

# **Ecology and Conservation of Bats in Villages and Towns**

Results of the scientific part of the testing & development project  
"Creating a network of roost sites for bat species  
inhabiting human settlements"

Matthias Simon, Sandra Hüttenbügel  
and Janna Smit-Viergutz  
in collaboration with Peter Boye

# Contents

<b>1</b>	<b>Introduction</b> .....	11
<b>2</b>	<b>Area of Investigation</b> .....	13
2.1	<b>Landform of the Marburg-Biedenkopf district</b> .....	14
2.2	<b>Climate</b> .....	15
2.3	<b>Landuse</b> .....	15
<b>3</b>	<b>Methods – aims, description and evaluation</b> .....	16
3.1	<b>Introduction</b> .....	16
3.1.1	Acoustic detection .....	16
3.1.2	Emergence observation .....	18
3.1.3	Capture and banding of bats .....	18
3.1.4	Data compilation of captured bats .....	22
3.1.5	Radio-tracking .....	23
3.1.6	Nocturnal observations of behaviour at the roost .....	25
3.1.7	Use of chemiluminescent light sticks .....	26
3.1.8	Automatic roost surveillance .....	27
3.1.9	Temperature measurement in roosts .....	28
3.1.10	Genetic Investigations of bats .....	29
3.1.11	Use of Geographical Information Systems (GIS) to analyse the habitat of different bat species .....	29
3.2	<b>Balancing of expense of the recording methods</b> .....	30
<b>4</b>	<b>State of the registration of bat population numbers before and after the project</b> .....	34
4.1	<b>Common pipistrelle (<i>Pipistrellus pipistrellus</i> [Schreber, 1774]) – 45 kHz-type</b> .....	37
4.1.1	Distribution and abundance within the project area .....	37
4.1.2	Regional and national distribution and abundance .....	44
4.2	<b>Serotine bat (<i>Eptesicus serotinus</i> [Schreber, 1774])</b> .....	44
4.2.1	Distribution and abundance within the project area .....	44
4.2.2	Regional and national distribution and abundance .....	46
4.3	<b>The greater mouse eared bat (<i>Myotis myotis</i> [Borkhausen, 1797])</b> ...	47
4.3.1	Distribution and abundance within the project area .....	47
4.3.2	Regional and national distribution and abundance .....	48
4.4	<b>Natterer's bat (<i>Myotis nattereri</i> [Kuhl, 1817])</b> .....	49
4.4.1	Distribution and abundance within the project area .....	49
4.4.2	Regional and national distribution and abundance .....	51
4.5	<b>Whiskered bat (<i>Myotis mystacinus</i> [Kuhl, 1817])</b> .....	52
4.5.1	Distribution and abundance within the project area .....	52
4.5.2	Regional and national distribution and abundance .....	53
4.6	<b>Common long-eared bat (<i>Plecotus auritus</i> [Linnaeus, 1758])</b> .....	53
4.6.1	Distribution and abundance within the project area .....	53
4.6.2	Regional and national distribution and abundance .....	54
4.7	<b>Grey long-eared bat (<i>Plecotus austriacus</i> [J.B. Fischer, 1829])</b> .....	54
4.7.1	Distribution and abundance within the project area .....	54

