Rhinolophus hipposideros 2000

Research program for the conservation of the
lesser horseshoe bat *Rhinolophus hipposideros*
in Switzerland

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Swiss Coordination Centre for the Study and Protection of Bats

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1. Introduction

Since the 50s or 60s, lesser horseshoe bats have undergone a severe decline in most of western Europe. The same dramatic development was recorded in Switzerland, where lesser horseshoe bats were once widespread and common, whilst today only some isolated populations remain in the alpine arc. The exact reason(s) for this decline is(are) not known. Moreover, it is not clear whether the remnant colonies are still confronted with the problems that led to the decline or whether the situation has changed meanwhile. As a result, no focused conservation scheme could be developed up to now; it is thus not surprising that roost protection has always been given the priority. There is definitely a need for a broader knowledge of the problems faced by the species so as to propose effective conservation measures that may be implemented, first, to foster the recovery of small populations and, second, to promote the progressive recolonisation of once inhabited but today abandoned areas. We present here a concept for an applied research program on the question. We hope that the implementation of the conservation measures that will be drawn from the proposed investigations might enable one to act efficiently for the conservation of that highly endangered bat species.

2. Aims of the conservation research project

The main goals of the proposed research are the following (some major constraints are also presented):

- Understanding the causes of regression of *R. hipposideros*, as far as feasible [an experimental approach being hardly applicable on that threatened and today rare species, we shall mostly rely on a comparative approach instead].
- Finding out the key factors which today may be responsible for the survival of the remnant colonies.
- Proposing an efficient conservation scheme for the endangered species in Switzerland, which includes both the protection of remnant colonies and their management so as to elicit, if feasible, an increase in population size and a progressive recolonisation of lost distribution.

3. Estimation of the status of the species and its demographic trends

3.1. Europe

We present here a brief overview of some data about the present status and recent demographic tendencies of *R. hipposideros* in Europe. *R. hipposideros* has become a rare species in Central Europe. This is particularly true for the Netherlands and Benelux countries where the species is almost extinct at present (Fig. 1). In the east and south-east of Germany, populations of some 600 lesser horseshoe bats are censused. There are some weak trends of population recovery observed today. Austria still reports some strong populations, especially in Kärnten and Steiermark. They found both, populations with steep downward trends and also population recoveries. Countries in East Europe still harbour large lesser horseshoe bat populations, although some tendencies of population decreases are reported there, too. In many countries of southern Europe, only few information about the current status and the demographic tendencies is known. They seem to be at least common. However, there are many reports of lost colonies there, too.

Fig. 1: Distribution of the lesser horseshoe bat in Europe. The recent distribution is shaded. The dotted line depicts the northern border of the distribution of the species before World War II (adapted from Ohlendorf 1995).

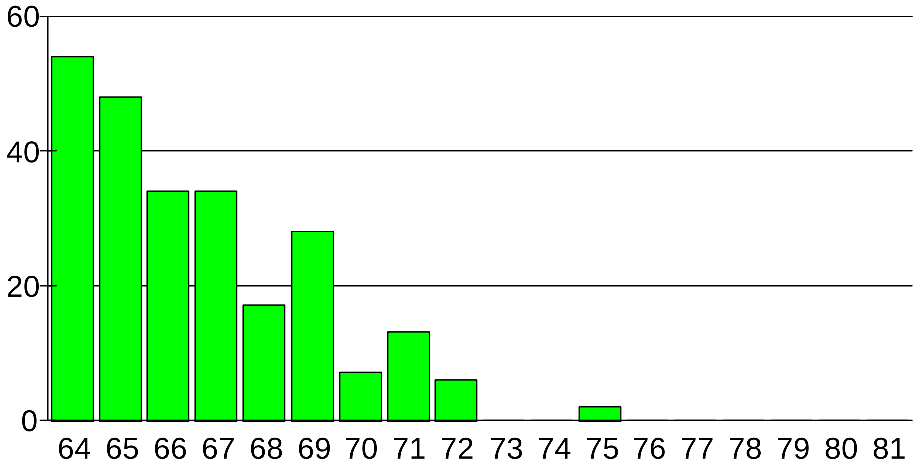


Fig. 2: An example of population decrease at one winter roost in Switzerland (number of counts, after Arlettaz et al. 1999).

3.2. Switzerland

There are numerous data assessing population crashes in Switzerland in the 50s–70s (see the example in Fig. 2). Regarding the current situation and most recent trends in Switzerland, we could obtain good data from an inquiry addressed to all Swiss regional bat coordinators (RFE/CR) and to other bat experts. In the inquiry form, it was asked for all records of colonies and whether nursery roosts had decreasing, stable or increasing population sizes during the 90s. We also requested additional data on monitoring to see whether precise population trends could be documented.

