, they are not yet adequately protected under the local legislation posing a significant threat to the bats. Wind farms currently pose another very significant threat to Greek bats: it has now been documented that large wind farms in Thrace kill hundreds if not thousands of bats from many species every year and throughout the year except winter (Georgiakakis and Papadatou 2011). There are plans for large-scale

wind farm development in the near future in many mountainous areas including still inaccessible lands in the country, posing a significant problem to wildlife in general and to bats in particular, given that bats do not even constitute a component in environmental impact assessment studies! Deliberate persecution due to ignorance and prejudice is another threat. On several occasions, Greek wildlife hospitals, pest control companies and the main author of this document have been contacted by people asking for advice on how to exclude bats from their houses or kill them, but there are certainly people that take initiative without asking for advice. In some private discussions, homeowners have confessed that they exterminated whole bat colonies roosting in the attics of their houses by burning them or that they killed individual bats trapped in rooms using a newspaper!

Despite the threats, Greece still preserves a rich bat fauna. This is probably because the country is largely not industrialized, because many mountainous and rocky areas are still inaccessible and because there are still highly structured and habitat-rich areas where humans and nature co-existed in a relatively harmonious manner until recently (and they still do to an extent). However, the future is uncertain given that more laws allowing “development” without strict control of its effects on the natural environment and wildlife are currently being voted by the Greek parliament, and bats are for the moment neglected.

8.2 Legal protection and conservation

The conservation status of bats in Greece remains largely unclear. An effort was made by the local bat scientists to assess the bats’ conservation status for the recently revised version of the Greek Red Data

Book of Threatened Animals (Legakis and Maragou 2009), based on available data and their expert judgment. Using IUCN (2009) criteria, 2 species were assessed as endangered (EN), 6 as vulnerable (VU), 8 as near threatened (NT), 8 species as least concern (LC) and 10 as data deficient (DD). Data deficient species means that neither available data nor the experts’ judgment allowed their inclusion in any of the IUCN threat categories (Legakis and Maragou 2009). Similarly to their distribution and ecology, much research is needed to better assess their conservation status.

Bats are legally protected in Greece mainly through international laws reported in PART I, section 4. They are also legally protected by the Presidential Decree 67/1981 (“On the protection of autochthonous flora and fauna and the definition of a procedure for the coordination and control of their research”), which declared as protected all bat species known at the time. This means that species recently included in the species list are not formally protected. In practice, however, none of the Greek bats are protected: they are not considered in EIAs and very rarely are they considered in any other types of environmental studies (e.g. special environmental studies prior to the declaration of an area as protected). This is primarily because, for the moment, bat conservation is not taken seriously by politicians and policy and decision makers, and there is lack of funding for wildlife conservation in general. In addition, Greece has not signed the EUROBATS agreement despite being a party of the Bonn Convention. Conservation organisations therefore concentrate their efforts into more apparently urgent issues. Greece has very limited human and funding resources to gather the information that is essential for effective bat conservation planning and the resources to fully implement conservation plans that may be developed.

Part III

Bats in Prespa

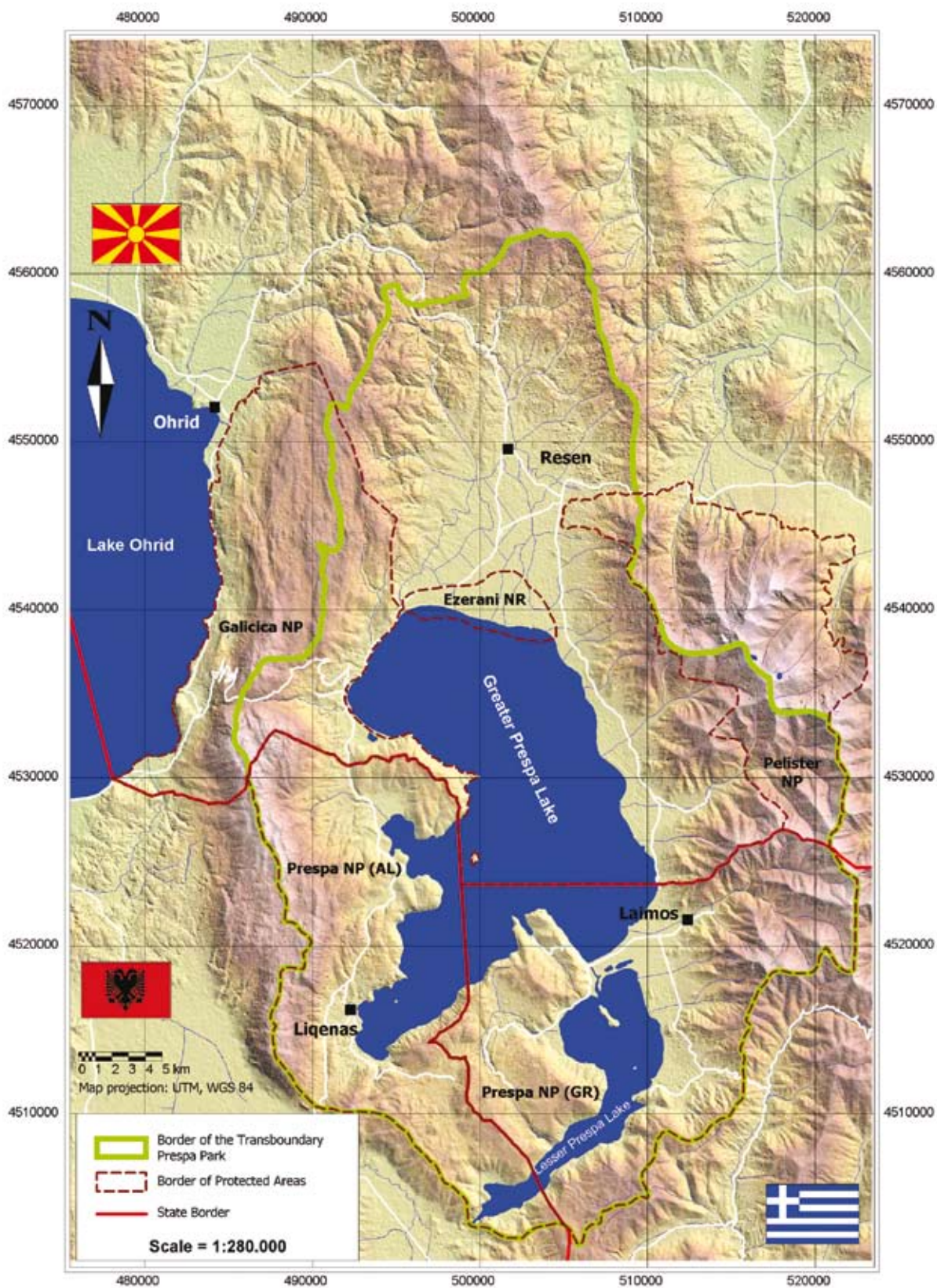


Fig. 9.1. The study area.

9. Study area – The Prespa Lakes Basin

9.1 Geographic and climatic features

Physical features. The Prespa Lakes basin is a natural geographic entity located in the Balkan Peninsula, around the meeting point of the borders of the FYR of Macedonia (Municipality of Resen), Greece (Municipality of Prespa) and Albania (Communes of Bilisht Qender, Proger and Liqenas, all included in the Prefecture of Korça). Geographically, it is divided into two sub-basins: the Lesser Prespa Lake basin (lake level around 853-854 m above sea level over the last years), and the Greater Prespa Lake basin (lake level around 843-845 m a.s.l.). The two lakes are linked by a small channel located at the westernmost part of the 4 km long and 100-500 m wide alluvial isthmus that separates them. The largest portion of the Greater Prespa Lake sub-basin is situated in the FYR of Macedonia and smaller portions in Albania and Greece, while the Lesser Prespa Lake sub-basin is situated in Greece (approx. 80% of the basin) and in Albania (Fig. 9.1). The Greater Prespa Lake has a surface area of 253.6 km², the Lesser Prespa Lake is 47.4 km² and the total area of the combined drainage basins and lakes is 1218.1 km² (Perennou et al. 2009). The Prespa Basin is surrounded by high mountains: the Baba Mountain Range (with the highest peak Pelister at 2601 m) and Mt. Varnous (2330 m) border the lakes to the east, Plakenska Planina (1998 m) and Bigla (1656 m) to the north, Galicica (2287 m) and Mali Thate / Suva Gora (2284 m) to the west, Mt. Ivan (1770 m) and Triklario / Sfika (1750 m) to the south-southeast.

Geology. The rock masses that make up the terrain of Prespa Basin belong to the West-Macedonian geotectonic unit (Klincarov 1997). The mountains to the east of the watershed are composed of silicate rocks (schist, magmatic and volcanic rocks), while the mountains to the north, south and west, are mainly carbonaceous (limestone complex). Due to the porous limestone rocks to the west there is a well-documented underground water flow from the Prespa Lakes to the lower Ohrid Lake, where water appears as numerous sub-lacustrine springs and mighty surface springs, like Drilon in Albania

and St. Naum in the FYR of Macedonia. The lowland part of the valley is composed of clastic complex of sediments (clay sediments, fluvioglacial residues, alluvial sediments, lake-swamp sediments and proluvial deposits).

Climatic features. The climate of the Prespa Basin is under Mediterranean and continental influences and could be characterized as Continental-Central European. The main climatic modifier of the environment is the water mass of the Greater Prespa Lake. The water mass with its thermodynamic inertia influences the entire Prespa watershed area. The average annual air temperature was 10.2°C for the period 1931 - 1960 and 9.6°C for the period 1961-1987. The warmest month in the year is July, with an average monthly temperature of 19.2°C, while the coldest is January, with an average temperature of +0.2°C. The earliest freezing temperatures come in October and the latest in May. The average freezing period is 167 days. Rainfalls are under the influence of the Mediterranean pluviometric regime. The main rainfall period is during late autumn and winter, while the least amount of rainfall is recorded in July and August. The average rainfall quantity from 1961 to 1991 was 730 mm/m². According to the average annual isohyetic maps (Ristevski 2000, based on data from eight rainfall stations in the Greater Prespa Lake region), the Greater Prespa Lake itself accepts 600 mm rainfalls annually. For the lower parts of the Prespa valley, precipitation ranges between 600 and 700 mm, while in the mountain belt it increases to 800-900 mm, and at the high-mountain belt 1000 mm. The Prespa valley is characterized by a unique regime of local winds conditioned mainly by the Greater Prespa Lake's water mass and by the unequal warming of the air over the lake surface and above the ground.

9.2 Hydrological features

The Greater Prespa Lake has an area of 253.6 km² (Hollis and Stevenson 1997), of which 176.8 km² belong to the FYR of Macedonia, 49.4 km² to Albania and 47.8 km² to Greece. Its length is 28.6 km and its width 16.9 km. It has a total volume of 4.8 billion m³. Its greatest depth is 54 m, its average depth is 18.8 m and the length of the shore-

line is 100.1 km. Because a portion of the water migrates downward through the limestone into Ohrid Lake near the locality of Vragodupka, the water level – as well as the lake surface – fluctuates considerably annually and through the years.

In the period 1986-1995 a notable decline of the water level of the Greater Prespa Lake was recorded. The constant reduction of the water level has adversely affected the state of the floating vegetation and faunal communities in the littoral zone of the lake. The presence of large quantities of organic silt on the lake bottom is accelerating the process of eutrophication, which manifests itself with the appearance of phytoplankton blooms during the summer periods. However, due to favourable hydrologic conditions over the last 4-5 years, the water level of the lake is increasing.

The Lesser Prespa Lake has a maximum length of 13 km, maximum width of 6 km, maximum depth of 8.4 m, and an area of 47.4 km² of which approximately 4 km² (8.5%) belong to Albania and 43.4 km² to Greece (Hollis and Stevenson 1997). The total catchment area is approx. 208 km² without the lake and 255 km² with the lake (GKP et al. 2005). Since 1975, the water level of the Lesser Prespa Lake has remained higher than that of the Greater Prespa Lake (Hollis and Stevenson 1997). Water outflows from the former to the latter are controlled by a sluice gate – road bridge system originally built in 1969 (first gate positioned in 1987) on the channel connecting the two lakes, and restored in 2004 to allow for control of the water level of the lake (Kazoglou et al. 2010).

The Prespa Lakes basin has a developed hydrographic network mainly in the eastern and northern parts, and a less developed such network in the western and southern (limestone) parts. All major watercourses are formed on the foothills of the mountains Pelister, Bigla, Plakenska and Varnous. The Golema Reka River (sourcing from the Plakenska and Bigla Mountains), including its tributary Leva Reka River, has the largest catchment area and plays a significant role in the water balance of the Greater Prespa Lake. Three more perennial rivers are found in the FYR Macedonian side and source from the Pelister Mountain: Brajcinska Reka River, Kranska Reka River

and Kurbinska Reka River. On the Greek side, the largest provider of water to the Greater Prespa Lake is Ag. Germanos River, while several smaller watercourses flow on the eastern side of the basin. River Devolli in Albania, which was seasonally diverted into the Lesser Prespa Lake from 1976 to 2000, is not affecting the Prespa water system anymore (Kazoglou et al. 2010).

9.3 Agronomic and socio-economic data

9.3.1 Greece

Population. According to the National census of 2001, the Municipality of Prespa (which since January 2011 also includes the area of Krystallopigi, Vatochori and Kotas located outside the Prespa Lakes basin) has a population of 2511 people living in 20 settlements. Of these, 1604 people live in the 13 settlements located inside the lakes basin, but it is estimated that less than 1000 people are permanent inhabitants. The majority of the population of the Municipality of Prespa belongs to the age classes of 25-39 and 40-54 years (Table 9.1).

TABLE 9.1 Population age classes in the Municipality of Prespa in 2001 (Koutretsi et al. 2006)

Age classes	Women (%)	Men (%)	Total (%)
0-14	7	7	14
15-24	4	9	14
25-39	9	14	23
40-54	7	12	19
55-64	5	5	10
65-79	7	6	13
>80	4	4	7
Total	43	57	100

The economically active population in 2001 comprised 903 people (305 women and 598 men) mainly occupied in agriculture, stock-breeding, tourism, fishing and forestry (Table 9.2). An update of the population data is expected from the publication of the current National census (May 2011).

TABLE 9.2 Population age classes and economically active population in the Municipality of Prespa in 2001
(adapted from Koutretsi *et al.* 2006)

Age classes	Women (number and proportion (%))	Men (number and proportion (%))	Total (number and proportion (%))
10-19	4 (1%)	21 (4%)	25 (3%)
20-24	28 (9%)	50 (8%)	78 (9%)
25-29	45 (15%)	80 (13%)	125 (14%)
30-44	120 (39%)	254 (42%)	374 (41%)
45-64	95 (31%)	174 (29%)	269 (30%)
>65	13 (4%)	19 (3%)	32 (4%)
Total	305 (100%)	598 (100%)	903 (100%)

Economic sectors			
Primary	187 (61%)	359 (60%)	546 (60%)
Secondary	9 (3%)	53 (9%)	62 (7%)
Tertiary	77 (25%)	138 (23%)	215 (24%)
Not clearly belonging to one of the above sectors	32 (10%)	48 (8%)	80 (9%)
Total	305 (100%)	598 (100%)	903 (100%)

Land use. Land cover types of Prespa National Park, i.e. the whole area of the Prespa Basin in Greece, are shown in Table 9.3. From the total area of agricultural land, 56% is found within the irrigation network and presently 41% (1150 ha) is actually irrigated (Local Land Reclamation Organization, pers. comm.).



TABLE 9.3 Main land cover types in the Prespa watershed in Greece (Argyropoulos and Giannakis 2001)

Land use type	Surface (ha)	Proportion (%)
Forests	11 973	40.0
Pastures, meadows, shrublands, rocky habitats	6198	20.7
Agricultural land	2781	9.3
River beds, stream outlets, sandy shores	175	0.6
Reedbeds, wet meadows	760	2.5
Open water	7880	26.4
Urban land	133	0.5
Total	29 900	100

Agriculture. The cultivation of beans (1000 ha of the 1150 ha of irrigated land) is by far the most important economic activity on the Greek part of Prespa. Middle-size, “giant” and “elephant” dry white beans are the main cultivated varieties in the area, labelled as products with “Protected Geographic Origin” for farmers following the processes of organic farming (approx. 15 farmers with a total of 45 ha) or integrated production management (approx. 120 farmers with a total area of 750 ha). Bean cultivation occupies more than 120 families in the area. Other crops are alfalfa, maize and cereals, while fallow lands represent approx. 14% of arable land.

Livestock breeding. Stock-breeding is practiced by 88 people in Prespa National Park. Cattle breeding (1308 animals in 2009) is developed in the eastern part of the Park (mainly in the villages of Agios Germanos and Kallithea) and has been showing increasing trends over the last 10 years, while sheep-goat breeding (8401 animals in 2009) is mostly practiced in the western part (villages of Vrondero, Pyli) showing decreasing trends (Giannakis *et al.* in prep., data from the Municipality of Prespa).

Honey production. Apiculture is practiced by less than five farmers living permanently in the area. The officially recorded number of beehives is only 20 (in Agios Germanos), but this is certainly an underestimation. However, in summer many (unrecorded number) honey producers come to Prespa from other areas of the country, e.g. Chalkidiki, and keep their beehives in the area until early to mid autumn.

Fishing. The total number of fishermen in the last years is 130 with 65 fishing boats in both lakes. Eighty fishermen come from the villages of Mikrolimni, Karyes, Lefkonas, Platy, Laimos, Agios Achilleios and Pyli, and fish in Lesser Prespa Lake (40 boats), while approx. 50 professional fishermen (25 boats) come mainly from the village of Psarades and fish in Greater Prespa Lake. Most of the fishermen are also doing other jobs to supplement their income, such as offering boat trips to visitors in the Greater Prespa Lake, keeping restaurants and small hotels, and farming (Malakou *et al.* 2007, Kazoglou *et al.* 2001).

Forestry. Two forestry cooperatives are active in the area of PNP-AL: the one based at Pyli has 33 members (20 active), while the one of Vrondero

has 40 members (23 active). Forestry seems to provide an important supplementary income to the families involved in forest logging (Giannakis *et al.* in preparation).

Tourism. This form of the tertiary economic sector has been steadily growing over the last 15 years mainly at the villages of Psarades, Agios Germanos, Laimos and Agios Achilleios. In 2001, 215 people were working in the tourism sector representing 24% of the economically active population (Table 9.2).

Protection status. Prespa National Park (Prespa NP) was established in July 2009 (Common Ministerial Decision no. 28651, dt. 23.07.2009) and covers the whole of the lakes’ basin in the Greek part of the transboundary Prespa Park. Prespa NP includes both Natura 2000 sites of the Prespa Lakes Basin, i.e. the “Prespa National Forest” coded GR 1340001 and the “Varnous Mt” coded GR 1340003 (Fig. 9.1). Lesser Prespa Lake is a Wetland of International Importance (Ramsar Convention).

9.3.2 Albania

Population. A population of approx. 5300 inhabitants lives in settlements inside the Prespa National Park (PNP-AL) territory, with a distance of 3-5 km between settlements. The Albanian part of the Prespa watershed is not very densely populated (estimated density *ca.* 20 people per km²).

Land use. Following Decision no. 80, dt. 18.02.1999, Prespa National Park has the following land categories (Table 9.4):

TABLE 9.4 Main land use types in the Prespa watershed in Albania

Land use type	Surface (ha)	Proportion (%)
Forests	13 500	48.6
Pastures, meadows	1828	6.6
Agricultural land (arable, vineyards, orchards)	2100	7.6
Water	4950	17.8
Unproductive surfaces, urban land etc.	5372	19.4
Total	27 750	100

Agriculture. Most of the households are engaged in agriculture (farming and livestock production). Farming is labor intensive, with women's labor particularly important in crop production, and men's labor crucial in animal husbandry. Livestock husbandry is integral to the farming system. Thus, almost all of the households hold one or two cows for milk, ten to fifteen chickens and a few sheep and goats.

The total number of agricultural holdings is 1448 (all mixed holdings, i.e. practicing agriculture and stock-breeding) with almost 2185 ha of total land. Cereals (i.e. wheat, corn, barley and rye) are the main crops covering 69.7% of the total land. The remaining 30% of agricultural land is cultivated with potatoes (1.4%), dry beans (3.2%), vegetables (8.2%), alfalfa (9.6%), fruit trees (0.9%) and vineyards (6.9%). Arable land is not cultivated intensively. Agricultural production is produced for livestock and home consumption and it is not included in the annual income generated in PNP-AL.

Livestock breeding. Livestock breeding is the most important source of income for local communities and directly depends on the PNP-AL's resources. Goats and sheep are predominant and cattle play also an important role. Actually, the animal production is taking priority in the total agricultural production and in the future this tendency may become even more important, in particular given the potential tourism development within the PNP-AL.

The breeding systems for small ruminants are still traditional: exploitation of the summer and winter meadows and low forests, grazing in considerable area of non-cultivated agricultural lands, tree lopping and a relatively limited use of concentrated and dry feed. However, in the future it is estimated that the total sheep and goat numbers will decrease, cow numbers may increase or remain stable and some farmers will specialize and enlarge their herd size, but rather in cows and sheep than in goats (Grazhdani 2008). Almost 100% of dairy products and 80% of meat is used for home consumption. Small quantities of milk and cheese are sold locally and 20% of meat is sold to traders "at the farm gate" and within the community (lambs and kids within

the community and calves to traders). Although there is a general trend of decrease in goat and sheep numbers, people still keep animals for different uses.

A few villages in the PNP-AL close to the border with Greece have different stockbreeding practices. People do not only keep livestock for subsistence production, but mainly for trading. Recently, people in these villages have started to sell meat to traders at the farm gate for the market in Tirana. Meat from the region is known for its high quality and good taste ("organic" production, no vaccinations, etc.).

Honey production. There are about 20 professional beekeepers in the park, while 5-10% of inhabitants have beehives for home consumption. Honey is either sold to traders or within the communities.

Fishing. Fishing is one of the main economic activities in the area. Currently, there are totally 100 fishermen who are organized and their fishing activity is carried out on an individual basis. Half of them are licensed, while the other 50 are unlicensed and thus their activity is considered illegal. It has been reported (Grazhdani 2008) that the numbers of economically valuable fish species, such as the carp (*Cyprinus carpio*), have decreased while those of smaller fish species that are less demanded have increased. The average daily catch of fishermen is 25 kg of small fish (only a small quantity of carp) between April and October. Between November and March, the average daily catch is 1.5 kg of carp (only a small quantity of small fishes). In most fishing households, at least two people are involved. While the men go fishing by boat, many women take the bus to the closest city of Korça to sell the fish in the streets.

Forestry. The total surface of forest lands in Prespa NP is 13 500 ha, of which 9399 ha (69.6%) belong to the state, 3721 ha (27.6%) are communal and 380 ha (2.8%) are private. Three factors impact the condition of forests in the PNP-AL: lopping for fodder (branches and leaves) for livestock, grazing (goats, sheep, and cows) and firewood extraction. These practices are carried out by the local population as subsistence economy activities, but also for income generation (selling

of firewood) and have led to the severe degradation of the forest areas. More than 50% of the forests are coppice. Dry foliage of oak branches cut in August and September comprise up to 80% of the winter diet of goats and sheep. The total firewood production in the PNP-AL is estimated at 20 000 m³.

Tourism. In the Prespa area, there is small-scale rural and family tourism, based on a few small hotels, private accommodation and restaurants. Capacities in hotels are up to 34 beds and in private accommodation up to 500 beds, and there are 11 restaurants with 345 seats. The occupancy rate for the few hotels ranges from 9-20% and for private accommodation between 0.02 and 3%. Restaurants are reported to have 200-1000 visitors per day at the weekends during the main summer season (July and August), resulting in about 2400-12 000 visitors per year.

Protection status. The PNP-AL, established in 1999, covers the entire Prespa watershed in its Albanian part (Fig. 9.1).

9.3.3 FYR of Macedonia

Population. In the Greater Prespa Lake basin there is one town, Resen, and 43 villages. The total number of inhabitants is 32 994, about half of which are permanent residents and the rest are irregular residents or present only in the summer months, with a dwelling period shorter than six months. From the 1980s, the population in the basin started to decrease, particularly due to emigration waves from the rural areas and decrease in birth rates. With regards to the age structure, the young population (0-19 years) and people in the second age class (20-59 years) decreased, whereas the number of people in the third age class (> 60 years) increased.

Land use. The area of the Greater Prespa Lake watershed is almost the same as the administrative border of the Municipality of Resen. The structure of the main land use types is presented in Table 9.5.

TABLE 9.5 Main land use types in the Prespa watershed in the FYR of Macedonia

Land use type	Surface (ha)	Proportion (%)
Forests	23 625	32.0
Pastures	8195	11.1
Arable land	11 932	16.1
Unproductive surfaces	30 132	40.8
Total	73 884	100

Agriculture. Favourable natural conditions and long-term tradition have established the apple cultivation as the most important agricultural activity in the Prespa Basin with the majority of lowland areas occupied by apple orchards. In 1998, orchards covered an area of 2771 ha or 23.7 % of the cultivated land. The total number of fruit trees was 1 642 800 of which 1 611 000 (98.1%) was apple trees (Ristevski *et al.* 2000). Orchards with apple trees of native, local provenance were dominant in Prespa up to the 1960s. In the following years, old apple orchards with apple trees of native origin were gradually uprooted and replaced by apple trees of internationally accepted varieties with higher commercial value. Currently, the lowland areas of Prespa are covered by large scale apple monocultures with heavy use of fertilizers and pesticides. Fertilization is generally performed in three phases: a) the main autumn application with complex NPK fertilizer¹ is usually applied in amounts of 700 kg/ha, b) the early spring application is applied at a rate of 500 kg/ha, and c) the late spring application with Nitrogen fertilizers, such as ammonium nitrate, is applied at a rate of 400 kg/ha. In the last few decades, intensive apple cultivation is coupled by heavy use of pesticides with 15 to 20 sprayings per year. Recently, traps for attracting harmful insects (pests) have been established at several locations, indicating their development cycles to activate an early warning system for the best period of spraying with pesticides. Consequently, the frequency of spraying has been reduced to a maximum of 10 times per year in the lower belt and up to 5 times in the higher belt (e.g. Brajcino village). Even though organic

1. NPK is a widely accepted code for macronutrient fertilizer compounds of Nitrogen (N), Phosphorus (P) and Potassium (K).

TABLE 9.6 Animal farming in some of the villages
in the Prespa watershed

Village	Cattle	Sheep	Goats	Chicken	Pigs
Brajcino	20	4	-	50	30
Arvati & Krani	20	1500	200	150	-
Ljubojno	7	-	165	-	8
Nakolec	6	-	-	100	-
Leva Reka	6	20	-	120	-

Source: BIOECO (NGO) interviews (2006)

farming in apple production has not been applied to date, the Government has generally given incentives to farmers for organic production, which have already been well accepted by farmers in other regions of the country.

Livestock breeding. Data on animal farming are presented only for a few villages on the basis of BIOECO interviews conducted in 2006 (Table 9.6).

Fishing. The annual yield collected between 2003-2004 amounts to 107 317 Kg (Z. Djurovski, pers. comm.). Greater Prespa Lake is far less productive compared to Lake Ohrid and Lake Dojran.

Forestry. The Prespa watershed is classified as an area with moderate forestation. Forests outside the borders of Galicica and Pelister National Parks (GNP and PelNP respectively) are mainly managed by the Public Enterprise “Makedonski shumi”. The annual cut is 67% of the allowed harvest. Clear cuts in oak forests are common practice and massive logging occurs in beech forests. Only a small portion in the northwest of the Pelister Mountain is managed by the forest unit from Bitola named “Kajmakchalan”. The annual cut is 29.8 % of the allowed harvest. The forests on the Galicica Mountain are managed by the GNP management body. Annual timber volume cut is 52% of the allowed harvest. Actually, this represents the main income of the GNP’s management authority.

Hunting. Hunting grounds in the Prespa watershed cover an area of 54 350 ha of which 5930 ha belong to the GNP and PelNP. The rest of the surface is divided into six hunting grounds of which four are for hunting large game and two for small game. Concessionaires of these hunting grounds

are the Hunting Society “Prespa” from Resen and the Public Enterprise “Macedonian Forests”. Approximately 400 hunters hunt in the area.

Protection status. Three protected areas are located within the Prespa Lakes Basin: a) the GNP, established in 1958, which extends to Ohrid Lake and up to the city of Ohrid, b) the PelNP, established in 1948, a large part of which also covers part of the Bitola watershed, and c) the Ezerani Nature Reserve on the northern shore of the Greater Prespa Lake, established in 1996 (Fig. 9.1). The Greater Prespa Lake was designated as the first Ramsar Site in the FYR of Macedonia in 1995, including the wetland of Ezerani.

9.4 Habitat types

9.4.1 Greece

The geomorphological character of the Prespa area is primarily determined by the presence of the two lakes, Lake Greater Prespa and Lake Lesser Prespa, as well as of the surrounding mountain ranges not very far from the shores of the lakes: Mt Vrontero and Mt Devas in the west, Mt Triklarion/Sfika in the south and Varnous in the east-northeast reaching altitudes of over 2000 m a.s.l. Therefore, the area is characterised by two basic ecosystems, the lake and littoral ecosystems, and the forested mountainous and subalpine ecosystems. The two lakes comprise 30% of the Prespa Basin in Greece.

Lake Lesser Prespa is located at an average altitude of 853 m a.s.l. with a northeast to southwest main axis and has an average depth of 4 m. The length of its shore in the Greek part reaches 46 km

and is largely surrounded by reedbeds of *Phragmites australis* and *Typha angustifolia* and, to a lesser extent, wet meadows. In the lake, there are two small islands, Ag. Achilleios (ca. 55 ha) and Vidronisi (ca. 4 ha). Lake Greater Prespa is much larger than Lesser Prespa and only 17% of its surface is located in the Greek part.

The rock beds on the east of the area are primarily granitic, whereas on the west they are primarily calcareous. In the limestone parts, the coastline of the lakes is largely rocky and corroded, forming numerous crevices, cavities and caves. Specifically, the Greater Prespa Lake is surrounded by largely steep and rocky shores with many crevices and cavities, and a number of caves of various sizes on the shore or higher up on inaccessible cliffs. Some of the small and almost inaccessible caves were used as hermitages in the past centuries. All of these caves are found close to the village of Psarades in the south of the lake. The founder of the Hellenic Speleological Society, A. Petrochilou visited Prespa with colleagues in 1977 and described

15 of these caves (Petrochilou *et al.* 1977; section 12.2.1). Parts of the north-western, south-eastern and western coast of Lesser Prespa Lake are also rocky with crevices and cavities.

The habitat types of Prespa NP in Greece (which corresponds to the combined territory of the Natura 2000 sites “Prespa National Forest” and “Mt Varnous”) have been recorded and described in the framework of the EU Habitats Directive 92/43/EEC (Ministry of Environment 2001). Table 9.5 includes relevant data with notes (for some of the 32 habitat types) stemming from ongoing research for the recording of habitat types in the same area 10 years after the original mapping (SPP, unpublished data). With “*” are marked the priority habitats. New findings suggest that currently one of the 32 habitat types recorded in 2001 does not exist, and that there are potentially another eight habitat types to be added in the list, thus totaling 39 habitat types. Whether 32 or 39 habitat types, Prespa NP is one of the most diverse and habitat-rich protected areas in the country.

TABLE 9.5 Habitat types in Prespa National Park, Greece (Habitats Directive 92/43/EEC)

Natura 2000 Code	Habitat type (Min. of Environment 2001)	Remarks (SPP unpublished data, 2011)
1020	Arable land	
1050	Settlement	
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation	Present in the area with > 15 plant communities
3170	* Mediterranean temporary ponds	Probably not present
3190	Open water-pelagic zone of lakes	
4060	Alpine and subalpine heaths	Probably not as extensive as presented in the 2001 maps
5110	Stable <i>Buxus sempervirens</i> formations on calcareous rock slopes (Berberidion p.)	
5150	Bracken fields	
6210	* Semi-natural dry grasslands on calcareous substrates (Festuco Brometalia)	Great importance of the area for the conservation of particular plant communities of this habitat type
6220	* Pseudo-steppe with grasses and annuals (Thero-Brachypodietea)	

Natura 2000 Code	Habitat type (Min. of Environment 2001)	Remarks (SPP unpublished data, 2011)
6230	* Species-rich <i>Nardus</i> grasslands, on siliceous substrates in mountain areas (and submountain areas in continental Europe)	Probably covers extensive areas on Mt Varnous
6420	Mediterranean tall-herb and rush meadows (<i>Molinio-Holoschoenion</i>)	Related to the very valuable wet meadow areas on the littoral zone of Lesser Prespa Lake
6430	Eutrophic tall herbs	Present only on Mt Varnous
6432	Subalpine and alpine tall herb communities	Present only at two localities of Mt Varnous [one of them including the habitat type (*) 7130]
72A0	Reed beds	Very important habitat type for wetland wildlife and associated habitat types
72B0	Large Sedge communities	Includes important plant communities
8210	Calcareous rocky slopes with chasmophytic vegetation	Includes unique combinations of plant communities at specific localities
8220	Vegetated silicicolous inland cliffs with chasmophytic vegetation	
8310	Caves not open to the public	
9110	Acidophilous (<i>Luzulo-Fagetum</i>) beech forests	
9130	Neutrophilous (<i>Asperulo-Fagetum</i>) beech forests	Probably not as extensive as presented in the 2001 maps
9140	Subalpine beech woods with <i>Acer</i> and <i>Rumex arifolius</i>	Found on high altitudes of Mt Varnous
9150	Calcareous beech forests (<i>Cephalanthero-Fagion</i>)	
91E0	* Residual alluvial forests (<i>Alnion glutinoso-incanae</i>)	New localities of this habitat type have recently been found
924A	Eastern white oak woods and balkanic thermophilous oak woods	
9250	<i>Quercus trojana</i> woods (Italy and Greece)	
925A	Hop-hornbeam, oriental hornbeam and mixed thermophilous forests	
9270	Hellenic beech forests with <i>Abies borisii-regis</i>	Hosts important plant taxa
9280	<i>Quercus frainetto</i> woods	More extensive than presented in the 2001 maps
92A0	<i>Salix alba</i> and <i>Populus alba</i> galleries	Partially converted to 91E0 (*)
951A	Greek silver Fir forests	Although this habitat type is recorded as such (Fir forests), the dominant species is <i>Abies borisii-regis</i>
9562	* Grecian juniper woods (<i>Juniperetum excelsae</i>)	Prespa NP is the only Natura 2000 site in the country with that particular habitat type

9.4.2 Albania

The Albanian National Park of Prespa is characterised by a high diversity of habitat types, represented by the following hierarchical levels according to the Habitats Directive (92/43/EEC, 2003 & TPVS (96) 102, 1996): a) Freshwater habitats, b) Temperate heath and scrub, c) Sclerophyllous scrub (Matorral), d) Natural and semi-natural grassland formations, e) Rocky habitats and caves, and f) Forests. Freshwater habitats represent the water body of the lakes, while the other habitat types are found in the terrestrial zone of the catchment area.

Aquatic vegetation is very important for its floristic elements and wildlife, especially water birds. In the Lesser Prespa Lake, the main habitats types are (Directive 92/43/EEC, 2003; Res. No. 4, 1996²):

- 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation,
- 72A0 Reed beds,
- 22.41 Free-floating vegetation,
- 22.43 Rooted floating vegetation,
- 22.431 Floating broad-leaved carpets,
- 22.432 Shallow water floating communities.

