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THE ADAMELLO-BRENTA NATURAL PARK BAT COMMUNITY (MAMMALIA, CHIROPTERA): DISTRIBUTION AND POPULATION STATUS

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ABSTRACT - Bats were censused in the Adamello-Brenta Natural Park (Trentino, central Italian Alps) in May-September 1999 and 2000, by mist-netting and roost surveys. In all, 90 sites (19 caves, 50 buildings and 21 foraging sites), over an area of about 618 km^2, were checked. The bat species distribution in both the Park and the surrounding areas was obtained by using field data, museum records and literature information. A total of 19 species was recorded: of these, one (*Myotis bechsteinii*) was known from a museum collection and 18 were recorded in the field (*Rhinolophus ferrumequinum, R. hipposideros, Myotis blythii, M. daubentonii, M. emarginatus, M. mystacinus, M. nattereri, Pipistrellus kuhlii, P. nathusii, P. pipistrellus, Nyctalus leisleri, Hypsugo savii, Eptesicus nilssonii, E. serotinus, Vespertilio murinus, Barbastella barbastellus, Plecotus alpinus, P. auritus*). Local distribution, habitat use and body size parameters of the species were studied, and selection of roosts and foraging sites by the bat community was analysed with logistic regression. The conservation status of the bat community is also discussed. We document the third record of breeding by *Pipistrellus nathusii* and the fourth *Eptesicus* (*Amblyotus*) *nilssonii* nursery in Italy, as well as the first roosting sites of the recently described *Plecotus alpinus*.

Key words: Chiroptera, distribution, conservation, Adamello-Brenta Natural Park, Alps

RIASSUNTO - ***Comunità di Chirotteri e status delle popolazioni nel Parco Naturale Adamello-Brenta (Trentino-Alto Adige)***. Vengono presentati i risultati di una serie di monitoraggi, effettuati con tecniche differenti (principalmente catture con reti *mist-net* ed esplorazione dei siti di rifugio) dal 1999 al 2000. Tali indagini hanno permesso di raccogliere dati originali sulla distribuzione e sullo *status* della chirotterofauna, ai quali sono state affiancate ulteriori informazioni derivanti dalla letteratura recente e da studi di collezioni museali, al fine di definire un quadro di sintesi aggiornato ed esaustivo della distribuzione dei Chirotteri nel Parco Naturale Adamello-Brenta (Trentino-Alto Adige). Complessivamente sono stati esaminati distribuzione e *status* di 19 specie tra cui 18 (*Rhinolophus ferrumequinum, R. hipposideros, Myotis blythii, M.daubentonii, M. emarginatus, M. mystacinus, M. nattereri, Pipistrellus kuhlii, P. nathusii, P. pipistrellus, Nyctalus leisleri, Hypsugo savii, Eptesicus nilssonii, E. serotinus, Vespertilio murinus, Barbastella barbastellus, Plecotus alpinus, P. auritus*) rilevate direttamente mediante il monitoraggio di 90 siti (19 grotte, 50 edifici e 21 stazioni di cattura in campo aperto) rappresentativi di una superficie complessiva di circa 618 km^2, ed una, *Myotis bechsteinii*, rilevata da informazioni derivanti da colle-

zioni museali. Vengono presentate informazioni concernenti il quadro distributivo locale, la selezione dell'habitat ed alcuni parametri biometrici per la comunità di chirotteri del Parco. Vengono inoltre esposte considerazioni su *status* e conservazione delle specie nell'area esaminata. In aggiunta, vengono riportate: la terza segnalazione per l'Italia di riproduzione di *Pipistrellus nathusii*, la quarta colonia riproduttiva nota per l'Italia di *Eptesicus* (*Amblyotus*) *nilssonii* e la prima segnalazione di colonie della nuova specie *Plecotus alpinus*.

Parole chiave: Chiroptera, distribuzione, conservazione, P. N. Adamello-Brenta, Alpi

INTRODUCTION

Chiroptera is the second largest order of Mammals, numbering over 900 species (Nowak, 1994; Findley, 1998); however the current knowledge of bat ecology and distribution is still poor in several geographical regions. Current knowledge of distribution and life-history parameters of bats in Italy is incomplete and often restricted to protected areas (Agnelli *et al.*, 2003). Moreover, few comparative data on the distribution, relative abundance and conservation status of Italian populations exist, although recent nation-wide surveys have been started (GIRC, in press). Considering conservation aspects, even if a legal framework dealing with bat conservation exists, this is often not enforced, or, in the worst case, its very existence is unknown to law-enforcing authorities. Consequently, there are no effective management guidelines for the conservation of bat populations.

The aim of this paper is to present an overall picture of the distribution, composition and conservation status of the bat community in the Adamello-Brenta Natural Park (central Italian Alps), based on field-surveys and historical data from museums and published records. When possible, recent data were used to define the current population status for some species, and to determine roost site selection and habitat preference (foraging sites) for the entire bat community.

STUDY AREA

The Adamello-Brenta Natural Park is the largest (618 km^2) protected area in the Trentino-Alto Adige region. It is located in the western part of Trento province and is bordered by the Giudicarie valleys in the south and south-east, the Sole valley in the north and the Non valley in the east. Two geomorphological distinct areas feature in the mountain massif: the limestone massif of Brenta Dolomites and the granitic massif of Adamello-Presanella characterised by the presence of numerous glaciers on the boundary with Lombardy (Buscaini and Castiglioni, 1977; Farneti *et al*., 1972; Gavazzi and Massa, 1976). The two massifs are separated by the glacial furrow of the Rendena valley (about 17 km), crossed by the Sarca stream. Elevation ranges from 400 m a.s.l. in the main valley bottom to 3500 m a.s.l. of the highest mountains. The park includes 37 villages (AA.VV., 1992) mostly characterised by old buildings.