According to this inquiry, at least eight Swiss cantons still harbour the species at present (Fig. 3). Fig. 4 shows the distribution of 37 known nursery colonies active from 1990 to 1999, whereas Table 1 presents a list of all 37 nursery colonies during the past 10 years, with estimated population size and recent demographic trends. As regards population trends within those 37 nurseries, 32% showed recent increase in number, 16% appeared stable, whereas 11% were decreasing; it should be noted, however, that 41% (n = 15) of all nursery sites did not yield data precise enough to estimate population tendencies (Tab. 2). When considering only the sites with sufficient data to document exact trends (n = 22), we stated that 55% of them exhibited an overall population increase, 27% seemed stable, whereas 18% only exhibited a marked decrease. These results suggest that some populations might well be undergoing a positive development in the most recent years, as exemplified by Fig. 5.

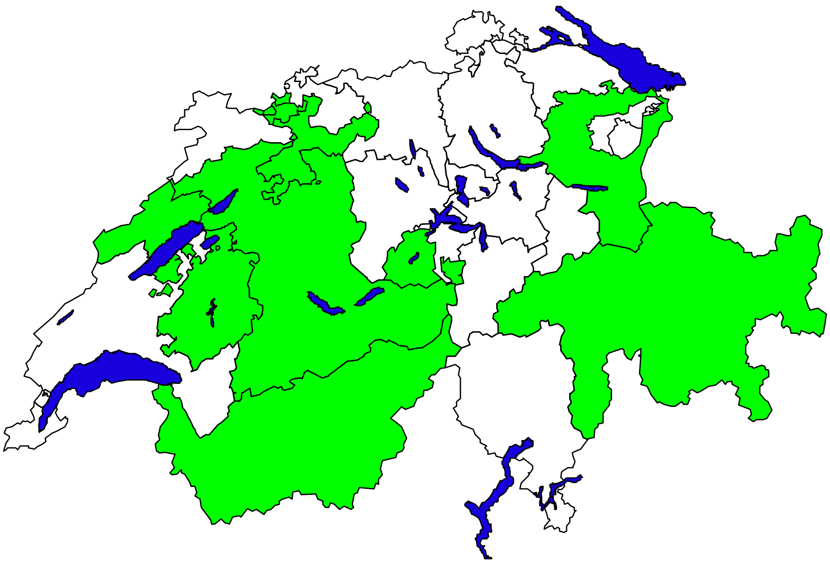


Fig. 3. The cantons which have reported extant populations of lesser horseshoe bats in the 90s are indicated in dark (green).

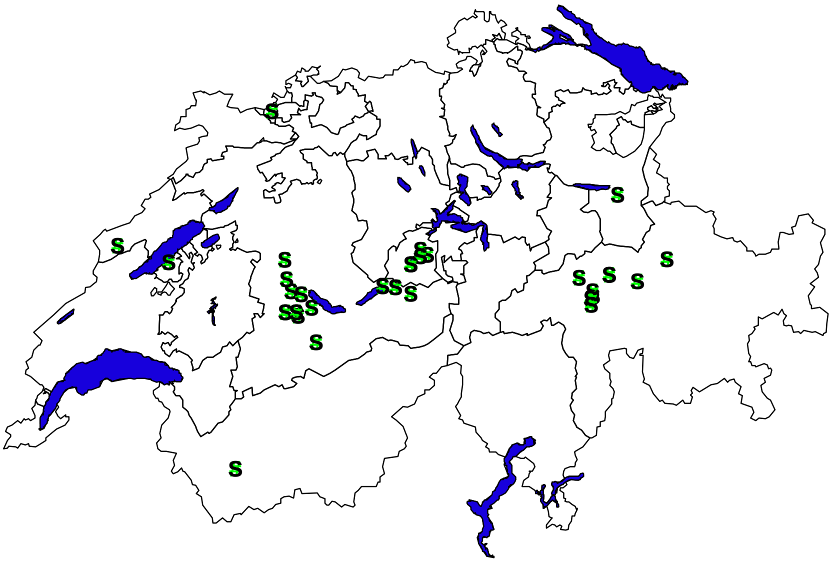


Fig. 4: Distribution of 37 known nursery roosts of *Rhinolophus hipposideros* in Switzerland in 1990-1999.

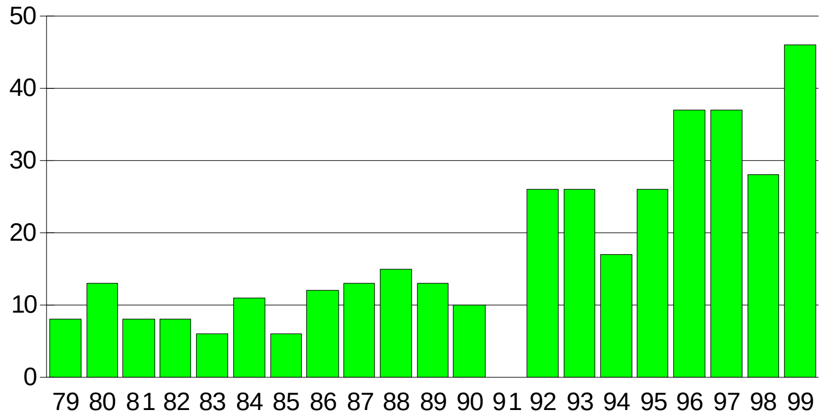


Fig. 5: Example of a recently increasing population: maximum number of individuals censused since 1979 at one maternity roost in Obwalden (data from Alex Theiler).