Aquatic vegetation in Lesser Prespa Lake has drastically changed over the last decades with floating leaved macrophytes expanding to the expense of free/ open water areas, as suggested by the comparison of satellite images with maps. This change was accelerated by the high sedimentation rate of the Devolli River to the Lesser Prespa Lake in 1970-1990 (Pano *et al.* 1997). From 1982 to 2000 (on a total area of 4 km²), the lake surface covered by aquatic vegetation (floating and emergent/reedbeds) increased from 2.06 km² to 2.63 km², while the open water surface areas decreased from 1.94 km² to 1.37 km². The analyses of satellite images (Image © Terremetrics, Europa Technologies, 2006-7) showed a further drastic increase of the floating vegetation with 1.25 km² (together with reedbeds 3.29 km²), whereas the open water surfaces were estimated at *ca.* 0.73 km². More recent data show that the open water surfaces of the lake have de-

creased year after year, whereas waters seasonally covered by floating vegetation have slightly increased (1.98 km²).

The vegetation of the Greater Prespa Lake appears almost unchanged over the last years and its surface area is negligible compared to the open water surface area. It is different from the vegetation of the Lesser Prespa Lake and it is composed mainly of three vegetation types: the floating, emergent and submerged vegetation of the classes: a) Lemnanea Tx. 1955, b) Potamogeton Klika in Klika et Novak 1941, and c) Phragmites-Magnocaricetea Klika in Klika et Novak 1941 (Dring *et al.* 2002). The largest part in the lowlands around the basin is covered by the following main categories or subcategories of habitats (Habitats Directive):

- 5110 Stable xerothermophilous formations with *Buxus sempervirens* on rocky slopes (Berberidion p.),
- 5130 *Juniperus communis* formations on heaths or calcareous grasslands,
- 9110 Luzulo-Fagetum beech forests,
- 9130 Asperulo-Fagetum beech forests,
- 41.2 Oak-hornbeam forests,
- 42.7 Mixed thermophilous forests,
- 91K0 Illyrian Fagus sylvatica forests (Arenio-Fagion),
- 9280 *Quercus frainetto* woods.

The higher parts of natural and semi-natural grasslands are dominated by:

- 6170 Alpine and subalpine calcareous grasslands,
- 34.51 West Mediterranean xeric grasslands,
- 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia),
- 6432 (37.8) Subalpine and alpine tall herb communities,
- 6520 Mountain hay meadows,
- 8140 Western Mediterranean and thermophilous scree.

Some habitat types are listed as priority habitat types:

- 6110* Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi,
- 6220* Pseudo-steppe with grasses and annuals (Thero-Brachypodietea),

2. The habitat codes used above, correspond to the NATURA 2000 and Bern Convention (Resolution No. 4) codes, whereas "*" indicates priority habitat types.

- 91G0* Pannonic woods with *Quercus petraea* and *Carpinus betulus*,

- 91H0* Pannonian woods with *Quercus pubescens*, and

- 9560* Endemic forests with *Juniperus* spp.

The terrestrial vegetation of the Lesser Prespa Lake watershed generally appears unchanged. Degradation trends of the oak and beech forests have created brushes or brushwood forests, especially in Buzëlliqen (Zagradec) and around Liqenas villages up to the Wolf gorge. The high presence of *Crataegus* sp., *Cornus* sp., *Rosa* sp. and *Coryllus* sp., and extended brushwood of *Buxus sempervirens*, are examples (and indicators) of this trend. The lowest slopes are the most exploited as agricultural lands; hence, the degradation of the vegetation is observed, i.e. of mixed oaks, pastures, forests and thermophilous shrubs. Overexploitation of the forests and shrubs combined with overgrazing and fires in the upper part are the main reasons for the decrease of vegetation cover of the Prespa watershed in the Albanian part.

9.4.3 FYR of Macedonia

The elevation difference between the lake (843 m a.s.l.) and the highest peak (Pelister, 2601 m a.s.l.) is 1758 m. Habitat types are presented below into belts corresponding to the vertical distribution of various biomes and in accordance with the Bern Convention Habitat Types listed in Resolution No 4 (1996):

The belt of Lake Prespa aquatic and marsh vegetation. Aquatic vegetation in the lake itself and the marshes and wet meadows around the lake: 22.412 Frogbit rafts, 22.415 *Salvinia* covers, 22.416 *Aldrovanda* communities, and 44 Temperate riverine and swamp forest and brush.

The belt of lowland meadows. A great portion of the areas under former meadows is currently abandoned and they are not mowed or are being transformed into apple orchards.

The belt of hill pastures. Hill pastures are developing on the foothills of the mountains Pelister, Galicica and Bigla, and on secondary habitats produced by degradation of former forest (mainly oak) ecosystems: 134.3 Dense perennial grasslands and middle European steppes, 142.A Western Palearctic cypress, juniper and yew forests.

The Oak forest belt (up to 1300 m). This is the lowest forest zone in Prespa watershed: 41.7. Thermophilous and supra-Mediterranean oak woods. It includes several distinctive communities, some of which have zonal distribution.

The Beech forest belt (1100-1650 m). At least three distinctive sub-belts can be distinguished and numerous extra-zonal communities: 31.46 *Bruckenthalia* heaths, 41.1 Beech forests, 41.4 Mixed ravine and slope forests, 42.17 Balkano-Pontic fir forests.

Sub-alpine mountain belt (1650-2250 m). The sub-alpine belt represents the highest belt of the forest vegetation. It occupies a wide mountain belt in the Prespa watershed at high altitudes: 31.46 *Bruckenthalia* heaths, and 42.7. High Oro-Mediterranean pine forests. Several climate-zonal forest communities (Sub-alpine Beech, Fir and Macedonian Pine forest) are developing in this belt:

a) the sub-alpine Macedonian Pine forest (*Myrtillo-Pinetum peucis* subass. *subalpinum*) is considered as primary habitat for the Macedonian Pine on Mt Pelister, from where it spreads downwards on secondary habitats; b) the forests of White-bark Pine (*Pinion heldreichii*) are developing only as fragments on calcareous bedrocks on Mt Galicica; c) heathlands of the plant community *Bruckenthalio-Juniperetum* usually appear after forest destruction as secondary habitats, adjacent to the secondary pastures (grasslands).

Alpine mountain belt (2250-2601 m). It is the area of climate-zonal high-mountain grassland communities which develop on altitudes higher than 2250 m asl. Conditions for the development of these communities in the Prespa watershed exist only on Mt Pelister. All grassland communities recorded up to date are included in the class *Caricetea curvulae* (alpine pastures on siliceous bedrock). The habitats of European importance (bogs, peat-bogs) on Mt Pelister have not been investigated yet.

Vegetation cover described according to the Habitats Directive habitat types with % of coverage in the FYR of Macedonia portion of the Transboundary Prespa Park watershed is presented in Table 9.6.

TABLE 9.6 Habitat types in the FYR of Macedonian part of the Prespa Basin (Habitats Directive 92/43/EEC)

Code	Habitat Type	Surface in %
Priority habitat types		
3170	* Mediterranean temporary ponds	0.1
6210	* Semi-natural dry grasslands on calcareous substrates (<i>Festuco Brometalia</i>)	5
6220	* Pseudo-steppe with grasses and annuals (<i>Thero-Brachypodietea</i>)	1
6230	* Species-rich <i>Nardus</i> grasslands, on siliceous substrates in mountain areas	1
91E0	* Alluvial forests (<i>Alnion-glutinoso-incanae</i>)	<1
9562	* Grecian juniper woods	<1
Important habitat types		
3150	Natural eutrophic lakes with <i>Magnopotamion</i> or <i>Hydrocharition</i> -type vegetation	1
4060	Alpine and Boreal heaths	5
6170	Alpine and subalpine calcareous grasslands	< 1
6420	Mediterranean tall-herb and rush meadows (<i>Molinio-Holoschoenion</i>)	<1
6430	Eutrophic tall herbs	<1
6432	Subalpine and alpine tall herb communities	<1
8210	Calcareous rocky slopes with chasmophytic vegetation	<1
8220	Vegetated silicicolous inland cliffs with casmophytic vegetation	<1
8310	Caves not open to the public	<1
9110	Acidophilous (<i>Luzulo-Fagetum</i>) beech forests	10
9130	Neutrophilous (<i>Asperulo-Fagetum</i>) beech forests	10
9140	Subalpine beech woods with <i>Acer</i> and <i>Rumex arifolius</i>	<1
9150	Calcareous beech forests (<i>Cephalanthero-Fagion</i>)	<1
9250	<i>Quercus trojana</i> woods (Italy and Greece)	3
9270	Hellenic beech forests with <i>Abies borisii-regis</i>	1
9280	<i>Quercus frainetto</i> woods	8
92A0	<i>Salix alba</i> and <i>Populus alba</i> galleries	<1
Other habitat types		
1020	Arable land	13.2
1050	Settlement	0.5
3190	Open water - pelagic zone of lakes	17
5150	Bracken fields	1
72A0	Reed beds	2
72B0	Large Sedge communities	<1
924A	Eastern white oak woods and balkanic thermophilous oak woods	7
925A	Hop-hornbeam, oriental hornbeam and mixed thermophilous forest	2

9.5 The Prespa Lakes Basin as Transboundary “Prespa Park” (TPP)

The description of the study area in the previous sections is based on the presentation of the biotic and abiotic environmental features in each of the three (national) parts of the Prespa Basin. However, even if one describes only one of the three parts of Prespa, the most prominent characteristic of the wider area (the “study area” in this case) is its **transboundary nature**, which is manifested in various manners e.g. through the account of similarities and links between the three sides of Prespa related to its geography, geology, hydrology, climate, biological features, nature conservation aspects, but also when studying human-related issues in the older times or in contemporary history. This important element of the Prespa Basin has been the basis for the commitment of the three states to support sustainable development in the area.

The political will of the governments was officially expressed through the *“Declaration on the creation of the Prespa Park and the Environmental Protection and Sustainable Development of the Prespa Lakes and their surroundings”*, signed by the Prime Ministers of Albania, Greece and the FYR of Macedonia on 2 February 2000. With that declaration, the entire Prespa Lakes basin forms **the Transboundary “Prespa Park” (TPP), the first transboundary protected area in the Balkans**. Based on that declaration, the Prespa Park Coordination Committee (PPCC) and its Secretariat were established, and forwarded important actions to support transboundary cooperation in Prespa. The TPP includes: the two Prespa National Parks (GR and AL), parts of the Galicica and Pelister NPs and the Ezerani Nature Reserve (FYR of Macedonia), both Prespa lakes (Wetlands of International Importance, Ramsar Convention), as well as the remaining territories in the Prespa Basin which are not protected by other conventions or national legislations.

Among other agreements between the three states concerning Prespa, it is important to note the two most recent ones: a) the “Joint Statement of the Prime Ministers of the three States sharing the Prespa Lakes Basin” of 27 November 2009 (Pyli, Greece), and b) the “Agreement on the Protection and Sustainable Development of the Prespa Park

Area”, signed by the Ministers of the Environment of the three countries and the European Commissioner for the Environment (2 February, 2010). The latter aims at further supporting transboundary conservation issues through specific principles and mechanisms of cooperation, such as the establishment of the Prespa Park Management Committee (with its Secretariat) and the Working Group on Water Management.

Transboundary cooperation between the three countries in Prespa has been achieved at high and low political levels (e.g. PPCC, Municipalities), but also at the level of nature conservation mainly through small-scale projects involving protected area management authorities, local NGOs and scientists active in Prespa. Of course, a lot more needs to be done, but it is very important to know that the basis of such cooperation has been created, and specific organizations and people have the will to further promote it.

Bats may travel long distances within and between seasons and they do not recognise national borders. Therefore, in the present work, except the TPP, we included roosting and feeding sites in and near the basin of Ohrid Lake located in the GNP, as well as a few sites in the north of the Greater Prespa Lake, and some sites in the adjacent area of PNP-GR (Fig. 9.1).

10. History of bat research at Prespa

10.1 Greece

First, Catsadorakis and Kollaros (1986), von Helversen and Weid (1990) and later Catsadorakis (1995) reported up to eight species of bats in Prespa. Prof. O. von Helversen visited the area a few times between 1981 and 1990, but only part of his data was reported in the 1990 publication. In 2007, he visited Prespa for the last time, adding one more species to the list (see Table 12.1).

In the early 2000s, X. Grémillet, president of the Groupe Mammalogique Breton (GMB), a French NGO for the study and protection of the mammals

of Brittany, France, visited Prespa to observe birds, otters *Lutra lutra*, and bears *Ursus arctos*. He then discovered rock cavities with bat colonies of horseshoe bats (*Rhinolophus* species) and Bent-winged bats *Miniopterus schreibersii*. In 2004, X. Grémillet and members of the GMB attempted the first expedition to the PNP-GR aiming specifically at studying bats in collaboration with Y. Kazoglou from the Society for the Protection of Prespa (SPP), and with the help of V. Arabatzis. Their expedition increased the number of bat species in Prespa to 13 (Grémillet and Boireau 2004). The team identified and mapped important sites used by bats for roosting (rock crevices and cavities, caves and man-made structures). Larger teams were later formed by X. Grémillet, members of the GMB, and independent French and Greek researchers (including the main author of this document) and naturalists, and expeditions were organised in 2007 (Grémillet and Dubos 2008, Grémillet *et al.* 2010), 2009, 2010 and 2011 with the help and collaboration of Y. Kazoglou and the SPP. The teams continued the inventory of bat species and the exploration of roosting and feeding sites, eventually increasing the number of species in the territory of the PNP-GR to 26 in autumn 2010 (27 species in the wider area). During these relatively short but intensive expeditions, data were collected on species distribution, status and habitat use (see section 12 for details).

In 2009, SPP launched a project aiming at the completion of a Conservation Action Plan for the bats of Prespa on a transboundary level. In the same year, the “bat” team visited the most widely known cave on the Albanian side of Prespa near the village of Treni (hereafter called Treni Cave) and explored Mali Grad Island for caves with the participation of the local forester N. Xega and F. Doleson from the SPP. In summer 2010, the first official transboundary collaboration was established between researchers from Greece, Albania and the FYR of Macedonia within the framework of a project for the development of a Transboundary Monitoring System (TMS) in the Prespa Park area (Perennou *et al.* 2009), implemented by the SPP in collaboration with the GEF/UNDP Prespa Park project³, and in collaboration with Galicica National Park (GNP). A

TMS workshop on bats including fieldwork in Albania and the FYR of Macedonia was held at Stenje, within the GNP, in July 2010, leading to the production of the first guidelines for future bat surveys and monitoring in and around the TPP (Papadatou, Grémillet & Kazoglou 2010). During summer 2010, bat surveys continued on the Greek side of Prespa and in autumn 2010 and winter 2011, surveys of bat roosting sites were conducted in all three countries with the participation of all authors of this document. Autumn and winter bat roost surveys were the first to be conducted in the area, since all previous work had been carried out in summer.

10.2 Albania

The first study on bats in the Albanian part of Prespa was conducted in May 1991 by Czech researchers (Chytil & Vlašin 1994). Their most important discovery was a large colony of approx. 10 000 *Myotis capaccinii* in Treni Cave, the largest known colony of the species in Europe at the time. In April 1995, a joint expedition of Slovak, Czech and Albanian researchers was organised in the Prespa area and other important sites in Albania (Uhrin *et al.* 1996). This survey resulted in new records on bat species in the Albanian part of Prespa, raising the number of known bat species to eight (*Rhinolophus ferrumequinum*, *R. blasii*, *R. hipposideros*, *Eptesicus serotinus*, *Myotis myotis*, *M. capaccinii*, *M. daubentoni*, *Hypsugo savii* and *Miniopterus schreibersii*). Of these, seven were in Treni Cave, thus making it the most important known underground roost in this side of Prespa, and one of the most important caves in Albania. However, researchers counted only 1000 *M. capaccinii* over that visit. In 2008, the Treni Cave was surveyed in the framework of a project conducted by the Albanian Society for the Protection of Birds and Mammals (ASPBM), entitled “Biodiversity Protection of Treni Cave, Prespa National Park”, funded by the GEF/SGP. During that time, the cave was fully explored by speleologists. More recently (2009-2011), the Treni Cave was surveyed by the French and local researchers and naturalists in collaboration with the SPP (see section 10.1), adding new species in the list (*Rhinolophus*

3. “Integrated Ecosystem management in the Prespa Lakes basin of Albania, FYR of Macedonia and Greece”

euryale, *Tadarida teniotis* and *Plecotus* sp.). Within the framework of this project, the rocky shore of the Greater Prespa Lake was explored and new roosting sites including some important caves for bats were discovered (see section 13.2).

10.3 FYR of Macedonia

The first data on bats were published by Karaman (1929) who recorded the presence of six bat species in the whole territory of the FYR of Macedonia, of which only one (*Rhinolophus blasii*) was reported from the Prespa region (Meckina Dupka Cave near Ohrid Lake). Much later, Felten (1977) reported another three bat species (*Rhinolophus euryale*, *R. ferrumequinum* and *Myotis blythii*) at Leskoec Cave. Hackethal & Peters (1987) reported *R. euryale* at Meckina Dupka and three species (*R. euryale*, *Myotis myotis* and *Miniopterus schreibersii*) at Jaorec Cave near Velmej. In his study on the distribution and taxonomy of *Myotis daubentonii* in Europe, Bogdanowicz (1990) reported the presence of the species at Trpejca, Lake Ohrid. Krystufek *et al.* (1992) further improved the knowledge on bats of the area: they confirmed the presence of most formerly recorded species, except *Myotis daubentonii*, and added another four species in the list: *Rhinolophus hipposideros*, *Myotis capaccinii*, *M. mystacinus* and *Hypsugo savii*. Overall, 11 species had been reported in the Prespa region by the early 1990s.

In summer 2006, the field group of the Dutch Society for the Study and Conservation of Mammals in cooperation with the management body of the GNP, the NGO Bioeco and the Macedonian Museum of Natural History organized a Summer Camp to investigate small mammals and bats in the region. For the bats, researchers applied acoustic sampling and mist netting, and visited roosts in caves and old abandoned or disused buildings. Overall, 17 bat species were recorded, of which nine were recorded in the Prespa region for the first time: *Myotis aurascens*⁴, *M. emargina-*

tus, *Pipistrellus kuhlii*, *P. pipistrellus*, *P. pygmaeus*, *Nyctalus leisleri*, *Eptesicus serotinus*, *Plecotus auritus* and *Tadarida teniotis* (Boshamer *et al.* 2006). The list of bat species hitherto recorded in the FYR of Macedonian part of the Prespa Park includes 19 species (20 including the ambiguous species *M. aurascens*).

10.4 Conservation Action Plan for the bats of Prespa

In the following sections we present in detail and synthesise all currently available knowledge on bats in the three countries sharing the Prespa Basin: Greece, Albania and the FYR of Macedonia. This information along with information provided in PARTS I and II forms the basis for research, survey and conservation recommendations presented in the fourth and final part (PART IV). In section 11, we present the techniques for data collection and analysis applied during our expeditions. Species accounts and other information presented in sections 12, 13 and 14 are derived by both the results of our field expeditions and bibliographical resources.

11. Data collection: field techniques and analysis methods

Fieldwork was carried out in the summers of 2004, 2007, 2009 and 2010, in the autumn of 2010 and in the winter of 2010-2011. Each field visit lasted a fortnight on average, during which usually a combination of complementary techniques were applied in both day- and nighttime to collect as much data as possible within the available time framework. Methods were complementary because bats may escape one method or the other (for example many bats escape nets and traps or they may escape echolocation call recordings because they emit low intensity sounds). The following methods were applied (see also Appendix I):

4. Because we finally adopted the view by Mayer *et al.* (2007), we have not included this species in the final list presented in Table 12.1, accepting that only the morphologically similar *Myotis mystacinus bulgaricus* is present in the area.

11.1 Day-time surveys

Many buildings such as old houses, churches, barns and other structures in the villages of Prespa are used by bats, in particular by colonies of the lesser horseshoe bat *Rhinolophus hipposideros*. We first checked buildings potentially used by bats under permission of the owners, unless the building was abandoned and open to access. We subsequently checked each house or other structures containing colonies of at least a few individuals on a regular basis, i.e. once on every visit of the team at Prespa. We performed these visits in day-time. On each visit, we identified species, if possible sex and age (usually mothers with young *R. hipposideros*) and counted individuals roosting in the building using torches. To avoid disturbance to the colony, a minimum number of people entered each site but they were most often at least two to cross-check counts. We sometimes used bat-detectors to verify species identification or to identify any other species that could have escaped our attention. Some bats may further use small buildings or other man-made structures as night roosts and some of these sites were regularly checked over the course of summer visits.

The rocky shores of the Greater Prespa Lake were investigated for rock crevices, cavities and caves potentially used by bats. These sites were checked for bats or signs of bat use such as droppings and urine stains on the walls and ceilings. Parts of the eastern rocky shores of the Lake Lesser Prespa were also surveyed in summer 2007.

11.2 Captures

We captured bats using mist nets, a harp trap, hand nets or flip nets (Appendix I) where appropriate, at roosts during evening emergence, and at commuting or foraging sites above water surfaces (streams, river estuaries, artificial pools, etc.), along forest edge or across forest roads, from the level of the lakes up to 1800 m a.s.l. Nets and traps were regularly checked for trapped individuals. Whenever a bat was captured, it was immediately removed, placed in a cloth bag and hung in a safe place for

a short time (less than 30 minutes on average). As soon as species, sex, age, reproductive condition and biometric data were recorded, the bat was released on site. In some cases, DNA samples from the wings were collected according to standard international methodologies (Worthington Wilmer and Barratt 1996). When a bat detector was available, bats were usually recorded on release to allow for the construction of an echolocation call reference library for bat species present at Prespa.

11.3 Echolocation call recordings

Bats were recorded in free flight at roosting, foraging and commuting sites, particularly in open spaces and high altitudes (e.g. subalpine meadows) or on release from captures. We used time-expansion detectors (Pettersson Elektronik, models D240X, D980, D1000X) and a recording device (Edirol, minidisc recorders) unless the detector had a built-in recording system to store data (compact flash card, model D1000X). Calls were subsequently downloaded on a computer and analysed using appropriate sound analysis software (BatSound, Pettersson Elektronik). Species were identified using echolocation experts' judgement and bibliographical resources (Papadatou *et al.* 2008a, Russo and Jones 2002) for species for which identification is relatively easy (e.g. *Pipistrellus pipistrellus*). However, for species whose call characteristics overlap, more elaborate statistical techniques were applied (Papadatou *et al.* 2008a, Russo and Jones 2002).

11.4 Roost emergence counts

The method was applied when the structure of a cave entrance allowed the count of emerging bats in the evening and when it was otherwise difficult or impossible to count bats inside the cave during the day (e.g. because they were agitated and flying or because we did not want to disturb a maternity colony). On certain occasions both methods were applied to cross-check counts. In some caves counting bats in the cave or during emergence was not possible (e.g. because the entrance structure

did not allow emergence counts), in which case we roughly estimated the order of magnitude of bats present in the cave. To count emerging bats, two observers were placed at each side of the entrance (more observers for more entrances) and a third person noted the two simultaneous counts, calculating the average. Bats crossed through the light of a soft torch not shining directly against the entrance but from an angle so that emergence was not disturbed. Heterodyne bat detectors placed at the exit helped observers by announcing emerging bats. Species identification was possible through visual observations (inside the roost during the day) and heterodyne or time-expansion bat detectors.

12. Bats on the Greek side of Prespa

12.1 Species accounts

Overall, 26 species have been recorded within the boundaries of the PNP-GR (Tables 12.1 and 12.2), i.e. almost 80% of all species found in Greece, a particularly high proportion for an area that only covers *ca.* 300 km². An additional species has been recorded commuting or foraging in the valley of Ladopotamos (located to the south of Mt Sfika in Greece), the Parti-coloured bat, *Vespertilio murinus*, which is likely to occur within the boundaries of the PNP-GR, since it offers suitable habitats for the species. Therefore, the overall number of species that occur in and around the Prespa Basin adds up to 27 (Table 12.1). The area has a unique bat fauna, hosting a large number of species with a wide range of roosting and foraging requirements. This most possibly reflects the presence of the lakes and associated wetlands along with the highly heterogeneous and structured environment offering a wide variety of habitat types both for roosting and for foraging, where insect prey is presumably still very abundant.

In this section, we briefly describe some general features of the bat species that live in the area of Prespa, mostly based on Dietz *et al.* (2009) and on our personal experience, unless stated otherwise. Forearm measurements reflect the skeletal size of bats. We further provide all currently

available information on each species distribution (Appendix II), status and habitat use in the PNP-GR and adjacent area. To date, 17 out of the 26 species (65%) have been confirmed to breed within the National Park (Table 12.2). For some species, mainly or only males and non reproductive females have been encountered, while for a few others their presence has been confirmed through visual observations and/or echolocation call recordings without the possibility to identify sex and age (Table 12.2). Autumn swarming behaviour has been confirmed for at least five species. Hibernating bats have generally not been found except a few tens of medium sized Rhinolophids (*R. euryale* and *R. blasii*) and a few *Rhinolophus ferrumequinum*.



E. PAPADATOU

TABLE 12.1 The 27 bat species found to date in and around the Transboundary Prespa Park, including the two National Parks of Prespa (Greece and Albania), and the Galicica National Park (FYR of Macedonia). Common names are given in the 3 local languages and in English.

Species (scientific name)		Common names			
		Greece	FYR of Macedonia	Albania	U.K.
Family Rhinolophidae					
1	<i>Rhinolophus hipposideros</i>	Μικρορινόλοφος	Mal Potkovichar	Lakuriq nate hund-patkua i vogel	Lesser Horseshoe Bat
2	<i>R. ferrumequinum</i>	Τρανορινόλοφος	Golem Potkovichar	Lakuriq nate hund-patkua i madh	Greater Horseshoe Bat
3	<i>R. euryale</i>	Μεσορινόλοφος	Juzhen Potkovichar	Lakuriq nate hund-patkua i Mesdheut	Mediterranean Horseshoe Bat
4	<i>R. blasii</i>	Ρινόλοφος του Blasius	Blasiev Potkovichar	Lakuriq nate hund-patkua i Blasius-it	Blasius Horseshoe Bat
Family Vespertilionidae					
5	<i>Myotis daubentonii</i>	Μυωτίδα του Daubenton	Voden Nokjnik	Lakuriq nate i Daubenton-it	Daubenton's Bat
6	<i>M. capaccinii</i>	Ποδαρομυωτίδα	Dolgoprst Nokjnik	Lakuriq nate gisht-gjate	Long-fingered Bat
7	<i>M. brandtii</i>	Μυωτίδα του Brandt	Brantov Nokjnik	-	Brandt's Bat
8	<i>M. mystacinus</i>	Μουστακονυχτερίδα	Mustakjest Nokjnik	Lakuriq nate me mustaqe	Whiskered Bat
9	<i>M. nattererii</i>	Μυωτίδα του Natterer	Chetiness Nokjnik	Lakuriq nate i Natterer-it	Natterer's Bat
10	<i>M. emarginatus</i>	Πυρρομυωτίδα	Troboen Nokjnik	Lakuriq nate i Geoffroy-it	Geoffroy's Bat
11	<i>M. bechsteinii</i>	Μυωτίδα του Bechstein	Dolgoushest Nokjnik	Lakuriq nate i Bechsteini-it	Bechstein's Bat
12	<i>M. myotis</i>	Τρανομυωτίδα	Golem Nokjnik	Lakuriq nate vesh-miu i madh	Greater Mouse-eared Bat
13	<i>M. blythii (oxygnathus)</i>	Μικρομυωτίδα	Ostroushest Nokjnik	Lakuriq nate vesh-miu i vogel	Lesser Mouse-eared Bat
14	<i>Nyctalus leisleri</i>	Μικρονυκτοβάτης	Shumski Vechernik	Noktule e Leisler-it	Lesser Noctule
15	<i>N. noctula</i>	Νυκτοβάτης	Lisest Vechernik	Noktule	Noctule
16	<i>Pipistrellus pipistrellus</i>	Νανονυχτερίδα	Dzudzest Liljak	Pipistrel i zakonshem	Common Pipistrelle
17	<i>P. pygmaeus</i>	Μικρονυχτερίδα	Kafeav Dzudzest Liljak	-	Soprano Pipistrelle
18	<i>P. nathusii</i>	Νυχτερίδα του Nathusius	Natusiev Liljak	Pipistrel i Nathusius-it	Nathusius' Pipistrelle
19	<i>P. kuhlii</i>	Λευκονυχτερίδα	Beloraben Liljak	Pipistrel i Kuhl-it	Kuhl's Pipistrelle
20	<i>Hypsugo savii</i>	Βουονονυχτερίδα	Saviev Liljak	Pipistrel i Savi-it	Savi's Pipistrelle
21	<i>Eptesicus serotinus</i>	Τρανονυχτερίδα	Shirokokrilest Severnik	Lakuriq nate serotine	Serotine
22	<i>Plecotus auritus</i>	Καφέ ωπονυχτερίδα	Ushest Liljak	Lakuriq nate veshgiate i zakonshem	Brown Long-eared Bat
23	<i>P. macrotullaris</i>	Ορεινή ωπονυχτερίδα	-	-	Alpine Long-eared Bat
24	<i>P. austriacus</i>	Σταχτιά ωπονυχτερίδα	Siv Ushest Liljak	Lakuriq nate vesh-giate i hirte	Grey Long-eared Bat
25	<i>Vespertilio murinus</i>	Παρδαλονυχτερίδα	Sharen Polnokjnik	Lakuriq nate dy ngjyresh	Parti-coloured Bat
Family Miniopteridae					
26	<i>Miniopterus schreibersii</i>	Πτερυγονυχτερίδα	Dolgokrilest Liljak	Lakuriq nate i Schreiber-it	Bent-winged Bat
Family Molossidae					
27	<i>Tadarida teniotis</i>	Νυχτονόμος	Opashest Liljak	Lakuriq nate bisht-lire	Long-tailed Bat

NOTES: All 27 species have been found in and around the National Park of Prespa in Greece. In **bold** are the common names of species that have been observed in the Prespa area of the FYR of Macedonia and Albania. *Plecotus macrotullaris* was recorded by O. von Helversen in 2007 (pers. comm.). *Vespertilio murinus* has not been found in the National Park of Prespa (GR), but in the immediate surroundings (Ladopotamos valley). For *M. blythii* we provide the scientific name adopted by Dietz *et al.* (2009) in brackets. The presence of *Nyctalus noctula* has been identified only through sound.

TABLE 12.2 The 26 bat species in the National Park of Prespa (GR) and their status

Species	Breeding	Males only	Autumn swarming	Autumn presence
<i>Rhinolophus hipposideros</i>	√	-	-	√
<i>R. ferrumequinum</i>	√	?	-	√
<i>R. euryale</i>	√	-	-	√
<i>R. blasii</i>	√	-	-	√
<i>Myotis daubentonii</i>	√	√	√	√
<i>M. capaccinii</i>	√	-	√	√
<i>M. brandtii</i>	√	-	-	-
<i>M. mystacinus</i>	√	-	-	-
<i>M. nattererii</i>	√	-	-	-
<i>M. emarginatus</i>	√	-	-	-
<i>M. bechsteinii</i>	√	-	-	-
<i>M. myotis</i>	-	√	√	√
<i>M. blythii (oxygnathus)</i>	√	√	-	√
<i>Nyctalus leisleri</i>	-	√	-	-
<i>N. noctula</i>	?	?	-	-
<i>Pipistrellus pipistrellus</i>	√	-	-	√
<i>P. pygmaeus</i>	-	√	-	-
<i>P. nathusii</i>	-	√	-	√
<i>P. kuhlii</i>	√	-	-	-
<i>Hypsugo savii</i>	√	√	-	√
<i>Eptesicus serotinus</i>	-	√	-	-
<i>P. auritus</i>	√	-	-	-
<i>P. macrobullaris</i>	?	?	-	-
<i>Plecotus austriacus</i>	√	-	√	√
<i>Miniopterus schreibersii</i>	-	√	√	√
<i>Tadarida teniotis</i>	?	?	-	√

NOTES:

- Data are from the 2004-2011 surveys.
- “Males only” refer either to male only roosts or to species for which only (or mainly) males have been recorded at hunting/commuting sites in the area. In some species, male roosts may include some non reproductive females, e.g. *M. daubentonii*. In turn, some breeding colonies may contain adult males.
- Only the echolocation calls of *Nyctalus noctula* have been

recorded; *T. teniotis* have been observed in or emerging from their roosts in rock crevices; only one male *P. macrobullaris* has been recorded to date (O. von Helversen 2007, pers. comm.).

- Individual *R. ferrumequinum* have regularly been observed roosting singly in caves and buildings: these are presumably male individuals.

- Autumn presence has only been confirmed for species in underground sites and in buildings.



E. STOJKOSKA

Rhinolophus hipposideros

12.1.1 *Rhinolophus hipposideros* (Bechstein, 1800)⁵

General features

This is the smallest rhinolophid bat and one of the smallest and most sensitive European species (forearm 36.1-39.6 mm, weight 4-7 gr). In Europe it is found from Ireland to Romania and from the Iberian Peninsula to Greece. It prefers warm areas and therefore its populations are more dense and numerous in the south of Europe. Today, its distributional range and population densities are strongly related to human activities (agro-pastoral areas and forests for feeding; traditional buildings for roosting), particularly nursery colonies.

Preferred habitat and movements. These bats are typically found in areas of extensive agriculture and a mosaic of landscapes, well connected with a network of linear landscape elements such as hedge-

rows, tree lines, forest edges and riparian vegetation. Their key foraging habitats are broadleaf woodlands, but they also feed in agro-pastoral landscapes preferably near water, and along hedgerows and riparian vegetation. Nursery colonies are generally found at altitudes below 1200 m a.s.l., but the species may reach up to 2000 m a.s.l. in summer. It is a sedentary bat, spending its annual cycle in an area of 10-20 km² that includes all the roosts (breeding, transitional and hibernation) and feeding habitats.

Roosts. They typically hibernate in natural or artificial underground structures. In summer, they look for the warmest sites in an area. Summer and autumn roosts are mostly artificial (mines, old and/or abandoned traditional houses, disused barns, chapels, attic rooms, roof spaces, chimneys, etc.) but they may also be natural (rock cavities and crevices, caves, trees). Maternity colonies are typically formed in warm roof spaces or other warm parts of buildings free of draughts. They prefer buildings in which they may roost at different locations in relation to optimal ambient temperatures. Their preferred buildings are often located near ponds, riparian forest and streams. Maternity colonies usually count between 10 to over 150 females with their young. In the natural environment, they are found in well heated cavities. In the absence of direct disturbance, *R. hipposideros* may tolerate human presence. *Rhinolophus hipposideros* and *R. ferrumequinum* can coexist within the same roost, but at different places.

Hunting habitats. Half of the times hunting takes place in the vicinity of the roost (600 m) and 90% up to 2.5 km from the roost, sometimes up to 4 to 8 km if there are secondary roosting sites connected to the primary roost. Hunting sites typically include:

- Trees near their roosts, forest edge, hedgerows, tree lines, old-growth broadleaf woodland with rich understory vegetation, riparian forest, and they may generally prefer sites near water.

- A mosaic of traditional agro-pastoral / agro-forestry systems (forested patches, orchards, small agricultural fields, pastures, etc.).

Threats. The modern way of life in Europe has resulted in the decrease of *R. hipposideros* populations in western and northern Europe, some of

⁵ *Rhinolophus hipposideros* is generally treated in more detail relatively to the rest of the species both with regards to its general features as well as specifically for Prespa, as it is the best known species in the area inhabiting almost exclusively most artificial sites (buildings) examined to date, as well as a number of natural roosts (rock cavities); some of the details (e.g. with regards to roosting spaces in buildings or specific hunting sites) may also apply to other species. Specific sections with proposed actions are devoted to the species in PART IV and these are based in the more detailed descriptions provided here.

which are now extinct in certain areas. For example, in Germany and Belgium, only 2000 and 200 bats remain respectively (for comparison, up to 200 bats are found in an old building in Prespa). Some good populations are still preserved in the Balkans (from Slovenia to Greece and Bulgaria), where human activities have not yet been radically changed. In the UK recent indications are that the dramatic decline in the species population levels recorded in the middle of the last century has slowed down and is reversing (Schofield 2010). In western Europe, the high mortality of the species is related to pesticides and chemicals used for the treatment of timber. The destruction of feeding habitats and roosts (e.g. closure of attic and other roof spaces) constitutes another major factor for the disappearance of certain populations. In Mediterranean Europe, the species is threatened by the abandonment of traditional agro-pastoral and agro-forestry practices, pesticides, intensive agriculture, and the destruction of traditional houses.

