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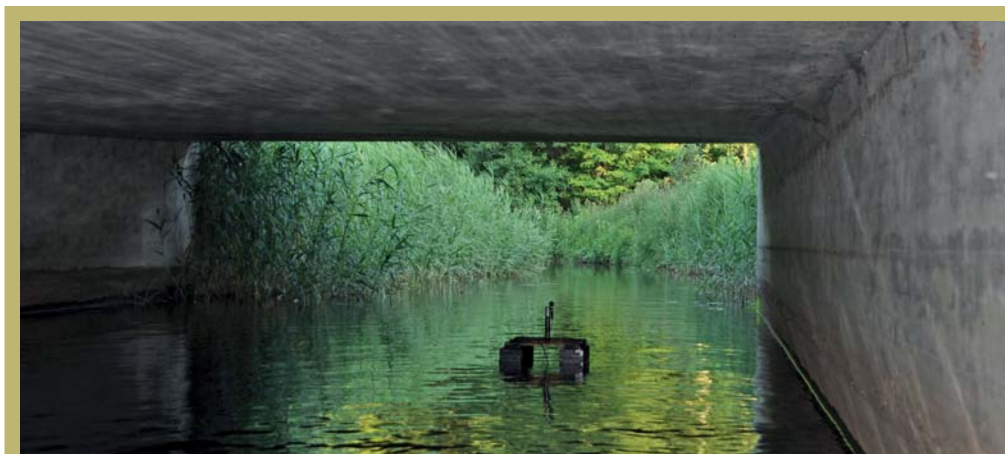
Over or under the road?

Effectiveness of bat road crossing mitigation measures

Roads may have detrimental effects on bat populations. At road severances of bat commuting routes, e.g. hedgerows, forest edges and river crossings, mitigation structures are sometimes constructed to reduce the mortality risk. Bat species have different flight characteristics. Consequently, the effectiveness of mitigation structures may differ between species. Clutter-adapted and moderately structure-bound species are most at risk when crossing roads, as these species tend to decrease their flight height when crossing open gaps.

To explore the effectiveness of two types of road mitigation measures for bats we studied 1/ two existing underpasses for rivers and 2/ four experiential hop-overs plus a control site. The two studies focused on two moderately structure-bound species, *Myotis daubentonii* and *Pipistrellus pygmaeus*, but other species were recorded as well. These two species are common in most of Europe, and due to their flight behaviour experiences a high collision risk when crossing roads. More than 2500 bat passes were analysed at seven sites.

Study 1 – Effectiveness of Underpasses



Methods

- 2 sites (Sakskøbing and Maribo) at river crossings under a old motorway built on a low embankment.
- 10 survey nights (27 June to 28 September 2013).
- 5 synchronised microphones per site placed through the culverts to record flight path.
- Bat passes over the road above the underpasses were recorded as control.
- Additional visual observation.

Tab. 1. Dimensions of the two culverts.

	Sakskøbing	Maribo
Width	7.2 m	5.6 m
Height	1.4 m	2.4 m
Length	24 m	30 m
Index (W*H)/L	0.42	0.45

Results

- *M. daubentonii* commuting and foraging on the rivers made extensive use of the culverts to cross under the motorway, but a relatively large percentage turned back at the low culvert.
- All other bat species crossed over the motorway, if they crossed the motorway. For most of these species the motorway was a barrier and they abandoned their attempt to cross the motorway.
- Roads on embankments are particularly dangerous to other bat less clutter-adapted species, if bats maintain their flight height on leaving the treelines and hedgerows.

Tab. 2. Percentage of bats that crossed over or safely under the motorway through the culverts, or abandoning the attempt to cross the road transect.