Table 1: List of the 37 nursery roosts of *Rhinolophus hipposideros* known in Switzerland from 1990 to 1999. The last four roosts could not be firmly confirmed as nursery roosts in the most recent years.

code	Canton	Gemeinde	ZIP code	maximal # adults	maximal # juveniles	prop. ad. / juv.	year of count	trend
1	SG	Flums	3292	8		0%	1995	down
2	SO	Kleinlützel	4245	1		0%	1997	
3	FR	Estavayer-le-lac	1470	4	3	75%	1999	(stable)
4	NE	St-Sulpice	2123	2			1990	down
5	GR	Camuns	7113	20	8	40%	1999	stable
6	GR	Castiel	7027	43	11	26%	1999	up
7	GR	Cumbel	7142	9	5	56%	1999	down
8	GR	Uors-Peiden	7114	95	48	51%	1999	
9	GR	Uors-Peiden	7114	53	15	28%	1999	stable
10	GR	Uors-Peiden	7114	145	62	43%	1999	up
11	GR	Surcasti	7115	142	62	44%	1999	up
12	GR	St. Martin	7116	201	46	23%	1999	up
13	GR	Tomils/Tumegl	7418	8			1999	stable
14	GR	Valendas	7122	18	8	44%	1999	up
15	GR	Valendas	7122	41	18	44%	1999	up
16	GR	Waltensburg	7158	121	25	21%	1999	
17	BE	Blumenstein	3638	63			1999	up
18	BE	Erlenbach	3762	61			1999	up
19	BE	Brienzwiler	3856	29			1999	
20	BE	Daerstetten	3763	19			1998	
21	BE	Diemtigen	3754	16			1999	
22	BE	Brienz	3855	11			1999	
23	BE	Burgistein	3134	11			1996	
24	BE	Daerstetten	3763	4			1999	
25	BE	Toffen	3125	22	19		1999	up
26	BE	Amsoldingen	3633	20			1998	up
28	OW	Giswil	6074	20	16		1999	stable
29	OW	Giswil	6074	23	6		1999	
30	OW	Sarnen	6060	30			1997	
31	OW	St. Niklausen	6066	3	1		1997	
32	OW	Sachseln	6072	46			1999	up
33	OW	Giswil, Militärpav.	6074	31			1998	
34	VS	Le Châble	1934	7			1999	up
35	BE	Erlenbach ?	3762	3			1995	
36	BE	Kandergrund ?	3716	1			1999	
37	BE	Meiringen ?	3860	12			1999	stable
38	BE	Wimmis ?	3752	1			1998	down

Table 2: Population trends in 37 nursery colonies in 1990-1999

Population trend	Number of colonies N (%)	Sites without missing data (%)
Up	12 (32%)	55%
Stable	6 (16%)	27%
Down	4 (11%)	18%
Missing data	15 (41%)	
Total	37 (100%)	100%

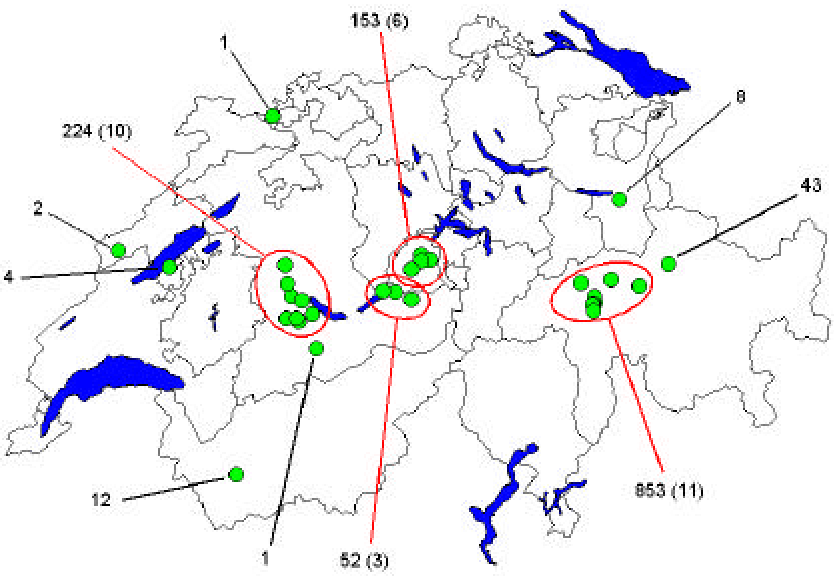


Fig. 6: Distribution of the 37 nursery colonies presently known in Switzerland. The four clusters sheltering the largest populations are depicted by circles. The numbers show the maximal numbers of animals counted (numbers of colonies).