4.7.2	Regional and national distribution and abundance	56
<b>4.8</b>	<b>Barbastelle bat (<i>Barbastella barbastellus</i> [Schreber, 1774])</b>	56
4.8.1	Distribution and abundance within the project area	56
4.8.2	Regional and national distribution and abundance	56
<b>4.9</b>	<b>Conservation status of investigated bat species according to Red Lists</b>	57
<b>4.10</b>	<b>Summary</b>	59
<b>5</b>	<b>Requirements of summer roosts for bats</b>	63
<b>5.1</b>	<b>Introduction</b>	63
<b>5.2</b>	<b>Roost types and categories</b>	63
5.2.1	Common pipistrelle	64
5.2.2	Serotine bat	71
5.2.3	Greater mouse-eared bat	73
5.2.4	Natterer's bat	75
5.2.5	Whiskered bat	78
5.2.6	Common long-eared bat	81
5.2.7	Grey long-eared bat	83
5.2.8	Barbastelle bat	84
<b>5.3</b>	<b>Exposition</b>	86
<b>5.4</b>	<b>Roost openings</b>	88
<b>5.5</b>	<b>Location of roosts in town</b>	90
<b>5.6</b>	<b>Age of buildings</b>	92
<b>5.7</b>	<b>Upkeep condition of the buildings</b>	93
<b>5.8</b>	<b>Height of buildings</b>	94
<b>5.9</b>	<b>Material of landing area</b>	94
<b>5.10</b>	<b>Roost temperatures</b>	94
5.10.1	Hollow spaces in the facade and behind facade siding	95
5.10.2	Intermediate roof	101
5.10.3	Hollow space in a breezeblock ceiling of a cowshed	103
5.10.4	Gap between two walls made of hollow concrete blocks	103
5.10.5	Attic	104
<b>5.11</b>	<b>What are the features of a potential roost?</b>	108
<b>5.12</b>	<b>Summary</b>	108
<b>6</b>	<b>How do bats explore their roosts?</b>	111
<b>6.1</b>	<b>Introduction</b>	111
<b>6.2</b>	<b>Swarming of the common pipistrelle at the hibernaculum</b>	111
6.2.1	Investigated hibernacula	112
6.2.2	Seasonal phenology	112
6.2.3	Swarming behaviour at and in the hibernaculum	119
<b>6.3</b>	<b>Spatiofunctional correlation between hibernaculum and summer roost (radio-tracking)</b>	120
<b>6.4</b>	<b>Experiments in and at the hibernaculum concerning the roost locating ability of the common pipistrelle</b>	124
<b>6.5</b>	<b>Invasions</b>	127
6.5.1	Seasonal phenology	127
6.5.2	Nocturnal phenology	131
6.5.3	Invasion sites are in hibernaculum towns and villages	131

6.5.4	Experiments concerning the roost locating ability of common pipistrelles at an invasion site – how do invasions happen? . . . . .	132
<b>6.6</b>	<b>Swarming at the summer roost</b> . . . . .	139
6.6.1	Nocturnal activity of the common pipistrelle at occupied maternity roosts . . . . .	139
6.6.2	Nocturnal activity of the common pipistrelle at unoccupied maternity roosts . . . . .	139
6.6.3	Nocturnal activity of the serotine bat at a roost complex . . . . .	144
<b>6.7</b>	<b>Summary</b> . . . . .	145
<b>7</b>	<b>Spatiofunctional relationships</b> . . . . .	148
<b>7.1</b>	<b>Introduction</b> . . . . .	148
<b>7.2</b>	<b>Summer roost assemblage (level 1)</b> . . . . .	148
7.2.1	Common pipistrelle . . . . .	149
7.2.1.1	Spatial examination of the roost assemblage . . . . .	149
7.2.1.2	Temporal examination of roost switching behaviour . . . . .	154
7.2.1.3	The chronological process of roost switching . . . . .	157
7.2.1.4	Frequency of roost switching by adult, subadult and juvenile bats in one year . . . . .	157
7.2.2	Serotine bat . . . . .	159
7.2.2.1	Spatial examination of the roost assemblage . . . . .	160
7.2.2.2	Temporal examination of roost switching . . . . .	164
7.2.3	Greater mouse-eared bat . . . . .	165
7.2.4	Whiskered bat . . . . .	168
7.2.5	Natterer's bat . . . . .	168
7.2.6	Barbastelle bat . . . . .	168
7.2.7	Grey long-eared bat . . . . .	170
<b>7.3</b>	<b>Utilisation of foraging sites (level 2)</b> . . . . .	170
7.3.1	Common pipistrelle . . . . .	171
7.3.2	Serotine bat . . . . .	172
7.3.3	Greater mouse-eared bat . . . . .	173
7.3.4	Whiskered bat . . . . .	175
7.3.5	Natterer's bat . . . . .	176
7.3.6	Barbastelle bat . . . . .	176
7.3.7	Grey long-eared bat . . . . .	177
<b>7.4</b>	<b>The summer move to another roost (level 3)</b> . . . . .	177
7.4.1	Common pipistrelle . . . . .	177
7.4.2	Serotine Bat . . . . .	178
7.4.3	Greater mouse-eared bat . . . . .	180
<b>7.5</b>	<b>Spatial relationship between summer roost and hibernaculum (level 4)</b> . . . . .	182
7.5.1	Common pipistrelle . . . . .	182
7.5.2	Greater Mouse-eared bat . . . . .	183
<b>7.6</b>	<b>Consequences for conservation</b> . . . . .	185
<b>7.7</b>	<b>Summary</b> . . . . .	189
<b>8</b>	<b>Population genetics</b> . . . . .	195
<b>8.1</b>	<b>Introduction</b> . . . . .	195
<b>8.2</b>	<b>Basics of population genetics</b> . . . . .	196