Prespa

The ecological features of the species here appear to be similar to the Bulgarian populations, with hunting sites in or near traditional villages. The species presumably forms a large population in the Prespa Basin, comprising many sub-populations, colonies or groups related to the topography, and the location of suitable roosts and hunting sites. Specifically:

Roosts. In the Greek part of Prespa, the main known subgroups are distributed in the following areas (Appendix II)⁶:

- Valley of Ag. Germanos (approx. 300 bats in total) comprising the villages of Ag. Germanos (> 100 bats; 1000-1185 m a.s.l.), Laimos (< 100 bats), and Milionas (< 100 bats; 900 m a.s.l.). Colonies were found in old or abandoned traditional houses and disused barns. Some nursery roosts disappeared following the renovation of buildings. Colonies are threatened either by the collapse of roofs and walls of abandoned houses or by their reconstruction/renovation without consideration of bats.

- The area of Oxya, comprising the villages of Oxya (< 100 bats; 880 m a.s.l.), Karyes (> 10 bats;

930 m a.s.l.) and Mikrolimni (> 50 bats; 860-900 m a.s.l.). Colonies were found in old or abandoned traditional houses and chapels. An old isolated house made of mud bricks (rough bricks made of soil and straw) in Seltza (Appendix II) hosting approx. 15 bats is currently in the process of collapse. In Oxya village, an abandoned house made of mud bricks and an old chapel host > 30 bats each, whereas some other abandoned houses < 10 bats. The biological station near Mikrolimni village hosts < 50 bats and a few individuals have been found in the rock cavities nearby.

- Agathoto. A nursery colony of up to 200 bats is found in a single site (approx. 45 bats in autumn). It is likely that the colony uses various small cavities and buildings in the adjacent areas of Vrondero (GR) and Shueç (AL).

- The island of Ag. Achilleios in Lesser Prespa Lake (< 100 bats in total). There are only a few suitable sites including Panagia Porphyra ruins (up to 32 bats before repairing the window, now < 10), two old houses with > 10 and > 65 bats each, and a rock cavity with < 10 individuals at Mikros Kampos (Appendix II).

- The Greater Prespa Lake. Some small groups or single individuals use cavities on the rocky cliffs along the shore in the southwest, from Psarades village to the border with Albania where a vault in the cliff has been found to host > 12 bats. Groups of bats have also been found in the hermitages of Metamorphosis, Analipsi and Eleousa. Bats may also be present in buildings in Psarades village, but these have not been examined.

Population size. The total size of the summer population on the Greek side of Prespa is estimated to approx. **700** individuals. For comparison, only about 200 *R. hipposideros* remain in the entire territory of Belgium!

Hunting habitats. Because the species roosts at sites located within its hunting habitats, we estimate that it hunts:

- Near the lakes, and along streams and rivers, in riparian vegetation, reed beds and traditional irrigation networks.

- Along tree lines, hedgerows and forest edge.

- In broadleaf woodland with pastures and meadows.

6. Numbers only refer to summer and are minima because many potential roosts were not visited as they are in private properties for which permission was not obtained.

- Generally in the mosaic of agro-pastoral and agro-forestry landscapes present in the area, including irrigated gardens, orchards, riparian vegetation, streams and wetlands, meadows, pastures, broadleaf woodland, etc.

Bats have most probably been recorded hunting at 1300 m in the riparian vegetation of Gaidhouritsa stream (Appendix II), at a site surrounded by mountain pastures and beech forest. Some echolocation call recordings suggest that the species may hunt at higher altitudes (see section 12.3, Table 12.4).

Annual cycle. In the autumn colonies progressively disperse from their summer roosts. The warmest among summer sites are still used in the autumn (better exposure to the sun, low altitude, and absence of draught). The species appears to spend the winter not far from its summer roosts, probably mostly staying at Prespa all year round, scattered in small groups (1 - 10 bats) at many sites that are often inaccessible to humans (e.g. very small caves, rock cavities, burrows, small holes or pipes), perhaps also in some ruins or cellars. Several bats were found in caves and small cavities around Prespa in winter 2010-2011 in all three countries. According to other studies, these bats may travel up to 20 km between summer and winter roosts and it is generally difficult to locate winter roosts, given the diversity of potential sites that the species may use in winter. Nursery roosts are already occupied at the beginning of May (even at an altitude of 1050 m a.s.l.)

12.1.2 *Rhinolophus ferrumequinum* (Schreber, 1774)

General features

This is the largest of the five European rhinolophid bats (forearm 53.0-62.4 mm, weight 18-24 gr). In Europe, the species distribution extends from the Iberian Peninsula through to the centre of the continent (including the south of England to the north) and the Mediterranean basin, the core of its European distribution. It is generally found in warm lowlands and in the Mediterranean in mountains up to 1500 m a.s.l.

Preferred hunting habitats. Highly structured environments with a mosaic of habitats including broadleaf forests, pastures, hedgerows, tree



Rhinolophus ferrumequinum

C. DIETZ

lines and orchards. Livestock grazing in the open provides the species with an important source of food: dung beetles. Riparian vegetation becomes an important foraging habitat in cool weather during the massive emergence of cockchafer. The species hunts on average at 5 km from the roost, chasing moths low above the ground or vegetation and close to livestock where dung beetles are abundant. It regularly hunts by a perch.

Roosts. The bat uses underground sites all year round, but in northern Europe as well as in areas without suitable underground sites in the south, summer maternity colonies roost in buildings.

Seasonal movements. It is a sedentary species with short-range movements (usually a few tens of km) between summer roosts and hibernacula.

Conservation status and threats. The species has experienced dramatic declines in northwest Europe within the last 100 years (e.g. UK, The Netherlands, and Belgium) and it is now almost extinct in Germany. In some European countries however, there are signs of recovery (Hutson *et al.* 2001). The most important factor for these declines were highly toxic pesticides (DDT etc.) used in agricultural practices and for the treatment of timber, decreasing insect prey and accumulating in the bats' bodies. Today, the greatest threats are hunting habitat degradation and loss, but pesticides still constitute a threat, as well as cave tourism and the use of anti-parasitic drugs in livestock leading to a decrease in dung beetles.

Prespa

The species breeds in the Prespa area (Table 12.2). A single breeding colony of up to a few hundred individuals and mixed with other rhinolophid bats is



T. PRÖHL

Rhinolophus euryale

known from the Greek side of Prespa, in Tchernia Cave (Appendix II). Lactating individuals have been captured at Devas mountain, hunting or commuting in oak forest, a few kilometres to the southeast of the cave. Individual bats (males?) roosting singly have been observed in several rock cavities along the lakes' shore, in old or abandoned houses, old chapels or other disused buildings often where *R. hipposideros* colonies are present, but roosting at different places within the same site. The species uses regularly a small building near the Mikrolimni Biological Station as a night roost (Appendix II). In autumn, some individuals appear to use Zachariadis' Cave as a mating site: in October 2010 three adult bats (one male and two females) all sexually active were found roosting together in the cave. In the same month, five more individuals were found roosting in a cave on the coast of Greater Prespa Lake, in the west of Psarades village, near Cape Roti, hereafter called the "Flea" Cave (Appendix II; large numbers of fleas were in the cave in summer and autumn 2010). We do not know where the species goes in winter, although two individuals were found torpid in a small narrow cave to the north of Tchernia Cave.

12.1.3 *Rhinolophus euryale* (Blasius, 1853)

General features

This is one of the three medium-sized Rhinolophids (forearm 45.0-51.0 mm, weight 9-14 gr). It has a Mediterranean distribution.

Roosts and movements. The species roosts in underground sites throughout the year (sometimes in buildings in the northern border of its distribution), though it moves between different roosts in summer and winter with recorded distances usually up to 100 km. Maternity colonies generally occur in areas below 800 m a.s.l. and are often mixed with other Rhinolophids, cave dwelling *Myotis* species and *Miniopterus schreibersii*.

Preferred hunting habitats. Oak and mixed forests, riparian forests and often scrubland. They can hunt in very dense vegetation, along forest edge and in tree canopy up to 20 m high or close to the ground. Open areas and conifer woodlands are avoided. Recorded distances between roosts and foraging grounds vary between 1.5 and 24 km on average.



Rhinolophus blasii

Conservation status and threats. Major declines of the species were observed in the 1950s in France, where only a small proportion of the original population remains and it is now extinct in parts of Slovakia. Important factors leading to these declines were most possibly roost disturbance (cave tourism, winter ringing) and chemical spraying of pesticides in forests, riparian vegetation for mosquito control and orchards. It is very sensitive to roost disturbance and disappears from caves opened to tourism.

Prespa

The species breeds in the Prespa area (Table 12.2). It forms a mixed species breeding colony in Tchernia Cave along with *R. ferrumequinum*. The two species roost separately from *Myotis capaccinii*, *M. emarginatus* and *Miniopterus schreibersii* which form mixed species clusters in a different part of the same cave. Echolocation call recordings inside the cave in 2007 revealed the absence of the species during that year but the colony was present both in 2009 and 2010. This suggests that the colony use alternative roosting sites for breeding which for the moment remain unknown. In autumn, a large colony mixed with *R. blasii* (about 760 bats in total) used a small cave behind Mikrolimni village (hereafter called Mikrolimni Cave; Appendix II). The summer colony was no longer present in Tchernia Cave during the autumn, suggesting the possibility that the same bats may move to Mikrolimni Cave where the conditions may be more suitable. The species has also been found foraging in oak forest at Devas Mountain, and visiting Kokkalis' and Zachariadis' caves at night (Appendix II). We do not know where the

species hibernates: in February 2011, only a small colony (< 50 bats) of medium sized Rhinolophids including *R. euryale* were found in the Mikrolimni Cave but they were not in deep torpor.

11.1.4 *Rhinolophus blasii* (Peters, 1866)

General features

This is another medium-sized rhinolophid (forearm 42.6-50.1 mm, weight 10-14 gr) and it is morphologically similar to *R. euryale*. It is confined to the south-east of Europe and it is a typical species of Mediterranean landscapes with a mosaic of small open habitats and shrubland. It usually occurs at lower altitudes.

Preferred hunting habitats. Scrublands, oak forests, and hedgerows in a highly structured environment, preferably at areas with sparse trees, open spaces, forest and shrubland, catching prey on the wing or close to the vegetation.

Roosts and movements. Maternity colonies are in underground sites, often mixed with other cave-swalling species (other Rhinolophids, *Myotis* species, *Miniopterus schreibersii*). It is a sedentary bat, but hibernacula may be in different underground sites from summer roosts. The bats fly up to 10 km from their roost to foraging areas and up to 100 km between summer and winter roosts.

Conservation status and threats. European populations are particularly threatened and are probably extinct in the northern border of the species distribution (Dalmatia, Slovenia, Romania and northern Bulgaria) with the distribution limit having been pushed 250-300 km to the south. In the south of Bulgaria and in Greece populations appear to be stable but are particularly threatened by cave tourism. It is therefore an urgent need to establish an international programme for the conservation of the European populations of the species.

Prespa

The typical echolocation calls emitted by the species were first recorded during day-time in Tchernia cave in 2009. However, it was not until 2010 that its presence was confirmed through the capture of a juvenile female night roosting in a small building near Mikrolimni Biological Station (Appendix II). There-

fore the species breeds in the area (Table 12.2), but to date no breeding roost has been found. It has further been recorded visiting some of the known caves (Kokkalis', Zachariadis', and Tchernia) in summer and autumn. Echolocation call recordings at Zachariadis' Cave suggest its regular use by the species probably as a night roost. Several hundred bats roost in Mikrolimni Cave in a mixed colony with *R. euryale* in autumn, probably using it as a transitional site between their summer and winter roosts which to date remain unknown. In February 2011, a small colony of medium sized Rhinolophids including *R. blasii* were found in Mikrolimni Cave but they were not in deep torpor. The species has also been recorded foraging near the stream of Ag. Germanos in summer.

12.1.5 The “trawling” bats, *Myotis daubentonii* (Kuhl, 1817) and *M. capaccinii* (Bonaparte, 1837)

General features

These are medium-sized bats but *M. capaccinii* is slightly larger than *M. daubentonii* (forearm 38.4-44.0 mm, weight 7-10 gr; forearm 33.1-42.0 mm, weight 6-10 gr, respectively). *Myotis daubentonii* is found in most of Europe but its distribution is fragmented in the Mediterranean part where it is mostly found on mountainous and hilly areas. In contrast, *M. capaccinii* is almost confined in the Mediterranean part of the continent.

Hunting habitats. Both species possess large feet to “scoop” insect prey from water surfaces, hence the term “trawling”. However, *M. daubentonii* may also hunt in forest, parks or above wet meadows. A basic habitat requirement therefore for both species is clean and calm water surfaces (streams, rivers, lakes, artificial water pools, etc.) relatively near their roosts.

Roosts and movements. *Myotis daubentonii* roost primarily in trees and may also use cracks in bridges; in the south of their distribution they also use rock crevices and cavities usually near the entrance of larger caves. In winter they may use trees, rock crevices and underground sites. In contrast, *M. capaccinii* is a strict cave-dwelling bat forming colonies from a few tens up to several hundred or thousand individuals in caves, tun-



Myotis capaccinii

C. DIETZ

nels, mines, etc., throughout the year. Individual bats may roost singly in rock crevices, and cracks in walls or bridges. Because of the limitations posed by its roost choice, *M. capaccinii* may travel longer distances up to a few tens of kilometers to find suitable foraging habitats, whereas *M. daubentonii* may be able to find suitable roosting sites closer to water relatively more easily. Both species use a network of roosting sites, frequently switching roosts within seasons (spring, summer and autumn; trees/bridges/rock crevices for *M. daubentonii*, and underground sites for *M. capaccinii*). They are short-distance migrants travelling up to 150 km distance on average between summer and winter roosts. In late summer and autumn they often travel several km to their swarming sites.

Conservation status and threats. *Myotis capaccinii* has experienced dramatic declines at the northern limit of its distributional range and it is now extinct in Switzerland and parts of northern Italy. Recently, aerial spraying of pesticides over agricultural areas and for control of mosquitoes was followed by the abandonment of some important cave roosts in the north of Bulgaria. Hunting habitats (water bodies) of both species may be polluted with toxic substances because of pesticides mixed with water used for irrigation.

Prespa

In Prespa, *M. daubentonii* and *M. capaccinii* are found in sympatry. Trawling bats have been observed hunting above the lakes' surface and near wet meadows, and *M. daubentonii* has been captured at Lesser Prespa Lake (Appendix II). *Myotis daubentonii* has the southern limit of its distribution in northern

Greece and *M. capaccinii* is a more common species with a patchy distribution throughout the country, particularly in areas with caves and water.

Both species are privileged in the area of Prespa, since suitable roosting sites are found right next to the lakes. Small groups of *M. daubentonii* roost in rock crevices on cliffs along the lakes' shore (e.g. near Mikrolimni village and Tchernia Cave; Appendix II); at least some of these are male roosts including a few non reproductive females, as it has been confirmed through captures. Breeding colonies roost in small cavities near the entrance of the Cape Roti Cave (Table 12.2; Appendix II). *Myotis capaccinii* forms large breeding colonies of several hundred individuals in Tchernia and Cape Roti caves (Table 12.2; Appendix II), roosting in the large domes of the ceiling. The breeding colony in Tchernia is mixed with other species (*M. emarginatus*, *Miniopterus schreibersii*). By the autumn these colonies from both species have mostly dispersed; only a few tens of individuals are left (Cape Roti Cave) or males swarming (Tchernia Cave). We do not know if they swarm at Cape Roti Cave.

The colouration of the fur of *M. daubentonii* found in Prespa is paler and more greyish-brown compared to its conspecifics in northern and central Europe, in accordance with von Helversen and Weid (1990) and Hanak *et al.* (2001) who report a difference in fur colouration between bats in the uplands and those found in the lowlands, as well as between the southern marginal populations and the populations in other parts of the species distribution. However, these differences have not been studied in detail.

12.1.6 Whiskered bats

General features

Myotis brandtii (Eversmann, 1845) and *M. mystacinus* (Kuhl, 1817) are morphologically very similar species often very difficult to be distinguished even in the hand. They are small bats (*M. brandtii*, forearm 33.0-38.2 mm, *M. mystacinus*, 32.0-36.5 mm; weight 4-7 gr). *Myotis brandtii* occurs in central and north-northeastern Europe, with some isolated records from mountainous regions in the south including the north of Greece which appears to be the southern limit of its dis-



Myotis brandtii

tribution. *Myotis mystacinus* is a more common bat with a wider distribution, occurring from the Iberian Peninsula through to northern, central and eastern Europe being quite common in the Balkans including Greece down to Crete.

Preferred hunting habitats. *Myotis brandtii* depends on forested areas with water: in the south-east it hunts almost exclusively in mountainous forests up to the tree line, more rarely in riparian vegetation; in contrast, *M. mystacinus* in the Balkans appears to be dependent for hunting on riparian vegetation and water at all altitudes from the lowlands up to the tree line. In the north of their distribution, both species use a wider range of habitats.

Roosts and movements. In summer, *M. brandtii* roosts in trees and artificial structures. *Myotis mystacinus* roosts in buildings and behind the exfoliating bark, and in the Balkans often in bridges, frequently switching between alternative roosting sites. Both species hibernate in underground sites and are sedentary, travelling less than 100 km between summer and winter roosts. *Myotis mystacinus* is among the most frequently encountered bats at caves during the swarming season.

Threats. Important threats are intensive forest management practices, forest clearings, and deforestation.

Prespa

Both species breed at Prespa NP (Table 12.2). Genetic analysis (F. Mayer, pers. comm.) confirmed the presence of *M. brandtii* in the PNP-GR in 2007. A male juvenile bat was captured in beech forest at 1300 m a.s.l., and a male adult in beech-fir forest at 1700 m a.s.l. (Appendix II). This is the second out of

three records of the species in Greece; it has not been recorded at Prespa since, suggesting that it is a rare bat in the area, rarer than *M. mystacinus*. This is no surprise given that Prespa is located in the southern limit of its distribution. In contrast, *M. mystacinus* appears to be much more common in the area (Appendix II): a few adult males have been captured near oak and beech forest and stream at 1200 and 1300 m a.s.l. respectively, in sub-alpine meadows hunting above water (a large livestock drinking site) at 1500 m a.s.l. and in beech-fir forest at 1700 m a.s.l.; one male was captured along forest edge near wetlands at the level of the lake. Most other bats were breeding females and juveniles found exclusively near water mostly at the level of the lake, and at wetlands and streams up to 1450 m a.s.l. in beech forest. It is the most frequently encountered bat along the stream of Ag. Germanos (Appendix II).

12.1.7 *Myotis nattererii* (Kuhl, 1817)

General features

A medium-sized *Myotis* species (forearm 34.4–44.0 mm, weight 7–10 gr) with relatively large ears. It occurs throughout Europe.

Preferred hunting habitats. It typically hunts near vegetation often gleaning from foliage and uses a variety of habitats from the lowlands up to the tree line: forests and areas with sparse trees such as orchards and parks, also near water. All forest types are used,

from beech and oak to pine and fir. Open spaces are used when in the vicinity of forest and orchards. In the Mediterranean, other forest types in the broader sense may also be used such as olive groves.

Roosts and movements. It roosts in trees and buildings in northern and central Europe and rather in rock and wall cavities and crevices in the south, frequently switching between a number of alternative sites within seasons. Hunting sites are usually up to 4 km from the roost. Autumn swarming at caves takes place in September and October; along with *Myotis myotis* and *M. daubentonii* it is the most frequently captured bat at swarming sites in central Europe. It hibernates in underground sites. It is a sedentary species and recorded distances between summer, swarming and hibernation sites usually do not exceed 60–90 km (Fleming and Eby 2003, Dietz *et al.* 2009).

Prespa

Although a common species in the rest of Europe, it is rather rare in Greece and Prespa appears to be no exception: two females were observed in a cavity in August 1988 by von Helversen & Weid (1990). An adult female and an adult male were further captured by the authors in a beech forest at 1450 m a.s.l. in 2007 and a juvenile male in forest at ca. 980 m a.s.l. in 2009 (Appendix II). The species therefore breeds in the PNP-GR (Table 12.2). We know nothing further about specific roosts and hunting sites of the species.



Myotis nattererii

12.1.8 *Myotis emarginatus* (Geoffroy, 1806)

General features

A medium-sized *Myotis* species (forearm 36.1-44.7 mm, weight 6-9 gr) with a characteristically ginger-red colouration of fur occurring from the Iberian Peninsula through to central and Mediterranean parts of Europe, down to the Balkans and Asia Minor.

Preferred hunting habitats. It hunts close to the vegetation, often in the tree canopy gleaning insects from foliage, in broadleaf forests, orchards, parks and gardens. In central Europe it hunts flies in barns and in Bulgaria bats have been observed hunting at sheep pens. In general, the species prefers a highly heterogeneous environment with many trees and shrubs, while it avoids conifer woodlands and open areas.

Roosts and movements. Roosts are in buildings in the north of its distribution and most often in caves and rock cavities in the south; the species uses a network of roosting sites within seasons. Single individuals may also be found in trees. Colonies mainly in the Mediterranean are often mixed with other species (Rhinolophids, other *Myotis* species and *Miniopterus schreibersii*). Recorded distance between foraging and roosting sites does not exceed 12.5 km. Autumn swarming behaviour at caves is typical for this bat, similarly to other *Myotis* species. It is sedentary with a recorded distance among winter and summer sites generally of less than 40 km.

Myotis emarginatus



Myotis bechsteinii

Conservation status and threats. Since the 1950s, it has experienced dramatic declines in the north of its distribution up to 90% in Poland, because of habitat loss and pesticide use. Its populations are stable in Germany but increasing habitat fragmentation because of road construction is a serious threat.

Prespa

The species breeds (Table 12.2) in Tchernia Cave in mixed species clusters and possibly in Cape Roti Cave, since a juvenile bat has been captured in the latter. The species has also been observed in a rock crevice along the shore of Greater Prespa (Appendix II). Some bats were flying near Zachariadis' Cave (capture records), but it is not clear whether they use the cave as a night roost or whether they hunted/commuted in the surrounding forest.

12.1.9 *Myotis bechsteinii* (Kuhl, 1817)

General features

A medium-sized *Myotis* species (39.0-47.1 mm, weight 7-10 gr) with characteristically long ears, present in western, central and eastern Europe.

Preferred habitats. It is a typical forest-dwelling bat inhabiting broadleaf (beech and oak) and mixed forests, more rarely coniferous woodland, from the lowlands up to the mountains. In the south it is rarer and is generally found up on the mountains or in riparian forest. The species flies slowly hunting at 1-5 m from the ground and gleaned insects from substrates (foliage from the ground level to the tree canopy).

Roosts and movements. Colonies roost in tree cavities and bat boxes (where tree cavities are not abundant), frequently switching between different trees. Hunting habitats are generally at up to 1 km from the roost, less frequently at up to 2.5 km. It is a sedentary species.

Threats. Because it is primarily adapted to old growth broadleaf forest habitats that are stable in the long-term, it was most possibly more abundant prior to the human intervention in forest ecosystems. Crossing open spaces including roads may pose a substantial risk because it flies low near the ground: it has been shown that it is reluctant to cross roads (Safi and Kerth 2009). Forest fragmentation and clearings are therefore an important threat to the species.

Prespa

Myotis bechsteinii is a rare bat in Greece and in the area of Prespa. Its presence was confirmed for the first time in 2009, when three breeding adult females were captured near the lake and at approx. 1200 m a.s.l. near beech forest (Appendix II). The species therefore breeds in the Prespa NP (Table 12.2), but we lack any further knowledge with regards to specific breeding roosts, as well as roosting sites used in the autumn or winter.

12.1.10 Mouse-eared bats

General features

Myotis myotis (Borkhausen, 1797) and *M. blythii* (Tomes, 1857) are large bats (*M. myotis*, forearm 55.0-66.9 mm, weight 20-27 gr; *M. blythii*, forearm 50.5-62.1 mm, weight 19-26 gr). They are sibling and morphologically similar species not easily separated in the field unless identified in the hand and even then, it may be difficult. *Myotis blythii* was until recently classified as the sub-species *M. b. oxygnathus* of a species described in India. Although it has been recently re-classified as *Myotis oxygnathus* (Monticelli, 1855) because of clear differences in the DNA of Asian and European sub-species (Dietz *et al.* 2009), we continue to use the traditional scientific name *M. blythii*, as it is currently still more widely applied.



Myotis blythii

In Europe, *Myotis myotis* occurs from the Iberian Peninsula and the Mediterranean up to the north of the continent reaching the Black Sea to the east; *M. blythii* is found in the Mediterranean up to the centre of the continent.

Preferred habitats. *Myotis myotis* typically lives below 800 m a.s.l. but if the climate is favourable it may be found at higher altitudes. Broadleaf deciduous or mixed forests with little understorey cover are preferred, but often coniferous forests are used. They forage in the forest, and also at meadows, pastures and freshly grazed or mown fields, usually 5-15 km from their roost (up to 26 km). *Myotis blythii* is found in warm and open landscapes, wet and other meadows, pastures, karstic plateaus, and extensive agricultural lands. Both species typically hunt close to the ground looking for ground-dwelling arthropods, but they may also hunt on the wing, e.g. along forest edge.

Roosts and movements. Both species are cave-dwellers throughout the year in the south of Europe, usually forming mixed species maternity colonies in underground sites (with *Rhinolophids*, other *Myotis* bats and *Miniopterus schreibersii*) but they use buildings to breed in summer in the north of their distribution. Single males roost in small cavities in and near the entrance of caves and rock overhangs, in buildings, bridges and even tree cavities. Hibernacula are in underground sites. They are both sedentary bats covering less than 100 km between summer sites and hibernacula.

Conservation status and threats. The destruction of roosts, the use of pesticides (DDT etc.) in agriculture and forestry and of toxic products for timber treatment in buildings, and agricultural intensification led to dramatic declines of *M. myotis* colonies in Germany in the 1970s (down to 10% of the population). Although populations are stable at the moment, they are still threatened by increasing habitat fragmentation from roads, by renovation of buildings and accumulation of chemical toxic substances in the environment. In the south, cave tourism, increasing use of pesticides and the decrease of extensively managed grasslands are serious threats for both species.

Prespa

Many large *Myotis* bats have been observed roosting singly in rock crevices in and outside caves. These bats apparently belong to one of these species but in most cases, it has not been possible to identify them at species level. These were most possibly males, since it is known that males usually roost singly in summer and autumn. On one occasion, we confirmed the presence of an adult *M. blythii* male in a rock crevice near Mikrolimni (Appendix II). To date, no breeding colonies have been recorded from either species. However, *M. blythii* appears to breed in the area (Table 12.2), since a juvenile bat was captured in beech forest at 1400 m a.s.l. in 2010. Apart from that, *M. blythii* males and a non reproductive female have been captured near the lake (Ag. Germanos stream estuary) and at Kokkalis' Cave; they utilise this cave most possibly as a night roost and probably as a swarming site. Only adult male *M. myotis* have been captured, mostly swarming at Kokkalis' Cave; individuals were further captured in the forest near Zachariadis' Cave and near forest at almost 1000 m a.s.l. (Appendix II).

12.1.11 *Nyctalus leisleri* (Kuhl, 1817) and *N. noctula* (Schreber, 1774)

General features

These are large bats: *Nyctalus leisleri* is the smallest (forearm: 38.0-47.1 mm, weight: 13-18 gr) and *N. noctula* the medium-sized (forearm: 47.3-58.9 mm, weight: 21-30 gr) among the three European *Nyctalus* species. *Nyctalus noctula* occurs from the north of the Iberian peninsula to the north-east and the Mediterranean part of Europe and further to Asia. However, it is rare or not found in the south of Italy and Greece and it is absent from the islands. *Nyctalus leisleri* occurs in most of Europe, but there are large differences in the densities of occurrence across the continent. It is absent from some parts of the Mediterranean.

Roosts. Both species are typical forest-dwellers, i.e. they use tree cavities for roosting throughout the year particularly in beech and oak forest and are often found in trees near forest edges or along forest paths and openings. They often use a



Nyctalus leisleri

number of trees at any location within a forest and they switch between these trees within seasons. In some parts of their distributional range, maternity colonies may be found in buildings. Male *N. noctula* may also form colonies in rock crevices and in artificial structures such as concrete bridges where traffic is not very frequent, or in buildings. In winter they roost in trees or artificial structures, and *N. noctula* may also use rock crevices.

Preferred habitats and movements. Both species fly fast (40-50 km/h) and may forage from a few km up to more than 20 km (*N. noctula*) away from their roost usually at 10-50 m but often at several hundred meters from the ground. *Nyctalus noctula* hunts above water, meadows, forest and even street lights; *N. leisleri* often prefers to hunt just above forest canopy, along forest edges and forest trails, above large water bodies and also meadows. Both species are adapted for long-range migration, and may cover more than 1000 km between summer roosts and hibernacula.

Threats. Roost loss primarily due to intensive forest clearing especially of old mature trees, deforestation and generally intensive forest management practices are important threats to both bats. They are currently particularly threatened by wind farms, mainly during migration but also in summer (e.g. Rodrigues *et al.* 2008, Georgiakakis and Papadatou 2011), because they fly at

the height of the moving rotor blades when commuting, hunting and migrating.

Prespa

Nyctalus noctula is less frequently encountered in Greece than *N. leisleri*. The range of *Nyctalus noctula* appears to be confined to the north of the country, whereas *N. leisleri* is found all the way down to Crete (Hakak *et al.* 2001, Benda *et al.* 2008). Mostly males in summer and a few females over the spring and autumn migration periods have been recorded from both species in Greece, although *N. noctula* appears to breed at least in the northeast of the country (C. Dietz, unpublished data). Males are most possibly present year-round, whereas females may be present from late summer and autumn to spring. Males of both species appear to set up mating roosts on the migration routes of the females. The area of Prespa is probably no exception: *N. noctula* has only been located from echolocation call recordings, whereas *N. leisleri* appears to be more common and has been located both through captures and echolocation recordings at sites in and around forested areas (beech and oak) and in sub-alpine meadows (Appendix II). Only adult males *N. leisleri* have been captured in summer, conforming to the general pattern observed in Greece.

Both species have been recorded from the level of the lake up to the sub-alpine meadows at almost 2000 m a.s.l. (Appendix II) apparently commuting through or foraging in the PNP-GR, but they may well use the area for roosting. *Nyctalus leisleri* was among the most frequently encountered bats at Mazi-Kirko (Appendix II). Because echolocation call characteristics of these two species may partly overlap with those of other species (*Vespertilio murinus*, *Eptesicus serotinus*) as well as between them, several calls recorded throughout the area were not identified to species level; this means that their presence is most probably more widespread than that presented in Appendix II and their frequency of occurrence may be higher. Future detailed studies may reveal the relative proportion of the two species in the National Park and aid species identification from echolocation call recordings with more certainty.

12.1.12 Small pipistrelles: *Pipistrellus pipistrellus* (Schreber, 1774) and *P. pygmaeus* (Leach, 1825)

General features

These are the smallest European bats (forearm: *P. pipistrellus*, 28-34.5 mm, *P. pygmaeus*, 27.7-32.3 mm; weight 3-7 gr). *Pipistrellus pygmaeus* was only recently defined as a separate species (Barratt *et al.* 1997). The two species occur in sympatry throughout Europe, but *P. pipistrellus* is more common than *P. pygmaeus* except in Greece where the opposite is true. *Pipistrellus pipistrellus* is one of the most common bats in Europe.

Preferred habitats. *Pipistrellus pipistrellus* is very flexible in terms of habitat preferences and may therefore be found in almost all habitat types; it prefers, however, forests and water when these are available. Along with *P. kuhlii* (see below), it is the most frequently encountered bat hunting in urban environments usually around street lamps. *Pipistrellus pygmaeus* is less of an opportunistic bat and depends a lot more on riparian forests, wetlands and water bodies than *P. pipistrellus*, avoiding agricultural lands and grasslands.

Roosts and movements. In summer, *P. pipistrellus* roosts in buildings, rock crevices, behind the exfoliating bark of trees and in bat boxes (where suitable trees are limited), frequently switching between a number of different sites. It hibernates in buildings and underground sites. It is rather considered as a sedentary bat, despite the records of some long-range migrations (Dietz *et al.* 2009). *Pipistrellus pygmaeus* roosts in buildings and other artificial structures, in tree holes and in bat boxes.

Threats. Both species are among those most likely killed by wind farms (Rodrigues *et al.* 2008, Rydell *et al.* 2010, Georgiakakis and Papadatou 2011).

Prespa

The typical echolocation calls emitted by *P. pipistrellus*, an opportunistic species roosting and feeding in a wide range of habitats, have also been recorded in a wide range of habitats and altitudes in the area of Prespa: near caves, above the lakes, wetlands and reed beds, in and



Pipistrellus pygmaeus

C. DIETZ

around villages, along riparian vegetation, and in sub-alpine meadows and beech forest up to almost 2000 m a.s.l. (Appendix II). In contrast, *P. pygmaeus* has mainly been found near water, commuting or hunting along riparian vegetation at streams, but also near caves and beech forest up to approx. 1170 m a.s.l. (Appendix II). *Pipistrellus pipistrellus* breeds at Prespa, whereas only male *P. pygmaeus* have been detected (Table 12.2) similarly to other parts of Greece (e.g. Papadatou *et al.* 2010). As with *Nyctalus* species, their echolocation call characteristics may partly overlap with those of other bats (*Miniopterus schreibersii*, other *Pipistrellus* species), so that many calls recorded throughout the area have not been identified to species level. This means that their presence is most probably more widespread than that presented in Appendix II and their frequency of occurrence may be higher. Future studies may reveal the relative proportion of these species in the PNP-GR in more detail and aid species identification from echolocation call recordings with more certainty.



Pipistrellus kuhlii

12.1.13 *Pipistrellus nathusii* (Keyserling & Blasius, 1839) and *P. kuhlii* (Kuhl, 1817)

General features

These are generally small and morphologically similar bats but the largest among pipistrelle species (forearm length approx. 32-37.1 mm, weight 5-10 gr). *Pipistrellus nathusii* occurs throughout Europe and exhibits long range migrations of up to 2000 km all the way down to the south of the continent, generally covering 29-48 km every night. It generally breeds primarily in the northeast of its distribution and hibernates more to the south-southwest. In contrast, the distribution of *P. kuhlii* extends from the Iberian Peninsula through to mainly the Mediterranean part of the continent and is a sedentary bat. The northern border of its distribution is currently expanding.

Preferred habitats. *Pipistrellus kuhlii* is a species very frequently encountered hunting in urban environments often around street lamps

along with other pipistrelle bats, in gardens, parks and often close to water, and adapts very well in landscapes transformed by human (e.g. agricultural lands and forest clearings). *Pipistrellus nathusii* hunts in natural and highly structured broadleaf and conifer forests, along riparian vegetation and streams, in parks, and near or above water, a few kilometers away from the roost. It usually flies at 3-20 m from the ground, often lower above water. During migration, it may hunt in human settlements.

Roosts, movements and threats. Roosts of *P. kuhlii* are in rock crevices and very often in any cavity type sites in buildings (e.g. wall crevices, under tiles, etc.); sometimes in bird nests or tree cavities. The species has generally been recorded below 1000 m a.s.l. Maternity colonies of *P. nathusii* roost in tree cavities or bat boxes if cavities are not available, and in buildings with wooden parts, in the lowlands, generally below 500 m a.s.l. Individuals may also roost in rock crevices and bridges. In winter, they may roost in trees, wood piles, rock crevices and buildings. In autumn,



C. DIETZ

Hypsugo savii

male *P. nathusii* occupy mating roosts on the migration routes of females often close to nursery roosts or hibernacula, attracting passing females with display calls. When migrating, they follow the coast and river valleys, and fly high over mountains: *P. nathusii* is among the main victims of wind farms with hundreds if not thousands of them being killed every year across Europe mainly during migration but also at other seasons of the year (Rodrigues *et al.* 2008, Rydell *et al.* 2010, Georgiakakis and Papadatou 2011).