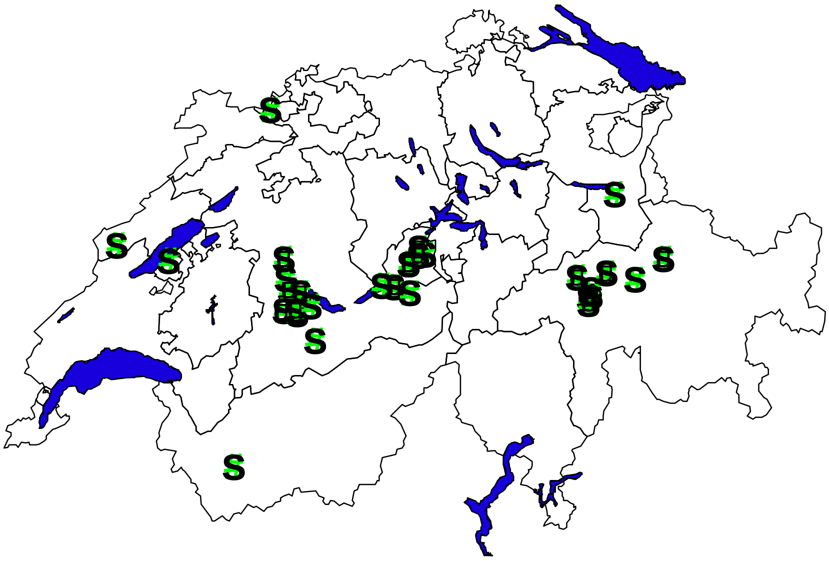


Fig. 7: 20 out of 37 nursery colonies of *Rhinolophus hipposidero*s shelter more than 20 individuals each (marked with star). The largest nursery colonies are situated in the core distribution areas (see Fig. 6).

4. Potential causes of the decline and evaluation of their relevance

We perform an analysis of potential causes of decline of *R. hipposideros*. For this purpose, we used three sources. First, referring to literature, we listed all potential causes suggested by various authors. Second, we made our own list and sorted the factors that seemed to us the most relevant ones (Table 3; see also comments below). Third, we asked all Swiss regional coordinators, during the inquiry described above, to make their own appraisal of possible factors (Table 4). Both our personal assessment and evaluation by local bat workers matched each other, demonstrating concording views about the possible origins of decline.

We present now our own comments about possible causes of decline, separating the factors in two main classes: abiotic and biotic factors, although both clearly interact and may correlate. The signification of the symbols is as follows: • *a priori* not a relevant factor; •• factor that might (have) play(ed) some role but further evaluation is requested; ••• factor ranked as a major potential cause of decline. The sections 'Comment' presents a justification of our classification into these three categories.

Tab. 3. Potential causes of regression of the lesser horseshoe bats in Switzerland. Replies from an inquiry submitted to 12 regional bat experts; factors were ranked from 0 (irrelevant factor) to 5 (very relevant factor), and averaged.

	Average rank
A. Abiotic factors	
1. Changes in the physical structure of habitats	3.1
2. Pesticides	4.0
3. Climate changes	0.4
4. Lost of roosts and roost deterioration	1.2
B. Biotic factors	
6. Food shortage	3.4
7. Competition against other species	0.8
8. Predation, including human disturbance	0.0
9. Genetic inbreeding	0.4
10. Diseases	0.2

4.1. Abiotic factors

••• *1. Changes in the physical structure of habitats*

Lesser horseshoe bats are believed to exploit primarily cultivated landscapes such as farmland or woodland, two types of habitats which have faced dramatic modifications since World War II. Traditional insect-rich meadowland and pastureland have been changed into crops, whereas forest patches, hedgerows and single trees have been systematically eradicated. This resulted in a loss of overall habitat diversity, patchiness and connection, including edge effects. Moreover, cattle and small domestic animals were banned from Swiss forests early this century, which certainly implied further losses in vegetation patchiness and vertical structure within woodlands. A direct influence of this is of course a global drop in the available insect prey biomass (see 4.2).