MATERIAL AND METHODS

Different census methods were used accor-

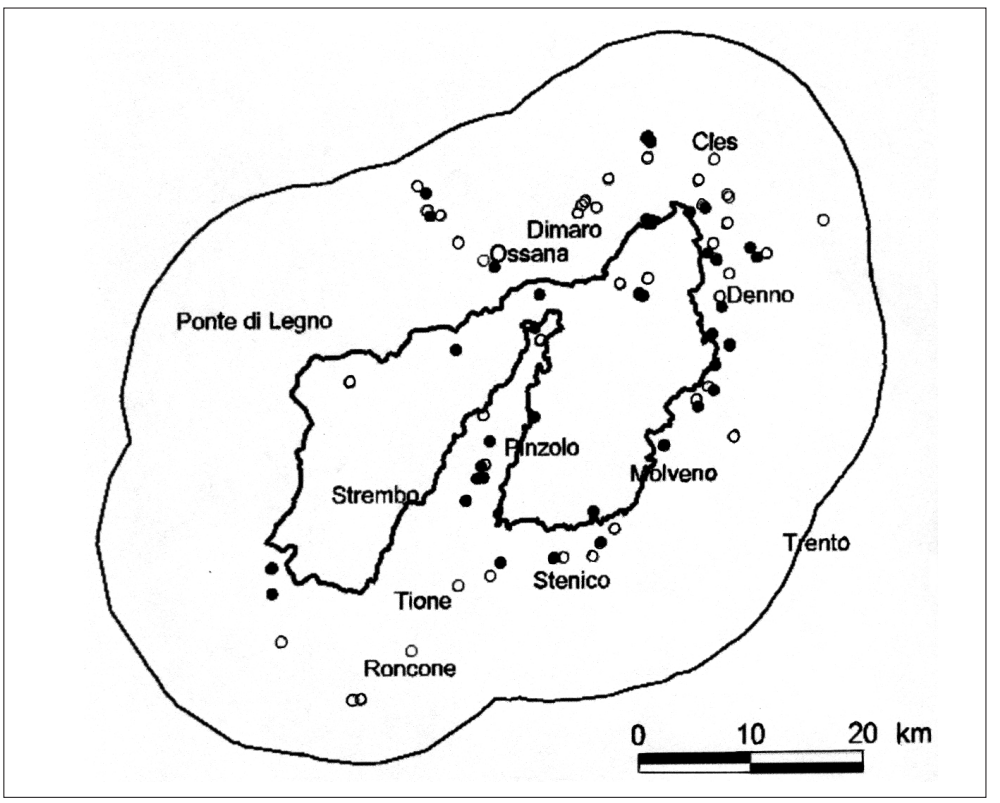

Figure 1 - Map of sampled sites. Solid circles show bat presence; empty ones absence. The thin line corresponds to the 12.5 km buffer surrounding the Adamello-Brenta Natural Park border (thick line).

ding to the characteristics of the surveyed areas.

Mist-netting. Mist-net captures were carried out in summers 1999 and 2000, using nylon twisted-thread mist-nets (Tuttle, 1976), with a 19 mm wide square mesh. Each net was made of five pockets, 60 cm high each, which could be combined to produce net lengths of 3 - 30 m. Mist-netting was conducted at 90 sites to cover all habitats occurring in the study area (except glaciers and surrounding areas). Sampling was planned in order to be representative of both species richness and relative abundance (Fig. 1). Mist-nets were placed along flight routes and at foraging sites, in particular near or across streams, lakes and ponds or at the entrance of caves. Nets were erected at dusk, just before roost emergence, and kept open until a clear decrease in bat activity, over at least one hour, was noticed from absence of catches and ultrasonic calls picked up with a bat detector. Nets were continuously checked, or at least every 10 minutes. The bats captured were removed immediately, held in cotton bags and released after data collection at the point of capture. At potential roost sites, mist-nets and/or hand-nets with 1 cm mesh were used to capture bats. The latter method was used when animals roosted in crevices or hung from the roost ceiling.

Roost surveys. Old buildings were checked for the occurrence of bats as described by Lutz *et al.* (1986). Preliminary surveys of a

large number of buildings were made over a wide elevation range. During roost surveys, we looked for bats, droppings, or food remains such as moth wings. When dead animals were found, they were collected, noting date and site. For each site, characteristics of the building, location, altitude, survey date and time were recorded. In June and September, bats were caught in buildings where preliminary surveys had revealed signs of bat presence.