Prespa

The two species occur in sympatry at Prespa. *Pipistrellus nathusii* was one of the first species recorded in the area by O. von Helversen in the 1980s (von Helversen, unpublished data, von Helversen & Weid 1990). To date, only male individuals have been captured, conforming to the male-only pattern observed generally in Greece in summer (Hanák *et al.* 2001, O. von Helversen, pers. comm.). A rock crevice along the shore of the Greater Prespa Lake has been confirmed to host a small male colony of *P. nathusii* (Appendix II), suggesting that the species may generally use rock crevices along the lakeshore for roosting. The species has been detected flying in villages, above streams, near caves, in beech forest and sub-alpine meadows up to almost 2000 m a.s.l. (Appendix II). Its echolocation calls have probably been more widely recorded over wetlands and reed beds, beech forest and sub-alpine meadows. However, recordings cannot be identified with certainty unless social calls are included and the

relative proportion of the two species occurring in the area is known: social calls are species-specific and help distinguish between *P. nathusii* and *P. kuhlii* whose echolocation calls largely overlap. *Pipistrellus kuhlii* was discovered in the area in 2009 and 2010 (Appendix II). From capture data, it appears to be less common than *P. nathusii*, but further studies need to confirm the relative proportion of the two species at Prespa. *Pipistrellus kuhlii* breeds in the area, but to date no specific breeding colonies are known (Table 12.2).

12.1.14 *Hypsugo savii* (Bonaparte, 1837)

General features

Hypsugo savii is a small bat with variable colouration of fur throughout Europe. It is of similar size with the larger pipistrelle species (forearm length 31.4–37.9 mm, weight 5–9 gr). In Europe, it is one of the most commonly encountered bats and occurs from the Iberian Peninsula through to Greece and Asia Minor, covering the entire Mediterranean region, up to the south of Switzerland, Austria and Hungary.

Roosts and movements. The species roosts in rock crevices often near cave entrances and in buildings (cracks on walls, under the tiles etc.). Distances between roosts and feeding sites vary between a few km up to *ca.* 20 km. The migratory status of the bat is unknown.

Preferred habitats and threats. It is found in a variety of habitat types from the coast to the mountains up to 3300 m a.s.l., generally in karstic areas with a mosaic of agricultural lands and Mediterranean scrub (macquis, garrigue), and it is relatively rare in densely forested areas (in Greece often found in open pine forests). It frequently hunts above water, alpine and other meadows, in and near human settlements usually around street lamps, under tree canopy, lands with sparse vegetation, and along rocky cliffs. When hunting, it can fly up to over 100 m from the ground, above rocky valleys, forests and scrub. This is perhaps the reason why so many individuals have been found dead under operating wind farms across Europe (Rodrigues *et al.* 2008, Georgiakakis and Papadatou 2011).

Prespa

The species appears to be common and widespread in the Prespa NP (Appendix II). Small colonies are present in crevices on rocky cliffs along the lakes' shore. These are possibly male groups as confirmed through captures near Tchernia Cave. The capture of lactating and post-lactating females at hunting/commuting sites has confirmed that the species breeds in the area (Table 12.2), but no specific breeding colonies are known. The bats also inhabit cracks and crevices on stony walls of buildings in the villages. They hunt or commute along the rocky cliffs of the Greater Prespa Lake, above wetlands, streams and the lakes, along the riparian vegetation of streams and beech forest edge surrounding pastures, and at sub-alpine meadows up to 2000 m a.s.l. Many adult individuals use Kokkalis' Cave as a night roost and/or for mating in summer.

12.1.15 *Eptesicus serotinus* (Schreber, 1774)

General features

Eptesicus serotinus is a large and robust bat (forearm length 48-58 mm, weight 18-25 gr). It is a widely spread species throughout most of Europe.

Preferred habitats. The bat occupies many habitat types and does not depend on forests. It hunts above agricultural lands, parks, orchards, pastures, along forest edges and trails, water bodies, in and near human settlements often around street lamps, and in open space. The presence of broadleaf trees appears to be an important element for the species hunting habitat, as they may hunt around isolated trees.

Roosts, movements and threats. In central Europe the species forms maternity colonies almost exclusively in buildings, but in the Mediterranean, besides buildings and bridges, porches at caves and rock crevices are used. Maternity colonies may switch roosts within seasons. Distance between roosts and feeding sites varies between 4 and 12 km on average. It is generally a sedentary bat. *E. serotinus* is among the species frequently found dead under wind turbines.

Prespa

The species is known to occur in summer at Prespa since 2004, but to date breeding has not been confirmed. Only three adult males have been captured at Ag. Germanos stream (Table 12.2; Appendix II), suggesting that it is rather a rare bat in the area. The presence of males only is not surprising given

Eptesicus serotinus



that maternity colonies are rarely found above 800 m a.s.l. and that males are regularly found at higher altitudes. Some echolocation calls recorded in the PNP-GR may belong to the species, but because its call characteristics largely overlap with those of calls emitted by *N. leisleri* and *V. murinus*, no recordings have been used to confirm its presence in the PNP-GR until a better idea of the species distribution and frequency of occurrence is obtained through a more intensive study.

12.1.16 *Plecotus* species

General features

The Prespa area is located within the distributional range of all four *Plecotus* species present in the European continent and three of them have so far been recorded: *P. auritus* (Linnaeus, 1758), *P. macrobullaris* (Kuzjakin, 1965) and *P. austriacus* (Fischer, 1829). These are medium-sized bats (forearm length, *P. auritus* 35.5–42.8 mm, *P. macrobullaris* 37.3–46.0 mm, *P. austriacus* 36.5–43.5 mm; weight 6–10 gr, all species) which mainly glean insects from foliage using passive listening aided by their large ears (Fig. 2.1b), although they also hunt on the wing.

Plecotus auritus occurs in the whole of Europe but its distribution is fragmented in the south. It is a typical forest-dwelling species: from central Europe to the east it occupies trees in summer and winter, but in western Europe it mainly occupies buildings and bat boxes in summer and underground sites in winter. In the south of Europe, it inhabits forested mountains often above 1000 m a.s.l. and usually hunts a few hundred meters away from its roost.

Plecotus austriacus occurs from the Iberian Peninsula through to central Europe and the Mediterranean, except the south of Italy and the centre and south of Greece. In central Europe, its habitat is rather linked to human settlements and agricultural landscapes. In the south of the continent it is more linked to natural habitats including forested and rocky areas, as well as open spaces. Most maternity colonies have been recorded below 550 m, although there are a few records above 1000 m a.s.l. The species roosts in buildings in the



Plecotus austriacus

north of its distribution and often in roof spaces. In contrast, in the Mediterranean part of its distribution, maternity colonies are often in rock crevices, often near the entrance of caves. Males can be found in a range of other sites such as bridges and other artificial structures. It hibernates in underground sites and rock crevices. The species hunts up to a few km from its roost, further than *P. auritus*. Both species frequently switch between a number of different roosting sites in summer, and are sedentary bats. Swarming occurs from August through to October and often in spring.

Plecotus macrobullaris is a newly described species (Spitzenberger *et al.* 2003) and its distribution is patchily known from the south of Europe. Most records of the species come from mountainous and alpine regions over 800 m a.s.l. but some maternity colonies have been found at lower altitudes, in a mosaic of agricultural lands and forests. In the Pyrenees the species has been found in alpine meadows and rocky surfaces with sparse vegetation of over 2800 m a.s.l. To date, only maternity and male colonies in buildings are known.

Threats. *Plecotus* species suffer from road kills because of their slow flight low above the ground. *Plecotus auritus* in particular suffers from deforestation and intensive forest management practices.

Prespa

Although *Plecotus auritus* is fairly common in northwest and central Europe, it is relatively uncommon in Greece where it appears to have its southern limit of its distribution. The species breeds in the Prespa NP (Table 12.2) and breeding colonies are found up to at least 1700 m a.s.l.: we have captured breeding females and juveniles foraging in mixed beech-fir forest at 1450 and 1700 m a.s.l. (Appendix II). An adult male *P. macrobullaris* was recorded in the PNP-GR by O. von Helversen in June 2007 (O. von Helversen, pers. comm.) and it is probably one of the rarest bats in the area. Three male *P. austriacus* and one female were recorded swarming at Kokkalis' Cave in autumn 2010 (Appendix II): these were the first records of the species in the PNP-GR. To date, no summer records of the species exist, but it is highly likely that it roosts and forages in the area throughout the year.

12.1.17 *Miniopterus schreibersii* (kuhl, 1817)

General features

This is a medium sized bat (forearm length 42.4–48.0 mm, weight 10–14 gr). In Europe, it is found in the Mediterranean countries up to the centre

of the continent. Delayed implantation of the embryo occurs between autumn mating and spring foetal development, in contrast to the sperm storage and delayed fertilization in most temperate zone bats (Hutson et al. 2001).

Roosts and movements. It is a cave-dwelling species, often forming large colonies of up to tens of thousands of individuals in Europe, more in other parts of its distribution. Individuals may be packed to a density of about 2000 per m². Females are highly philopatric and in common with many other species they generally show high individual fidelity to their roosting sites. Maternity colonies have been found roosting up to 1200 m a.s.l. but non reproductive animals (males and females) may be found much higher. They practically never roost alone forming mixed species colonies. In temperate regions they migrate between summer sites and hibernacula at an average distance of up to 100 km, but migrations of over 800 km have been recorded in France. Males often migrate less, but their movements and summer behaviour are poorly understood (Hutson et al. 2001).

Preferred hunting habitats. The bats use a variety of habitats to hunt, often in open areas under, around or above broadleaf forest and other vegetation, above water surfaces but also in drier areas. They fly fast up to 10–20 m or more above

Miniopterus schreibersii



ground, feeding on moths, small Diptera and beetles. Because of their particularly large colonies, individuals may be obliged to feed quite far from their roost, even more than 40 km (10-20 km on average).

Conservation status and threats. In the northern limits of their distribution, major declines have been recorded because of pesticide use (DDT etc.), chemical treatment of oak forests (Slovenia) and the loss of hunting habitats and roosts (e.g. cave tourism).

Prespa

A large colony of several thousand *M. schreibersii* roosts in Tchernia Cave in summer. Only a few hundred bats roost in the cave in the autumn, but many more arrive during autumn nights with a typical swarming behaviour, chasing each other in and outside the cave. The vast majority of these bats both in summer and autumn are adult males (Table 12.2). The species utilises Kokkalis' Cave as a night roost in summer and as a swarming site in autumn. It has also been detected at hunting sites (Appendix II). Of 149 bats captured in both seasons in total, only 7 were adult females representing only 0.05% of the sample and these were either non reproductive individuals or they were captured outside the breeding season. No adult females have so far been recorded in the neighbouring countries (Bimbilova Cave, FYR of Macedonia; Treni Cave, Albania). Where do the adult female *M. schreibersii* roost and breed?

Many echolocation calls of the species have been recorded at several hunting sites, but because it was not always clearly separated from *Pipistrellus pipistrellus* and *P. pygmaeus* often emitting calls with overlapping frequency parameters, only a proportion of calls recorded was used to assess the species distribution in the PNP-GR (Appendix II). From capture and echolocation call data combined, we have found hunting and/or commuting *M. schreibersii* in a variety of habitats including wetlands and streams near the lake, oak and beech forest and sub-alpine meadows up to almost 2000 m a.s.l. (Appendix II).



T. PRÖHL

Tadarida teniotis

12.1.18 *Tadarida teniotis* (Rafinesque, 1814)

General features

Tadarida teniotis is among the largest European bats (forearm length 54.7-69.9 mm, weight 20-30 gr). In Europe, it occurs from the Iberian Peninsula through to the Balkans and can be found from the sea level up to over 2000 m a.s.l.

These bats typically roost inside mostly inaccessible rock crevices and fly fast (often over 65 km/h) between 10-300 m from the ground. They may cover up to 100 km from their roost to their feeding grounds in a single night, hunting in the open, high above forest canopy, water bodies, cities, pastures, agricultural lands and meadows. It is believed that it is not a migratory species, but rather sedentary and faithful to its roosts all year-round: ringed individuals in Switzerland and Spain were found in the same roosting sites throughout the year. However, they may switch roosts within and between seasons. Wind farms

may pose a significant threat to these bats, since they commute and hunt high above the ground near the moving rotor blades.

Prespa

Colonies roost in crevices in the rocky cliffs along the lakes' shore and they appear to be relatively common. A small colony roosts in a rock crevice at a quarry near Mirkolimni village (Appendix II). Because these rock crevices are inaccessible, it has not been possible to identify sex and age of these groups (Table 12.2). The species emits loud calls in the audible range (10-14 kHz). No other bat emits calls at that frequency within the PNP-GR, hence its identification has been fairly easy: the species hunts above the lakes, near streams, beech forest and above sub-alpine meadows up to 2000 m a.s.l. (Appendix II).

12.2 Important roosting sites

12.2.1 Natural sites: caves, cavities and rock crevices

A number of key natural sites for roosting have been identified so far in all three countries surrounding the Prespa Basin (see sections 13.2 and 14.2 for sites in Albania and the FYR of Macedonia respectively), hosting a minimum of one and a maximum of 10 species depending on roost type (rock crevice or cave) and on seasons (specifically for caves see Table 12.3). No tree roosts have been located to date, as this needs a much more intensive study (see PART IV, section 16). Caves are used by breeding colonies, as night roosts, for autumn swarming and mating, as stop-over (transitional) sites, possibly as satellite sites, as autumn shelter and for hibernation. Rock crevices are used by small male groups that may include non reproductive females (e.g. *M. daubentonii*); we do not know whether they are used by breeding groups. In winter, most caves on the Greek side are not used probably because they are relatively small and hence temperature is low and unstable (it is influenced by ambient temperature fluctuations) or because their temperature may not be low enough for hibernation (e.g. Mikrolimni Cave).

Specifically, crevices, cavities and caves formed in the steep and rocky slopes surrounding the

Greater Prespa Lake, as well as crevices and cavities on the rocky slopes along parts of the north-western and western coast of Lesser Prespa Lake may host small (crevices) or large (caves) bat colonies. Petrochilou *et al.* (1977) identified 15 caves along the rocky shore of Greater Prespa. In 1963, both lakes had approximately the same level, but the level of Greater Prespa has been generally decreasing since (Hollis & Stevenson 1997). By the end of December 2010, the level of Greater Prespa was *ca.* 844.70 m.a.s.l. (records of the SPP on the water levels of the Prespa Lakes, unpublished data), being about 5-6 m lower compared to the lake level in 1977 when A. Petrochilou and colleagues published their report (Petrochilou *et al.* 1977). Therefore the caves' situation must have been very different at the time, with some lacustrine caves currently having dried out and other, new caves, as well as rock crevices having been revealed. Indeed, the 1977 description of some of the caves that we visited during this project does not fit with the current situation; for example, the location and description of a cave called "Roti" in Petrochilou *et al.* (1977) fits with the "flea" cave which is now a dry cave about 4 m above the level of the lake (Table 12.3; Appendix II). On the other hand, the lacustrine cave on the tip of Cape Roti (Table 12.3; Appendix II) must have been covered in water at the time, as it is not reported by Petrochilou *et al.* (1977) and therefore it was probably not used by the bats.

Rock crevices and cavities. Many rock crevices along the steep rocky limestone slopes of the Greater Prespa Lake are used in summer by groups of bats from several species including *Myotis daubentonii*, *Hypsugo savii*, *Pipistellus nathusii* and *Tadarida teniotis* (see bat species distribution maps in Appendix II). *Myotis daubentonii* also use crevices on the southern coast of Lesser Prespa near Mikrolimni village (Appendix II) and generally shows a preference for crevices within rock overhangs or cave entrances. We do not know the autumn and winter use of these rock crevices. Some small caves or cavities along the south coast of the Greater Prespa Lake in the west of Psarades village may host single *R. ferrumequinum* and/or small groups of *R. hipposideros* in summer, e.g. in and behind Analipsi chapel, in Panagia Eleousa



(hermitages and chapel), near St. Nikolaos mural or Gaiintsa (Appendix II), some of which may also host *M. daubentonii*.

Caves. Perhaps the most important among caves in the area for breeding in summer and for autumn swarming, mating or generally shelter in autumn is **Tcherna** Cave on the south coast of the Lake Greater Prespa (Table 12.3, Appendix II), half lacustrine in 1977 (Tcherna 2, Petrochilou *et al.* 1977). In summer, the cave hosts important breeding mixed-species colonies of *Rhinolophus euryale*, *R. ferrumequinum*, *Myotis capaccinii*, *Myotis emarginatus* and a male colony of *Miniopterus schreibersii*. Male *Hypsugo savii* have also been found in summer near the cave entrance. Summer colonies comprise several thousand individuals. *Myotis* bats and male *Miniopterus schreibersii* roost in the large chamber of the cave, whereas most Rhinolophids roost separately in a different chamber. The large piles of droppings on the cave floor and the large stains on the ceiling are a proof of its long term use by the bats.

Numbers of bats seem to fluctuate across years, suggesting that they may switch among a number of different underground sites forming a network, similarly for example to *Myotis capaccinii* in Greek Thrace (Papadatou *et al.* 2008b, 2009). This is not surprising given the number of known underground sites suitable for roosting across the whole territory of Prespa (Table 12.3; sections 13.2 and 14.2) and perhaps a number of potentially unknown sites. In autumn, most bats have left the Tcherna Cave, but there are still several hundred male *M. schreibersii*, and other species also roost in the cave in smaller numbers. The cave is also used by a large number of swarming/mating bats or bats using it simply as a night roost (*Rhinolophus ferrumequinum*, *R. euryale*, *R. blasii*, *Myotis capaccinii*, *M. daubentonii*, *Pipistrellus pipistrellus*, *P. nathusii*). It is therefore used by at least 10 bat species (Table 12.3). The cave is too cold and temperature fluctuates to a large extent to be suitable for hibernation. Only two torpid *R. ferrumequinum* were found in winter 2011 (February) in a small very narrow but deep cave to the north of the main cave. Where do all these bats go in winter?

In 2010, the cave at **Cape Roti** which is not too

far from Tcherna (Table 12.3; Appendix II) was confirmed to be used by important breeding colonies of *Myotis capaccinii* and *M. daubentonii*. The presence of a male juvenile *Myotis emarginatus* suggests that this species may also breed in the cave, but confirmation requires further study. It was not possible to estimate the size of the colonies, since they roost in a dome high up in the ceiling at *ca.* 10 m half hidden by rocks, and smaller groups roost inside deep crevices. The structure and the location of the entrance on the lakeshore did not allow emergence counts either. However, the cave must roughly host many hundred up to a few thousand bats in the summer. In the autumn the large maternity colonies have dispersed and a few hundred individuals from the same species remain roosting in groups mostly inside rock



A. GEORGANDA

Mikrolimni Cave



Large stains on the ceiling of Tcherma Cave are a proof of its long term use by the bats.

crevices around the cave. **The “flea” cave** between Cape Roti and the hotel opposite Psarades village (Appendix II) has signs of past heavy use (stains on the walls and ceiling and large quantities of bat droppings mixed with the soil) but it was not used in summer whereas only five *R. ferrumequinum* were found inside the cave in deep torpor in autumn 2010. Is the lack of current use especially in summer related to the large numbers of fleas in the cave and/or is it related to the gradual drying out of the cave since the 1970s that may have altered the cave’s microclimate? In winter, no bats were found in the cave.

Except the three caves on the south rocky shore of Greater Prespa described above, a few more important underground sites for bats were identified over the course of this project, not very far from the lakes. The cave near the village of **Mikrolimni** on the southern shore of the Lesser Prespa Lake is

an important underground roost (Table 12.3; Appendix II). In summer, only a few individual *R. ferrumequinum* have been found in the cave, but large piles of bat droppings suggest its heavy and long-term use by bats, apparently in other seasons. In spring 2008, over 650 bats were counted emerging from the roost, whereas on an autumn night of 2010, at least 760 bats emerged: these were all medium-sized Rhinolophids, *Rhinolophus euryale* and *R. blasii*. During autumn emergence, the latter species appeared to be more numerous and emerged first, followed by the former (Fig. 12.1). Species identification was confirmed both by visual observations and call recordings inside the cave during day-time and the use of two bat detectors alongside emergence counts. Although not very obvious in Fig. 12.1, exit was bimodal: at about 19:55 most *R. blasii* had already emerged from the cave and most *R. euryale* started to

emerge. In winter 2011 (February) the site was used by up to 50 medium sized *Rhinolophids* that were not in deep torpor, suggesting that this cave may not be typically used as an hibernation site (winter 2010-2011 was mild and at least some bats may have not been in hibernation for at least some of the time).

At least two more caves are important for bats: **Kokkalis' Cave** (Civil War Hospital Cave) at ca. 1120 m a.s.l. and **Zachariadis' Cave** at ca. 1050 m a.s.l., both surrounded by oak forests. These caves have great historical value related to the Greek civil war in the late 1940s and hence an effort for mild tourist development has been made by the local authorities. They are used by only a few *Rhinolophus hipposideros* or *R. ferrumequinum* individuals during day-time. At night, however, many bats utilise them: Kokkalis' Cave is an important swarming site, i.e. it is used by bats with a typical swarming behaviour in autumn. Many bats also visit the site throughout the night presumably using it as a night roost in summer. Overall, 10 species have been recorded at Kokkalis' Cave (Table 12.3). Zachariadis' Cave is not suitable for swarming (small entrance surrounded by densely

structured vegetation) and is rather used at night as a night roost in summer and autumn by several species including *Rhinolophus euryale*, *R. blasii*, *Plecotus* species and possibly *Myotis emarginatus*. However, it is possible that at least *R. ferrumequinum* use it as a mating site in the autumn: three reproductively active adult individuals, two females and one male were observed in the cave roosting together during day-time and subsequently captured on their return to the roost later on the same night. A male adult *Nyctalus leisleri* was further captured among oak trees near the cave entrance in October 2010, presumably foraging or commuting, not using the cave.

More caves are present along the shore of the Greek Greater Prespa Lake (Petrochilou *et al.* 1977). A significant proportion of them has been explored by X. Grémillet and colleagues on foot or by boat up to the Albanian border but no large bat colonies were found other than small colonies or singly roosting individuals. More caves must generally be present in the west and south of the Prespa Basin, some of which are known. We explored a few of these sites during this project. With the aid of a local inhabitant (Mr

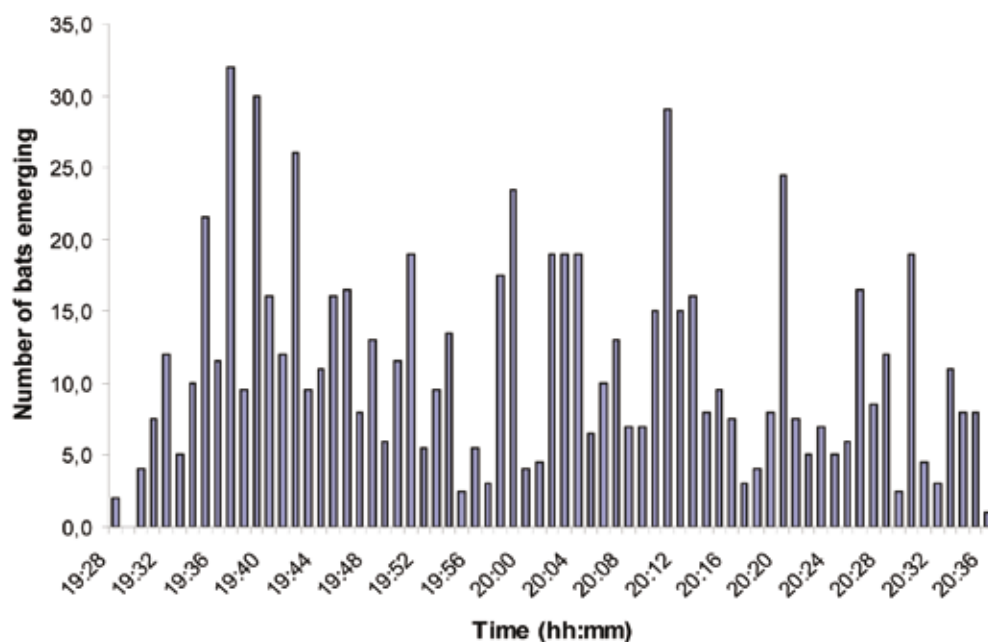


Fig. 12.1 Evening emergence of *Rhinolophus blasii* and *R. euryale* on an autumn night of 2010 at Mikrolimni Cave (see text for details). Number of bats emerging is the average from two observers.



T. DUBOS

Ruins of abandoned traditional house near Oxya village hosting a maternity colony of *R. hipposideros*.

D. Pitoulis) two vertical shafts were located and examined on the slope to the south-south west of Vrondero village, but these appeared not to be used by bats (Georgiakakis 2010). With the aid of the then Chairman of Krystallopigi village (Mr A. Trasias), two more vertical shafts were located and explored on Mt. Malimadi, to the south and east of the village. Only a few bat droppings were found near the entrance of one of the two shafts (Georgiakakis 2010), suggesting its use as a night roost.

12.2.2 Artificial sites: buildings

Rhinolophus hipposideros appears to be depending on the traditional housing practices for roosting from about mid to late spring through to mid to late autumn. Summer roosts are found both in the karstic and in the granitic zones from the level of the lakes up to 1185 m a.s.l. Some bats roost in natural sites, i.e. rock cavities on the rocky cliffs in the south of Greater Prespa Lake, where a few small nursery groups (up to 12 bats) and individuals roosting singly have been found. However, the vast majority of breeding colonies are in man-made structures such as old or abandoned traditional houses, old chapels, sheep barns, rarely some modern buildings, etc., where often individual *R. ferrumequinum* may

also roost, usually singly (a maximum of six non reproductive individuals have been observed). These artificial roosting sites (range: 1-200 bats) apparently offer ideal thermal conditions: they are exposed to the sun for much of the day and they have roofs made of roman tiles on a mixture of reeds and dried earth or occasionally of galvanised steel. Roof and other spaces have insulating walls made of wood, reeds and mud bricks. The roof and walls absorb heat and act as a heat sink during the day radiating warmth back into the roost at night, when no solar heating occurs. Bats may also roost in cellars where there are boilers and heating pipes.

The distribution of summer colonies shows that the limiting factor for the *R. hipposideros* population at Prespa is rather the availability of such favourable constructions and not the rich and productive hunting habitats: nursery colonies are rare in villages where old or abandoned traditional buildings are rare. Furthermore, the species largely depends on habitats that are globally threatened: mosaics of broadleaf forests, agro-pastoral landscapes and wetlands, where their roosting sites are located. These are generally well preserved at the Greek side of Prespa, but many abandoned houses are in the process of collapse, whereas others are or have been reconstructed without considering bats.

TABLE 12.3 Known important cave roosts in or near the Prespa Basin, bat species that use them, their annual function and approximate size of colonies. The “flea” cave (Greece), Jaorec and Meckina Dupka (FYR of Macedonia), and Gollomboç and Zaroshka (Albania) caves are not included in the table (see text for details).

Cave	Location and description	Species	Annual use	Colonies size
Greece				
Tchernia	Partly lacustrine cave in the south of the Lake Greater Prespa, west of Psarades village	<i>Rhinolophus ferrumequinum</i> , <i>R. euryale</i> , <i>R. blasii</i> , <i>Miniopterus schreibersii</i> , <i>Myotis capaccinii</i> , <i>M. emarginatus</i> , <i>M. daubentonii</i> , <i>Hypsugo savii</i> , <i>Pipistrellus pipistrellus</i> , <i>P. nathusii</i>	Summer breeding; autumn shelter, mating & swarming; male only <i>M. schreibersii</i> colony	Several thousand in summer; several hundred in autumn; unknown number swarming
Cape Roti	Lacustrine cave, in the south of the Lake Greater Prespa, west of Psarades village	<i>M. capaccinii</i> , <i>M. daubentonii</i> , <i>M. emarginatus</i>	Summer breeding, autumn shelter	Several hundred (autumn) up to a few thousand (summer)
Mikrolimni	Warm cave on the east coast of the Lake Lesser Prespa, near Mikrolimni village	<i>R. euryale</i> , <i>R. blasii</i>	Spring and autumn shelter; winter use	> 700 individuals
Kokkalis'	Dry cave with historical importance in the west of Lesser Prespa Lake, near the village of Vrondero surrounded by oak forest	<i>H. savii</i> , <i>P. pipistrellus</i> , <i>Myotis capaccinii</i> , <i>M. blythii</i> , <i>M. myotis</i> , <i>Miniopterus schreibersii</i> , <i>Plecotus austriacus</i> , <i>R. blasii</i> , <i>R. euryale</i> , <i>R. ferrumequinum</i> , <i>R. hipposideros</i>	Night roost; autumn swarming	Tens up to a few hundred bats
Zachariadis'	Dry cave with historical importance in the southwest of Lake Lesser Prespa, near the village of Pyli surrounded by oak forest	<i>Rhinolophus hipposideros</i> , <i>R. ferrumequinum</i> , <i>R. blasii</i> , <i>R. euryale</i> , <i>M. emarginatus</i> , <i>M. myotis</i> , <i>Plecotus</i> sp	Summer roosting; night roost; autumn mating?	A few tens of bats
Albania				
Treni	Cave in the southern tip of the Lake Lesser Prespa, near reed-beds and the Treni village	<i>Miniopterus schreibersii</i> , <i>Myotis capaccinii</i> , <i>M. myotis</i> , <i>M. daubentonii</i> , <i>Plecotus species</i> , <i>R. blasii</i> , <i>R. euryale</i> , <i>R. hipposideros</i> , <i>R. ferrumequinum</i> , <i>Eptesicus serotinus</i>	Summer breeding; autumn shelter, mating & swarming; male only <i>M. schreibersii</i> colony; <i>M. capaccinii</i> hibernation	Several thousand in summer; several hundred in autumn and winter; unknown number swarming
Mali Grad	Dry cave on the eastern shore of Mali Grad Island, Lake Lesser Prespa	<i>Miniopterus schreibersii</i>	Autumn and probably spring shelter	> 2000 individuals
FYR of Macedonia				
Bimbilova	Cave on Golem Grad Island, Lake Greater Prespa	<i>Miniopterus schreibersii</i> , <i>Myotis capaccinii</i> , <i>Rhinolophus ferrumequinum</i>	Summer breeding; autumn shelter, mating & swarming; male only <i>M. schreibersii</i> colony; hibernation	> 10 000 in summer; > 7000 in autumn; > 3000 in winter
Samotska Dupka	Cave to the west of the Mountain Hut Asan Gura surrounded by beech forest	<i>R. hipposideros</i> , <i>Myotis blythii</i> , <i>M. myotis</i>	Hibernation; other use?	> 80 individuals in winter
Leskoec	Dry and warm cave in the north-west of Lake Greater Prespa, near Leskoec village surrounded by oak forest	<i>Rhinolophus euryale</i> , <i>R. blasii</i>	Autumn and probably spring shelter	> 500 individuals
Naumova	Cave on the eastern shore of Lake Ohrid, approx. 700 m to the south of the village of Trpejca	<i>Rhinolophus hipposideros</i> , <i>R. ferrumequinum</i> , <i>R. euryale</i> , <i>Myotis emarginatus</i> , <i>M. capaccinii</i> , <i>Miniopterus schreibersii</i>	Summer breeding; autumn shelter; hibernation?	> 600 in summer; 10-100 in autumn & early winter; a few bats in winter



Forest and subalpine meadows at Mazi-Kirko, Mt. Varnous

12.3 Bat activity at high altitudes

To date, habitat use by bats at high altitudes has not been systematically studied in Greece. However, such studies are currently an imperative need because of the death of many bats caused by collision with wind turbines on or near mountain tops worldwide. More recently this has been confirmed at wind farms in Thrace, Greece (Georgiakakis and Papadatou 2011). Within the framework of the project at Prespa, we studied the use by bats of subalpine meadows and beech forests near the tree line at high altitudes (up to *ca.* 2000 m a.s.l.) at the borders of and near the National Park of Prespa, where **large-scale wind farms are under construction or planned without prior impact assessment studies accounting for bats**. This is particularly worrying given the devastating effects on the bat fauna at areas where little or no impact assessment on bats has been carried out prior to the construction and operation of wind farms

(Rodrigues *et al.* 2008; Georgiakakis and Papadatou 2011) and the fact that bats may travel long distances to commute and forage. The National Park of Prespa has a particularly rich bat fauna as described earlier, including species at high risk of collision with wind turbines. Many of these bats will not be confined within the borders of the PNP-GR to forage or even roost. Bats often cross mountain ridges and passes when commuting between roosting and foraging sites, and when they move seasonally (migrate). In addition, some bats may forage at very high altitudes: *Tadarida teniotis* is among the open-space foragers and fast-flyers that may fly up to more than 2000 m a.s.l. when foraging (Rydell and Arlettaz 1994; pers. obs.). Except the direct risk of death posed by wind turbines at these altitudes, the construction of wind farms alters the landscape in ways that may affect bat populations indirectly, e.g. by affecting insect populations or fragmenting the habitats with the construction of roads and other infrastructures.

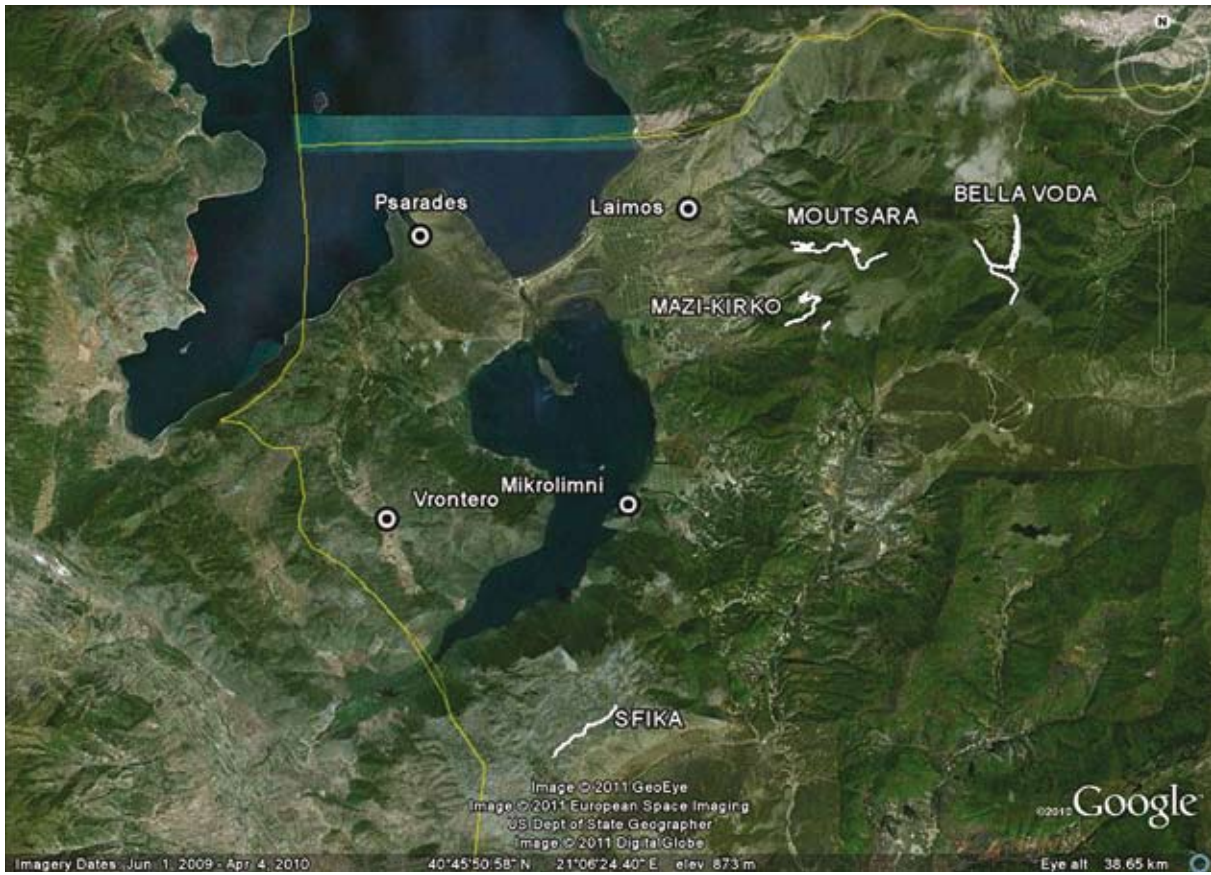


Fig. 12.2 Study sites (in capital letters) at high altitudes (white lines are acoustic transects)

We used acoustic transects, acoustic point sampling and mistnetting to study bat habitat use in summer at the following mountainous and sub-alpine areas: Bella Voda, Mazi-Kirko and Moutsara (Mt. Varnous), and Sfika (Mt. Triklarion) (Table 12.4; Fig. 12.2); these sites are proposed for wind farm development except Moutsara. Specifically at Bella Voda, because the proposed wind farm is under construction and the environmental impact assessment ignored bats (ADK 2009-10), we performed repeated surveys: once in summer 2009 (22/7/2009) and three times in 2010, twice in summer and once in autumn (30/07/2010, 2/8/2010 and 30/9/2010). Our goal was to make a preliminary assessment of bat diversity and activity across the years, as well as within and between seasons. We also repeated the survey at Mazi-Kirko in October 2010. All other sites were surveyed once in summer 2010. During acoustic transects, observers walked along some pre-defined routes along the study areas recording the echolocation calls

of passing bats. When point sampling, observers stood at fixed points for specific time to record bat calls. Finally, observers used mistnets to capture bats at specific locations of the study sites in summer 2010. For further details on the acoustic methods, see Galand *et al.* (2010).