Tab. 4. Suggestions for priorities in conservation research proposed by 11 regional bat experts; the proposed topics are ranked with respect to the number of counts.

	number of counts
Habitat use	8
Diet	4
Roost availability/function	4
Identification of potential foraging habitats	3
Comparative landscape evolution	3
Pesticide analysis of faeces/tissues	3
Pesticide analysis of potential prey	3
Connection of roosts	2
Comparison with foreign colony (optimum)	2
Spatial use around nurseries	2
Protection and improvement of foraging areas	2
Landscape analysis around nurseries	2
Structure and microclimate of roosts	2
Changes in climate	1
Finding of new colonies	1
Monitoring colonies	1
Genetic variability within and between colonies	1
Conservation of existing colonies	1
Recolonialisation of roosts	1
Reproduction success/body mass and condition/mortality	1
Legal situation for protection of sites	1

Comment: Habitat changes are ranked among the probable major factors of decline. However, as many areas still harbour highly structured landscapes but no lesser horseshoe bats any more, habitat destruction may explain the extinction of local populations, but certainly not the whole phenomenon of the decline of lesser horseshoes across most of Western Europe. Regarding the changes in woodlands, they may have been largely underestimated. Major changes in farming practices could have had a large scale impact on lesser horseshoe bats.

••• *2. Pesticides*

The extensive use of pesticides began during the period of World War II, particularly in agriculture. Many animal species began to decrease soon after, as exemplified by raptors (peregrine falcons, sparrowhawks, etc.) that were heavily contaminated by organochlorined pesticides (DDT, etc.). Horseshoes may have faced the same problem. Yet, those raptors have now largely recovered in Europe, including Switzerland, whereas there has not been such a dramatic increase in horseshoe bat populations. It should be pointed out that a slower population recovery in bats may be due to their lower reproductive rate. The effects of pesticides may be the contamination of the food chain (abiotic) and/or a decreasing food availability (biotic, discussed in section B).

Comment: The hypothesis that pesticides may be responsible for the decline of the lesser horseshoe bat is appealing as it typically represents a global effect. Recent investigations have shown that some pesticides act as hormons and can then potentially interfere with reproductive ability. If pesticides are the main factor of decline, we would expect to observe population recoveries unless pesticides especially harmful to horseshoes are still in use. A research project exists in this field in Switzerland, but conclusive results are not yet available. The main problem is that even if one finds a correlative evidence of a relationship between environment contamination and bat population status, the causality is not demonstrated. Also, this would raise the question whether the incriminated pesticides still persist in the environment and constitute therefore a permanent source of contamination.

•• *3. Climate changes*

Fluctuations in climate may cause alterations in distribution and population sizes; a climatic optimum actually took place in the late 40s and early 50s, i.e. just before lesser horseshoes began to decline.

Comment: The decrease of *R. hipposideros* took place almost simultaneously in much of western Europe. This supports the hypothesis of a global effect. If global warming starts to affect earth, we should soon expect a population recovery. If climate is the main factor, there are no special measures to implement for species conservation… However, the fact that *R. hipposideros* was an abundant species in Switzerland early this century, when the climate was not significantly warmer than today, contradicts the scenario of a great thermic dependence as a single acting factor.

•• *4. Lost of roosts and roost deterioration*

Lesser horseshoes in Switzerland use to roost in large lofts (attics, mostly during the summer) and in underground cavities (mostly outside the summer). Renovation of buildings and decrease in mining activity may have reduced the number or quality (insulation of roofs which deteriorates thermic conditions) of roosts available to bats.

Comment: Lost of roosts and roost alteration could have played a role locally, but they would hardly be able to explain the widespread decrease of the species in western Europe.

4.2. Biotic factors

••• *6. Food shortage*

Availability of insect food to bats has certainly decreased a lot in the past decades in most of western Europe, due mainly to habitat transformation (farmland into human settlements), use of pesticides (dramatic drop in insect prey biomass; for contaminatinon see 4.1), or changes in agriculture (meadows into crops, pastures into arable land) and sylviculture (deciduous into coniferous trees). As a result, many relevant habitats do no longer exist today or do not provide enough insect biomass. This may have affected lesser horseshoes.

Comment: As food is usually the most important condition for species existence and reproduction, this hypothesis should be given the highest priority. However, little is known about insect availability in the past. It is noteworthy that lesser horseshoe bats have gone extinct in areas where changes in food supply have certainly be slight and could certainly not explain complete population disappearance.

•• *7. Competition against other species*

Recent investigations have suggested that some bat populations have probably dramatically increased in the past decades, presumably as a consequence of foraging upon insects attracted by street lamps. This is possibly the case of pipistrelle bats whose diet appears similar to that of lesser horseshoes. As European bat communities appear saturated (it is difficult for a new incomer to find a vacant niche space), it is difficult to imagine that one species could substantially increase in number without affecting the demography of others using convergent resources.

Comment: This hypothesis would benefit from a deeper evaluation. However, how could it explain the recent positive populations trends observed in several lesser horseshoe bat populations? The only possibility would be that white lamps particularly attractive for some bats have progressively been replaced by orange bulbs, which do not offer such favorable foraging conditions… but this seems denied by observations.

• 8. Predation, including human disturbance

Predation and human disturbance may well explain some population crashes at a local scale but certainly not similar global phenemonons as the population decline of *R. hipposideros*.

• 9. Genetic inbreeding

A lack of exchanges between colonies and populations could cause some genetic inbreeding.