Recordings of ultrasonic calls. This technique was employed for discriminating *Pipistrellus pipistrellus* from *P. pygmaeus* and for monitoring the presence of *Tadarida teniotis*, a species difficult to catch in foraging areas. In addition, we increased our ultrasonic call database and investigated the possibility of distinguishing *Plecotus alpinus* from its congeners by ultrasonic call parameters. Recordings were made with a D-980 bat detector, (Pettersson Elektronik AB), used in the 10x time-expansion mode. Time-expanded calls were then sampled with a laptop computer equipped with a Compaq ESS 1689 audio-card with a compatible Creative Sound Blaster AWE 32 at a sampling rate of 44100 Hz, 16 bit resolution. Audio samples were stored in a RIFF ADPCM format (".wav" format) for further analysis. Sound analysis was performed with the software BatSound, (Pettersson, 1999). One echolocation call was selected from each sequence recorded and the following variables were measured: start frequency, maximum frequency, minimum frequency, frequency of highest energy, end frequency, central frequency (i.e. frequency of highest energy taken at half call duration) and duration. All variables were measured in kHz except duration expressed in ms. All recordings were taken from hand-released bats, placing the bat detector at ca. 10 m from the release point. Before recording, we ascertained the absence of other free-flying bats, in order to avoid recording of unwanted echolocation signals.

Species identification and biometry. From each bat, we took the following measurements: forearm length, third finger length, fifth finger length, wing length, hind foot length, ear length, tragus length, tibia length, thumb (1st finger) length (*Plecotus* sp.), and thumb claw length (*Plecotus* sp.). Measurements were taken to the nearest 0.1 mm with a precision calliper. Bats were weighed to the nearest "g" with a dynamometer (Pesola 50 g). Sex, determined by inspecting genitals, and age class were recorded. Each bat was classified as juvenile, sub-adult or adult by observing the closure of epiphyseal growth plates in the metacarpal-phalangeal joint of the fourth finger (Stebbings, 1988; Kunz, 1988) against a bright light source; body size and development of genitals were also taken into account.

Species identification was carried out according to Lanza (1959), Helversen (1989), Gebhard (1991), Schober and Grimmberger (1997) and Roesli and Moretti (2000). *Myotis myotis* and *M. blythii* were identified by applying the discriminant function (Arlettaz *et al.*, 1991).

In order to identify unambiguously *Plecotus alpinus*, tissue samples were collected from all *Plecotus* bats. Two tissue samples of 4 mm diameter were taken from the tail membrane (uropatagium) of each bat with a biopsy punch, and stored in a 0.2 ml eppendorf vial filled with 70% ethanol kept at –20 °C until genetical analyses were made. These latter were carried out on 41 *Plecotus* bats. Patagium sampling is completely harmless to bats and all re-captured animals had regenerated the skin area punched in less than a month.

Analysis of population size and habitat use. Historical data were obtained from museum collections and from the literature (e.g. Lanza, 1959).

A relative abundance index (%) was calculated for each species as the number of caught individuals per site divided by the total number of bats captured, multiplied by 100.

To quantify landscape structure around sampling sites we used CORINE Land Cover categories (Commission of the European Communities, 1993). Polygons in this coverage were reclassified using ARC/INFO GIS, based on dominant land use types, to describe the landscape within a buffer-zone (500 m radius) around the sampling locations. This reclassification yielded six land use types: coniferous forest (CONIF), deciduous forest (DECID), alpine meadows (AMEAD), agriculture crops and fields (AGRIC), water bodies (WATER), and urbanised areas (URBAN). Other landscape structure parameters at each sampling point were determined using ARC/INFO GIS: sampling site distances from the nearest water source (DIWAT) and from the nearest urbanised area (DIURB), forest-alpine meadows fragmentation index (FFOME), rocks-alpine meadow fragmentation index (FROME), and elevation (m a.s.l.). For any pair of land cover classes (i.e. forest vs. alpine meadow and rock vs. alpine meadow), the fragmentation index was calculated using the proportion of 30 m pixels surrounding a given pixel belonging to a different land use class. Thus, a pixel with fragmentation index = 0 is completely surrounded by those of the same land cover class, whereas a pixel with fragmentation = 1 is completely encompassed by pixels of a different class. In addition, we considered the annual average temperature (TMEAN) and the minimum average temperature for the coldest month (TMINJ), extrapolated from thematic maps of temperature data from a 40-years weather time-series pertaining to the entire Alpine area (Raimondi, 2003).

Landscape composition variables (proportion *p* of each land use type in buffer-zone) were transformed using the arcsin square root *p* transformation (Zar, 1996).

Bat presence/absence records, pooling all species together, were kept separate for buildings (roosts), caves (roosts), and foraging sites. Based on the sampling surveys, each site was defined as having bats 'present', when at least one individual was found (roosts) or captured (foraging sites), or 'absent' when no bats were observed or caught, yielding a binary response variable. Logistic regression analyses (Hosmer and Lemeshow, 1989) were used to search for relationships between bat presence/absence and landscape variables, elevation and temperature. A stepwise forward selection procedure with a significance for inclusion criterion of p = 0.05 was used, as this method reveals the predictor variables that best explain the variation in the response parameter (Hosmer and Lemeshow, 1989).

RESULTS AND DISCUSSION

BODY SIZE

In Tables 1 and 2 body measurements and body mass are described for each species recorded and for males and females separately. *Plecotus alpinus* parameters are compared with those of the sibling species *P. auritus* (Tab. 3). Elsewhere, we test a discriminant function based on different body measurements to distinguish between the two sibling species (our unpubl. data).

HABITAT USE BY THE BAT COMMUNITY

Nineteen bat species were recorded in the Park area. Only *Myotis bechsteinii*, known from a museum specimen, was not found during field surveys.

At many sampling sites in potentially suitable buildings, bats were not observed (Figs. 2 and 3). Most caves and buildings were used only by one spe-

Table 1 - Body measurements (mean ± SD, mm) and body mass (mean ± SD, g) for rare (n < 10) bat species captured in the Adamello-Brenta Natural Park (For. = forearm; F = female; M = male).