Table 12.4 shows the study areas and respective species or species groups identified commuting or foraging at these areas. Specifically:

Bella Voda. Detailed accounts of the 2009 survey are given in Galand *et al.* (2010) and in Vrahnakis *et al.* (2010). Repeated acoustic transects showed that the site is generally heavily used by commuting and foraging *Tadarida teniotis* throughout the summer and apparently in both years. Repeated acoustic point sampling in both years on the mountain pass next to where the first wind turbine is being constructed showed that the specific location is heavily used by bats from several species (Table 12.4; Appendix II) mostly commuting from other areas (e.g. Florina plain and Pisoderi

valley) to forage in the rich in habitats and insect prey Prespa Basin. The list includes species at high risk of collision with wind turbines, such as *Pipistrellus pipistrellus*, *Nyctalus noctula* and *Tadarida teniotis* (Table 12.4). In the autumn, activity decreases but there are still bats commuting over the mountain ridge, even on cold nights.

Mazi-Kirko. The site (Fig. 12.2) is heavily used in summer by commuting and foraging bats from several species including species at high risk of collision with wind turbines, such as *P. pipistrellus*, *H. savii*, *Nyctalus leisleri*, *N. noctula* and *Tadarida teniotis* (Table 12.4). In autumn, bats still cross the sub-alpine meadows to commute or hunt.

Moutsara. Only *N. noctula* was recorded near the highest point of the ridge, whereas all other species were found lower, foraging near the tree line and along beech forest edge.

Sfika. We covered a large area outside the Prespa Basin, i.e. in the basin of Krystallopigi. The highest

activity of most species (Table 12.4) was recorded towards the lower and less exposed locations.

Our results generally suggest that subalpine meadows and forests near the tree line are used by many commuting and/or foraging bats: both bat diversity and activity were important. The establishment of wind farms may therefore negatively influence bats, as it has been shown in other areas of Europe including Greece (Rodrigues *et al.* 2008, Rydell *et al.* 2010, Georgiakakis and Papadatou 2011). The risk may be particularly important for species at high risk of collision with the turbines, such as *T. teniotis*, *N. leisleri*, *N. noctula*, *P. pipistrellus*, *P. nathusii* and *H. savii* which are present in these areas. More detailed and long-term impact assessment studies on the bat fauna are therefore a prerequisite prior to and certainly after the establishment of wind farms at these altitudes. The importance of subalpine meadows for bats should be further assessed by more detailed and long-term research studies.



P. KATSIYIANNIS

Setting up the field survey at Bella Voda, Mt Varnous

TABLE 12.4 Study sites at high altitudes (subalpine meadows and beech forest near the tree-line) and respective species or species groups identified.

Study site	Altitude (m a.s.l.)		Species
Bella Voda	1900-2000	1	<i>Pipistrellus pipistrellus</i>
		2	<i>Nyctalus noctula</i>
		3	<i>Miniopterus schreibersii</i>
		4	<i>Tadarida teniotis</i>
		5	<i>Hypsugo savii</i>
		6	<i>P. nathusii</i>
		7	Myotis species
		8	Myotis myotis/M. blythii
		9	<i>N. leisleri</i>/ <i>E. serotinus</i>/ <i>V. murinus</i>
Mazi-Kirko	1900-2000	1	<i>P. pipistrellus</i>
		2	<i>Hypsugo savii</i>
		3	<i>Nyctalus leisleri</i>
		4	<i>N. noctula</i>
		5	<i>M. schreibersii</i>
		6	<i>T. teniotis</i>
		7	Myotis species
		8	Myotis myotis/M. blythii
		9	<i>P. nathusii</i>/ <i>P. kuhlii</i>
		10	<i>N. leisleri</i>/ <i>E. serotinus</i>/ <i>V. murinus</i>
		11	<i>M. schreibersii</i>/ <i>P. pygmaeus</i>
Moutsara	1700-2000	1	<i>N. noctula</i>
		2	<i>Myotis blythii</i>
		3	<i>Rhinolophus hipposideros</i>
		4	Myotis species
Sfika	1400-1700	1	<i>Myotis mystacinus</i>
		2	<i>P. pipistrellus</i>
		3	<i>P. kuhlii</i>
		4	<i>H. savii</i>
		5	<i>M. schreibersii</i>
		6	Myotis myotis/M. blythii
		7	<i>P. nathusii</i>/ <i>P. kuhlii</i>
		8	<i>N. leisleri</i>/ <i>E. serotinus</i>/ <i>V. murinus</i>

NOTES:

Altitudinal ranges are approximate. In **bold** are species at high risk of collision with wind turbines. Some bats were not identified at species level (indicated in grey), so it is likely that one or more may be present in the respective area, hence number of actually identified species is the minimum. Data collected by: T. Cheyrezy, S. Declercq, N. Deguines, N. Galand, P. Georgiakakis, E. Papadatou, S. Puechmaille, X. Grémillet, Y. Kazoglou.

12.4 Conservation status

All bat species are protected by national and international laws, conventions and agreements (see PART I, section 4). Table 12.5 shows the legal protection status of all species present in the Prespa area according to the European and Greek legislation, and their conservation status according to the IUCN (2009) Red Data List and the Greek Red Data Book of Threatened Animals (Legakis and Maragou 2009). Several species classified as LC on a global scale are classified as NT or VU or DD in Greece, because of their limited distribution or very limited data available (for explanations of these abbreviations, see Table 12.5). The majority of species present at Prespa are either not sufficiently known in Greece or are under a threatened status. Ten species are in Annex II of the Habitats Directive and all are in Annex IV (Table 12.5).

In particular, with regards to the family Rhinolophidae represented by four out of the five Euro-

pean species at Prespa, Hutson *et al.* (2001) state: “In mainland Europe, *R. ferrumequinum* is now rare in many countries. For example, fewer than 250 individuals are thought to occur in Belgium, it is considered critically endangered in Israel, only one nursery colony remains in Luxembourg, and it is probably the most endangered species in Hungary. The species is the subject of a European Action Plan prepared under the Bern Convention. There are similar concerns about *Rhinolophus hipposideros*, although in the UK the population appears to be stable or increasing. *R. hipposideros* is thought to be extinct in the Netherlands and Luxembourg, and critically endangered in Germany. In Switzerland, a drastic decline has been seen since 1940”. *Rhinolophus blasii* and *R. euryale* are similarly thought to be extinct or seriously threatened in a number of countries. It is therefore important to preserve their populations at Prespa where they appear to be relatively abundant. The same applies for all other species of conservation concern.



Kokkalis' Cave (Civil War Hospital Cave)

TABLE 12.5 Species found in and around the National Park of Prespa (GR), and their conservation and legal protection status.

Scientific name	Red Data Book IUCN 2009	Red Data Book GR 2009	92/43/EEC	Bern Convention	Bonn Convention	P.D. 67/1981
<i>Rhinolophus ferrumequinum</i>	LC	LC	II, IV	II	II	+
<i>R. hipposideros</i>	LC	LC	II, IV	II	II	+
<i>R. euryale</i>	NT	NT	II, IV	II	II	+
<i>R. blasii</i>	LC	NT	II, IV	II	II	+
<i>Myotis daubentonii</i>	LC	VU	IV	II	II	+
<i>M. capaccinii</i>	VU	NT	II, IV	II	II	+
<i>M. brandtii</i>	LC	DD	IV	II	II	-
<i>M. mystacinus</i>	LC	DD	IV	II	II	+
<i>M. nattererii</i>	LC	NT	IV	II	II	+
<i>M. emarginatus</i>	LC	NT	II, IV	II	II	+
<i>M. bechsteinii</i>	NT	NT	II, IV	II	II	+
<i>M. myotis</i>	LC	NT	II, IV	II	II	+
<i>M. blythii (oxygnathus)</i>	LC	LC	II, IV	II	II	+
<i>Nyctalus leisleri</i>	LC	LC	IV	II	II	+
<i>N. noctula</i>	LC	DD	IV	II	II	+
<i>Pipistrellus pipistrellus</i>	LC	DD	IV	III	II	+
<i>P. pygmaeus</i>	LC	DD	IV	II	II	-
<i>P. nathusii</i>	LC	DD	IV	II	II	+
<i>P. kuhlii</i>	LC	LC	IV	II	II	+
<i>Hypsugo savii</i>	LC	LC	IV	II	II	+
<i>Eptesicus serotinus</i>	LC	LC	IV	II	II	+
<i>Plecotus auritus</i>	LC	VU	IV	II	II	+
<i>P. macrobullaris</i>	LC	VU	IV	II	II	-
<i>P. austriacus</i>	LC	DD	IV	II	II	+
<i>Vespertilio murinus</i>	LC	DD	IV	II	II	+
<i>Miniopterus schreibersii</i>	NT	NT	II, IV	II	II	+
<i>Tadarida teniotis</i>	LC	LC	IV	II	II	+

Red Data Books, IUCN and Greece (GR)

VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient

Habitats Directive (92/43/EEC)

Annex II: Animal and plant species of community interest whose conservation requires the designation of special areas of conservation;

Annex IV: Animal and plant species of community interest in need of strict protection

Bern Convention: “Convention on the Conservation of European Wildlife and Natural Habitats”

Annex II: Strictly protected fauna species; Annex III: Protected fauna species

Bonn Convention: “Convention on the Conservation of Migratory Species of Wild Animals (CMS)”

Appendix II: Migratory species conserved through Agreements

P.D. 67/1981 “On the protection of native flora and fauna”: Presidential Decree 67/1981 (Greek legislation)

12.5 Threats

To date, threats faced by bats on the Greek side of the Prespa Basin are not sufficiently known. Here, the known (currently existing, potential and predicted) threats are examined with regards to groups of species or sites (i.e. not examined at species specific level) except *Rhinolophus hipposideros*. Threats generally concern the modification or destruction of feeding habitats and commuting corridors; the disturbance, modification or destruction of natural and artificial roosting sites; and the development of wind farms.

12.5.1 Feeding habitats and commuting corridors

Threats include:

- The **abandonment of traditional agro-pastoral and agro-forestry systems and practices**, leading to the loss of important feeding habitats, decrease in insect prey, and hedgerows used by the bats for hunting and for commuting.

- The **development of intensive agriculture**, such as the large-scale bean monocultures near the lakes where often (and in some cases inappropriate) pesticides and chemical fertilizers may be heavily used, probably leading to a decrease in insect populations or directly poisoning bats as it has been observed in intensively managed agricultural landscapes elsewhere. Agrochemicals in intensive agriculture may accumulate in the animals' bodies impairing reproduction and even killing bats. Therefore, impacts may not be immediately perceived. Agrochemicals may end up in the lakes and presumably affect insect fauna on which bats feed. In particular, the trawling bats *M. capaccinii* and *M. daubentonii* may be directly poisoned since they feed directly above water often collecting dead insects. Spraying agrochemicals in a site in Bulgaria led to the abandonment of some roosts by important *M. capaccinii* colonies (Dietz *et al.* 2009).

- **Current forest management practices** have led to extensive areas covered by densely structured young oak and beech forests that are unsuitable both for roosting and for hunting. Most bats are not able to hunt in densely forested areas, whereas the remaining old and dead standing trees are few.

12.5.2 Roosts

Natural cavities and crevices on the rocky cliffs of Greater Prespa are generally considered safe. This may not be the case for caves. In 1977, Petrochilou *et al.* published a report on 15 caves of the area funded by the Greek Tourism Organisation (E.O.T.) with the aim of future **exploitation of caves for tourists**, mostly using a boat. Nothing has been implemented since, but in case of future exploitation, particular care should be taken for key roosting sites, such as Tcherná Cave: these sites should not be visited (as well as others that may be discovered in future) as they host sensitive breeding colonies from many legally protected species. Cave tourism is a real threat for other very important bat caves in the north of Greece (see e.g. Paragamian *et al.* 2004). Shot cartridges have been found at Tcherná Cave, suggesting that hunters shoot animals near the site (probably ducks in winter from inside the cave); if they shoot when bats are present, they certainly disturb them, not to mention that such shooting may provoke collapse of rocks and **damages to the cave structure**. **Uncontrolled visits of caves** are a problem for bats. Changing **the configuration of the landscape near the entrance** may also affect the bats utilising the caves (e.g. Mikrolimni or Kokkalis' Caves, both mapped as Natura 2000 habitat types "Caves not open to the public"). There is currently a mild tourist exploitation of the two historic caves, Kokkalis' and Zachariadis', without major changes in or outside the caves⁷; heavier use could affect the configuration and microclimate of the caves and hence their use by bats.

The gradual collapse of old and abandoned houses at villages in the Prespa Basin is an important threat for the colonies of *Rhinolophus hipposideros* as breeding colonies depend on these sites. Similarly, the **reconstruction or renovation** of old houses and chapels may be a threat, by excluding the bats, closing access to attic and other spaces or using chemicals for the treatment of timber that may poison the bats. Excluding or

7. The non-modification of the entrance of Kokkalis' Cave (i.e. vegetation preserved) and the installation of non-continuous lighting were made possible after recommendations of the second author of this document and SPP efforts – contacts with the Municipality of Prespa and the company that undertook the restoration works (Grémillet and Kazoglou 2006).

even killing bats from old inhabited houses based on misconception may be a threat, but there are no such reports from the area to date (there are many cases however in other parts of Greece).

12.5.3 Wind farm development

Subalpine meadows and forests near the tree line on Bella Voda (Mt. Varnous) and Mazi-Kirko in the east of Prespa and on or within the border of the National Park are used by many bats. These largely include species at high risk of collision with wind turbines such as *T. teniotis*, *N. leisleri*, *N. noctula*, *P. pipistrellus*, *P. nathusii* and *H. savii* (Rodrigues *et al.* 2008, Rydell *et al.* 2010, Georgiakakis and Papadatou 2011). Wind farms are planned to be established at these sites. Specifically, at Bella Voda the wind farm is under construction. However, the impact assessment study and therefore the placement of the turbines did not account for bats: turbines are being installed on the mountain pass used heavily by bats commuting between the plains to the east of Mt. Varnous and the Prespa lakes by many species and bats; many of the turbines are further planned to be placed on feeding sites of *T. teniotis*. The impacts on bats are therefore expected to be important, especially given the fact that often the species and bats recorded at the observers' level are fewer compared to those flying at greater heights, especially near the moving rotor blades, hence monitoring from the ground may not indicate the true risk (Barclay and Baerwald 2007). Many bats are expected to be killed because of **direct collision with the moving blades or barotrauma** (Baerwald *et al.* 2008) as it has already been shown at similar situations in other parts of Europe including Greece (Rodrigues *et al.* 2008, Rydell *et al.* 2010, Georgiakakis and Papadatou 2011). Indirect impacts from other wind farm infrastructures on the bats populations are not sufficiently known. More detailed and long-term impact assessment studies on the bat fauna are a prerequisite prior to and following the establishment of wind farms at these altitudes.

12.6 Protection

Are bats in the Greek Prespa protected? Legally yes, especially those within the borders of the National Park; however, with a few exceptions, they are not actively protected. First, they are flying animals with a wide range of ecological requirements and the ability to cover long distances through their life cycle. Some bats may therefore spend their entire annual cycle within the borders of the National Park; others, however, may roost outside the PNP-GR and forage over the prey-rich habitats of the lakes, as it was suggested for example by our results on Mt Varnous (section 12.3) or they may generally move between the PNP-GR and adjacent areas for roosting and for feeding. Second, within the PNP-GR, knowledge on bats was until recently insufficiently known and therefore management decisions did not account for bats in most cases, for example with regards to the forest management practices or access to important caves for bats. Specifically for *R. hipposideros*, renovation of most old traditional houses used by colonies of the species did not account for the bats until recently, leading to their exclusion from the sites. A few important exceptions are the Biological Station near Mikrolimni village, an agricultural shed at Milionas village and a barn at Ag. Germanos village (see PART IV, section 17 for details).

Overall, to truly protect a bat population all sites used by the population must be protected, i.e. winter, summer, transitional and autumn roosts, feeding habitats, as well as commuting and migratory corridors. The prerequisite for effective conservation and protection is good knowledge of all of these sites, as well as of the movement patterns of bats, their specific ecological requirements and the particular threats they face in the area.

13. Bats on the Albanian side of Prespa

13.1 Species accounts

Ten species of bat were known to occur until recently in the Albanian part of the Prespa lakes: *Rhinolophus ferrumequinum*, *R. blasii*, *R. hipposideros*, *Myotis capaccinii*, *M. daubentoni*, *M. myotis*, *Pipistrellus kuhlii*, *Eptesicus serotinus*, *Hypsugo savii* and *Miniopterus schreibersii*. Another three species were added in the list during our autumn field survey at Treni Cave (October 2010): *Rhinolophus euryale*, *Tadarida teniotis* and a species belonging to the genus *Plecotus*. *Myotis blythii* was also probably recorded but because biometric data fell in the overlap zone with *M. myotis*, further records will be needed to confirm the presence of the species on the Albanian side of Prespa. *Pipistrellus kuhlii* was first observed in Albania and subsequently in Greece in summer 2009. Overall, to date, 13 species of bat are known in the area. Detailed species accounts are given below, while their distribution is given in Appendix II. Because of lack of systematic research and monitoring, little is known on the status and function of roosting sites for most bats (for example, breeding has been confirmed for only a few species), whereas almost nothing is known about their hunting sites.

13.1.1 *Rhinolophus ferrumequinum*

This is one of the most common bats in the karst regions of Albania, similarly to the neighbouring countries (Horáček *et al.* 1974, Červený & Kryštufek 1988, Kryštufek 1991, Kryštufek *et al.* 1992, Uhrin *et al.* 1996, Hanák *et al.* 2001). It was recorded in the Prespa area of Albania for the first time in 1995, at Treni cave (2 males and 1 female netted in April 1995; Uhrin *et al.* 1996), and it was observed in the cave in subsequent years (1998, 2007, 2008 and 2010, F. Bego pers. obs.). We further netted an adult female at the cave in October 2010. A few individuals were also observed in Shueç tunnel in autumn 2010. Although the species has only been recorded in the area of the Lesser Prespa Lake, it may well roost in caves along the Greater Prespa Lake.



Rhinolophus ferrumequinum, Treni Cave

13.1.2 *Rhinolophus hipposideros*

This species was recorded for the first time on the Albanian side of Prespa in 1995 (1 male and 1 female, both torpid sub-adults in one of the caves located ca. 1 km east of Gollomboç village, April 1995; Uhrin *et al.* 1996; Appendix II). The species was also observed in a number of other caves in the areas of the Greater and Lesser Prespa lakes, including the Treni Cave, in late autumn 2007, 2008 (F. Bego pers. obs.), 2010 and winter 2011 (Bego 2011). In particular, over our last field surveys (Nov. 2010 and Feb. 2011), several torpid individuals of the species were observed in two of the Gollomboç caves, in Zaroshka Cave and in Treni Cave (Appendix II). Apparently, these sites are used for hibernation by these bats. It is likely that the species uses other caves, as well as deeper parts of the known caves as hibernacula. To date, the presence of the species in traditional buildings has only been confirmed in an old traditional house in Buzëlliqen (Zagradec) village. Bat droppings in the Shueç pumping station most likely belong to *R. hipposideros* (see section 13.2.2).

13.1.3 *Rhinolophus euryale*

The species was only recently recorded on the Albanian side of the Prespa area: a yearling female was caught in October 2010 at Treni Cave. It is likely that it forms mixed species colonies with *R. ferrumequinum* and *R. blasii* in the cave. The species may use other roosting sites in the areas of both Prespa lakes. The presence of the yearling may imply that *R. euryale* breeds in the area, but further surveys in summer are needed to confirm this hypothesis.

13.1.4 *Rhinolophus blasii*

Similarly to *R. ferrumequinum*, *R. blasii* was recorded for the first time on the Albanian side of Prespa in 1995, at Treni Cave (1 male and 1 female netted in April 1995; Uhrin *et al.* 1996). We further captured a few individuals at the cave including yearlings in October 2010 (1 female, 2 males), suggesting that the species breeds in the area similarly to *R. euryale*.

13.1.5 *Myotis myotis* & *M. blythii*

Myotis myotis was recorded on the Albanian side of Prespa in 1995 (2 males and 3 females, all adults, netted at Treni Cave in April 1995; Uhrin *et al.* 1996). One individual was observed in the first chamber of the Treni Cave in autumn 2008 (F. Bego, pers. obs.). More recently, in October 2010, we captured six adult bats (4 males and 2 females) that were in apparent oestrus, whereas a number of bats were observed roosting in deep crevices in the cave earlier in the day, singly or with another individual. This suggests that Treni Cave is used by the bats for swarming/mating and shelter in autumn. Breeding bats may be present in mixed species summer colonies, but this remains to be confirmed. The species may also be present at other recently discovered underground sites along the rocky shore of the Greater Prespa Lake, such as “Golema Dupka”, a cave near Kalla-

mas village, the “Badger’s cave” in Gollomboç peninsula and Zaroshka Cave near Zaroshka village (Appendix II), as it was suggested by some large bat droppings under crevices observed in some of these caves in autumn 2010.

To date, it is uncertain whether *M. blythii* has been recorded in the area. In autumn 2010, the biometric measurements of an adult male captured at Treni Cave fell in the overlap zone of the two sibling species. In July 2009, an individual of one of the two species was observed in a vertical crevice on Mali Grad Island (Appendix II).

13.1.6 *Myotis daubentonii*

Myotis daubentonii is another species among those recorded for the first time in the Albanian side of Prespa in spring 1995, when two adult females were netted in one of the small caves ca. 1 km SE of Gollomboç village (Appendix II) and 12 males were netted at the entrance of Treni Cave (Uhrin *et al.* 1996). We further captured two adult males each in summer 2009 and in autumn 2010 at Treni Cave. Since the lakes offer suitable habitats for the species, it is highly likely to be present in other caves and rock crevices along the lakes’ shoreline, such as Golema Dupka, Gollomboç and Zaroshka caves (Appendix II).

13.1.7 *Myotis capaccinii*

The first record of *Myotis capaccinii* for the Prespa area was on 30 May 1991, when the largest nursery colony of the species known in Europe at the time (ca. 10 000 individuals) was observed in the deepest part of the Treni Cave (Chytil and Vlasin 1994). Four years later, during the 1995 expedition (20 and 21 April; Uhrin *et al.* 1996) an adult male and an adult female were netted at one of the Gollomboç caves (Appendix II), whereas a colony of only ca. 1000 individuals was observed at Treni Cave (54 bats netted, of which 17 males and 37 females; Uhrin *et al.* 1996). The species was regularly observed in the cave in the following years (1998, 2007 and 2008, F. Bego, pers. obs.). Our more recent surveys of 2009, 2010 and 2011 have confirmed the importance of Treni Cave not only as a nursery site for the species, but also as a swarming



Myotis myotis, Treni Cave

and hibernation site. Several bats, mainly males in oestrus, were captured in October 2010, whereas chasing and social calls typical of swarming behaviour were observed. In February 2011, several hundred bats were roosting singly or in clusters of a few tens up to a few hundred bats in the cave. It appears that the species is well established in the Prespa region. The population of *M. capaccinii* in the Albanian part of Prespa may roughly fluctuate between 2000-10 000 individuals.

13.1.8 *Pipistrellus kuhlii*

Pipistrellus kuhlii was first recorded in the Albanian part of Prespa in July 2009. It was a lactating female hunting above the reedbeds at the lake-shore, near the village of Buzëlliqen (Zagradec).

13.1.9 *Eptesicus serotinus*

Eptesicus serotinus was recorded in the Albanian part of Prespa for the first time in April 1995, when two adult males were netted at one of the Gollomboç caves (Appendix II) and another adult male was netted at Treni Cave (Uhrin *et al.* 1996). Similarly to the Greek side of Prespa, only males have been detected to date.

13.1.10 *Hypsugo savii*

Hypsugo savii is among the species recorded for the first time in April 1995, when two adult males were netted at one of the Gollomboç caves (Appendix II). The Prespa area provides suitable habitats for the species (e.g. the rocky shores of the Greater Prespa Lake), so it is likely that more systematic studies in the future may increase the records of this frequently encountered bat at other sites of Prespa.

13.1.11 *Plecotus species*

A bat belonging to the genus *Plecotus* was recorded for the first time in the Albanian part of Prespa in October 2010 at the Treni Cave. In the following winter (2011) we observed another individual in deep torpor in the cave, near the entrance. In both cases it was not possible to determine the species.

13.1.12 *Miniopterus schreibersii*

The first record of *Miniopterus schreibersii* in the Albanian part of Prespa dates back to 30 May 1991, at Treni Cave, along with the *Myotis capaccinii* (Chytil and Vlasin 1994). Four years later, in April 1995, 8 individuals were netted at the cave (5 males and 3 females), representing 37.3% of the bats netted at the cave at the time (Uhrin *et al.* 1996). In the following years (1998, 2007 and 2008), it was the dominant species in the colonies observed in the cave in summer and early autumn (F. Bego pers. obs.).



Miniopterus schreibersii,
Treni Cave

In particular, in July and September 2008, a large mixed species colony of ca. 5000 individuals dominated by *M. schreibersii* was observed. Our recent surveys of 2009, 2010 and 2011 have confirmed the importance of the Treni Cave for the species in summer and autumn. In summer, a few thousand male *M. schreibersii* roost in the cave, whereas in autumn a few hundred still remain using the site as a shelter. We do not know where these bats hibernate, since they are no longer present in winter. We also do not know whether the species breeds at any of the underground sites on the Albanian side of Prespa, since mostly males have been detected to date, similarly to the Greek caves. Finally, a cave on Mali Grad Island was used by over 2000 individuals in September 2008 (W. Fremuth, pers. com.), but no bats were found in summer 2009 nor in late November 2010 (Bego 2011), suggesting that the cave may be used only as an autumn (and probably spring) shelter.

13.1.13 *Tadarida teniotis*

Tadarida teniotis is a new species for the Albanian part of Prespa, detected through its audible echolocation calls at Treni Cave in October 2010 for the first time. At the time, bats presumably also emitted what appeared as very loud social calls

suggesting a strong social activity near the cave (involving mating?). *Tadarida teniotis* may be common in the area (similarly to the Greek side), since there is an abundance of roosting sites for this species that typically roosts in rock crevices.

13.2 Important roosting sites

13.2.1 Natural sites: caves, cavities and rock crevices

Arguably, the most important cave on the Albanian side of Prespa is **Treni Cave**: it is used all year round by large summer colonies, swarming/mating bats, hibernating populations and bats simply using it as an autumn shelter. Along with Bimbilova and Samotska Dupka caves (Table 12.3; section 14.2), they are the most important known winter sites. Some thousand *Myotis capaccinii* spend their entire year in the cave, breeding, swarming and later hibernating. In the summer, the cave hosts several thousand bats from breeding *Myotis capaccinii* and male *Miniopterus schreibersii*. Other species may breed in the cave, such as *Myotis myotis*. In the autumn, several hundred mostly male *M. schreibersii* roost in the cave, whereas another eight species utilize the cave as a roost and/or a swarming/mating site (Table 12.3). In winter, several hundred *M. capaccinii* hibernate in the cave, whereas only a few other bats have been found from three species (*R. ferrumequinum*, *R. hipposideros*, *Plecotus* sp).

Some more caves appear to be important for bats along the Albanian shore of the Greater Prespa Lake near the villages of **Gollomboç**, **Zaroshka** and **Kallamas** (Golema Dupka) (Appendix II). The quantities of bat droppings and urine stains on the walls and ceiling suggest their relatively heavy use by bats presumably in spring (confirmed for at least one of these sites, where *Myotis daubentonii*, *M. capaccinii*, *Eptesicus serotinus* and *Hypsugo savii* were found in 1995; Appendix II; Uhrin *et al.* 1996) and summer, since no bats were found in autumn and winter, with the exception of a few *Rhinolophus hipposideros*. A few bat droppings at some other shallower caves suggest their use by only a few bats as night or satellite roosts.

Finally, the cave on **Mali Grad** Island used by over 2000 *Miniopterus schreibersii* in September



F. BEGO

View of Greater Prespa Lake from a cave



X. GREMILLET

Pumping station southeast of Shueç village

2008 (W. Fremuth, pers. com.) suggest that the cave may be used only as an autumn shelter and perhaps in spring (Table 12.3). The quantities of bat droppings and urine stains on the ceiling suggest its long term use by the bats.

13.2.2 Artificial sites: tunnels and buildings

A tunnel with two entrances near the village of **Shueç** was used by a few *R. ferrumequinum* in October and in November 2010 (Bego 2011). The tunnel is currently exposed to draught, but if one entrance is sealed, it may become an important bat roosting site. Southeast of Shueç and on the shore of the Lesser Prespa Lake, there is a pump-

ing station that has not been used in the last 20 years. Droppings found in autumn 2010 suggested the presence of bats in the building at other times of the year, despite the draught (no door and open windows under the roof). This small building situated close to the border with Greece is probably used as a satellite and/or night roost by bats that may be connected to the largest known colony in Prespa, at Agathoto (Appendix II). The building can be renovated to host roosting bats (see Part IV). Military tunnels (bunkers) along the roads cannot host large bat colonies because of their small size; however, many of them appear to be used as night roosts by hunting bats or as temporary shelters (Bego 2011).

13.3 Threats

The primary threat to the bats on the Albanian side of the Prespa lakes is the **disturbance of important roosting sites**, such as the Treni, Golomboç and Golema Dupka caves (Appendix II). These sites are frequently used by shepherds during summer to shelter their animals (large herds of sheep and goats). Shepherds sometimes even make fire in the caves, disturbing bat colonies in the deepest parts. Uncontrolled and unauthorised visits by people in the caves may even involve rituals: in February 2011 the grille gate recently placed at the entrance of the Treni Cave (Kazoglou *et al.* 2010, WAMP *et al.* 2011) was forced open and objects, such as a mirror and candles, were found in the cave. The gate has been repeatedly forced open in the past.

Bat roosting sites in buildings are threatened by **reconstruction of old traditional houses** with modern techniques without accounting for bats.

Another important threat is the **severe degradation of the forested areas** because of overexploitation and uncontrolled practices (lopping for fodder, grazing and firewood extraction). Overexploitation of forests and shrubs combined with the overgrazing and fires in the uplands have led to a decrease of the vegetation cover which is highly likely to affect bat roosts and hunting habitats.

The intensification of agricultural practices (e.g. for increasing apple production) including **heavier**

use of pesticides coupled with the **abandonment of traditional agro-pastoral practices** constitute an important threat for the hunting habitats of bats.

Finally, given the importance of some roosting sites such as the Treni Cave and the current lack of effective protection (see section 13.4), **“bat tourists”** may be attracted. If uncontrolled, they may constitute a threat through disturbance of nursery and hibernating colonies.

13.4 Conservation and legal protection

All bat species are protected according to the Albanian legislation. The Law on Protection of Biodiversity and the Law on Hunting and Wildlife Conservation are both providing legal protection for bats and their roosting sites throughout the country. However, the main problem remains the enforcement of the laws. This is partially due to low performance of the forest service and environmental inspectors that are responsible for the legal enforcement and implementation of the laws and regulations.

14. Bats on the side of the FYR of Macedonia

14.1 Species accounts

Bat species distribution maps in Appendix II include the distribution of species in the entire Prespa Basin including the FYR of Macedonia. Table 12.3 summarises the most important underground sites, the respective species roosting in them and their annual function.

14.1.1 *Rhinolophus hipposideros*

Published data: Krystufek *et al.* (1992): Leskoec Cave. Boshamer *et al.* (2006): Leskoec village, Shurlenci village, Leva Reka village (31 July 2006), Gorno Konjsko village (02 August 2006).

Original data: Leskoec Cave (small cave: 1 individual, main cave: 2 individuals, 26 July 2010); Leskoec Cave (1 individual, 11 January 2011);

small caves/cavities at the Monastery St. Spas (12 individuals, 27 July 2010); Zandana Cave (small cave – rock cavity) close to the Albanian border (3 individuals, 10 October 2010); Naumova Cave near Trpejca (5 individuals, 11 October 2010); Crna Pest Cave (1 individual, 11 January 2011); Jaorec Cave near Velmej (5 individuals, 19 February 2011); Meckina Dupka Cave near Ohrid (4 individuals, 19 February 2011); Samotska Dupka Cave (38 individuals roosting singly, 10 March 2011); tunnels near Skrebatno (2 individuals, 23 February 2011).

14.1.2 *Rhinolophus ferrumequinum*

Published data: Felten (1977): Leskoec Cave. Krystufek *et al.* (1992): Leskoec Cave (8 individuals, 17 September 1989). Boshamer *et al.* (2006): Shurlenci village; Gorno Konjsko village near Ochrid (02 August 2006).

Original data: Leskoec Cave (main cave: 1 individual, 26 July 2010); Crna Pest Cave near Trpejca (a few individuals, 28 July 2010); Naumova Cave near Trpejca (several hundred individuals in a mixed colony with *Rhinolophus euryale*, *Miniopterus schreibersii* and *Myotis emarginatus*, 28 July 2010); Naumova Cave near Trpejca (2 individuals, 09 December 2010); Meckina Dupka Cave near Ohrid (2 individuals, 28 July 2010); Bimbilova Cave (Golem Grad Island) (1 individual, 08 December 2010; 2 individuals, 20 February 2011).

14.1.3 *Rhinolophus euryale*

Published data: Felten (1977): Leskoec Cave. Hackethal & Peters (1987): Meckina Dupka Cave near Ohrid (20 individuals); Jaorec Cave near Velmej, 1010 m a.s.l. (30-40 individuals). Krystufek *et al.* (1992): Leskoec Cave (2 individuals, 09 May 1975); Jaorec Cave near Velmej, 1010 m a.s.l., (data after Felten and Hackethal & Peters). Boshamer *et al.* (2006): Naumova Cave near Trpejca (500 individuals, 28 July 2006); Leva Reka (31 July 2006); Shurlentsi village.