Comment: Genetic bottlenecks could play some detrimental role within local populations close to extinction, but they would certainly not be able to eventually cause extinction from an initially panmictic population, which was still the situation in the 50s.

• 10. Diseases

Pathogens suddenly introduced into a population, particularly when they are of alien origin, may provoke rapid extinctions through sudden, massive mortality.

Comment: Diseases usually decimate populations quickly, whereas the decrease of *R. hipposideros* has been progressive. Moreover, pathogens tend to affect all populations similarly, but several populations have remained almost unaltered in the present case.

5. Research demands and needs

To establish priorities for research, we took into account the following constraints, either set by the framework of the mandate or by ourselves:

- The research concept should be realistic and provide a description of research topics, priorities, possible study areas and time schedule.
- Poor knowledge in some fields ranked as relevant for conservation (see above) must dictate research priorities.
- *A posteriori*, comparative research is envisageable, particularly as experimental work is mostly hardly feasible.
- Comparative analysis should take advantage of the various geographical situations available in Switzerland, and of the various demographic situations: extinct vs. extant populations of lesser horseshoes, increasing vs. decreasing colonies, etc.
- Research (retrospective) will be carried out in priority in areas where population trends have been sufficiently documented in the long-term or at colonies with best chance of augmentation of population size (prospective).
- The proposed research program includes control instruments.

6. A proposal for a conservation research program

Referring to our list of potential causes of population decline (Tab. 3), and considering the convergent views of regional bat experts and ourselves for the evaluation of the factors possibly involved, we propose the following research topics (Table 5):

- Resource exploitation, subdivided in two sections: use of space, and trophic & foraging ecology
- Contamination by pesticides
- Population dynamics
- Roost conditions
- Climate change
- Population genetics
- Colonisation potential

The research program was divided into two chronological phases (Table 5), the first one being subdivided into two priorities (Phase I.1, phase I.2, phase II). The first two topics (resources exploitation and pesticides) are the most relevant and therefore, both are included in phase I as first priority. Moreover, the development of refined monitoring methods for long-term population dynamics surveys must also be placed in phase I.1 as much work depends on accurate monitoring. Altogether, this first phase is planned over three years. Planning of the second phase has to be submitted to a reevaluation once the first phase has been completed.

Since most of the research methods involved (e.g. electronical techniques, manipulations of the animals, statistical analysis, etc.) require scientific skill in the field of bat research, most work has to be carried out by renown bat biologists. However, some projects would certainly offer opportunities for students to get familiar with field bat work.

We propose that every given project is being considered as a separate unit from an organization viewpoint, with an attributed team and supervisors. The latter have to further plan the research, coordinate the activities, and contribute to data analysis and publication.

We present now, in a telegraphic mode, more information about the research topics, planned methods and approximate time schedules.

6.1. Resource exploitation

1.1. Use of space (revealed by radiotracking) - phase I

- Habitat selection (i.e. habitat use vs. availability) in different regions
- Use of microhabitat: preferred vs. avoided vegetation structure
- Home range use in relation to landscape structure and connectivity
- Roost use and availability in relation to landscape structure and connectivity