Species	Sex (n)	For. length	5th Finger	3rd Finger	Body mass
Rhinolophus ferrumequinum	M (2)	56.00 ± 0.71	71.05 ± 1.91	83.35 ± 2.62	21.00 ± 1.41
Myotis blythii	M (5)	58.94 ± 5.21	75.60 ± 6.69	95.72 ± 5.70	25.96 ± 2.12
Myotis emarginatus	M (1)	39.10	52.00	64.20	6.00
Myotis mystacinus	M (5)	34.66 ± 0.82	46.64 ± 2.75	56.12 ± 3.89	5.60 ±0.82
Myotis nattereri	M (3)	38.63 ± 1.64	52.23 ± 1.61	65.30 ± 2.98	5.67 ± 0.58
Pipistrellus kuhlii	F (4)	34.00 ± 0.80	45.18 ± 1.50	61.15 ± 2.62	5.63 ± 0.25
Pipistrellus nathusii	F (2)	34.95 ± 1.20	46.45 ± 1.91	60.00 ± 1.27	7.00 ± 0.00
Nyctalus leisleri	M (2)	43.45 ± 0.35	54.15 ± 5.44	76.45 ± 3.04	14.50 ± 0.71
Hypsugo savii	F (2)	35.10 ± 1.98	46.00 ± 1.13	60.50 ± 3.25	9.00 ± 2.83
	M (6)	33.72 ± 1.20	42.95 ± 2.32	57.37 ± 2.68	6.33 ± 0.61
Eptesicus serotinus	M (3)	51.10 ± 0.17	63.67 ± 1.96	89.23 ± 2.60	21.17 ± 1.15
Vespertilio murinus	M (1)	44.00	54.30	75.60	17.00
Barbastella barbastellus	M (1)	38.00	55.00	69.70	7.50

Table 2 - Body measurements (mean ± SD, mm) and body mass (mean ± SD, g) for common (n > 10) bat species captured in the Adamello-Brenta Natural Park (F = female; M = male).

Species	Sex (n)	Forearm	5th Finger	3rd Finger	Mass
Rhinolophus hipposideros	F (5)	38.80 ± 1.08	53.80 ± 0.64	57.40 ± 0.87	6.70 ± 1.04
	M (11)	37.78 ± 0.64	52.75 ± 1.35	55.85 ± 1.38	5.27 ± 0.34
Myotis daubentonii	M (30)	36.66 ± 1.31	47.86 ± 1.66	59.44 ± 1.87	6.74 ± 0.40
Pipistrellus pipistrellus	F (112)	31.43 ± 0.76	41.52 ± 1.31	54.67 ± 1.39	4.96 ± 0.51
	M (20)	30.31 ± 0.56	40.14 ± 2.54	52.53 ± 1.64	4.19 ± 0.45
Eptesicus nilssonii	F (19)	40.95 ± 1.21	51.43 ± 2.23	68.46 ± 2.76	11.83 ± 1.58
	M (13)	40.26 ± 2.08	50.38 ± 2.83	66.08 ± 3.37	10.16 ± 1.37
Plecotus auritus	F (28)	39.43 ± 2.52	52.33 ± 5.09	63.16 ± 6.67	7.39 ± 1.27
	M (18)	39.69 ± 1.53	52.69 ± 3.06	64.65 ± 4.56	7.18 ± 0.85
Plecotus alpinus	F (33)	41.01 ± 1.83	53.77 ± 3.26	67.35 ± 4.73	8.76 ± 1.71
	M (8)	40.04 ± 1.43	52.79 ± 2.34	65.50 ± 2.38	7.46 ± 0.87

cies and the number of individuals in some cases was very high, such as for *Pipistrellus pipistrellus* nurseries (Figs. 2 and 3). At foraging sites, 1-5 bat species were recorded but few bats were captured (Figs; 2 and 3). The proportion of roosts found in buildings (20 out of 50, 40%) did not differ from that recor-

Table 3 - Comparison between *Plecotus auritus* and *P. alpinus* biometries (F = female; M = male).

Species	Sex (n)	Forearm	5th Finger	3rd Finger	Wing	Tail
P. auritus	F (28)	39.43 ± 2.52	52.33 ± 5.09	63.16 ± 6.67	113.69 ± 6.19	45.26 ± 4.87
	M (17)	39.69 ± 1.53	52.69 ± 3.06	64.65 ± 4.56	114.44 ± 4.71	45.56 ± 3.70
P. alpinus	F (33)	41.01 ± 1.83	53.77 ± 3.26	67.35 ± 4.73	119.76 ± 8.13	50.01 ± 3.34
	M (8)	40.04 ± 1.43	52.79 ± 2.34	65.50 ± 2.38	118.51 ± 8.90	49.78 ± 2.56