Original data: Leskoec Cave (more than 500 individuals, of which 400 *Rhinolophus euryale* were counted through emergence counts and capture

of bats, 10 October 2010); Leskoec Cave (4 individuals counted, 11 January 2011); Leskoec Cave (3 individuals counted, 20 February 2011); Crna Pest Cave near Trpejca (approx. 30 individuals, 28 July 2010); Naumova Cave near Trpejca (approx. 600 individuals, mainly *Rhinolophus ferrumequinum* and *R. euryale*, mixed with a few *Myotis emarginatus* and *Miniopterus schreibersii*, 28 July 2010); Naumova Cave near Trpejca (9 individuals, 11 October 2010).

14.1.4 *Rhinolophus blasii*

Published data: Karaman (1929): Meckina Dupka Cave near Ohrid (9 individuals, October 1923). Krystufek *et al.* (1992): Leskoec Cave (2 individuals, 02 May 1986).

Original data: Leskoec Cave (approx. 100 individuals in mixed colony with more than 400 individuals of *Rhinolophus euryale*, 10 October 2010).

14.1.5 *Myotis daubentonii*

Published data: Bogdanowicz (1990): Trpejca village (Ohrid). Boshamer *et al.* (2006): Shurlenci village (identified by bat detector).

14.1.6 *Myotis capaccinii*

Published data: Krystufek *et al.* (1992): Golem Grad (one mummified individual).

Original data: Bimbilova Cave on Golem Grad Island (mixed colony with *Miniopterus schreibersii*, June 2010 and 27 July 2010); Bimbilova Cave on Golem Grad Island (a cluster of up to a few thousand *Myotis capaccinii* were counted during the day visit and several thousand individuals of *Miniopterus schreibersii*; counts/captures of emerging bats with a harp-trap was generally not appropriate, since bats emerged in large clusters; 09 October 2010); Bimbilova Cave on Golem Grad Island (approx. 350 individuals counted, 08 December 2010); Bimbilova Cave on Golem Grad Island (> 2000 individuals, 20 February 2010); Naumova Cave near Trpejca (approx. 150-200 individuals, 09 December 2010); Naumova Cave near Trpejca (18 individuals, 11 January 2011).

14.1.7 *Myotis emarginatus*

Published data: Boshamer *et al.* (2006): Naumova Cave near Trpejca (50 individuals, July 28, 2006).

Original data: Naumova Cave near Trpejca (numerous individuals in a mixed colony with *Rhinolophus ferrumequinum*, *R. euryale* and *Miniopterus schreibersii*, 28 July 2010); Crna Pest Cave near Trpejca (2 individuals, 28 July 2010).

14.1.8 *Myotis myotis*

Published data: Hackethal & Peters (1987): Jaorec Cave near Velmej (600 adult females, 27 May 1984 and 23 June 1985). Krystufek *et al.* (1992): Jaorec Cave near Velmej (100 individuals, 16 September 1989). Boshamer *et al.* (2006): Jaorec Cave near Velmej (approx. 2000 individuals, 27 July 2006); Velmej springs (mist netted, 01 August 2006); Asan Gura Pond, 1473 m a.s.l. (mist netted, 27 July 2006).

Original data: Samotska Dupka Cave (45 individuals mixed with *M. blythii*, roosting singly or in small groups, 10 March 2011).

14.1.9 *Myotis blythii*

Published data: Felten (1977): Leskoec Cave. Krystufek *et al.* (1992): Leskoec Cave. Boshamer *et al.* (2006): Studino Pond, 1400 m.a.s.l. (mist net, 28 July 2006); Leva Reka Stream, 963 m a.s.l. (mist net, 31 July 2006); Velmej springs, 876 m a.s.l. (mist netted, 01 August 2006); Simonchevska Lokva Pond, 1481 m a.s.l. (mist netted, 29 and 31 July 2006; 03 August 2006).

Original data: Samotska Dupka Cave (45 individuals mixed with *M. myotis*, roosting singly or in small groups, 10 March 2011).

14.1.10 *Myotis mystacinus*

Published data: Krystufek *et al.* (1992): Velmej springs, 3 km east of the village Velmej (mist netted, 16 September 1989); Kurbinovo Stream (mist netted, 17 September 1989). Boshamer *et al.* (2006): Simonchevska Lokva Pond, 1481 m a.s.l. (mist netted, 29 July 2006), Bolnska Reka Stream, 937 m a.s.l. (mist netted, 02 August 2006). [*Myotis aurasceus*]: Boshamer *et al.* (2006): Simonchevska Lokva Pond, 1481 m a.s.l. (mist netted, 29 July 2006); Pond at

Gorno Konjsko near Ohrid, 1100 m a.s.l. (mist netted, 02 August 2006); Bolnska Reka Stream, 937 m a.s.l. (mist netted, 02 August 2006).

14.1.11 *Pipistrellus kuhlii*

Published data: Boshamer *et al.* (2006): Simonchevska Lokva Pond, 1481 m a.s.l. (mist netted and recorded by bat detector, 29 and 31 July 2006, 03 August 2006), Gafa Pond, 1460 m a.s.l. (29 July 2006), Velmej springs, 876 m a.s.l. (01 August 2006).

14.1.12 *Pipistrellus pipistrellus*

Published data: Boshamer *et al.* (2006): Bolnska Reka Stream, 937 m a.s.l. (mist netted, 02 August 2006), Shurlentsi (recorded by bat detector), Asan Gura Pond, 1473 m a.s.l. (mist netted, 27 July 2006, 02 August 2006), Mountain Hut Asan Gura, 1450 m a.s.l. (recorded by bat detector and mist netted, 02 August 2006).

Original data: Golem Grad Island (at least 2 individuals in wall crevices of the Chapel St. Peter, 1 individual in the neighbouring abandoned building, 27 July 2010).

14.1.13 *Pipistrellus pygmaeus*

Published data: Boshamer *et al.* (2006): Cavkalica Pond, 1065 m a.s.l. (recorded by bat detector, 01 August 2006), Leva Reka Stream, 963 m a.s.l. (recorded by bat detector, 31 July 2006), Bolnska Reka Stream, 937 m a.s.l. (recorded by bat detector, 02 August 2006).

14.1.14 *Hypsugo savii*

Published data: Krystufek *et al.* (1992): Velmej springs, 3 km eastwards from the village of Velmej, 876 m a.s.l. (mist netted, 16 September 1989), Kurbinovo Stream, 980 m a.s.l. (mist netted, 17 September 1989). Boshamer *et al.* (2006): Mountain Hut Asan Gura, 1450 m a.s.l. (recorded by bat detector, 02 August 2006); Gafa Pond, 1460 m a.s.l. (recorded by bat detector, 02 August 2006).

Original data: Golem Grad Island (one dead individual, Gojdarica Port, June, 2010).



Mixed species colony in Bimbilova Cave

14.1.15 *Nyctalus leisleri*

Published data: Boshamer *et al.* (2006): Asan Gura Pond, 1473 m a.s.l. (recorded by bat detector, 02 August 2006), Simoncevska Lokva Pond, 1481 m a.s.l. (recorded by bat detector, 27 and 31 July 2006, 03 August 2006), Gafa Pond, 1460 m a.s.l. (recorded by bat detector, 29 July 2006), Velmej springs, 3 km east of Velmej, 876 m a.s.l. (mist netted, 01 August 2006), Leva Reka Stream, 963 m a.s.l. (mist netted, 31 July 2006), Bolnska Reka Stream, 937 m a.s.l. (mist netted, 02 August 2006).

14.1.16 *Eptesicus serotinus*

Published data: Boshamer *et al.* (2006): Simonchevska Lokva Pond, 1481 m a.s.l. (3 individuals mist netted, 31 July 2006, 03 August 2006).

14.1.17 *Plecotus auritus*

Published data: Boshamer *et al.* (2006): Asan Gura Pond, 1473 m a.s.l. (mist netted, 27 July 2006); Gorno Studino Pond, 1481 m a.s.l. (mist netted, 28 July 2006), Simonchevska Lokva Pond, 1481 m a.s.l. (mist netted, 29 July 2006); Leva Reka Stream, 963 m a.s.l. (mist netted, 31 July 2006).

14.1.18 *Miniopterus schreibersii*

Published data: Hackethal & Peters (1987): Jaorec Cave near Velmej, 1010 m a.s.l. (60-70 individuals, 27 May 1984 and 23 June 1985). Krystufek *et al.* (1992): Velmej springs, 3 km east of Velmej, 876

m a.s.l. (2 individuals netted across the pond, 16 September 1989); Jaorec Cave near Velmej (approx. 1000 individuals, 16 September 1989). Boshamer *et al.* (2006): Naumova Cave near Trpejca (235 individuals, 28 July 2006); Jaorec Cave near Velmej (approx. 2000 individuals, 27 July 2006); Velmej springs, 3 km east of Velmej, 876 m a.s.l. , (mist netted, 01 August 2006); Leva Reka Stream, 963 m a.s.l. (mist netted, 31 July 2006), Gorno Studino Pond, 1400 m a.s.l. (mist netted, 28 July 2006).

Original data: Bimbilova Cave (approx. 7000 individuals counted in June 2010); Bimbilova Cave (several thousand individuals mixed with *Myotis capaccinii*, 27 July 2010); Bimbilova Cave (several thousand individuals counted during the day; counts/captures of emerging bats with a harp-trap was generally not appropriate, since bats emerged in large clusters; 09 October 2010); Bimbilova Cave (approx. 3000 individuals counted, 08 December 2010); Bimbilova Cave (approx. 300-400 individuals counted, 11 January 2011); Bimbilova Cave (> 1000 individuals, 20 February 2010); Naumova Cave near Trpejca (1 individual flying in the cave, 11 October 2010).

14.1.19 *Tadarida teniotis*

Published data: Boshamer *et al.* (2006): Mountain Hut Asan Gura (1450 m a.s.l.), Asan Gura Pond (1473 m a.s.l.).

Original data: Leskoec village (a few individuals identified by their audible calls and the use of a bat detector, 10 October 2010).



Golem Grad Island

14.2 Important natural roosts: underground sites

At least three important caves for bats on this side of the Prespa Basin have been identified to date: **Bimbilova Cave** on Golem Grad Island, **Leskoec Cave** near Leskoec village and **Samotska Cave** to the west of Mountain Hut Asan Gura (Table 12.3; Appendix II). Bimbilova Cave has only recently been discovered (June 2010). It is used by many thousands of bats in summer and autumn, whereas several thousand hibernate in the cave, making it one of the most important known hibernacula in the entire Prespa along with Samotska Dupka and Treni caves. Breeding has not been confirmed; nevertheless it hosts large bat colonies from at least two species (*Myotis capaccinii* and *Miniopterus schreibersii*) throughout the year. Two torpid *R. ferrumequinum* were also observed in February 2011. Different visits in winter suggested that bats may move

among different locations in the cave even during this season. Samotska Dupka Cave is the largest known cave in the Galicica National Park (GNP). It was used by over 80 hibernating bats from three species (*Rhinolophus hipposideros*, *Myotis blythii*, *M. myotis*) in winter 2011, whereas droppings suggest its use by most possibly large numbers of bats at other times of the year. It is the most important known hibernaculum for *R. hipposideros* in the area (almost 40 individuals counted in winter 2011). The cave is cold and offers good conditions for hibernation. A gate placed at the entrance of the cave in 2005 prohibited uncontrolled public visits; however, it was not designed specifically for bats leaving a relatively small opening at its upper part. The replacement of the gate by a “bat-friendly” grille may help attract more bats in the cave (see section 14.5). Leskoec Cave is used by all four *Rhinolophus* species present in the Prespa area. It is an important cave for medium sized Rhinolophids (*R. eury-*

ale and *R. blasii*) at least in the autumn months, since it is used by over 500 bats for roosting and most probably mating. In winter 2011, a few medium sized *Rhinolophids* and *R. hipposideros* were found torpid in the cave. A few *R. hipposideros* actually use the cave throughout the year, whereas a *R. ferrumequinum* was roosting singly in the cave in summer 2010.

Naumova and Meckina Dupka are important caves near Ohrid (Table 12.3; Appendix II). Naumova hosts a large mixed species breeding colony of many hundreds of bats in summer from four species (*Rhinolophus ferrumequinum*, *R. euryale*, *Miniopterus schreibersii* and *Myotis emarginatus*; Table 12.3). *Rhinolophus ferrumequinum* and *R. euryale* are the most numerous in the summer colony but most of them are no longer present in the autumn: are these the same *R. euryale* that use Leskoec Cave in that season? In autumn 2010, only a few *R. euryale*, *R. hipposideros* and *M. schreibersii* were observed in the cave, but in December of the same year, approx. 150 bats from another species appeared, *Myotis capaccinii*: where did these bats come from? A few *R. ferrumequinum* were also present at that time. Later on in winter however, most of these bats were gone. Therefore the cave is used by at least six species and bats are present throughout the year with their numbers fluctuating among and within seasons. A small cave next to Naumova (Crna Pest Cave) seems to act as a satellite cave in summer; this cave is not used in the autumn; in winter a single *R. hipposideros* was observed in deep torpor. Meckina Dupka on the other hand has been used by up to a few tens of bats from all four *Rhinolophus* species in the past (Karaman 1929; Hackethal & Peters 1987; Krystufek, unpublished data). We recently found two *R. ferrumequinum* (summer 2010) and four *R. hipposideros* (winter 2010-2011) in the cave, whereas there were almost no bat droppings on the cave floor. Presumably the cave is very little used by bats because of disturbance and habitat changes surrounding the cave (but see section 14.3 below).

Jaorec Cave near the village of Velmej in the north of the Prespa Basin (Appendix II) appears to be an important cave hosting several thousand bats in summer from at least three species (*R. euryale*, *Myotis myotis*, *Miniopterus schreibersii*;

Hackethal & Peters 1987; Krystufek *et al.* 1992; Boshamer *et al.* 2006). The cave is only used by a few *R. hipposideros* in winter. The relation of bats between this cave and the caves within the Prespa Basin is unknown. Only male *Myotis myotis* and *Miniopterus schreibersii* have been detected to date within Prespa in summer. Do female *M. myotis* and *M. schreibersii* breed in Jaorec Cave forming at least part of the missing breeding population and if so, why?

Finally, the **cavities at Sv. Spas Monastery** (Appendix II) appear to be important for some small breeding colonies of *R. hipposideros*. These cavities apparently offer suitable thermal conditions to breeding bats and serve as natural roosting sites for the species. Some bats use them as night roosts (e.g. *Plecotus* species). A **tunnel near Skrebatno village** (Appendix II), at approx. 10 km from Ohrid near the northern border of GNP, has a gate that almost completely blocks the entrance except a small window with a grille that allowed 2 bats (*R. hipposideros*) to enter the site in winter 2011.

14.3 Threats

The emigration waves especially at the rural areas caused dramatic demographic declines in the past decades (1970-2000), resulting in the **abandonment of the traditional practices of livestock herding** in the upland areas of the Galicica and Pelister Mountains. In the past, herds counting tens of thousands of sheep were grazing in the mountainous rural areas, roosting in the upland grazing farms during the summer and in barns in the villages during the winter. These traditional land-use patterns were maintaining the specific grassland ecosystems into a form of hilly and mountain pastures, also providing plenty of animal droppings that attract insect prey for bats. In addition, stock-farm buildings, buildings for grain storage, as well as the village houses built in vernacular style were important roosting sites for certain bat species. Currently, the traditional stock-breeding is almost completely abandoned. On both mountains only a few hundred sheep and black cattle are still bred in a traditional way, resulting in slow natural succession of the former pastures by shrubbery and forest

ecosystems and the landscape evolved through the interaction of local people and nature over centuries, using traditional, sustainable land-use patterns is gradually disappearing.

Current **forest management practices** such as clear cuts in oak forests, thinning and massive logging in beech forests outside Galicica and Pelister NPs are an important threat to forest bats. In PelNP there are still old growth forests, some pristine oak and beech woodlands and ancient fir forests, including old and standing dead trees, such as those commonly used by bats for roosting. In GNP however only small patches of old growth forests are still preserved. In forests outside the NPs, old and standing dead trees and old growth patches are not preserved.

The **intensification of apple growth** is a threat to hunting bats. Traditional apple orchards have largely been replaced by intensive monocultures heavily using fertilizers and pesticides with many sprayings per year. These intensive apple monocultures now cover the lowland areas of Prespa to a great extent.

Frequent, uncontrolled visits by humans in

Meckina Dupka Cave may cause disturbance to the bats, as the recent observations of only a few bats in the cave coupled with the presence of garbage and writings on its walls suggest. The cave is located on the outskirts of the City of Ohrid and recently, new private houses were built near the cave. The signs of disturbance were a warning for the authorities of the GNP to undertake mitigation measures for the protection of the cave and fit a grille gate at its entrance. The grille was designed in accordance with the standards given by EUROBATS. On the other hand, the placement of **gates at cave and mine entrances** not accounting for bats may prohibit bats to enter and roost in these sites (e.g. Samotska Dupka Cave and Skrebatno tunnel).

Visits and interviews of local people at four villages (Brajcino, Arvati, Dolno Dupeni, Kurbinovo) in December 2010 revealed that the reconstruction of old and/or abandoned houses and other buildings such as old mills to be used for apple storage has resulted in the **exclusion of bats** from these sites. On one occasion bats were actively excluded by the owner of an abandoned house.



14.4 Legal protection

Bat protection in this part of Prespa is regulated by the national legislation, as well as by international Conventions, EU Directives and Agreements. The Law on Nature Protection adopted in 2004 (Official Gazette of the Republic of Macedonia No. 67/2004) follows the IUCN criteria for the Categories of Protected Areas, as well as the rules of the EU Habitats Directive (Directive 92/43/EEC) and the EU Birds Directive (Directive 79/409/EEC) for the conservation of wild animal and plant species and natural habitats. The Law regulates the system of protected areas and the protection of biodiversity in and outside the protected areas.

The area is largely covered by a system of protected areas. The Greater Prespa Lake itself is proclaimed as Protected Area in the category of Monuments of Nature and it is a Ramsar Site. The north-eastern shoreline belt of the lake that encompasses various wetland ecosystems with wide areas of reedbeds, the lower flow and the mouth of Golema Reka River, located between the villages of Asamati and Sirhan is a Strict Nature Reserve (Ezerani Nature Reserve). A large portion of the Mt Galicica belongs to the GNP. The upper basin of the Brajcinska River is included in the borders of the PelNP.

The FYR of Macedonia is a Member Party of the Agreement on the Conservation of Populations of European Bats (EUROBATS) since September 15, 1999. It is also Contracting Party to the following International Conventions, which are directly or indirectly related to bat conservation:

- Ramsar Convention on Wetlands since October 08, 1991.
- The Convention on Biological Diversity (CBD) since December 02, 1997.
- The United Nations Framework Convention on Climate Change since April 28, 1998.
- The Bonn Convention on Migratory Species (CMS) since January 11, 1999.
- The Bern Convention on the Conservation of European Wildlife and Natural Habitats since April 01, 1999.

14.5 Conservation in practice

In GNP there were no direct actions to protect bat species until recently. However, a series of measures to protect all habitats have been undertaken by the GNP's authorities, which may also benefit bats. For example, it is an established practice to preserve large old and standing dead trees. In 2005, the entrance of the Samotska Dupka Cave was closed in an effort to control public visits and protect it. Because the gate was not designed at the time specifically for bats, and following more recent revelations of its importance as a bat roost, it is now being considered by the GNP's authorities to replace it by a new grille gate according to the EUROBATS standards. In 2010, the entrance of the Meckina Dupka Cave, another much visited cave in the GNP, was closed by a grille. The GNP authorities recently developed and are currently implementing systematic long-term monitoring of bats and their habitats for the first time in the GNP and its vicinity, starting in 2010. This systematic monitoring provides valuable information on bat populations and for best practice on their protection.

15. Synthesis: bats in the Transboundary Prespa Park and its surroundings

Knowledge on the bats of Prespa is recent and incomplete. Surveys have mainly been implemented in summer. More recently, the first surveys at swarming sites and generally autumnal shelters were undertaken, as well as the first winter surveys.

A number of limestone caves, rock crevices and cavities in all three countries surrounding the Prespa Basin host important summer, autumn and/or winter bat colonies (see Table 12.3 for the most important known caves). Cave-dwelling bats in the south of Europe switch between different underground sites both within and between seasons (e.g. Papadatou *et al.* 2008b, 2009, SFEPM 2008). This may well be the case for bats at Prespa: because borders between countries are not physical barriers to bats, they may move among roosting sites across Greece, Albania and the FYR of Macedonia, along

the shore of the Greater Prespa Lake, the islands of Golem Grad and Mali Grad, and in inland areas. These sites probably form a network used by the bats throughout the year and may also include other locations that to date are unknown and may even be found away from the Prespa Basin. This hypothesis is supported by the fact that the size of colonies fluctuates among years, seasons and even months. Some caves may not be used on certain years (e.g. Tcherná Cave was not used by *R. euryale* in 2007). Similarly, movements of bats may occur among rock crevices depending on microclimatic conditions in relation to the bats annual ecological requirements. Further

reasons for roost switching have been discussed in section 2.4.1. The annual use of these sites by bats and the movement patterns among them can be investigated through long-term studies using a variety of methods; e.g. *Miniopterus schreibersii* and *Myotis capaccinii* between Bimbilova, Naumova, Tcherná, Treni, Gollomboç and Mali Grad caves; *Rhinolophus euryale* and *R. blasii* between Naumova and Leskoec caves or between Tcherná and Mikrolimni caves (see Research and Survey Recommendations, Part IV).

Jaroec Cave is at a ca. 50-70 km straight distance from caves in the Prespa Basin such as Tcherná and Treni. These are distances easily travelled by species such as *Miniopterus schreibersii*; therefore it is likely that the cave is part of the network of underground sites used by the bats in the Transboundary Prespa Park and its adjacent areas. The same may apply for other caves surrounding the TPP.

Only Bimbilova, Samotska and Treni caves have to date been confirmed as important hibernacula for *Myotis capaccinii* (Bimbilova and Treni), *M. blythii*, *M. myotis* and *Rhinolophus hipposideros* (Samotska) and *Miniopterus schreibersii* (Bimbilova). We do not know where most other bats go in winter. Because bats tend to hide in deep inaccessible crevices in underground sites or in inaccessible sites in general (e.g. vertical shafts), we may get a limited answer to this question even after systematic studies in the future.

Rock crevices in the Prespa area are used by bat species known to regularly use trees, bridges and other man-made structures in north, west and central Europe. For example, *Myotis daubentonii* roost in crevices in rock overhangs and in caves along the shore of the Prespa lakes. These may be either breeding (e.g. Cape Roti Cave) or male/non-reproductive roosts.

We know little about forest bats. Many forest species are present in the area (e.g. *Myotis bechsteinii*, *Plecotus auritus*) up to the tree line (approx. 1700 m a.s.l.) but these appear to be rare compared to other bats in the area. We know little on their distribution and status. We do not know their roosting sites and the exact impacts of current forest management practices on their populations and behaviour in any of the three countries.

We know little about the use and importance of



E. STOJKOSKA

View of Greater Prespa Lake and Golem Grad Island from a cave

bat hunting sites. To date, no detailed studies on feeding habitats in Prespa have been implemented and the current knowledge is patchy. Nevertheless, the lakes and their associated wetlands appear to be the most important hunting sites for many if not most bats, whereas many bats from populations outside the Prespa Basin appear to arrive each night to feed near the lakes. Forests and subalpine meadows are also used by the bats for hunting. Similarly to using a network of roosting sites, bats may also cross the countries' borders to forage at a variety of habitats.

The biology and exact ecological requirements are not sufficiently known for the majority of species in the Prespa area. We do not attempt to provide an estimate of their population status (size and trends) other than the rough colony estimates in cave roosts (Table 12.3), since such estimates require more systematic and long-term studies. An exception is *R. hipposideros* for which we currently have a more specific idea with regards to its population size, roosting preferences and hunting areas. Our current knowledge about this bat allows some species-specific conservation recommendations (see PART IV, section 17).

Despite the limitations, we have now confirmed that the Transboundary Prespa Park and its surroundings host a unique bat fauna and important bat roosting sites and hunting habitats. The area shows an incredibly high bat diversity including species with a wide range of roosting and foraging requirements. The high bat diversity presumably reflects the highly heterogeneous and structured environment, the lakes and their associated wetlands, offering a wide variety of habitat types both for roosting and for foraging, coupled with the unique geomorphology and the climate of the area. These habitats are still relatively well preserved despite the various forms of threats and insect prey is presumably still very abundant. The

lakes, wetlands and the remaining traditional livestock breeding (e.g. Greece and Albania) are valuable resources of insect prey for bats. Extensive old growth forest areas in the FYR of Macedonia part of Prespa (particularly in Pelister NP) presumably offer an ideal habitat for forest bat species. It is therefore crucial to preserve the area and improve the conditions at certain locations.

However, a number of factors are threats to these bats and their habitats. These include current forest management practices, intensive bean and apple monocultures using increased amounts of (in some cases inappropriate) pesticides and fertilisers, the partial abandonment of the traditional agropastoral and agro-forestry systems, the disturbance of roosts through uncontrolled public access, the collapse or restoration practices of old traditional houses and the development of wind farms.

To preserve a favourable conservation status for bat populations in the area, we need to design and apply conservation management and monitoring plans encompassing both their roosts and their foraging habitats. Because bats know no borders, scientific research, survey and monitoring work (PART IV, section 16), and associated conservation and habitat management actions and education projects (PART IV, sections 17 and 18) require the transboundary cooperation of researchers, naturalists, local authorities, management bodies of protected areas and NGOs. Conservation projects should be community-based, with the participation of local people at both the planning and execution stages. The pilot transboundary monitoring system of bat roosts elaborated in 2010 (Papadatou, Grémillet & Kazoglou 2010) and this Action Plan form the basis for future collaboration of the three countries in the TPP and the surrounding area.

Part IV

Research, survey
and conservation
recommendations



Recommended actions are defined along three axes, all of which are essential in bat conservation and inter-connected:

1. Improving knowledge;
2. Protection;
3. Raising public awareness.

More than one axis may be involved in the same action, nevertheless we present actions in three different sections (15, 16 and 17 respectively). Actions primarily concern species assemblages or bat habitats and they are not species specific with the exception of *R. hipposideros*. Although there is often good reason to focus on particular species that have specific ecological requirements and are faced with unique or at least clearly definable threats, in many cases it is more appropriate to look at an assemblage of bats or bat habitats (Altringham 2011), since several species may simultaneously benefit from the latter approach. In addition, our knowledge on the ecology of the majority of bat species in the Prespa area is still limited to allow us to define species-specific conservation actions.

16. Recommended research and survey actions

Objective: To increase our knowledge and understanding of bats, their ecological requirements, their roosting and feeding habitats and the specific threats they face in the area of Prespa to form appropriate conservation measures and priorities.

This section is primarily concerned with the first axis. Research and survey recommendations are directly linked to protection and conservation actions, since their ultimate aim *is* bat conservation. We need to have sound evidence-based information and a solid understanding of their ecological requirements and threats they face in the particular area, in order to proceed with recommending and applying appropriate and effective conservation measures and to develop management plans. **Greater understanding of the bats' ecological requirements and threats will allow for management plans that are regionally adapted and for targeted use of resources.** Recommendations generally concern all three countries surrounding the Prespa Ba-

sin (e.g. caves and rock crevices along the shore of the Greater Prespa Lake) and are presented in Boxes 16.1-16.5. Because bats know of no borders, research and surveys should ideally be done on a transboundary level. Surveys for species or species assemblages whose conservation status is unfavourable (e.g. threatened, vulnerable, endangered) on a national or international level should be given priority. There may be some overlap between certain actions or groups of actions.

Box 16.1. Rock crevices and underground sites

Rock crevices, cavities and caves along the shores of the Prespa lakes

- ▷ Investigate the rocky shores of both Prespa lakes to update and complete the current knowledge on the presence and location of rock crevices, cavities and caves [speleological research]; identify any further sites that may be important to bats.
- ▷ Assess their annual bat use by carrying out seasonal surveys through the year; in particular, assess species, sex and age structure, size of colonies and fluctuations.
- ▷ Determine the main function of roosts through these seasonal surveys: maternity, mating, satellite, transitional, night roost, hibernation, autumn shelter, male-only roosts. Concentrate effort on caves and if possible on selected rock crevices and cavities. Timing and frequency of surveys is the key to roost determination.
- ▷ Monitor the annual use of key sites (e.g. Bimbilova, Tchernia and Treni caves, etc.) on a long-term basis, across years; assess the natural fluctuations and population trends of colonies roosting in caves (see Papadatou, Grémillet & Kazoglou 2010 for details on monitoring plans).

Other underground sites

- ▷ Investigate the bat use to update and complete the current knowledge on known underground sites (e.g. Samotska Dupka).
- ▷ Investigate the Prespa area for other un-

known underground sites that may be used by the bats [speleological research].

- ▷ Assess their annual use by bats through seasonal surveys.
- ▷ Monitor the annual use of target sites on a long-term basis.
- ▷ Search for hibernation sites.
- ▷ Investigate caves and assess their annual use by bats in areas adjacent to the Prespa Basin (e.g. Jaroec Cave).

Movement patterns

- ▷ Assess the movement patterns among caves (and rock crevices where possible) within and between seasons and years. Annual and seasonal fluctuations in colonies size may provide basic information on movement patterns but other methods such as ringing, genetics and stable isotopes may provide more detailed assessments.
- ▷ Some specific recommendations. Tchernia and Mikrolimni caves: Verify whether it is the large breeding colony of *Rhinolophus euryale* using Tchernia Cave in summer that moves to Mikrolimni Cave where the conditions may be more suitable in the autumn, before the bats move to their (unknown) hibernation sites. Similarly, with regards to the large mixed colony of *Rhinolophus euryale* and *R. ferrumequinum* using Naumova Cave in summer no longer present in the cave in the autumn: Verify whether these are the same *R. euryale* that move to Leskoec Cave in the autumn, before they move to their (unknown) hibernation sites.

Box 16.2. Forest bats

- ▷ Investigate the presence, diversity and distribution of forest-dwelling bat species through intensive field surveys.
- ▷ Assess the diversity, abundance, activity and structure of forest bat communities in relation to:
 - Altitude,
 - Forest type (oak, beech, mixed, etc.),
 - Forest age structure.

- ▷ Assess the importance of old trees and standing dead wood for different selected (target) bat species.
- ▷ Identify important and key roosting areas and trees within forests.
- ▷ Investigate the roosting requirements and behaviour of target tree-roosting bat species.
- ▷ Assess the degree and importance of roost switching and the number of trees used by the target tree-roosting bats.
- ▷ Assess the impacts of current forest management practices on bats roosting in trees and/or foraging in forest habitats (the latter may include species not roosting in the forest).

Box 16.3. Feeding habitats, commuting corridors and home range

- ▷ Investigate the commuting corridors and the feeding habitat preferences at species assemblages / landscape level (using e.g. bat detector surveys and captures) in the different habitat types (e.g. wetlands, forests, pastures, etc.).
- ▷ Investigate the commuting corridors and the feeding habitat preferences at species-specific level for target species (e.g. using radio-telemetry). Target species may be selected depending on population and conservation status.
- ▷ Assess the home range of target species.
- ▷ Identify key hunting areas at species assemblages and species specific levels.
- ▷ Assess specifically the importance of wetlands and the lakes as bat hunting habitats.
- ▷ Make a list of agrochemicals currently used and their effects on bats from bibliographical resources; investigate the impacts of current pesticide use on bat populations as applied in practice at e.g. apple monocultures in the FYR of Macedonia and bean monocultures in Greece.
- ▷ Investigate the use of areas in and around bean monocultures including drainage channels with reed beds and hedgerows as bat feeding habitats; investigate the insect

fauna constituting bat prey at these sites; compare to other less intensively managed agricultural lands in the area including organic bean fields; apply to apple monocultures as appropriate.

- ▷ Study the habitat associations of bat prey [surveys of insect and other arthropod fauna constituting bat prey].
- ▷ Investigate the use of subalpine meadows by bats as feeding and as commuting sites.
- ▷ Implement pre-construction studies of bat diversity and activity at areas proposed for wind farm development; study in detail the potential impacts of proposed wind farms on bats. Investigate a full annual cycle of bat diversity and activity at each of these sites to be used as a reference and as a guide for developers for the definition of turbine locations and periods of halted operation (see Box 17.2).

Box 16.4. General recommendations

- ▷ Assess the population status (size and trends) of target species (cave- and forest-dwelling).
- ▷ Provide baseline data against which ongoing presence of bat species can be monitored for future conservation status assessments.
- ▷ Update bat species distribution maps following survey work.
- ▷ Map the distribution of core breeding maternity colonies and generally of core roosting sites and update following survey work.
- ▷ Record weather data alongside research and survey actions, as weather conditions may affect bat findings; this will ensure that results reflect the true situation.
- ▷ Identify key areas for integrated conservation management of habitats (e.g. forest for roosting and wetlands for feeding).
- ▷ Assess the migratory movements of target species among countries.
- ▷ Investigate sites used for hibernation (other than underground).
- ▷ Define the role of local partners (conserva-

tion NGOs, and the management bodies of NPs and TPP) in relation to bat research, survey and monitoring actions.

- ▷ Train and permanently equip local conservation NGOs and the NPs' management bodies with the appropriate skills and tools for bat research, survey and monitoring actions.
- ▷ Promote transboundary (trans-national) research, survey and monitoring plans.
- ▷ Establish common systems (methods, protocols, etc.) of research, survey and monitoring in the three countries involved (see e.g. Papadatou, Gremillet & Kazoglou 2010) so that results are comparable.
- ▷ Develop national and transboundary (common) bat data bases; organise a centralised system of data management.

Box 16.5. *Rhinolophus hipposideros*

Priority actions:

- ▷ Investigate potential roosting sites in Albania and the FYR of Macedonia to obtain a global vision of the species in all three countries surrounding the Prespa Basin.
- ▷ Record all buildings (old or abandoned traditional houses, chapels, etc.) used by the species and assess their annual use.
- ▷ Determine the true function of roosts through seasonal surveys: maternity, satellite, transitional, night roost, hibernation.
- ▷ Identify the key roosts.
- ▷ Identify hibernation sites.

Further actions:

- ▷ Investigate commuting corridors, hunting habitats and home range of summer colonies.
- ▷ Identify key feeding sites.
- ▷ Investigate the relations and exchange among different colonies in the Prespa Basin.
- ▷ Investigate the relations of Prespa colonies with external colonies, e.g. on the Greek side, the valleys of Melas-Kranionas-Gavros and of Pisoderi-Gavros.

17. Recommended conservation actions

Objectives: To develop appropriate conservation management actions in order to ensure the long-term survival and favourable conservation status of bat species in Prespa based on their distribution, ecological requirements, habitat preferences and threats to them.

*“Perhaps the first step in conservation is identifying that there is, or will be, a problem. The decline or disappearance of a species from a locality clearly indicates that there is cause for concern on a local scale and suggests we should look to see if the decline is more widespread. We must then identify the cause of this decline and take appropriate action. **Even without evidence of decline, if we understand a species’ particular ecological needs, such as a dependence on a scarce and vulnerable type of roost or food, we can anticipate problems and try to avoid them.** Applying the ‘precautionary principle’ may be necessary before population data are available. We can also plan at a more strategic level: some ecological traits or suites of traits, widespread within a particular genus or even family, may make them unusually vulnerable (e.g. those of slow-flying, gleaning specialists). This knowledge can be used for longer term, more global planning, as well as in local decision making” (Altringham 2011).*

This section is concerned with the second axis: protecting bats and their habitats. We recommend conservation management actions (Boxes 17.1-17.7) based on currently available knowledge and experience. The results of these actions should be monitored and conservation recommendations be adapted to the results of the monitoring as well as of the research and survey actions. More specific conservation action plans targeting at particular species and/or habitats may then be produced. Conservation management actions will help stabilise or increase populations of vulnerable species and improve their conservation status on a local level. The protection, preservation or enhancement of bat roosts and foraging habitats are the key actions in achieving favourable conservation status. There may be some overlap between proposed actions. Important points:

- Conservation recommendations concern all three countries.
- Bats may use a network of roosts and feeding habitats beyond the countries’ borders (see PART III and in particular section 15). In addition, threats to bats may be common among the three countries surrounding the Prespa Basin. For example, uncontrolled pesticide use may affect the water quality of both lakes further than the countries’ borders. The transboundary cooperation among scientists, naturalists, and the local authorities, management bodies and NGOs is important in the design of larger scale conservation measures.
- Bats are very faithful to their roosts especially with regards to more permanent sites such as the caves. Tree-roosting bats are faithful to roost areas. The same applies to their foraging sites: bats may forage to the same sites every night across the years through their lifetime. Bats use a network of roosting places and follow specific commuting corridors to their hunting territories. It is extremely important to account for these facts when designing conservation management plans for these animals: **to maintain bats, we must also maintain the natural ecosystems that make up their habitats.**
- **Conservation projects should be community-based and have the full participation of local people at both the planning and execution stages, ensuring that the benefits are made available to local people.** Recommended actions should be implemented within the framework of co-existence of humans and bats. Bats should therefore not only be linked to ecosystem health, but also to human community prosperity with projects that focus on the needs of bats, humans and their shared resources. Raising public awareness (section 18) will play a significant role in dissolving the misunderstandings and shedding light into the importance of the ecological role of bats and the need to protect and preserve them.
- Any restoration or protection works should be implemented when the bats are absent from the sites.