1.2. Trophic and foraging ecology - phase I

- Diet vs. insect prey biomass availability according to habitat and region

1.3. Use of space - phase II

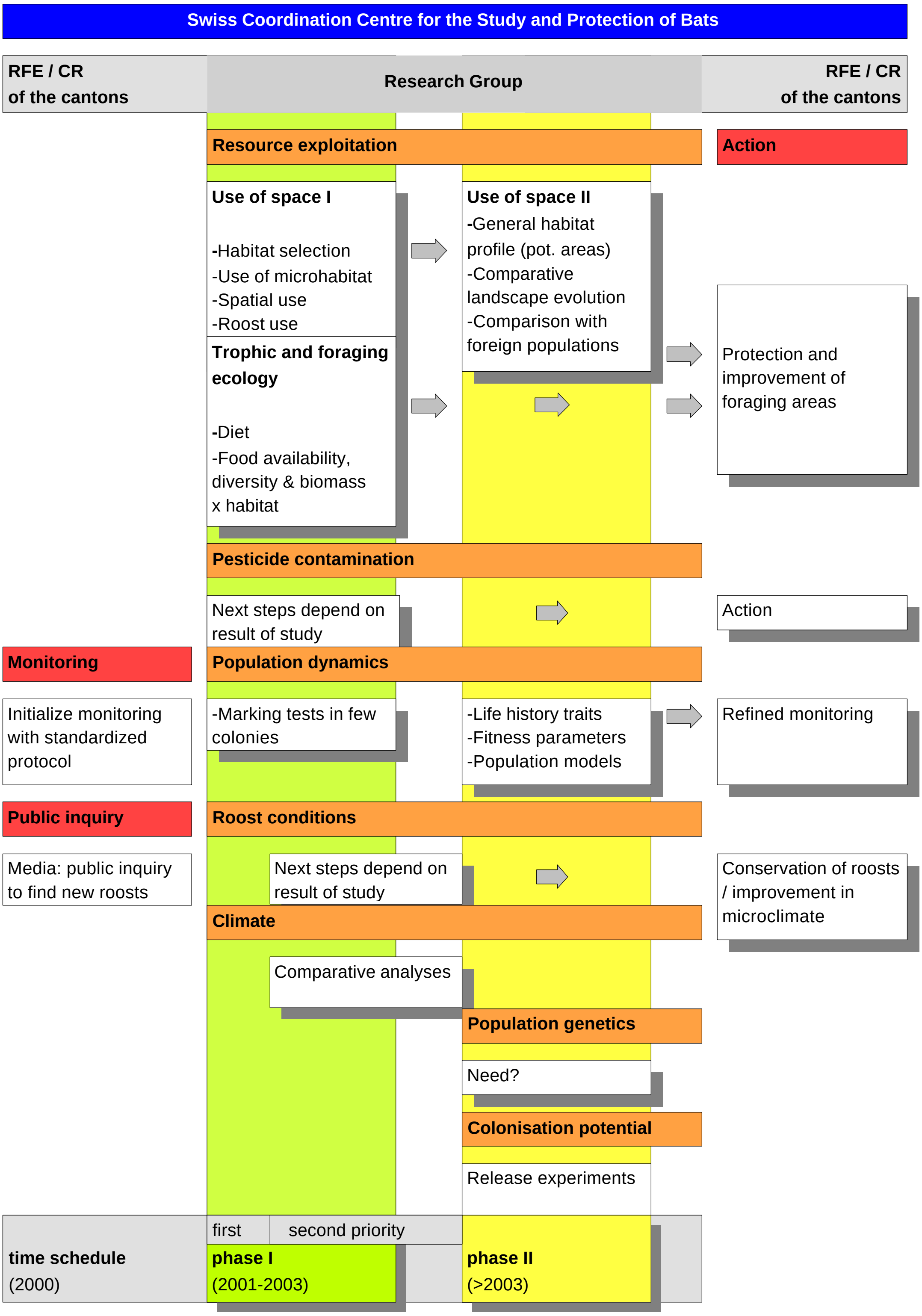
- General habitat profile and comparative landscape evolution (possibly including comparisons with foreign populations)

Description of work (phase I)

The study of resource exploitation in phase I aims at comparing different regions with various population dynamics.

As regards radiotracking, we propose to tag six lesser horseshoe bats in every of the four main populations. Data on habitat use and spatial behaviour of two animals should be collected in each spring, summer and autumn at any given location. In addition, for enlarging the spectrum of situations that will enable us to compare resource exploitation in healthy vs. remnant populations, further data from relict colonies will be collected: 1-2 animals will be radiotracked at 4-6 sites, if feasible.

Tab. 5: Overview of the proposed projects



Individual bats will be captured with mistnests outside the roosts across their traditional flight lines in order to minimize disturbance at colony roosts. We shall use the lightest and smallest radio-tags available on the market and avoid marking heavily gravid females. In any case, the surplus weight of tags should not overpass the 10% of body mass rule (Bontadina et al. 1999; a pilot study conducted on 10 lesser horseshoe bats).

In the intensively investigated regions, food availability will be assessed by insect trapping within foraging grounds of the species, using various sampling methods (light traps, sticky traps, etc.). Diet will be studied by means of fecal analysis. Selectivity of predation will be approached through a comparison of diet composition with that of insect availability.

Time schedule

Radiotracking as well as data acquisition on resource availability and diet is planned during the seasons 2001/02. Winters are devoted to data compilation and analyses.

6.2. Pesticide contamination

There is already an extensive research project on that subject at the moment. The idea is to see whether pesticide contamination correlates with the decline of lesser horseshoe bat populations. Results have been presented at the Bat Conference 1999 and are expected to be reported in due form this year. Any further project on pesticides will depend on the results of that study.

6.3. Population dynamics

3.1. Marking and methodological tests - *phase I*

- Development of refined monitoring methods enabling to estimate sex ratios, and proportions of yearlings and other age classes within populations
- Development of a safe method enabling the marking of young cohorts

3.2. Population dynamics and modelling - *phase II*

- Collection of data on life history traits and fitness parameters
- Prospective and predictive modelling of population dynamics

Description of work (phase I)

Various techniques are evaluated with the aim to minimize sampling effort (and thus colony disturbance) whilst getting reliable basic population data: maximal number of adults and youngs in a nursery roost, sex ratios, mean or median date of birth, growth of young, and, possibly, reproduction success of mothers.

A yearling cohort is ring-marked in one nursery colony, whereas a cohort is captured, but not ringed, in another colony (control). The behaviour of the young bats before and after ringing is monitored using IR video cameras at both sites, and behaviour is compared.