Species	Sex (n)	Foot	Thumb	Thumbnail	Tragus	Mass
P. auritus	F (28)	7.64 ± 0.78	7.21 ± 0.43	2.49 ± 0.32	14.64 ± 1.61	7.39 ± 1.27
	M (17)	7.53 ± 0.49	7.10 ± 0.33	2.46 ± 0.26	15.47 ± 1.35	7.18 ± 0.85
P. alpinus	F (33)	7.75 ± 0.69	7.15 ± 0.46	2.38 ± 0.20	16.24 ± 1.22	8.76 ± 1.71
	M (8)	7.55 ± 0.67	7.10 ± 0.37	2.34 ± 0.28	16.34 ± 1.25	7.46 ± 0.87

ded for caves (8 out of 19, 42%, Fisher Exact Test: p = 1.00). Foraging bats were captured at 12 out of 21 (57%) sites. We first tested for differences in elevation according to site type (building, cave or foraging) and bat presence (present vs. absent) using a two-way ANOVA (Tab. 3). Foraging (capture) sites were at higher elevations than caves and buildings (site effect F = 22.2;

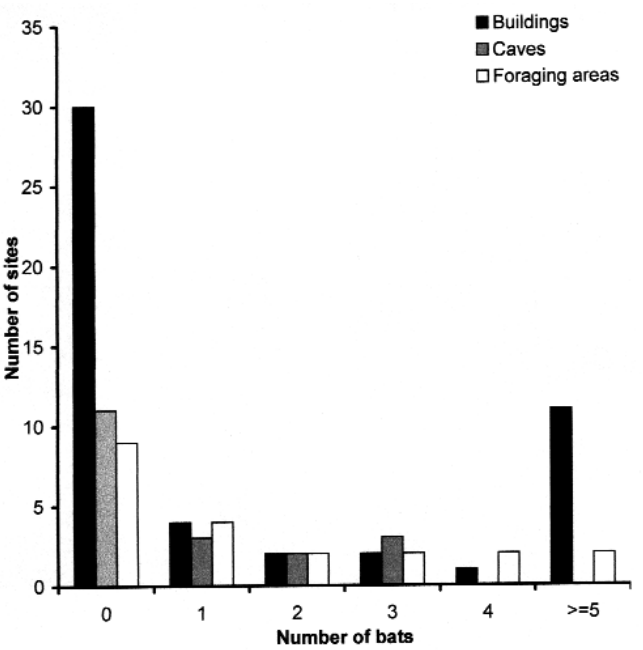

Figure 2 - Frequency of bats caught for each site type (building, cave and foraging site).

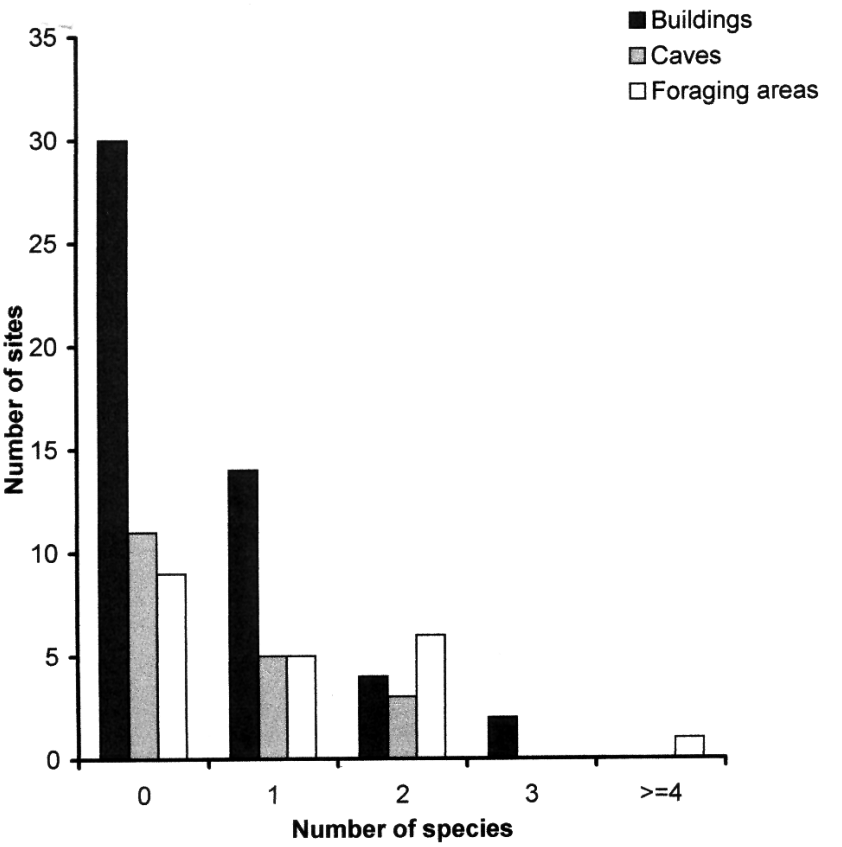

Figure 3 - Frequency of caught species per site type (building, cave and foraging site).

df = 2, 84; $p < 0.0001$) and there was a significant type/presence interaction ($F = 10.9$; df = 2, 84; $p < 0.001$). Therefore, separate t-tests were calculated comparing mean elevation of positive (bats present) and negative (bats absent) sites for buildings, caves and foraging sites (Tab. 4). Foraging sites where bats were caught were at higher elevations than potential foraging sites where no bats were caught (Tab. 4). Hence, there was a marked elevation difference between roosts and foraging sites and, on commuting, bats made vertical movements of several hundred meters to reach foraging sites. This evidence was confirmed by logistic regression on habitat selection. A similar selection pattern has been described for *M. daubentonii* in southern part of Italy (Russo, 2003). Many landscape variables influenced significantly the probability of finding foraging bats at capture sites. The proportion of deciduous forest and agriculture areas negatively affected foraging activity (DECID $\chi^2 = 10.68$, df = 1, $p = 0.0013$; AGRIC $\chi^2 = 7.70$, df = 1, $p = 0.006$), whereas that of alpine meadows, as well as elevation, had a positive effect (AMEAD $\chi^2 =$

Table 4 - Elevation (mean ± SD, in m a.s.l.) of study sites checked for the presence of bats.Within each site type, the altitude difference between sites with and without bats was explored with t-test.

