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Infrared video-monitoring of mammals at a fauna underpass

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Fauna passages have been built to provide safe crossover sites for wildlife. Some authors have examined wildlife use of different kinds of passages (Olbrich 1984; Madsen 1996; Foster and Humphrey 1995; Broekhuizen and Derckx 1996; Rodriguez et al. 1996, 1997), but few have directly observed the behaviour of animals entering or leaving fauna passages. The only species observed at fauna passages, to our knowledge, are the North American mule deer (*Odocoileus hemionus*; Reed 1981; Reed et al. 1975; Ward 1982) and mountain goat (*Oreamnus americanus*; Singer 1978; Pedevillano and Wright 1987).

In our study the entrance of a 155 m long underpass was surveilled. The entrance of the underpass is shaped like a half circle, and is 13 m wide and 7.5 m high. The underpass is placed under highway E45 between Aarhus and Randers in Jutland, Denmark. On this site an 18 m high dam is built across a 500 m wide valley, and a small stream runs through the valley, traversing the dam in the middle of the underpass. On each side of the stream is a 4–4.5 m wide dry bank.

Along the highway is a 1.75 m high fence on each side. The length of each of the fences is approximately 2 km, in both directions 1 km from the underpass.

The equipment used in surveillance included two infrared lamps, a light-sensitive camera, with zoom optic, and pan/tilt head, which were placed at a distance of 50 m from the entrance of the underpass. It was connected to a monitor, video cassette recorder, and remote control, which was placed in a vehicle a further 100 m away, uphill, behind a group of trees. Power was supplied by a generator.

The underpass was surveilled for two periods each lasting 30 days; April 10 to May 11, 1997 and August 4 to September 3, 1997. During the 60 nights the underpass was surveilled for 495 hours.

During surveillance the camera was pointed towards the entrance of the underpass so that mammals leaving or entering could be seen and visually followed. All observations of mammals were recorded on video tape for further analysis.

Besides the infrared video surveillance, tracks of mammals were registered in sand layers at both ends of the underpass on each side of the stream. Every morning the sand layers were investigated for tracks and then prepared for new tracks by raking. Criteria described by Bang and Dahlstrøm (1989) were used for identifcation of tracks.

During the two periods of surveillance a total of 122 red foxes (*Vulpes vulpes*), 16 badgers (*Meles meles*), 18 stone martens (*Martes foina*) and 20 roe deers (*Capreolus capreolus*) was observed passing through the underpass. The total number of mammals passing through was higher in April–May than in August–September (Tab. 1).

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Table 1. Observed mammals passing through the underpass, compared to the number of tracks in the sand layers in the same periods. The percentage of observed mammals of the total number of mammals that passed through the underpass is shown in the right column.

	April–May			August–September		
	Observed	Tracks	Percent	Observed	Tracks	Percent
Red fox	74	100	74	48	61	79
Badger	0	0	–	16	22	73
Stone marten	11	31	35	7	10	70
Roe deer	11	25	44	9	16	56
Total	96	156	62	80	109	73

The number of individual carnivores using the underpass was estimated, based on fur and behaviour, to be at least three different foxes, three different badgers, and only one or possibly two different stone martens. When individuals of the three species of carnivores entered or left the underpass they seldomly changed behaviour or velocity. When changes did occur it was almost always in accordance with territorial marking behaviour or smelling of markings from other animals. Foxes were observed marking at the entrance of the underpass 13 times (of 122 passages), badgers four times (of 16 passages) and stone martens six times (of 18 passages). When carnivores passed through the underpass there were no specific distances to the stream or to the wall of the underpass.

It was possible to observe the mammals the first 50 m in the underpass. The velocity of the foxes at the outmost 50 m of the underpass in April–May (mean velocity = 2.6 m/sec., N = 17) was significantly higher than in August–September (mean velocity = 1.4 m/s, N = 22; Mann-Whitney test, U = 327, critical value = 246, $p < 0.05$). Because of insufficient observations it was not possible to compare the velocities of badger and stone marten.

Only one male roe deer identified by its antlers was observed passing through the underpass. In many cases the roe deer travelled along the same path from the underpass to a forest 80 m away. So it was possible to measure the velocity of the roe deer in the underpass (the first 50 m) and outside the underpass. The roe deer travelled at significantly higher velocity in the underpass (mean velocity = 2.1 m/s, N = 9) than outside (mean velocity = 1.2 m/s, N = 10; Mann-Whitney test, U = 78.5, critical value = 66, $p < 0.05$). In the underpass, the roe deer always kept a distance of about 3.5 m to the wall and 0.5 m to the stream. At the entrance, the roe deer often changed its manner of walking. It often stopped, looked around or lowered the head. In the underpass, the roe deer seldomly changed the manner of walking. In April–May, the roe deer often galloped into or out of the underpass. This did not happen in August–September.

Apart from the single roe deer that used the underpass, five adult roe deer (3 males and 2 females) and three roe deer kids were observed in the area. Only one female roe deer with one kid was observed close to the entrance of the underpass. This occurred three times, but the two individuals only looked into the underpass without entering it.

At least three brown hares (*Lepus europaeus*) were observed in the area. Brown hares were only observed entering the underpass twice, and in both cases the brown hares showed reluctant behaviour, turned around, and ran out very rapidly.

Carnivores (except small mustelids) use different kinds of fauna passages usually without difficulties (Broekhuizen and Derckx 1996; Bekker et al. 1995). Therefore, no change in behaviour could be expected at the underpass for species such as fox, badger, and stone marten. The observed individuals of these three species did not seem to be influenced by the underpass. When the animals came close to the underpass, they went through with very few exceptions. These few exceptions could in most cases be explained

by the presence of other mammals or perhapes as a reaction to the infrared light. The reason that the foxes moved faster in the underpass in April–May than in August–September is possibly a result of the breeding season.

Apparently the roe deer habituated to the underpass during summer. Galloping through the underpass was only observed in April–May. The reason is probably that the roe deer used the underpass all summer in connection with territorial defence, and so it is likely that the roe deer habituated to the underpass.

According to Olbrich (1984) the openness has to be approximately 0.75 before roe deer are willing to use an underpass. The studied underpass had an opening of 0.5 and thus it appears that the underpass is too narrow for roe deer. This might explain why only one roe deer used the underpass.

The studied underpass was of sufficient size for fox, badger, and stone marten. Based on our results, underpasses have to be very large, and with an opening of 0.5–0.75 before roe deer in general will use them. If all species are to be catered for, it will be necessary to build larger underpasses or other types of passages.

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