	Barbastalla barbastellus	*Eptesicus serotinus*	*Nyctalus noctula*	*Pipistrellus nathusii*	*Pipistrellus pygmaeus*	*Myotis daubentonii*	All species
Sakskøbing	(N= 19)	(N= 29)	(N= 99)	(N= 37)	(N= 537)	(N= 474)	
Over the road	47.4 %	20.7 %	44.4 %	27.0 %	39.5 %	3.2 %	**38.7 %**
Via underpass	0 %	0 %	0 %	0 %	0.2 %	71.7 %	**0.1 %**
Turned back	52.6 %	79.3 %	55.6 %	73.0 %	60.3 %	25.1 %	**61.1 %**
Maribo	(N= 4)	(N= 8)	(N= 127)	(N= 47)	(N= 316)	(N= 815)	
Over the road	0 %	37.5 %	59.1 %	48.9 %	35.8 %	0.5 %	**42.5 %**
Via underpass	0 %	0 %	0 %	0 %	7.9 %	96.9 %	**5.4 %**
Turned back	100 %	62.5 %	40.9 %	51.1 %	56.3 %	2.6 %	**52.2 %**

Conclusion – Underpass

- Underpasses were only effective for *M. daubentonii*.
- The height of the underpass is important for the effectiveness, even for *M. daubentonii* at rivers.
- The motorway was a barrier for a large percentage for most other bats.

Roadkilled *Eptesicus serotinus*

Study 2 – Effectiveness of Hop-over sections

Methods

- 4 experimental sites and 1 control site at natural gaps in commuting routes.
- 5-7 survey nights per site (10 June to 3 September 2015). 2 nights before, 1st night with and 2-4 nights at weekly intervals after the screens were installed.
- 5 surveys at the control site (8 July to 17 September).
- 2-4 synchronised microphones at different heights at the hop-over to assess flight height.
- Visual observation and 4K night-vision video.

Results

- The percentage of *M. daubentonii* that crossed the hop-over site at heights above 4 m increased from 31 % to 76 % (X^2=109, P<0.001), but variation between sites was high (Fig. 1). No change in flight heights was observed at the control sites.
- At site D, the proportion of *P. pygmeaus* that crossed the hop-over gaps at heights above 4 m increased from 39 % to 61 % (X^2=7.1, P<0.01) after installation of the screens, while no change was observed for *B. barbastellus* (before 87 %, after 89 %).
- *M. daubentonii* habituated quickly to the screens, and the screens did not present a barrier.
- 67 % of *P. pygmeaus* flew around the screens to cross the imaginary road at heights, where they would be at high risk for vehicle collisions.

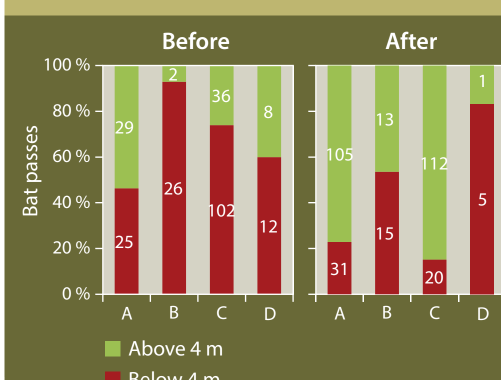


Fig. 1. *M. daubentonii* crossing height before and after establishment of the hop-over screens based on recordings from synchronised microphones. Numbers indicate recorded bat passes.

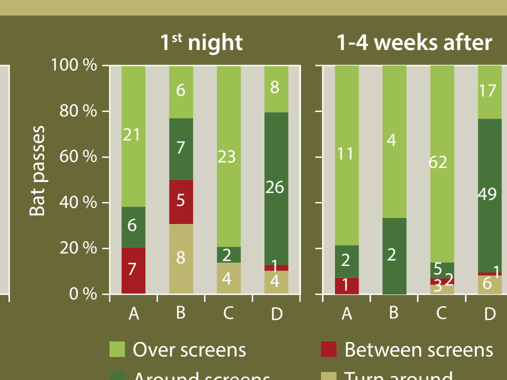


Fig. 2. Behaviour of *M. daubentonii* (site A, B and C) and *P. pygmeaus* (site D) on the 1st night with screens and 1-4 weeks later based on visual observations and night vision video. Numbers indicate recorded bat passes or attempts.

Conclusion – Hop-over

- Hop-overs with screens showed a potential for reducing bat-vehicle collision risk, and did not appear to represent a major barrier.
- However, hop-overs cannot be generally recommended, as their effectiveness is too low at some site.
- Hop-overs may not reduce collision risk notably for *P. pygmeaus* but just move the collision site to the end of the screens or dense vegetation.

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