Site type	Bats present	Bats absent	t-test
Buildings	740 ± 287	768 ± 261	$t_{48} = 0.36$; p = 0.72
Caves	827 ± 194	1120 ± 406	$t_{15} = 2.09$; p = 0.054
Foraging sites	1590 ± 405	1003 ± 317	$t_{19} = 3.59$; p = 0.002

9.57, df = 1, p = 0.002; elevation χ^2 = 9.73, df = 1, p = 0.002). Foraging sites also tended to be further away from urbanised areas than sites where no bats were recorded (DIURB χ^2 = 3.52, df = 1, p = 0.057). The selected model, which accounts for 51% of total deviance, included effects of relative availability of deciduous forests and alpine meadows surrounding foraging sites (DECID χ^2 = 10.68, df = 1, p = 0.0013; AMEAD χ^2 = 4.06, df = 1, p = 0.042; $G_{(xi)}$ = 0.12 (± 0.75) - 25 (± 104) DECID + 4.3 (± 3.4) AMEAD). Thus, bats selected alpine meadows at higher elevations for foraging and avoided low-elevation (deciduous) forests.

The probability of finding bats in buildings increased significantly with the distance from urbanised areas and with the presence of water in the vicinity (DIURB χ^2 = 4.08, df = 1, p = 0.041; WATER χ^2 = 4.01, df = 1, p = 0.043), both factors explaining only 12% of total deviance. Minimum January temperature did not improve the fit of the model (TMINJ χ^2 = 3.13, df = 1, p = 0.073). The selected model was described by $G_{(xi)}$ = -1.06 (± 0.41) + 0.0047 (± 0.0027) DIURB + 4.2 (± 2.3) WATER. Our data suggest that bat roosts were more likely to be found in isolated buildings (churches, farms, barns, etc.) with ponds or small rivers as water sources in the vicinity, than in suitable buildings in urbanised areas. There was a significant negative effect of elevation on the presence of bats in caves (χ^2 = 4.18, df = 1, p = 0.039), and a negative effect of the proportion of alpine meadows surrounding caves (AMEAD χ^2 = 3.68, df = 1, p = 0.052). Only elevation was included in the selected logistic regression model ($G_{(xi)}$ = 3.4 (± 2.3) - 0.0040 (± 0.0025), and accounted for 16% of total deviance explained. Hence, bats tended to avoid roosting in caves located at higher altitude and surrounded mainly by open habitats (alpine meadows).

DISTRIBUTION AND RELATIVE ABUNDANCE OF SINGLE SPECIES

The distribution of presence/absence of bat species is represented by a synthetic map (Fig. 1). For conservation reasons, the exact location of roosts is not provided and all roosts are here identified by the corresponding site or town name.

RHINOLOPHIDAE

Rhinolophus ferrumequinum (Schreber, 1774) – Greater horseshoe bat

Threat level - Europe: Lower Risk – LR (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
The species was only found in 3 buildings; one bat (0.6% of total) was a lactating female bearing young). Historically it was found in 1966 (Seghe valley, *legit* Osti, conserved in Spormaggiore museum).
Very rare in the study area; currently, only one roost site (Campodenno) is known. No large colonies have been recorded, and no animals were caught in caves. Two solitary males and a female with young were observed in old building garrets. This species is considered locally endangered, in particular in valley bottom habitats, heavily modified by human activities. A similar situation was described in comparable habitats in the neighbouring area of Alto Adige/Südtirol (Niederfriniger, 2001) where only two nurseries were found.

Rhinolophus hipposideros (Bechstein, 1800) – Lesser horseshoe bat
Threat level - Europe: Vulnerable - VU (IUCN, 1996); Italy: Endangered – EN (Bulgarini *et al.*, 1998).
For this species 7 records were obtained, (4.8% of the captured bats): one pregnant female in a breeding roost in a cave; and six solitary males, two in temporary roosts in caves and four in buildings. In one of these temporary roosts in buildings (Spormaggiore) the species was present in both years. This species seems to be strongly declining in alpine and prealpine areas, if current observations are compared with historical data: Gulino and Dal Piaz (1939) reported that this was "the commonest species of its genus judging from the number of animals observed" in northern Italy. In the Park area this species is very rare with only one breeding site found in a cave in S. Giacomo; no large cave colonies, once common, were found. Thus this species must be considered endangered. A better situation has been described for Alto Adige/Südtirol (Niederfriniger, 2001) where a fairly high number of (small) nurseries was found

VESPERTILIONIDAE
Myotis bechsteinii (Kuhl, 1817) – Bechstein's bat
Threat level - Europe: Vulnerable – VU (IUCN, 1996); Italy: Data Deficient – DD (Bulgarini *et al.*, 1998).
Its occurrence was known until 1966 (Seghe valley, *legit* Osti, conserved in Spormaggiore museum). During this study no individuals were caught. At present, the species is either absent or very rare in the study area, despite the large availability of suitable habitats. This situation reflects the trend observed at regional (a single nursery in Alto Adige/Südtirol, Niederfriniger, 2001) and national scale.