Box 17.1. Roosts

- ▷ Ensure the legal and physical protection of important sites for breeding, hibernation, autumn shelter and swarming/mating; these include all the important caves known to date (Table 12.3 and other) and buildings used by breeding colonies of *R. hipposideros* (see Boxes 17.5 & 17.6). More sites may be added in the list following future investigations.
- ▷ Monitor core roosting sites on a long-term basis.
- ▷ Restrict access to vulnerable caves by placing grilles at their entrances or constructing fences around their entrances where appropriate; grilles with horizontal bars allow bats to fly between them (guidelines have been published by EUROBATS and other sources).
- ▷ Monitor the sites for potential impacts of the grilles or fences on bat populations and make appropriate adjustments if needed; a specific example is the Meckina Dupka Cave that is monitored by the Galicica NP following the installation of the grille at its entrance for any beneficial or adverse effects to the bats roosting in the cave.
- ▷ Replace old gates unsuitable for bats at cave entrances by “bat-friendly” grilles according to the recommended guidelines provided by EUROBATS and other bat professionals; example: the Samotska Dupka Cave.
- ▷ Closely monitor the sites where it is inappropriate to install grilles or fences to prevent potential impacts of uncontrolled public access.
- ▷ Leave the configuration of the habitat at the cave entrances unaltered; e.g. the trees in front of Mikrolimni or Naumova caves, unless the entrance is blocked.
- ▷ Inform and establish links and long-term management agreements between the NPs management bodies/conservation NGOs and the local municipalities, stakeholders, landowners, professionals and authorities whose actions may affect the bats roosts (e.g.

forest service,, tourism, historical monuments, etc.).

- ▷ Include legal protection measures of important bat roosts and habitats in the management plans of the NPs and the TPP.
- ▷ Include legal protection measures of important bat roosts in the future update of the Common Ministerial Decision (“KYA”) or Presidential Decree of the PNP-GR; protection measures of key roosting sites have recently been incorporated in the Management Plan of the PNP-GR.
- ▷ Incorporate bat requirements in the forest management practices (see Box 17.3 for more specific recommendations on forest bats).
- ▷ Restore existing or create new artificial roosts; reopen abandoned mines and other artificial underground sites, and secure them from public access; e.g. bunkers, Shueç tunnel and pumping station in Albania (see Box 17.6).

Box 17.2. Feeding habitats and commuting corridors

- ▷ Consider bat requirements in the management and development plans of habitats important to bats.
- ▷ Inform and establish links and long-term management agreements between the NPs management bodies/ conservation NGOs and the local municipalities, stakeholders, landowners, professionals and authorities whose actions may affect the bats feeding habitats (forest service, farmers, etc.).
- ▷ Maintain habitat heterogeneity (the mosaic of habitats).
- ▷ Restore the connectivity of the landscape among areas rich in insect prey (the lakes and associated wetlands, forests, agricultural lands, meadows, pastures, riparian woodlands, etc.) where necessary, e.g. by planting hedgerows or gapping up existing ones.
- ▷ Maintain or create hedgerows, tree lines with diverse structure, reed beds, etc. among cultivations; maintain isolated trees.

- ▷ Maintain or restore riparian forests, e.g. replant broadleaf woodland or fence river and stream banks to encourage riparian vegetation to grow naturally.
- ▷ Promote agro-forestry systems.
- ▷ Promote traditional orchards.
- ▷ Monitor the impact of pesticide use on bats; reduce pesticide use; inform policy makers.
- ▷ Encourage, promote and support extensive agricultural and traditional practices, and organic cultivations. In the Greek Prespa, organic cultivations have been established since the early 1990s, whereas in the FYR of Macedonia incentives for organic production given by the government have already been well accepted by the farmers in other regions of the country.
- ▷ Maintain or develop the breeding of buffalo and local cattle races.
- ▷ Incorporate bat requirements in the forest management practices (see Box 17.3 for specific recommendations).
- ▷ Inform wind farm developers with regards to the necessity of pre- and post-construction impact assessment studies on bats to take appropriate action (e.g. remove wind turbines from sites with high bat diversity and activity, etc.).

Box 17.3. Forest bats

As mentioned in Boxes 17.1 and 17.2, bat requirements should be integrated in the forest management practices. Forest recommendations should be adapted on the findings of research and survey actions as recommended in section 16 (Box 16.2). However, some recommendations and guidelines can be provided here for forest management appropriate for bats based on our current experience from Prespa and the international experience. Specifically:

- ▷ Inform and establish agreements with the local forest services.
- ▷ Educate and train foresters with regards to bat biology, habitat requirements, threats,

- legal protection and appropriate management practices for bats.
- ▷ Produce good practice guidelines and inform wood workers/ loggers on their importance.
- ▷ Replace extensive forest clearings by selective logging.
- ▷ Create a network of suitable tree-roosts by preserving all currently old and standing dead trees, including trees near forest edge (forest openings, forest roads, etc.) as well as groups of old trees; avoid extensive forest clearings around them and preserve a number of old trees at various distances to act as connectivity points in the network.
- ▷ Create and preserve new stands of mature forest.
- ▷ Preserve fallen dead wood.
- ▷ Produce an inventory of the trees or groups of trees with potential bat-hosting interest (identification and mapping); regularly update the inventory (e.g. every 10 years).
- ▷ Produce an inventory of known roost trees; regularly update the inventory.
- ▷ Mark known roost trees for protection and/or educational purposes.
- ▷ Integrate protection of important bat roost trees in the law, e.g. the future update of the Common Ministerial Decision ("KYA") or Presidential Decree of the PNP-GR.
- ▷ Preserve or increase variation in forest structure.
- ▷ Preserve forest openings (e.g. small pastures through grazing and meadows) but reduce extensive clear-cuts and monitor for overgrazing in wooded areas.
- ▷ Preserve or restore (e.g. Platy) hedgerows and tree-lines to connect wooded areas and the lakes.
- ▷ Preserve riparian forests.
- ▷ Promote native species and avoid exotic and mono-specific plantations.
- ▷ Prohibit the use of insecticides in the forest; use biodegradable lubricating oil for saw-chains.
- ▷ Create small ponds in dry forests, in particular areas at a long distance from the lakes (e.g. Devas, Sfika, etc.).

- ▷ Stop firing practices near wooded areas (e.g. Vrontero).
- ▷ Preserve the trees near the entrances of bat roosts (e.g. Mikrolimni and Kokkalis' caves, etc.).
- ▷ Introduce bat boxes to complement the natural bat habitat where it appears to offer limited roosting sites to forest bats given the current management practices.
- ▷ Create sanctuary areas (e.g. "Heritage Forest") without any human intervention, i.e. management, grazing or logging to become "wilderness areas" in each of the main forest zones: e.g. Psarades - Devas , Agathoto, Latsista, Giovanitsa, Sfika.



Preserved trees near the entrances of Kokkalis' Cave (above) and Agathoto chapel (below).



Box 17.4. General recommendations

- ▷ Use the research and survey results to assist in the development of guidelines and policies for habitat protection and management.
- ▷ Ensure the statutory protection of key roosting sites and other important bat habitats; generally incorporate protection measures of important bat habitats in the local legislations, e.g. in the future update of the Common Ministerial Decision ("KYA") or Presidential Decree of the PNP-GR. Recently, the protection of some key roosting sites and some forest management practices accounting for bats were incorporated in the Management Plan of the PNP-GR.
- ▷ Promote an integrated approach to bat conservation looking at the range of roosting sites and hunting habitats used by the bats throughout the year.
- ▷ Establish long term monitoring plans.
- ▷ Establish links and promote trans-national management agreements between the three countries surrounding the Prespa Basin; promote integrated conservation and management plans on a transboundary level.
- ▷ Define the role of local partners (conservation NGOs, and the NPs and TPP management bodies) in relation to bat monitoring, management and conservation.
- ▷ Promote common systems of bat surveys and monitoring (see e.g. Papadatou, Grémillet & Kazoglou 2010).
- ▷ Train and permanently equip local conservation NGOs and the NPs' management bodies with the appropriate skills and tools for bat monitoring, management and conservation.
- ▷ Prepare and promote conservation management guidelines for landowners, the NPs management bodies, professionals, etc. for targeted bat species, species assemblages and important bat habitats.
- ▷ Produce and promote guidelines to be used across Greece, FYR of Macedonia and Albania in bat conservation initiatives.

Roosts, feeding habitats, commuting corridors and forest bats: some details

Landscape management may strongly impact the density of insect populations mainly through agricultural, livestock farming and forestry practices. Therefore, because European bats are insectivorous, they depend on these practices. The local practices and habitat management are apparently different in the three countries sharing the Prespa Basin. Some of the local or national landscape management practices are suitable for bats, but others may have negative impacts. Some bat species have small home ranges and their roosts are located within their foraging habitats (e.g. *Rhinolophus hipposideros*, *Plecotus auritus*). Others have much larger home ranges covering several kilometres from their roosts to their foraging sites. Irrespectively of the size of their home range, bats often use linear landscape elements (forests edge, tree-lines and other hedges, streams, rivers, etc.) as commuting corridors. Bat survival is ultimately linked to the quality of their roosting sites, their feeding habitats and commuting corridors.

Public information and link with the local inhabitants and authorities

Landscapes are primarily the result of the interaction of geological and climatic factors, and human land use. Therefore we must not forget that habitats suitable for bats may also be suitable and used by the local inhabitants. The first and perhaps most important objective for bat conservationists is to establish links with the local inhabitants and authorities. However, many local inhabitants in the area may not be concerned by bat conservation. Therefore, conservation management should provide them with some benefits from bat conservation projects. Here, the “bat mediator” may play a significant role (see section 18).

The valley of Ag. Germanos River

The valley of Ag. Germanos River is used by many bats as a commuting corridor and as a feeding habitat from the uplands down to its estuary at the Greater Prespa Lake. It acts as an important

Hundred years old oak in broadleaf forest, valley of Brajcinska Reka River





Old hollow trees used as bat roosts marked as “Veteran trees” by GMB in Brittany, France.

link between the lakes, wetlands, agricultural lowlands, gardens, orchards, broadleaf forests, sub-alpine meadows and the mountain passes towards the valleys and lowlands outside the Prespa Basin. A number of species have been found foraging and/or commuting through the different sections of the valley (Appendix II). Many of these bats may roost in or near these sites:

- Estuary-Laimos: *H. savii*, *Pipistrellus spp*, *E. serotinus*, *N. noctula*, *M. schreibersii*, *T. teniotis*, ...
- Laimos - Ag. Germanos: *R. hipposideros*, *H. savii*, *Pipistrellus spp*, *E. serotinus*, *M. schreibersii*, ...
- Gaidouritsa valley: *M. daubentonii*, *H. savii*, *Pipistrellus spp*, ...
- Giovanitsa forests (*Fagus* and *Abies* forests): *M. mystacinus*, *M. brantii*, *M. nattererii*, *M. bechsteini*, *Pipistrellus spp*, *Pl. auritus*, ...

Despite the importance of the bat diversity and abundance in the valley, broadleaf forests important to bats (e.g. *Quercus*, *Carpinus* and *Ostrya* species) have largely disappeared at the lower altitude. In contrast, these forests still constitute a remarkable vegetation zone in other valleys (e.g.

Psarades, Latsista, Agathoto, etc.), extending up to an elevation of 900 to 1200 m a.s.l. The forest in the valley of Brajcinska Reka River in the FYR of Macedonia shelters many hundred years old often hollow oaks.

In the valley of Ag. Germanos River, it is important to restore such a vegetation zone through:

- Surveys, identification, recording, mapping and marking the last old hollow trees e.g. as “Nature Heritage Trees” or “Veteran trees” and preserving them.
- Informing land owners and the local inhabitants. The bat mediator can include such trees in educational outdoor activities (see section 18).
- Control of cutting, grazing and other activities around these trees.
- Establishment of some “no-grazing areas” in the most suitable sites for bats as an objective to launch a spontaneous forest recovery.

Further conservation recommendations may vary depending on the different sections. The main principles which should lead specific management plans are:



Estuary - Laimos

There are three main objectives: preserve the stream and its associated wetlands and riparian forest, cease any direct pollution and reform agricultural practices. Specifically:

- Preserve or restore the network of hedgerows especially along the ditches and channels.
- Preserve or restore the estuary.
- Control the dumping and improve the collection of rubbish.
- Prevent the direct chemical pollution: bean farmers mix biocides and water in the tank sprayers near the stream. It is easy and low cost to set up safe and efficient sprayer filling stations away from the stream.
- Develop and support organic bean farming.
- Diversify agricultural methods and productions (e.g. hay, alfalfa, permanent meadows, etc.) which need only a few mild or not any biocides.
- Encourage and support traditional agricultural practices.
- Maintain sheep, cattle and buffalo grazing, but control for eventual overgrazing.



Ag. Germanos valley: riparian forest, gardens and sheep folds.

Laimos - Ag. Germanos

This area is a remarkable mosaic of habitats including the mountain streams, riparian forests, irrigation network, hedgerows, bushes, woods, small orchards, gardens, agricultural fields, meadows and pastures with scattered ruins, livestock barns, cowsheds and sheep folds, offering a wide range of roosting and foraging sites to many bats.

The area needs a conservation project aiming at preserving or enhancing habitat heterogeneity:

- Prevent large-scale plans (e.g. a dam or road



X. GREMILLET

in the valley, intensive agricultural fields, large housing estates, etc.)

- Preserve or enhance the riparian forest along the stream.
- Preserve the traditional irrigation network and the hedgerows along this network.
- Control the dumping and improve the collection of rubbish.
- Control the dumping of cattle excrements in the stream banks; promote manure use in close gardens and fields.
- Limit the use of biocides and promote organic and traditional farming practices.
- Control against eventual overgrazing.
- Inform and establish links with the different land users, land owners, stakeholders and authorities, farmers and breeders.
- Establish volunteer or official agreements with users or owners of buildings to preserve bat roosts in roof spaces, cellars or other parts of their buildings (e.g. “bat refuges”).
- Restore ruins as bat roosts through official or private funds, sponsoring funds, volunteer work, etc.; build a bat information centre and an alternative bat roost (see Boxes 17.6 and 17.7).



X. GREMILLET

Ag. Germanos: hedgerows near the watermill
(*R. hipposideros* roost).

Gaidouritsa valley

- Preserve hedgerows and riparian forest.
- Preserve isolated groves, trees and bushes.
- Survey, record, map and preserve old hollow trees; identify and mark them as e.g. “Nature Heritage Trees” or “Veteran trees”.
- Maintain summer grazing but avoid and monitor overgrazing; if necessary protect overgrazed sections using fences.
- Prefer extensive breeding practices (rotation of



Cow herds in the Gaidouritsa meadows

Giovanitsa forest, a potential “wilderness area”.
Inset: “Tree roost” mark used in Brittany, France.

Giovanitsa forests

They comprise beech, fir and mixed beech-fir forests (1500 – 1800 m a.s.l.) and they provide an excellent habitat for forest bats. Conservation recommendations will not only benefit bats but also birds and other mammals. The recommendations provided in Box 17.3 apply here but more specifically:

- Inform forest services and workers about the bat biology and diversity in the area.
- Plan with the forest management services a forest conservation project (sustainable management, sanctuary area, etc.)
- Survey all forests from 1400 up to 2000 m a.s.l. between Potistres and Elatia to identify, record and map the old forest zones and trees suitable as bat roosts.
- Preserve recorded old trees and mark them as e.g. “Nature Heritage Trees” or “Veteran trees”.
- Avoid clear cutting around these trees; replace extensive clear cutting by selective logging.

pastures, local cattle breeds, balanced diet, etc.) as chemical anti-parasite treatments of livestock have an impact on non-target bat insect prey such as the dung beetles; replace very toxic compounds (e.g. avermectin) in anti-parasite treatments by less toxic compounds (e.g. moxidectin) and apply wormers indoors (not when animals are on mountain pastures).

- Preserve standing dead trees and decomposing fallen dead wood.
- Preserve the riparian forest.
- Select and preserve a sanctuary area (e.g. “Heritage Forest”) without any management to become a “wilderness area”; for instance the forest between Kaloneri and Giovanitsa streams between 1400 and 1800 m a.s.l. which combines beech, fir and mixed forests. Access to the area is difficult and several trees with potential bat-hosting interest are present.

Subalpine meadows at Mt. Varnous

- Maintain summer grazing, but monitor for eventual overgrazing.
- Prefer extensive breeding practices (rotation of pastures, local cattle breeds, balanced diet, etc.) as chemical anti-parasite treatments of livestock have an impact on non-target bat insect prey such as the dung beetles; replace very toxic compounds (e.g. avermectin) in anti-parasite treatments by less toxic compounds (e.g. moxidectin) and apply wormers indoors (not when animals are on mountain pastures).
- Prevent the construction of new roads.

Lands proposed for windfarms (Mt. Varnous, Mazi-Kirko, Sfika and others)

Wind turbines on mountain passes and generally ridges may dramatically impact the bat populations of the Prespa Basin, as well as those of Florina lowlands and other valleys (e.g. Pisoderi, Korestia, Krystalopigi, etc.) that cross the mountains to forage and/or roost in Prespa:

- Avoid wind farm development on mountain ridges around the Prespa Basin and, in particular, exclude the installation of wind turbines on mountain passes.
- Exclude the installation of wind turbines near ponds, streams, in or near forests and forest edge, hedges and valleys.
- Avoid construction of wind farms at less than 30 km away from *Miniopterus schreibersii* roosts.
- In case of an operating wind farm near the area, stop wind turbine operation at low wind speeds (<6.5 m/s) and during all nights of intensive bat



Gkortse Toumpa, Mt Varnous (above), and Varnous ridge and Pisoderi valley (below): subalpine meadows threatened by wind farm projects

activity periods (e.g. mating and migration in late summer to mid autumn).

- Implement pre- and post-construction studies of bat diversity and activity and monitor bat mortality at wind farms; take any appropriate mitigation measures if necessary.
- Monitor the effects of the construction of accompanying infrastructure, such as soil erosion and water pollution. Restore habitats destroyed by the construction works e.g. underground electricity lines.



Karyes-Mikrolimni (above) and Laimos (below left): intensive bean monocultures are less suitable as bat hunting areas

Agricultural lands, pastures and wet meadows

Recommended actions proposed above for the valley of Ag. Germanos River from the level of the lakes up to the mountains may be applied in other agricultural areas in the Prespa Basin (e.g. Platy, Lefkonas, Karyes – Oxya – Mikrolimni and Pyli). Current management practices of the wet meadows around the Lesser Prespa Lake (Ag. Achilleios, Koula, Slatina, Plati, Kale, Mikrolimni) generally benefit biodiversity (vegetation, fish, arthropods, birds, etc.) and presumably bats using them as hunting areas.



Oxya, wet meadows and *Narcissus poeticus* (above right) and Koula-Slogi-Viro-Slatina wetlands (below): these areas are highly favourable for bat hunting

Farming of buffalo and the local cattle breed

The development of the farming of buffalo and the local shorthorn cattle breed would provide unquestionable benefits to the Prespa area: conservation of historical and valuable genetic resources, appropriate wetland management and conservation, biodiversity conservation and local economy development (farming and tourism). Buffalo and local cattle eat rough vegetation and do not need toxic anti-parasite treatment. Furthermore, they create openings in the reed beds that are suitable for insects and attract foraging bats.

Box 17.5. Creation, restoration and maintenance of artificial roosts (Appendix III)

General recommendations

- ▷ Plant shrubs or trees to create vegetation cover and/or place fences or grilles at entrances to prevent uncontrolled access to the roost and to provide protection by predators.
- ▷ Plant or preserve vegetation cover (e.g. hedgerows) around the roost to connect the roost and the feeding areas. Plant orchards and trees that attract insects where possible.
- ▷ Clean the future roost from garbage, toxic objects, chemicals, etc.
- ▷ Prevent draughts and maintain relatively stable levels of temperature, humidity and light in the roost.
- ▷ Provide alternative roosting places inside the roost with a range of micro-climates (temperature and humidity levels) so that bats have access to warm or cool areas depending on roost function (season) and time of the day.
- ▷ Provide a range of roosting places in the roost adapted to different species.
- ▷ Avoid illumination of bat entrances and flight paths.

Buildings

- ▷ Establish and maintain points of contact and cooperation between bat conservationists and organisations associated with the care and restoration of buildings, owners of



Sheep in Vrondero dry meadows (above) and local cattle race in Ag. Achilleios wetland (below): traditional agro-pastoral systems provide good hunting habitat for bats.

old or abandoned buildings, and authorities managing public or historical buildings (e.g. old historical chapels).

- ▷ Conserve or make new crevices in the walls; fix structures such as bat boxes or hollow bricks that favour certain species (e.g. small *Myotis* bats).
- ▷ Make the roost as large as possible and incorporate a range of micro-climates so that bats have access to warm or cool areas depending on roost function or in times of intense sunshine. This may be achieved through con-

serving or building several levels: basement, ground floor and roof space.

- ▷ Roof spaces will be attractive to bats if they are warm and the temperature shows small fluctuations between day and night. The roof should therefore be warmed up by the solar energy, e.g. using roman tiles. Temperature may remain stable using the local traditional practices e.g. sarkings, wood planks or mud and reeds between the frames and tiles.
- ▷ Create roof openings for the entrance and exit of bats (e.g. dormer in the lower part of the roof for the *Rhinolophus ferrumequinum* or at the level of wall plates for *R. hipposideros* and *Myotis* species).

Box 17.6. *Rhinolophus hipposideros* (Appendix III)

A very useful textbook under the title “The Lesser Horseshoe Bat: Conservation Handbook”, written by H. Schofield and published by VWT in 2010, provides specific guidelines and practical advice for surveying, enhancing or constructing *R. hipposideros* roosts.

- ▷ Preserve an adequate number of appropriate roosting sites, since the population at Prespa uses a network of roosts.
- ▷ Inform owners and farmers and create formal or informal agreements between owners and local naturalists, conservation NGOs and the NPs management bodies. See as a model, the “Refuges for the bats” (<http://www.gmb.asso.fr/PDF/PlaqueRefuge.pdf>), agreements signed between private or public owners and the GMB in Brittany, France).
- ▷ Inform and establish links with authorities responsible for the preservation, protection and restoration of public buildings including historical monuments, chapels, etc.
- ▷ Inform the professionals involved in building works (builders, carpenters, roofers, architects, civil engineers, etc.); provide them with good practice guidelines.
- ▷ Work with roost owners to promote appro-

priate positive management of sites, including adjacent feeding habitat.

- ▷ Restore or modify existing roosts in old and abandoned traditional buildings or create new using traditional practices to replace those in the process of collapse (e.g. in Oxya village and Seltsa, Appendix II).
- ▷ Renovate buildings by employing the general principles described in Box 17.5 combined with an understanding of the bats’ roosting requirements to transform them into optimal roosts; roost function is a key factor in determining the range of conditions suitable for the bats.
- ▷ Integrate bat requirements in the preservation and restoration works of traditional buildings that are used by important colonies (e.g. sheep barns, the Biological Station at Mikrolimni, traditional houses, chapels, etc.). For example, create spaces (e.g. in the roof spaces) reserved to bats and ensure an appropriate opening to be used as an entrance and exit by the bats.
- ▷ Create or preserve roosts in other disused artificial sites (bunkers, pumping stations, etc.).
- ▷ Restore a traditional building as a roosting site for the species and as a bat information centre (see Box 17.7).
- ▷ Monitor the reaction of the colonies and adjust the restoration works if necessary.
- ▷ Generally define measures depending on the local conditions. This involves the sensitisation of the local inhabitants, the respect of the socioeconomic condition of the local communities, and the preservation of the traditional architectural heritage.
- ▷ Maintain the trees close to the roosts and preserve the corridors (hedgerows, tree lines, etc.) among roosts and hunting areas.
- ▷ Maintain and promote the mosaic of traditional agro-pastoral and agro-forestry landscape (orchards, pastures with isolated trees, forest edge, riparian vegetation, sheep barns, etc.).

In summary, roost buildings should

(adapted from Schofield 2010):

- ▷ Have access points easily identifiable by the bats.

- ▷ Have the entrance close to vegetative cover and unlit by external lighting.
- ▷ Have cool rooms to expand the range of microclimates provided for the colonies. These should be on the ground floor of buildings or in the cellar and have, where possible, an earth floor.
- ▷ Be close to blocks of broadleaf or mixed woodland.
- ▷ Be connected to the nearest woodlands by continuous vegetative cover such as hedges and tree lines.
- ▷ Provide alternative entrances not accessible to predators or humans (e.g. galvanised steel grilles over large entrances and entrances high above the ground).

Box 17.7. Some specific recommendations on *Rhinolophus hipposideros* colonies by country

Greece

Four projects are under study:

i. Nursery colony in the roof space of the new SPP building at Laimos (Appendix III):

Similarly to the Biological Station of Mikrolimni (see below), the roof space can be reserved for a colony of *R. hipposideros*. What is needed is an opening under the eave (removing a single wall plate may be enough) close to vegetative cover, a half-waterproof tarpaulin on the floor to protect it from the bat droppings and to be more easily cleaned, and a vegetative or wooded cover to ensure connectivity to the riparian vegetation of the river of Ag. Germanos located near by. These works are simple to implement and low cost.

ii. Nursery colony in the roof space of the old SPP building at Ag. Germanos (Appendix III):

The amounts of bat droppings under the roof structure suggest that the roof space may be used as a transitional or satellite site by the species. Placing plywood panels and building a “hot-box” (Schofield 2010) will trap warm air to allow the establishment of a nursery colony (dimensions of roost exit 20 cm x 60 cm).

iii. Restoration of a sheep barn in the valley of Ag. Germanos (Appendix III):

There are numerous ruins of sheep barns in this area, directly connected to the species hunting habitats. Any of them could be restored according to the traditional building methods and be transformed into a thematic information centre on the bats of Prespa. Roof space and/or basement may allow the establishment of a breeding colony. It is essential to preserve wooded cover or to plant trees near the roost to ensure connectivity to the fields and the river. The public may be able to observe the colony without disturbing it through specific openings or through infrared (IR) cameras.

iv. Restoration of a building at the abandoned village of Agathoto:

The current situation is the best for this nursery colony (~ 200 bats). However, it is necessary to save the colony by establishing an alternative bat roost, e.g. a house among the old village ruins and near the edge of the forest may be reconstructed using the traditional building methods and proper setting/orientation according to sunlight, winds, etc.

More information:

- Groupe Mammalogique Breton: www.gmb.asso.fr/
- AMIKIRO: www.maison-delachauvesouris.com/
- Saint-Maurice abbey: www.saint-maurice.clohars-carnoet.fr

Albania

Some simple and low-cost projects can be implemented in Albania for specific roosting sites:

i. Restoration of Shueç tunnel (Appendix III):

An old tunnel near the village of Shueç can be transformed into a bat roost which may also benefit other species: one of the two entrances should be completely blocked using material available on site (rocks and earth) to prevent draughts. The second entrance

can be partly blocked using the same material leaving a relatively small opening. In the absence of draughts, the tunnel will become suitable as a bat roost. Rubbish should be removed from the area to prevent toxic smoke from fires going into the tunnel. This project can be part of the sensitisation of the public to the protection of bats which in turn can be part of a larger-scale environmental awareness project.

ii. Restoration of the old pumping station at Shueç (Appendix III):

This disused small building situated close to the border with Greece is probably used as a transitional or satellite roost by bats that may be connected to the largest known colony in Prespa, at Agathoto (Appendix II). A simple restoration project would aim at minimising disturbance by placing a door and at improving the thermal conditions by preventing the draughts. A wooden inner floor with a trap door can provide a range of microclimates. The door can have a bat-opening, in which case both windows should be closed, otherwise only one window can be closed. Trees should be planted to shelter the building. The site should be further protected by a fence to prevent access by livestock. The project should be part of a larger-scale project in consultation with the local inhabitants, e.g. construction of barns alongside the restoration of the pumping station.

FYR of Macedonia

In this part of the Prespa Basin, there are many old and abandoned buildings. However, these are unfavourable for the establishment of *Rhinolophus hipposideros* colonies because there is no insulation beneath the tiles. Thus, the basic recommendation for that area, e.g. within Galicica and Pelister NPs, is the construction of one or several favourable buildings following the instructions presented in Boxes 17.5 & 17.6.

Three projects have already been implemented on the principles described in Boxes 17.5 & 17.6:

a) Biological Station near the village of Mikrolimni (Appendix III):

Having been abandoned for many years this building was utilized as a roosting site by a breeding colony of *R. hipposideros* (approx. 50 bats). The building was renovated in 2009. After agreement with its owner, the Elliniki Etairia (Hellenic Society for the Protection of the Environment and the Cultural Heritage), and based on proposals by the GMB and SPP, a small opening under the roof eave was created in July 2009 by removing a wall plate to allow the bats to re-enter in the attic space. The trees close to the opening were preserved. By 2010, the entire breeding colony had returned to the building, roosting in the renovated attic space. There was no financial cost to these works.

b) Agricultural shed at Milonas village:

A number of traditional buildings were recently bought to be restored as a principal residence. After discussions of the sensitised new owners with people from the GMB and the SPP, the



Wall plate removed in the roof of Mikrolimni Biological Station

owners restored the buildings within their properties and preserved a small shed (1.5 x 2 m) for *R. hipposideros* which lived in the different parts of the abandoned buildings. In 2010, the nursery colony was successfully established in the shed. The protection of this colony is the result of the sensitisation of the owners who appreciated its importance.

c) Sheep barn near Ag. Germanos village (Appendix IV):

A traditional barn hosts a nursery colony of approx. 40-50 *R. hipposideros*. The GMB and SPP informed the owner on the importance of the colony and the need to avoid disturbance. A verbal agreement has currently ensured the maintenance of the colony.

In general, restoration works to improve artificial bat roosts should be a positive element of progress. Projects should be perceived alongside the local inhabitants, and be implemented by local artisans. The implementation of any restoration projects should be linked to the socio-economic conditions of the local villages.

18. Advisory, communication, public awareness and training

Objective: To increase public awareness on the ecological role and significance of bats, the threats to their survival and the necessity of management measures for their protection and conservation; to increase public support towards the conservation of Prespa bats through the dissemination of information.

This section is concerned with the third axis: raising public awareness. The general public, local authorities and professionals whose actions are involved in bat conservation are considered (Box 18.1). **For conservation management to be effective, it should be implemented with the full support of the local community.**

Box 18.1. General recommendations (see Appendix IV for illustrations)

- ▷ Develop public awareness campaigns in all three local languages.
- ▷ Educate the general public through events, and the production and diffusion of educational material including brochures, handbooks, films, etc.
- ▷ Include information on the bats of Prespa in the information centres of the Prespa NPs, SPP (GR) and Galicica NP.
- ▷ Install outdoor information panels.
- ▷ Inform policy and decision makers, civil services, landowners, municipalities, authorities and professionals (e.g. forest services, farmers, architects, authorities responsible of historical monuments, etc.) on the role and significance of bats in local ecosystems, their ecological requirements (e.g. the needs of tree-roosting species), as well as the national and international laws and agreements that protect them, through the production and diffusion of information material designed specifically for each target group, e.g. handbooks with best practice guidelines and techniques for forest managers, information brochures for owners of houses and other buildings, etc.
- ▷ Establish agreements with policy and decision makers, landowners, local stakeholders, municipalities and authorities and encourage them to implement bat conservation actions.
- ▷ Organise training courses for professionals for best practice, e.g. foresters, architects, etc.
- ▷ Create a webpage on the bats of Prespa as part of the websites of the NPs and the SPP to ensure an effective diffusion of information through the internet addressed to the different audiences.
- ▷ Restore a traditional building as a roosting site and use it as an information centre on bats; roost spaces may be observable through IR cameras and projection screens (see e.g. <http://www.maisondelachauvesouris.com/>).
- ▷ Organise school programs on bats (e.g. bat

games for children, annual bat events such as “Bats in Our Village”).

- ▷ Organise conferences, symposia and workshops at national, transboundary and international levels on bat research and conservation (see e.g. Papadatou, Grémillet and Kazoglou 2010).
- ▷ Distribute press releases and give interviews to the local and public mass media (newspapers, television, radio, etc.).
- ▷ Recruit and train local people with the necessary skills and tools to organise and be in charge of education and mediation programs (see details below).
- ▷ Recruit and train volunteers to aid local mediators and guarantee future monitoring.

Geomorphologic, climatic and other environmental features may act as limits on biodiversity. Human borders, however, cannot limit the wandering of bears or the flight of bats. In Prespa, the flora and fauna (e.g. butterflies, birds, bears, foxes, and bats) know only one Prespa ecosystem. Consequently, research, survey and conservation projects for bat populations in Prespa need transboundary plans and cooperation, although they may be adapted to the local conditions. The same applies to the advisory, communication, public awareness and training projects that may vary according to the local socioeconomic situation even if the main ideas and objectives are the same.

Permanent local bat mediators (bat workers)

Raising public awareness on the ecological significance of bats should be based on the development of public education campaigns. It should be a long term purpose for which permanent local mediators with an official mission and status should be assigned in each of the three countries surrounding the Prespa Basin (e.g. employees in NGOs and/or the management bodies of NPs and the TPP).

Permanent local bat mediators will be in charge of establishing links with the local inhabitants and authorities, the design and implementation of school teaching and other education programs, and the design and diffusion of information for

professionals including the forest service, land-owners, shepherds, breeders and farmers, the building industry, etc., as well as authorities such as the departments in charge of the historical and cultural heritage. Because mediators will generally be in charge of informing policy and decision makers, local stakeholders and the different authorities, they should be able to speak the local languages and to understand the rural behaviour. To be successful in their work, they should build good social relations with the local inhabitants who do not know about bats and may not care about their protection. They will not necessarily be scientists, but they should be trained with the necessary qualifications and skills as bat workers. More specifically mediators should:

- Know bat biology and be regularly trained and consulted by bat experts.
- Be in contact with bat scientists for updated scientific information and evidence-based solutions.
- Act as a connection point between bat experts, and local inhabitants and authorities.
- Propose restoration projects of ruins to architects in favour of bats.
- Inform the building industry on how to integrate bats into their work and supervise the restoration works.
- Inform forest services (workers, engineers and administration) on how to integrate bats into forest management practices; inform them on site e.g. show suitable trees and habitats for the bats in the forest.
- Manage the bat information centre in Prespa (Boxes 17.6 and 18.1).
- Create and manage a centre or technical library to provide information material on bats for local inhabitants and for professionals whose work may have an impact on bat populations or who are involved in education (teachers, architects, conservationists, foresters, builders, etc.). This may be part of a bat information centre.
- Design and prepare information material (brochures, handbooks, guides for professionals etc.).
- Develop training programs for professionals.
- Design education programs for schools and children in general, e.g. outdoor and indoor bat games.