Time schedule

This module, one year in duration, should be started in the first year already. The results will serve to establish a standard protocol for monitoring all nursery roosts in the country.

6.4. Roost conditions

- Roost structure and microclimate
- Next possible steps depend on the results of an ongoing study

There is a running research project at the moment with the aim to compare roost climatic conditions in different attics occupied by lesser horseshoes in the Grisons. Results could be presented at the next Bat Conference in 2000. Any new project on roost conditions will depend on those results.

6.5. Overall climatic effects

- Long-term evaluation of possible climatic changes in different areas of Switzerland.

Description of work (phase I)

Various Swiss regions showing different demographic trends of *R. hipposideros* will be compared from a climatic perspective: Valais, Grisons, Berner Oberland as regards the alpine arc, but also areas of the Swiss Plateau and Jura mountains. Seasonal subgroups should be analysed, looking for statistical trends in precipitation and temperature. The extant data collected by the Swiss Meterological Institute (SMA) since 1930(50) can be used.

Time schedule

This is part of the second stage of phase I according to the ranking of research topics. Data are delivered as spreadsheets by the SMA; analysis could be performed by a student, for instance in geography, but supervision must be funded.

6.6. Population genetics

Any project on that topic has to be reconsidered once the first phase is completed.

6.7. Colonization potential / release experiments

The need for such a research as well as the methods to use have to be considered when the first phase is completed.

7. Accompagnying measures

We list here some non research activities which have to be developed in parallel and will be complementary to the research, but are actually not typical research tasks. They are usually done either by the Coordination centres or the local bat workers (RFE/CR).

7.1 Public campaign

- Nationwide public campaign to locate new horsehoe bat roosts
- Regional inquiries and/or calls complementary to the nationwide action

Description of work (phase I)

Successful public calls and inquiries in Obwalden and the Berner Oberland have shown that such actions are well worth additional effort. Horseshoe bats in particular are very suitable as an inquiry target through the mass medias as they are easily recognizable due to their unique morphology. From a simple photograph, it could be seen whether a colony effectively consists of horseshoes or of another species. We propose that our two Coordination centres (KOF & CCO) launch such a global, national public campaign in the year 2000 already. Under the supervision of the centres, the RFE/CR could take over the operations in the various regions, relaying information in the regional/local medias. Along with the call for signalling new roosts, the campaign has to inform about the degree of thread of lesser horseshoe bats and about the planned conservation project. The strategy should be discussed together with the Centres and the RFE/CR. An internet site as well as a target-group approach must be envisaged.

Time schedule

It would be advantageous to carry out the inquiry from spring 2000, so that the following research project could benefit from the results.

7.2. Monitoring program

In order to facilitate the collection of long-term data on population dynamics, the protocols for population monitoring have to be standardized under a given minimal format. The following must be considered:

- Establishment of a minimum monitoring scheme (number of bats present, number of adults vs. young, etc.)
- Focus on the future demographic evolution of nursery colonies
- As far as possible, collection of parameters relating to life history traits and fitness
- Use of this refined monitoring as a tool for control of implementation actions

Description of work

Data collection on population dynamics should start from the beginning considering all needs for long-term population surveys and modelling. We propose to establish a working group (in which RFE/CR are included) with the task to elaborate a common, standardized monitoring scheme. Also, a monitoring centre should collect the data, analyse it on a nationwide level, provide overviews and, finally, send the results back to the local responsibles. The monitoring scheme should be, as far as possible, Euro-compatible. Permanent contact and exchange with people in charge of the population dynamics project are requested so as to optimize reciprocal improvments of the methods and survey efficiency.

Time schedule

A minimum monitoring scheme should be co-ordinated from the very beginning of the whole project. Fine surveys are expected to be performed every second year.

8. Action plan

The action plan itself consists of the implementation of all conservation recommendations drawn from the research results. The implementation of the action plan is firstly the job of the RFE/CR, but, according to conservation needs, it may require further fundings and the engagement of additional personal. Appropriate implementation may also require some clarification of the legal basis for the conservation measures proposed.

Description of work (phase I)

As soon as available conclusions from research may be put into application.

Time schedule

During the progress of research, it can be decided at any time if exemplary management measures must be immediately put into application to save time.

9. Sources and references

9.1. Sources

Database from Réseau Chauves-souris Valais, December 1999

CCO database, December 1999

KOF database, June 1997

NISC – Wildlife Worldwide, Mars 1997

Database from Guido Reiter, Austria, August 1998

Database from Fabio Bontadina, December 1999

9.2. Literature list

The following web site provides a list of all references consulted during the preparation of this report and further references on lesser horseshoe bats:
http://www.dplanet.ch/users/fabio.bontadina/112/lit.html.
A tab-delimited version for download is also available there.

10. Acknowledgements

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Fabio Bontadina and Dr Raphaël Arlettaz, 18 January 2000