Myotis blythii (Tomes, 1857) – Lesser mouse-eared bat
Threat level - Europe: Not evaluated – NE (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
This species was recorded in three temporary roosts: two in buildings and one in cracks in a bridge (Molveno). In one

of these temporary roosts in buildings (Strembo) the presence of *M. blythii* was confirmed in 1999 and 2000. The presence of 5 solitary males (1.5% of captured bats) at 2 temporary roosts and at one foraging site indicates that this species is not abundant and is perhaps in a critical conservation status. There are no recent records of large colonies, once common. Although during this study the presence of the congener *M. Myotis* - which often shares the same roosting and foraging sites - was not confirmed, its presence cannot be ruled out.

Myotis daubentonii (Kuhl, 1817) – Daubenton's bat
Threat level - Europe: Not Evaluated - NE (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
Only one temporary roost site with 20 males (6% of captured bats) was recorded (Molveno) in 1999 and 2000. The presence of this species in the park is very limited, probably due to the scarcity of suitable water bodies, in particular in the lower valley. This species is also rare in Alto Adige/Südtirol (Niederfriniger, 2001).

Myotis emarginatus (Geoffroy, 1806) – Geoffroy's bat
Threat level - Europe: Vulnerable – VU (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
The species seems extremely rare with only one male roosting in a cave in S. Giacomo (0.3% of captured bats). The species had been recorded in Seghe valley in 1966 (Seghe valley, *legit* Osti, conserved in Spormaggiore museum). Hence, the species seems rare in spite of the availability of suitable forested habitats at elevations from the valley bottom up to 1200-1400m a.s.l. In Alto Adige/Südtirol, in contrast, *M. emarginatus* is quite common (Niederfriniger, 2001).

Myotis mystacinus (Kuhl, 1817) – Whiskered bat
Threat level - Europe: Not Evaluated – NE (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
Five animals were caught at four sites (1.5% of captured bats), one in a temporary roost in a cave, the others at foraging sites. Rare in the study area, unlike in Alto Adige/Südtirol (Niederfriniger, 2001). At present only one temporary roost, occupied by a single male, is known (a cave in the Andalo area).

Myotis nattereri (Kuhl, 1817) – Natterer's bat
Threat level - Europe: Not Evaluated – NE (IUCN, 1996); Italy: Endangered – EN (Bulgarini *et al.*, 1998).
Only one temporary roost is known for this species - a cave in Stenico, where three males were caught (0.9% of captured bats). Although *M. nattereri* preferred habitats, namely, mixed mature deciduous forests, are largely available, the species is extremely rare and may be classified as endangered as is the case in Alto Adige/Südtirol (Niederfriniger, 2001).

Pipistrellus kuhlii (Kuhl, 1817) – Kuhl's pipistrelle
Threat level - Europe: Not Evaluated –

NE (IUCN, 1996); Italy: Lower Risk – LR (Bulgarini *et al.*, 1998).
Four individuals caught at a single foraging site near Cunevo (1.2% of captured bats).
Low contact frequency probably also due to the sampling methods concentrated mainly in natural habitats or in unsuitable roosting sites in towns (old buildings). Anyway, this species, which is usually found in urban buildings, can be considered rare in the study area, probably in relation to its preferences for lower altitude (Schober and Grimmberger, 1997; Vernier and Bogdanowicz, 1999; Russo and Jones, 2003).

Pipistrellus nathusii (Keyserling and Blasius, 1839) – Nathusius's pipistrelle
Threat level - Europe: Not Evaluated – NE (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
Two lactating females caught at a single foraging site near Cunevo (0.3% of captured bats).
Although apparently extremely rare in the study area, the present record is the third of *P. nathusii* breeding in Italy (Martinoli *et al.*, 2000; Niederfriniger, 2001).

Pipistrellus pipistrellus (Schreber, 1774) – Common pipistrelle
Threat level - Europe: Not Evaluated – NE (IUCN, 1996); Italy: Lower Risk – LR (Bulgarini *et al.*, 1998).
Very abundant (39.5% of captured bats) as in neighbouring Alto Adige/Südtirol (Niederfriniger, 2001). Found in one roost site (Tovel valley) and caught at three other foraging sites. The most common species in the study area. In a nursery, over 100 bats were counted both in 1999 and in 2000. The presence of the sibling species, *P. pygmaeus* has not been recorded but it cannot be ruled out.

Nyctalus leisleri (Kuhl, 1817) – Leisler's bat
Threat level - Europe: Lower Risk – LR (IUCN, 1996); Italy: Vulnerable – VU (Bulgarini *et al.*, 1998).
Two males were caught (0.6% of captured bats), one in a temporary roost (Tovel valley) and one at a foraging site (near the town of Cunevo). Our data reflect the common situation for this species in Italy: females generally breed in northern Europe and males, especially subadults, may remain at their hibernation sites also during spring and summer. An exception to this population characteristic has been recently recorded: in the neighbouring area Alto Adige/Südtirol where a nursery was found (Niederfriniger, 2001).

Hypsugo savii (Bonaparte, 1837) - Savi's pipistrelle
Threat level - Europe: Not Evalueted – NE (IUCN, 1996); Italy: Lower Risk – LR (Bulgarini *et al.*, 1998).
Eight individuals were caught at a single foraging site near Cunevo (2.4% of captured bats). Rare, and probably restricted to a few sites like in Alto Adige/Südtirol (Niederfriniger, 2001) probably in relation to its thermophily (Russo and Jones, 2003). The species breeds in the study area (2 lactating females caught).