8.2.1	Mitochondrial DNA	196
8.2.2	Genetic drift and gene flow	196
<b>8.3</b>	<b>Materials and methods</b>	197
<b>8.4</b>	<b>Results</b>	198
8.4.1	Serotine bat	198
8.4.2	Common pipistrelle	200
<b>8.5</b>	<b>Discussion</b>	203
<b>8.6</b>	<b>Summary</b>	206
<b>9</b>	<b>Roost destruction</b>	207
9.1	Introduction	207
9.2	Roost destruction in the project area	207
9.3	Summary	210
<b>10</b>	<b>How successful is the creation of new roosting opportunities?</b>	211
10.1	Introduction	211
10.2	Description of roost offer	211
10.2.1	Schedule of establishment of roost offers: at which point of time were potential roosts habitable for bats?	211
10.2.2	Differentiation between new creation, optimisation, preservation, and replacement of roosts	211
10.2.3	Roost types	213
10.2.3.1	Gable panneling inside with access from outside (category II)	214
10.2.3.2	Crevice roost under roofing with access from outside (category II)	215
10.2.3.3	Bat roosting board, single- and double-walled (category I)	215
10.2.3.4	Crevice roost behind ridge beam (category I)	217
10.2.3.5	Crevice roost behind slate facade (category I)	218
10.2.3.6	Crevice roosts in attics (category III)	219
10.2.3.7	Dormer window with bat fly-in entrance (category IV)	221
10.2.3.8	Ventilation dormer window out of zinc sheet (category IV)	222
10.2.3.9	Wooden shutter in gable window with fly-in crevice (category IV)	223
10.2.4	Spatial distribution	223
<b>10.3</b>	<b>Control to determine success of newly created potential roosts</b>	224
10.3.1	Usage rate of newly created potential roosts	224
10.3.2	Which bat species use the newly created potential roosts?	225
10.3.3	Temporal perspective of the process of reconnoitring or inhabiting roosts – How fast are potential roosts discovered or inhabited?	227
10.3.4	Which type of newly created potential roost finds most acceptance?	228
10.3.4.1	Interior panelling with outside access	228
10.3.4.2	Crevice roosts under roofing with outside access	230
10.3.4.3	Crevice roosts in attics	230
<b>10.4</b>	<b>Final evaluation of newly created and optimised potential roosts</b>	230
<b>10.5</b>	<b>Summary</b>	231
<b>11</b>	<b>Landscape features and distribution</b>	233
11.1	Introduction	233
11.2	Correlation between occurrence of particular bat species and specific landscape features	233

11.2.1	Common pipistrelle	233
11.2.3	Serotine bat	234
11.2.2	Natterer's bat	235
11.2.4	Barbastelle bat	236
<b>11.3</b>	<b>Flight routes of different bat species</b>	<b>238</b>
<b>11.4</b>	<b>Summary</b>	<b>241</b>
<b>12</b>	<b>Synopsis</b>	<b>243</b>
12.1	Project goals and hypotheses	243
12.2	Evaluation of danger to bats	243
12.3	Conservation of bats in areas where they have settled	246
12.4	Improvement of database for bat conservation	247
12.5	Demands on federal, state and local government	248
<b>13</b>	<b>Acknowledgements</b>	<b>250</b>
<b>14</b>	<b>References</b>	<b>251</b>