- Develop local bat events for the public (e.g. European Bat Night, “Bats in Our Village”, “Bats in Your Property”, etc.).
- Promote bat refuges in private or public properties.
- Monitor protected roosting sites to prevent disturbance or destruction.
- Remedy damages or disturbance in buildings used as roosting sites.
- Survey local bat sites if necessary outside the regular transboundary surveys.

Information centre on the bats of Prespa

There are several examples of bat information centres in Europe (Belgium, France, Ireland, U.K., etc.). In Prespa, it is recommended to create a “Bat Information Centre” in each of the three countries, presenting the different aspects of the bats’ life linked to the local conditions. Bat information centres should:

- Be easily accessible by local inhabitants and visitors (potential locations are e.g. the Treni village in Albania and Ag. Germanos or Milionas in Greece).
- Provide educational and other bat material to the public (e.g. brochures, handbooks, photos, posters, videos, bat mock-ups, bat boxes, etc.), advice to schools on bat education programs and to professionals.
- Provide an example of an artificial bat roost through the restoration of a traditional building (Boxes 17.6 and 18.1; e.g. ruins of a traditional sheep barn). They should therefore comprise two distinct parts, one open to the public for the exhibition and the bat shop, and one used as a roost by the bats (attic and basement) not open to the public. Infrared cameras can allow bats to be seen by the public without being disturbed. The roost entrance should be located on the quietest side near bushes and trees and connect the colony directly to foraging sites with a wooded corridor. Bat emergence at dusk may be watched by people from a hide; bat detectors may be used simultaneously to “listen” to bats as they emerge.
- A room devoted to a life-size artificial cave with bat mock-ups may introduce the public to the bat cave environment and may serve as an educational tool for species identification: pretend-

ing to be bat workers and using lamps they may search in the dark for the different bat species present in the Prespa area (“Your challenge: find the bats of Prespa”). Another room may be devoted to the projection of videos. Infrared cameras may also be placed in natural roosts (e.g. Treni cave in Albania).

- Interactive games are a very useful educational tool that may be included in the centres.

It is desirable that:

- Bat mediators manage the bat information centres in each country.
- The resource centre or technical library concerning bats is located in the bat information centre.

School education programs

Educational activities may vary depending on season, the age of the children, as well as the local social conditions and legal framework. They may include: colouring bat drawings, singing, playing theatrical games, creating stories, bat watching, listening to bats using bat detectors, volunteer work (e.g. restoring ruins as bat roosts), etc. If bat mediators are not allowed by law to enter the schools during the school times, they may design and produce educational activities to be implemented by the teachers, as well as organise outdoor activities outside the school programs.

Conferences, symposia and workshops on bat research and conservation

The network of bat roosts and hunting habitats shared between the three countries at Prespa call for transboundary symposia, workshops and meetings. Prespa is also suitable for the organisation of conferences, symposia and workshops on bat research and conservation at national and international levels, since it hosts important bat populations and habitats at European level and therefore the different aspects, issues and challenges of bat conservation can be well illustrated. Conferences are a good way to “advertise” bat conservation. Scientific workshops and meetings is a good opportunity for students, professionals, administration, stakeholders and authorities to discover bats and to appreciate and integrate bat conservation into their work.

Through the application of research, surveys and conservation recommendations, as well as the implementation of public awareness activities, Prespa may serve as a model for bat conservation on a national level (Greece, FYR of Macedonia and Albania), as well as a model of trans-national cooperation for the conservation of bats.

19. Cooperation at the transboundary level: TMS

The Transboundary Prespa Park offers ample ground for cooperation on conservation and scientific work on bats (section 15). The basis for such cooperation has already been established through this work and the workshop organized at Stenje (Galicica NP, July 2010; Papadatou, Grémillet and Kazoglou 2010) in the framework of the SPP-UNDP project on the development of a transboundary monitoring system for the Transboundary Prespa Park. In parallel to priorities set at national levels, the need to conduct transboundary work and cooperation was underlined during the workshop by all three sides. Based on these initial steps of transboundary cooperation on the monitoring, the following activities have been considered essential for the near future:

- Establish working groups on bats and appoint a coordinator in each country,
- Organize regular contacts, exchange of information/findings of bat surveys, and meetings,
- Plan and implement joint monitoring and research efforts based on commonly agreed methodologies,
- Train the staff of the NPs,
- Use the already established collaboration of bat experts in the three countries as a model for transboundary conservation and monitoring work in the Transboundary Prespa Park.

According to the study on the development of the transboundary monitoring system (TMS) for the Transboundary Prespa Park (Perennou *et al.* 2009), the TMS at its first stage of application should be realistic, low-cost and applicable. One of the aims of the bats' workshop in July 2010 at Stenje was to identify and propose scientifically-based and practical methods to monitor bats in transboundary Prespa from a wide variety of methods and techniques. However, resources necessary to implement such monitoring in the future have not been secured or defined yet, so it is very probable that its implementation in the near future may include collection of relatively simple data (i.e. not demanding highly skilled personnel or complex methods and equipment) based on common methodologies and field protocols for the three sides of Prespa to be implemented by well-trained local people. In addition, bat monitoring should require resources comparable to those allocated for the other thematic areas and elements of the TMS, such as bird midwinter counts which do not require large funds. In brief, based on these preconditions and the existing experience on transboundary bat monitoring, a bat TMS should be initiated with the following activities (Papadatou, Grémillet and Kazoglou 2010):

- Identify common methods and protocols to be applied on the three sides of Prespa for a period of 3-5 years,
- Train staff involved in bat monitoring by experts already acquainted with the area so as to achieve the best possible results in terms of quality of data and compliance with code of ethics,
- Monitor nursery colonies at sites of major importance around the Prespa and Ohrid Lakes by means of visual observations of presence-absence of bats and emergence/roost counts,
- Carry out winter counts at selected sites provided that all precautions are met for minimal disturbance of bats.

20. Useful websites

EUROBATS

<http://www.eurobats.org/>

The Bat Workers' Manual

<http://jncc.defra.gov.uk/page-2861>

Bat or mammal research and conservation organizations:

Bat Conservation International

<http://www.batcon.org/>

BatLife Europe

<http://www.batlife-europe.info/>

Bat Conservation Trust

<http://www.bats.org.uk/>

Lubee Bat Conservancy

<http://www.batconservancy.org/>

Bat Conservation Ireland

<http://batconservationireland.org/>

Société Française pour l'Etude et la Protection des Mammifères (SFEPM)

<http://www.sfepm.org/chiropteres.htm>

Groupe Mammalogique Breton

<http://www.gmb.asso.fr/>

Russian Bat Research Group

<http://zmmu.msu.ru/bats/>

Slovak Bat Conservation Group

<http://www.netopiere.sk/>

Bat Research and Conservation Centre

(National Museum of Natural History, Bulgaria)

<http://www.nmnh.com/bat-research-and-conservation-centre-en.html>

Bat information centres :

<http://www.maisondelachauvesouris.com/>

<http://www.museum-bourges.net/>

http://www.comblainaupont.be/ancien_site/de-cou/index.html

<http://www.saintmaurice.clohars-carnoet.fr/>

Bats, other wildlife and roads:

http://english.verkeerenwaterstaat.nl/kennisplein/page_kennisplein.aspx?DossierURI=tcm:195-17870-4&Id=273409

<http://www.cbm.slu.se/iene/>

<http://www.ecologyandsociety.org/vol12/iss1/art11/>

Bats and IR cameras:

<http://www.muluparkbatcam.com/>

LIFE projects on bats:

<http://www.lifechiromed.fr/>

<http://www.sfepm.org/LifeChiropteres/Resultats.htm>

References

- ADK (2009-2010) Environmental Impact Assessment Study for the wind-farm (28.9 MW) at location Toumpa-Anthovouni of Mt Varnous, Prefecture of Florina (with its amendment for the re-location of wind turbines 1 and 2). Anemos Makedonias A.E.E. (in Greek)
- Aihartzia JR, Goiti U, Almenar D, Garin I (2003) Evidences of piscivory by *Myotis capaccinii* (Bonaparte, 1837) in southern Iberian Peninsula. *Acta Chiropterologica* 5: 193-198
- Altringham JDA (2003) *British Bats*. Harper Collins, London, pp 218
- Altringham JDA (2011) *From evolution to conservation*. 2nd edition. Oxford University Press, Oxford, pp 352
- Anderson ME, Racey PA (1991) Feeding behaviour of captive brown long-eared bats, *Plecotus auritus*. *Animal Behaviour* 42: 489-493
- Argyropoulos D, Giannakis N (2001) Special Environmental Study for the protected area of Prespa National Park. Prefecture of Florina
- Arlettaz R, Godat S, Meyer H (2000) Competition for food by expanding pipistrelle bat populations (*Pipistrellus pipistrellus*) might contribute to the decline of lesser horseshoe bats (*Rhinolophus hipposideros*). *Biological Conservation* 93: 55-60
- Arlettaz R, Jones G, Racey PA (2001) Effect of acoustic clutter on prey detection by bats. *Nature* 414: 742-745
- Baerwald EF, D'Amours GH, Klug BJ, Barclay RMR (2008) Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* 18: R695-R696
- Barclay RMR, Baerwald EF, Gruver JC (2007) Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85: 381-387
- Barclay RMR, Brigham RM (1991) Prey detection, dietary niche breadth, and body size in bats - Why are aerial insectivorous bats so small? *American Naturalist* 137: 693-703
- Barclay RMR, Harder LD (2003) Life Histories of Bats. In: Kunz TH, Fenton MB (eds) *Bat Ecology*. The University of Chicago Press, Chicago and London, pp 209-253
- Bego F, Griffiths HI (1994) Preliminary data on the bats (Mammalia, Chiroptera) of Albania. *Stud. Speleol.* 9: 21-25
- Bego F (2011) Bat roosting sites in the territory of Prespa National Park, Albania. Mimeographed report, Society for the Protection of Prespa. Tirana, Albania
- Benda P, Georgiakakis P, Dietz C, et al. (2008) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 7: The bat fauna of Crete, Greece. *Acta Soc. Zool. Bohem.* 72: 105-190
- Bogdanowich W (1990) Geographic variation and taxonomy of Daubenton's bat *Myotis daubentoni* in Europe. *Journal of Mammalogy* 71: 205-218
- Boshamer J, Buys J, Bekker JP, Mostert K, Vogelaers L, Willemsen J (2006) Mammal survey Galicica National Park (Macedonia). Field Study Group of the Dutch Society for the Study and Conservation of Mammals, Arnhem, pp 1-56
- Catsadorakis G, Kollaros D (1986) Preliminary notes on the mammalian fauna of Lake Prespa National Park (Greece). 3rd Int. Cong. Zoogeogr. and Ecol. Greece, Patras, 1984. *Biologia Gallo-Hellenica* 12: 507-519
- Catsadorakis G (1995) The texts of the information centre of Prespa. Society for the Protection of Prespa, Agios Germanos, pp 126
- Chardaloupas Y, Kazoglou Y (2009) Prespa: Agriculture & Environment - Preliminary actions for labeling of agricultural products as "Prespa Park Products". Brochure produced in the framework of the "One Europe, More Nature" project. Society for the Protection of Prespa, WWF Greece
- Chytil J, Vlašin M (1994) Contribution to the knowledge of bats (Mammalia: Chiroptera) in Albania. *Folia Zool.* 43: 465-467
- Červený J, Kryštufek B (1988) A contribution to the knowledge of the bats of Central and Southern Dalmatia, Yugoslavia (Chiroptera, Mammalia). *Biol. Vest.* 36: 17-30
- Crichton EG (2000) Sperm storage and fertilisation. In: Crichton EG, Krutzsch PH (eds) *Reproductive Biology of Bats*. Academic Press, London, pp 295-320
- Davy CM, Russo D, Fenton MB (2007) Use of native woodlands and traditional olive groves by foraging bats on a Mediterranean island: consequences for conservation. *Journal of Zoology* 273: 397-405
- Dietz C, Nill D, von Helvesen O (2009) *Bats of Britain, Europe and Northwest Africa*. A & C Black, London, pp 400
- Dring J, Hoda P, Mersinllari M, Mullaj A (2002) Plant communities of Albania - A preliminary overview. *Annali di Botanica, Nuova Serie*, 2: 7-30
- Eick GN, Jacobs DS, Matthee CA (2005) A nuclear DNA phylogenetic perspective on the evolution of echolocation and historical biogeography of extant bats (Chiroptera). *Molecular Biology and Evolution* 22: 1869-1886
- English Nature (2003) Managing landscapes for the greater horseshoe bat. External Relations Team, English Nature, Peterborough, pp 5
- Felten H (1977) Zur Kleinsaugerfauna West-Anatoliens. Teil IIIa. - In: Felten H, Spitzenberger F, Storch G (eds): *Zur Kleinsaugerfauna West-Anatoliens*. Seckenberg. Boil. 58: 1-44
- Fleming TH, Eby P (2003) Ecology of bat migration. In: Kunz TH, Fenton MB (eds) *Bat Ecology*. The University of Chicago Press, Chicago and London, pp 156-208
- Furman A, Ozgul A (2002) Distribution of cave-dwelling bats and conservation status of underground habitats in the Istanbul area. *Ecological Research* 17: 69-77
- Furman A, Ozgul A (2004) The distribution of cave-dwelling bats and conservation status of underground habitats in Northwestern Turkey. *Biological Conservation* 120: 243-248
- Galand N, Declercq S, Cheyreyz T, Puechmaille SJ, Deguines N, Grémillet X, Papadatou E, Kazoglou Y (2010) Bat survey on the subalpine grasslands of Mt Varnous (Florina, Greece): preliminary results. Proceedings of the 7th Panhellenic Rangeland Congress, Hellenic Rangeland and Pasture Society, 14-16 October 2010, Xanthi, Greece, pp 305-314
- García-Mudarra JL, Ibañez C, Juste J (2009) The straits of Gibraltar: barrier or bridge to Ibero-Moroccan bat diversity? *Biological Journal of the Linnean Society* 96: 434-450

- Georgiakakis, P. (2009) Geographical and altitudinal distribution, acoustic identification and ecology of bats in Crete. PhD dissertation, Dept. of Biology, University of Crete, pp 275 (in Greek)
- Georgiakakis P, Vasilakopoulos P, Mylonas M, Russo D (2010) Bat species richness and activity over an elevation gradient in Mediterranean shrublands of Crete. *Hystrix* 21: 43-56
- Georgiakakis P, Papadatou E (2011) Impacts of wind farms on bats, Thrace, Greece, for the period July 2008-August 2010. WWF Greece, Athens, pp 48 (in Greek)
- Georgiakakis P (2010) Activities and findings of the bat expedition in the transboundary Prespa Parc. Mimeographed report, Society for the Protection of Prespa, Greece. pp 17 (in Greek)
- Giannakis N, Bousbouras D, Argyropoulos D, Kazoglou Y, (compilers) (in prep.). Management Plan for the protected area of Prespa National Park. Land Reclamation Service – Prefecture of Florina, Management Body of Prespa National Park
- GKP, SPP, PPNEA (2005) Study on the interaction between Lake Micro Prespa and River Devolli (Albania – Greece), Task II.2 “Water management in Albania and Greece: Catchment delineation, geological & hydrogeological features”. Hellenic Aid (Ministry of Foreign Affairs, Hellenic Republic). Agios Germanos, pp 68 + Annexes and maps.
- Grémillet X, Boireau J (2004) Les chauves-souris du Parc National de Prespa. Macédoine occidentale-Grèce. Mimeographed report, Groupe Mammalogique Breton, Sizun, France, pp 35
- Grémillet X, Kazoglou Y (2006) Memo on the wintering bat populations at the cave of Vrondero village (old “rebels’ hospital”). Unpublished report (in Greek)
- Grémillet X, Dubos T (2008) Bilan chiroptérologique des prospections estivales organisées par le Groupe Mammalogique Breton dans le Parc National de Prespa - Macédoine occidentale, Grèce. Mimeographed report, GMB, pp 48
- Grémillet X, Dubos T, Le Champion T (2010) Bilan chiroptérologique des prospections estivales organisées jusqu’en 2007 par le Groupe Mammalogique Breton dans le Parc National de Prespa, Macédoine occidentale (Grèce). *Symbioses* 25: 1-6.
- Grazhdani D (2008) Analysis of socio-economic status and market trends in Prespa National Park. BALWOIS 2008 - Ohrid, Republic of Macedonia - 27, 31 May 2008
- Hackethal H, Peters G (1987) Notizen über Mazedonische Fledermäuse (Mammalia: Chiroptera). - *Acta Mus. Mac. Sci. Nat.*, Skopje 18 (6/152): 159-176.
- Hanák V, Benda P, Ruedi M, Horaček I, Sofianidou TS (2001) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean. Part 2: New records and review of distribution of bats in Greece. *Acta Soc. Zool. Bohem.* 65: 279-346
- Holland RA, Thorup K, Vohnhof MJ, Cochran WW, Wikelski M (2006) Navigation - Bat orientation using Earth’s magnetic field. *Nature* 444: 702-702
- Holland RA, Waters DA, Rayner JMV (2004) Echolocation signal structure in the Megachiropteran bat *Rousettus aegyptiacus* (Geoffroy 1810). *Journal of Experimental Biology* 207: 4361-4369
- Hollis GE, Stevenson AC (1997) The physical basis of the Lake Mikri Prespa systems: Geology, climate, hydrology and water quality. *Hydrobiologia* 351: 1-19
- Horaček I, Červený J, Taušl A, Vitek D (1974) Notes on the mammal fauna of Bulgaria (Insectivora, Chiroptera, Rodentia). *Vest. Čs. Společ. Zool.* 38: 19-31
- Hutson AM, Mickleburgh SP, Racey PA (2001) Microchiropteran bats: global status survey and conservation action plan. IUCN/SSC Chiroptera Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK, x + pp 258
- Jaeger JAG, Raumer H, Esswein H, Müller M, Schmidt-Luttman M (2007) Time series of landscape fragmentation caused by transportation infrastructure and urban development: a case study from Baden-Württemberg, Germany. *Ecology and Society* 12
- Kalko EKV, Schnitzler HU (1993) Plasticity in echolocation signals of European pipistrelle bats in search flight: implications for habitat use and prey detection. *Behavioral Ecology and Sociobiology* 33: 415-428
- Kazoglou Y, Papanastasis V, Catsadorakis G, Malakou M, Marinos Y, Papadopoulos A, Lambrinou E, Apostolidis I (2001) Study on the restoration and management of wet meadows at Lake Mikri Prespa. Society for the Protection of Prespa, General Secretariat of Research and Technology
- Kazoglou Y, Xega N, Doleson F (2010) Guidelines for wetland vegetation management in Lake Micro Prespa, Prespa National Park, Albania. Women Association of Micro Prespa, Prespa National Park (Forest Service Directorate, Korça), Society for the Protection of Prespa, UNDP Albania – Small Grants Programme, pp 44 + 6 Appendices
- Karaman S (1929) O slepim mishevima Jugoslavije. (Über die Fledermäuse Jugoslawiens). *Glasnik Skopskog Nauchnog Drushtva*, Skopje, 6: 217-221
- Kerth G, König B (1999) Fission, fusion and nonrandom associations in female Bechstein’s bats (*Myotis bechsteinii*). *Behaviour* 136: 1187-1202
- Klincarov S (1997) Geological-hydrological characteristics of Prespa Basin and their influence on the hydrological conditions of the lake. Proceedings of the International Symposium “Towards Integrated Conservation and Sustainable Development of Transboundary Macro and Micro Prespa Lakes”, 24-26 October, 1997, Korça, Albania, pp 79-83
- Koutretsi P, Tsakiropoulou I, Argyropoulos D, Kotzampopoulos A, Papadopoulos D, Stoios A, Grammatikou E, Dimopoulos T, Nikolaou S, Papayannis T (2006) Land planning study for the Municipality of Prespa, Phase A’. Municipality of Prespa, Society for the Protection of Prespa
- Kryštufek B (1991) Sesalci Slovenije [Mammals of Slovenia]. Ljubljana. Prirodoslovni Muzej Slovenije, pp 294 (in Slovenian)
- Kryštufek B, Vohralik V, Flousek J, Petkovski S (1992) Bats (Mammalia: Chiroptera) of Macedonia, Yugoslavia. In: Horaček I, Vohralik V (eds) *Prague Studies in Mammalogy*. Karolinum-Charles Univ. Press, Praha, pp 93-111
- Kryštufek B, Petkovski S (2003) Annotated checklist of the

Mammals of the Republic of Macedonia. Bonner zoologische Beitrage 51: 229-254

Kunz TH (1982) Roosting ecology of bats. In: Kunz TH (ed) The Ecology of Bats. Plenum Press, New York and London, pp 1-55

Kunz TH, Lumsden LF (2003) Ecology of cavity and foliage roosting bats. In: Kunz TH, Fenton MB (eds) Bat Ecology. The University of Chicago Press, Chicago and London, pp 3-89

Legakis A, Maragou P (eds) (2009) The Greek Red Data Book of Threatened Animals. Hellenic Zoological Society, Athens, pp 528

Limpens HGJA, Lina PHC, Hutson AM (2000) Action Plan for the Conservation of the Pond Bat in Europe (*Myotis dasycneme*). Nature and Environment, No.108. Council of Europe Publishing, Strasbourg, pp 50

Malakou M, Kazoglou Y, Koutseri I, Parisopoulos G, Rigas A, Mertzou E, Athanasiadou E (2007) Guideline document on the restoration and management of wet meadows at Lake Mikri Prespa (2007-2012). LIFE-Nature project LIFE2002NAT/ GR/8494. Society for the Protection of Prespa

Mayer F, Dietz C, Kiefer A (2007) Molecular species identification boosts bat diversity. Front. Zool. 4: 4

Mersinllari M (1997) General data on vegetation of Ohrid and Prespa watershed area. Proceedings of Int. Symposium, Korcha, Albania, pp 147-155

Mickleburgh SP, Hutson AM, Racey PA (2002) A review of the global conservation status of bats. Oryx 36: 18-34

Némoz M, Brisorgueil A (2008) Connaissance et conservation des gîtes et habitats de chasse de 3 Chiroptères cavernicoles : *Rhinolophe euryale*, *Murin de Capaccini*, *Minoptère de Schreibers*. SFEPM, Museum National d'Histoire Naturelle, Paris, pp 104

Pano N, Rakaj N, Kedhi M (1997) Principal limnological characteristics and hydroecological equilibrium of Prespa Lake system. Proceedings of Int. Symposium, Korcha, Albania, pp 3-8

Papadatou E, von Helversen O. (2007) Bats (Chiroptera). In: Dimopoulos P, Kati V (eds) Biodiversity of the protected area of Tzoumerka-Peristeri. Dept. of Environmental and Natural Resources Management, University of Ioannina, pp 289-302 (in Greek)

Papadatou E, Butlin RK, Altringham JD (2008a) Identification of bat species in Greece from their echolocation calls. Acta Chiropterologica 10: 127-143

Papadatou E, Butlin RK, Altringham JD (2008b) Seasonal roosting habits and population structure of the long-fingered bat *Myotis capaccinii* in Greece. Journal of Mammalogy 89: 503-512

Papadatou E, Butlin RK, Pradel R, Altringham JD (2009) Sex-specific roost movements and population dynamics of the vulnerable long-fingered bat, *Myotis capaccinii*. Biological Conservation 142: 280-289

Papadatou E (2010) Bats (Mammalia: Chiroptera): species diversity, distribution and abundance. In: Catsadorakis G,

Kallander H (eds) The Dadia-Lefkimi-Soufli Forest National Park, Greece: Biodiversity, management and conservation. WWF Greece, Athens, pp 215-226

Papadatou E, Grémillet X, Kazoglou Y (2010) Monitoring of bat populations. Development of a Transboundary Monitoring System for the Prespa Park Area, Pilot Application, Stenje, Galicica National Park, 26-28 July. Workshop report, Society for the Protection of Prespa, pp 17

Paragamian K, Nikoloudakis E, Papadatou E, Sfakianaki E (2004) Biological- environmental study of Maronia Cave: analysis of current status—proposals. Greek Institute of Speleological Research, Irakleion, Greece (in Greek)

Perennou C, Gletsos M, Chauvelon P, Crivelli A, De-Coursey M, Dokulil M, Grillas P, Grovel R, Sandoz A (2009) Development of a Transboundary Monitoring System for the Prespa Park Area. Agios Germanos, pp 381

Petrochilou A, Theologou A, Moschona G, Kitseli T (1977) Speleological research at Lake Greater Prespa, Florina. Hellenic Speleological Society Bulletin, Athens, pp 100-140 (in Greek)

Petkovski S, Avramoski O, Stojkoska E (2011) First draft report in the framework of the Status Survey and Conservation Action Plan for the Bats of Prespa. Mimeographed report, Society for the Protection of Prespa. Skopje, FYR of Macedonia

Popa-Lisseanu AG, Delgado-Huertas A, Forero MG, Rodriguez A, Arlettaz R, Ibanez C (2007) Bats' conquest of a formidable foraging niche: the myriads of nocturnally migrating songbirds. Plos One 2

Popa-Lisseanu AG, Bontadina F, Mora O, Ibanez C (2008) Highly structured fission-fusion societies in an aerial-hawking, carnivorous bat. Animal Behaviour 75: 471-482

Puechmaille SJ, Verdeyroux P, Fuller H, Gouilh MA, Bekaert M, Teeling EC (2010) White-Nose Syndrome Fungus (*Geomyces destructans*) in Bat, France. Emerging Infectious Diseases 16: 290-293

Racey PA, Entwistle AC (2000) Life-history and Reproductive Strategies of Bats. In: Crichton EG, Krutzsch PH (eds) Reproductive Biology of Bats. Academic Press, London, pp 363-414

Ransome RD, Hutson AM (2000) Action Plan for the Conservation of the Greater Horseshoe Bat in Europe (*Rhinolophus ferrumequinum*). Nature and Environment, No. 109. Council of Europe Publishing, Strasbourg, pp 53

Rebelo H, Tarroso P, Jones G (2010) Predicted impact of climate change on European bats in relation to their biogeographic patterns. Glob. Change Biol. 16: 561-576

Risteovski P (2000) Climatic and agroclimatic characteristics in the Prespa Lake basin. Proceedings of the International Symposium on the Sustainable Development of the Prespa Region, 23-25 June 2000, Oteševo, Macedonia

Risteovski B, Popovski H, Damevski K, Georgievski D (2000) Fruit production in a function of sustainable development of Prespa Region. Proceedings of the International Symposium on the Sustainable Development of the Prespa Region, 23-25 June 2000, Oteševo, Macedonia

Rodrigues L, Bach L, Dubourg-Savage M-J, Goodwin J,

Harbusch C (2008) Guidelines for consideration of bats in wind farm projects. EUROBATS Publication series No. 3 (English version). UNEP/EUROBATS Secretariat, Bonn, pp 51

Russo D, Jones G (2002) Identification of twenty-two bat species (Mammalia : Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *Journal of Zoology* 258: 91-103

Rydell J, Arlettaz R (1994) Low frequency echolocation enables the bat *Tadarida teniotis* to feed on tympanate insects. *Proceedings of the Royal Society of London Series B-Biological Sciences* 257: 175-178

Rydell J, Bach L, Dubourg-Savage M-J, Green M, Rodrigues L, Hedenström A (2010). Bat mortality at wind turbines in northwest Europe. *Acta Chiropterologica* 12: 261-274

Safi K, Kerth G (2004) A comparative analysis of specialization and extinction risk in temperate-zone bats. *Conservation Biology* 18: 1293-1303

Schnitzler HU, Kalko EKV (1998) How echolocating bats search and find food. In: Kunz TH, Racey PA (eds) *Bat Biology and Conservation*. Smithsonian Institution Press, Washington, pp 183-196

Schofield H (2010) The Lesser Horseshoe bat: Conservation Handbook. The Vincent Wildlife Trust, Herefordshire, UK, pp 78

Senior P, Butlin RK, Altringham JD (2005) Sex and segregation in temperate bats. *Proceedings of The Royal Society B-Biological Sciences* 272: 2467-2473

Shuka L, Malltezi J, Mersinllari M, Vardhami I (2008) Dynamics of vegetation cover of Prespa lakes and its watershed (Albanian side). BALWOIS 2008 - Ohrid, Republic of Macedonia - 27, 31 May 2008.

Spitzenberger F, Strelkov P, Haring E (2003) Morphology and mitochondrial DNA sequences show that *Plecotus alpinus* Kiefer & Veith, 2002 and *Plecotus microdontus* Spitzenberger, 2002 are synonyms of *Plecotus macrobullaris* Kuzjakin, 1965. *Natura Croatica* 12: 39-53

Stone EL, Jones G, Harris S (2009) Street lighting disturbs commuting bats. *Current Biology* 19: 1123-1127

Strelkov P (1969) Migratory and stationary bats (Chiroptera) of the European part of the Soviet Union. *Acta Zoologica Cracoviensia* 14:393-440

Teeling EC, Springer MS, Madsen O, Bates P, O'Brien SJ, Murphy WJ (2005) A molecular phylogeny for bats illuminates biogeography and the fossil record. *Science* 307: 580-584

Trpevski V, Spirovski J, Stojanova M, Damevski K, Kocovski V (2000) Results from researches of some soil characteristics, application of mineral fertilizations in Prespa region and steps for protection of life environment. *Proceed-*

ings of the International Symposium on the Sustainable Development of the Prespa Region, 23-25 June 2000, Oteševo, Macedonia

Turner GG, Reeder DM (2009) Update of white nose syndrome in bats. *Bat Research News* 50: 47-53

Uhrin M, Horacek I, Šibl J, Bego F (1996) On the bats (Mammalia: Chiroptera) of Albania: survey of the recent records. *Acta Soc. Zool. Bohem.* 60: 63-71

von Helversen (1998) *Eptesicus bottae* (Mammalia, Chiroptera) auf der Insel Rhodos. *Bonn. zool. Beitr.*: 113-121

von Helversen O, von Helversen D (1994) The "advertisement song" of the lesser noctule bat (*Nyctalus leisleri*). *Folia Zoologica* 43: 331-338

von Helversen O, Weid R (1990) Die Verbreitung einiger Fledermausarten in Griechenland. *Bonn. Zool. Beitr.* 41: 9-22

von Helversen O, Heller KG, Mayer F, Nemeth A, Volleth M, Gombkoto P (2001) Cryptic mammalian species: a new species of whiskered bat (*Myotis alcathoe* n sp) in Europe. *Naturwissenschaften* 88: 217-223

Vrahnakis M, Papadatou E, Kazoglou Y (2010) Grasslands as bat-lands: evidence from Mount Varnous, Greece. *European Dry Grassland Group Bulletin* 8: 7-9

Wegiel A, Wegiel J (1998) Bat protection in caves in Poland. *Myotis* 36: 63-69

Weid R (1988) Occurrence of the particoloured bat *Vespertilio murinus* (Linne, 1758) in Greece and some observations on its display behaviour. *Myotis* 26: 117-128

Wickramasinghe LP, Harris S, Jones G, Vaughan N (2003) Bat activity and species richness on organic and conventional farms: impact of agricultural intensification. *J. Appl. Ecol.* 40: 984-993.

Wickramasinghe L, Harris S, Jones G, Vaughan N (2004) Abundance and species richness of nocturnal insects on organic and conventional farms: effects of agricultural intensification on bat foraging. *Conservation Biology* 18: 1-10

Women Association of Micro Prespa (WAMP), Prespa National Park (Forest Service Directorate, Korca) and Society for the Protection of Prespa (2011) Final report of the project "Implementation of pilot wetland management and public awareness activities in Lake Micro Prespa, Albania". UNDP Albania, Global Environment Facility (GEF) – Small Grants Programme (SGP)

Woods M, McDonald RA, Harris S (2003) Predation of wildlife by domestic cats *Felis catus* in Great Britain. *Mammal Rev.* 33: 174-188

Worthington Wilmer J, Barratt E (1996) A non-lethal method of tissue sampling for genetic studies of Chiropterans. *Bat Research News* 37: 1-3

Appendix I

Bat study techniques



1. Setting up mistnets over river (left) and a harp trap in front of a cave (right)



2. Flip-net over water



E. PAPADATOU

3. Looking for bats in rock crevices



T. DUBOS

4. Identifying species and taking measurements before releasing the bat on site



E. PAPADATOU

5. Preparing equipment for echolocation call recordings

Appendix II

The distribution of bats in and around the Prespa Lakes Basin

For more information on the distribution of bats please contact the SPP on spp@line.gr

Appendix III

A brief history of artificial
bat roosts at Prespa.
Roost creation, restoration
and maintenance.

(text by Xavier Grémillet; photos by X. Grémillet and GMB)

Originally, bats only roosted naturally in caves, cavities, vaults and crevices in the rocky cliffs, and in trees:



Then people built shelters and hermitages in some of these cliffs as well as houses and barns in other habitats and locations:



In this way, some bats, especially *Rhinolophus hipposideros*, discovered more suitable thermal conditions to establish their nursery colonies in the roof spaces of these buildings (e.g. roman tile roofing, wood or reed-adobe laths):



People created an agro-sylvo-pastoral landscape in the native forest. There, *R. hipposideros* and other species discovered a number of suitable habitats for hunting and spaces offering excellent conditions for the establishment of nursery colonies (e.g. in the attics of houses):



Today, many suitable buildings used by the bats for roosting are in the process of collapse or are reconstructed without considering bats:



Renovated buildings could still be used as bat roosts without inconvenience to their human inhabitants through simple and low cost solutions. Some examples are the old SPP building at Ag. Germanos village (above left), the Biological Station at Mikrolimni village (above right) and the new SPP building at Laimos village (below left and right):



In Ag. Germanos village, the ruined sheep barn seen below is located near bat feeding sites. This is an example of a site that can be rebuilt using traditional techniques and transformed into a suitable bat roost and information centre within the framework of a bat conservation project:



Disused buildings and other artificial sites can be easily transformed into summer and/or winter roosts for bats (e.g. Shueç tunnel and pumping station in Albania):



To transform artificial sites into suitable bat roosts, toxic waste must be collected, some openings should be closed against draughts and disturbance must be prevented (e.g. through bat grilles or partly closed doors; GMB bat refuges, Brittany, France):



Appendix IV

Disseminating information on bats – education – public awareness

(text by Xavier Grémillet; photos by X. Grémillet and GMB
unless stated otherwise)

1. St Maurice Abbey, Clohars-Carnoët, France

This is a historical site. The attic space is partly reserved to a nursery colony of *Rhinolophus ferrumequinum*. In the picture below, a group of visitors is standing in front of the wooden roof door that was especially converted into an entrance for the bat colony.



Behind the wall of the bat roost, the bat mediator shows the location of the colony on the abbey plan to the public (above) and the bat colony through an infrared camera (below): the public can see directly the bats through the camera and therefore can watch the birth and the suckling of young, daily and nightly activities of bats, etc. without disturbing them.





2. AMIKIRO and Kernascleden church, France

AMIKIRO is a Non Governmental Organisation (NGO) established and run by bat workers. The NGO has a museum where schools, the general public, professionals and administration can find exhibition rooms, books, a shop, a library, and education games, and see bats directly through infrared cameras.

This historical church (left) shelters 650 *R. ferrumequinum*. The Bat Museum AMIKIRO (right) is located just on the other side of the street.

In the museum, there are:

- A video room to watch directly (or through recorded video material) the life of the bat colony in the attic space of the church (left).
- A "large bat ear bike", a funny but effective illustration of a bat's hearing system (right).



3. Outdoor bat education programs for the public, France



▶ 189

Learning about echolocation using bat detectors during bat night public events.



Informing the public in a County Council estate on how to create a bat refuge in their property.



Logo "Bat Refuge" for the private or public properties whose owners sign a bat protection agreement with the GMB.

4. Examples of education tools



Bat mock-up



Bat colouring page

5. Informing stakeholders about bats: owners of buildings, professionals, workers, etc. in Prespa

Bat workers inform barn owners, farmers and shepherds.



191

Bat workers and architects plan some works in favour of the bat nursery colony in the attic of the Biological Station at Mikrolimni.



ISBN: 978-960-85811-8-0