Eptesicus nilssonii (Keyserling *et* Blasius, 1839) – Northern bat
Threat level - Europe: Not Evalueted – NE, IUCN (1996); Italy: Data Deficient – DD (Bulgarini *et al.*, 1998).
We found a nursery at one of the lowest altitudes so far known (Madonna di Campiglio) for this species and individuals were also recorded at eight foraging sites. In Italy, the first nursery was recorded by Niederfriniger (2001) in Alto Adige/Südtirol. Northern *E. nilssoni* mainly foraged in areas with scarce vegetation, generally close to water bodies. Over 30 bats were captured (9.6% of captured bats), more than 50% of which were breeding females. This species was often recorded in several areas of the Park. Few records of this species are known for Italy. This study shows that a relatively large *E. nilssoni* population occurs in the study area and this species can be considered as common.

Eptesicus serotinus (Schreber, 1774) – Serotine
Threat level - Europe: Not Evalueted – NE (IUCN, 1996); Italy: Lower Risk – LR (Bulgarini *et al.*, 1998).
Three males were caught at a single foraging site, a pond near Cunevo (0.9% of captured bats).
This situation reflects a common trend in Italy where nurseries are not frequent. However, in nearby Alto Adige/Südtirol several nurseries were found (Niederfriniger, 2001).

Vespertilio murinus (Linnaeus 1758) – Parti-colored Bat
Threat level - Europe: Lower Risk – LR (IUCN, 1996); Italy: Data Deficient – DD (Bulgarini *et al.*, 1998).
Only one male was caught at a lake (foraging site) near Cles (0.3% of captured bats). This species is considered accidental both in the study area and probably in the whole of Italy: in fact the species occurs only in the north-eastern part of the country (see also Niederfriniger, 2001 for Alto Adige/Südtirol; Lapini *ex verbis* for Friuli-Venezia Giulia).

Barbastella barbastellus (Schreber, 1774) – Barbastelle
Threat level - Europe: Vulnerable – VU (IUCN, 1996); Italy: Endangered – EN (Bulgarini *et al.*, 1998).
One male Barbastelle (0.3% of captured bats) was caught in a cave (temporary roost) close to the locality of S. Giacomo, and no reproductive sites were recorded. In Alto Adige/Südtirol (Niederfriniger, 2001) many nurseries are known.

Plecotus auritus (Linnaeus, 1758) – Common long-eared bat
Threat level - Europe: Not Evaluated – NE (IUCN, 1996); Italy: Lower Risk – LR (Bulgarini *et al.*, 1998).
Historical evidence dated at 1966 (Seghe valley, *legit* Osti, conserved in Spormaggiore museum).
Abundant (13.8% of captured bats), and present throughout the entire study area. At least 14 roosts (mostly nurseries) are known, used in both years (Bocenago, Caderzone, Cavedago, Giustino, Ragoli). All but a temporary

roost in a cave (Andalo) were in old buildings. This species was also caught at 3 foraging sites and has to be regarded as one of the commonest in the study area. Anthropic areas, generally near patchy areas of fields, meadows and small plantations, and mixed forest sites, were selected for roosting. Foraging areas were located at higher elevations within or near coniferous forests, woodland-scrub edges and alpine meadows.

Plecotus alpinus (Kiefer and Veith, 2002 n.s.) – Alpine long-eared bat
Threat level – Europe and Italy: not yet evaluated (the species has been described only recently; Kiefer and Veith, 2002).
Relatively common in the study area (12.3% of captured bats). Our data are the first report of its occurrence in Italy.

CONCLUSIONS

Because historical data are scarce, we cannot provide an estimate of population trends for the bat species recorded. However, it is well known that from the beginning of the 1950s, in many European countries, and specifically in Italy, most large bat colonies have gradually disappeared and currently roosts numbering over 1000 bats are extremely rare. Therefore, it is vital to improve our knowledge on bat distribution, population size and habitat use in order to develop effective conservation strategies. Also, the actual, immediate causes of (local) decline need to be understood to protect and manage suitable roost sites and foraging habitats (Ransome, 1990). Thirty-five bat species currently occur in Italy, including those discovered only recently (Amori *et al.*, 1999; Russo and Jones, 2000; Kiefer and Veith, 2001; Spitzenberger *et al.,* 2001; Mucedda *et al.,* 2002; Scaravelli, 2003) and excluding *Myotis dasycneme* and *Rhinolophus blasii*, which should be regarded as accidental (Agnelli *et al.*, 2003). Of these, 19 species occur in the Adamello-Brenta Park area. Some of them, such as *B. barbastellus* and *V. murinus,* are rare over their entire distribution range, while other rare species are abundant in the study area (*E. nilssonii*). Interestingly, we recorded many nurseries of *P. auritus*, as well as of the newly described taxon *P. alpinus*.
Because of the significant presence of suitable habitats and roost sites used by the bat community, the Adamello-Brenta Natural Park should be considered a priority area for bat conservation in the North-Italian Alps. Our findings have important implications for landscape management to preserve bats. Roost and foraging site selection were based on different elevation and habitat requirements. Hence, bat conservation strategies should target relatively large areas including anthropic areas (especially buildings structurally suitable as roosts), as well as natural alpine habitats intensively used by foraging bats.

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