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# Video Surveillance of Rat (*Rattus norvegicus*) Movement and Activity in Agricultural Landscape in United Kingdom

*Pengawasan Video Terhadap Pergerakan dan Aktiviti Tikus (Rattus norvegicus) Dalam Langksap Pertanian di United Kingdom*

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## Abstract

Rats' activity level was monitored for 57 days continuously using a monochrome video camera with wide angle lens sensitive to infra red light. A time-lapse video cassette recorder was connected to the video camera and set at a recording resolution of 2 frames per second. Video monitoring of a single trap system provided evidence that rats are active during both day and night. Early dusk and midnight was the peak of diel activity. A comparison of the rate activity based on number of rat sightings per hour, showed there was no significant difference among time periods (ANOVA, $F_{3,164} = 2.20$, $p = 0.09$). The level of activity was relatively low in this study with an average of 5 sightings per day. Their direction of movement was not consistent and trapping appeared not to change rat behaviour.

**Keywords** Rat's activity, video surveillance, movement direction, trap

## Abstract

Selama 57 hari berturut-turut, aktiviti tikus telah dipantau dengan menggunakan video kamera monokrom berlensa sudut lebar (wide angle). Perakam video kaset sela-masa telah disambung kepada video kamera dengan resolusi rakaman sebanyak 2 'frame' sesaat. Melalui pemantauan ini menunjukkan tikus adalah aktif pada kedua-dua waktu iaitu siang dan malam. Kemuncak aktiviti harian tikus berlaku pada waktu senja dan awal tengah malam. Perbandingan kadar aktiviti tikus berbanding bilangan tikus yang dicerap per jam mendapati tiada perbezaan yang signifikan antara tempoh masa yang dicerap (ANOVA, $F_{3,164} = 2.20$, $p = 0.09$). Secara relatifnya tahap aktiviti tikus adalah rendah dalam kajian ini iaitu secara puratanya sebanyak lima ekor haiwan dicerap setiap hari. Arah pergerakkan mereka juga adalahtidak konsisten dan aktiviti pemasangan perangkap didapati tidak mempengaruhi perlakuan tikus dari segi pergerakkannya.

**Kata Kunci** Aktiviti tikus, pengawasan video, arah gerakan, perangkap

## Introduction

Little is known about the behaviour and ecology of free-ranging brown rats (*Rattus norvegicus*). In the laboratory, many studies have been conducted on laboratory rat strains but it is clear that there are significant differences between wild and laboratory rats (Hart, 1973; Klemann & Pelz, 2005). Therefore, any conclusions about wild rat behaviour and their ecology cannot be derived solely from studies of laboratory rats. Like other animals, rat population dynamics are likely to be influenced by the local environmental conditions (availability of food, refuges and seasonal variations in these), the rate of predation, the extent of inter-specific and intra-specific competition for food and refuges, the birth rate and rates of immigration and emigration.

The Brown rat is associated with farm buildings in rural areas. A survey conducted by Langton *et al*. (2001) estimated that 3.8% of farms had a problem with rat infestations that occurred inside farm buildings, while 38.3% had infestations that were outside. Rat infestations are a particularly serious problem when there is careless management of the farm environment; abundant food, rubbish and debris that provides shelter from predators.

There is poorly understood the extent to which rats move from one farm to another or from fields into farm. Such movements might have a significant impact on population dynamics by linking local populations to a larger-scale metapopulation structure (Smith, 1999). One suggestion has been that rats rely on landscape features for movement, particularly hedgerows, which thereby act as corridors for movement. In order to take a metapopulation approach to rat population management it is important to understand and to obtain a greater understanding about their ecology and behaviour, particularly movements among populations. These data could then contribute to more ecologically based rat management systems.

In this study, video monitoring was used to identify movement and activity levels. The use of video monitoring equipment may be a valuable tool to understand the behaviour of rats; observations can be run continuously, day and night, and in all weather conditions. A video monitoring system was used to observe rat daily activity near a trap system on a farm site. The trap system used was based on the concept of the Trap Barrier System (TBS), developed

**Photo 1** Example of trap system built in a gap along a hedgerow.

in Indonesia by Singleton *et al.* (1998). In a modification of the TBS system, an "attractive" refuge was constructed along a hedgerow using locally available materials to funnel rats into a covered trapping area where their activity can be monitored or they can be trapped (Photo 1).

The TS were constructed from four straw bales. Each straw bale was approximately 1.5m long and 0.75m high and 0.3m wide. Wire netting was fitted along both side of the bales and served as a funnel at both ends for channelling rats through the trap. Wire netting was fitted to a pole at both ends, adjacent to the hedge. The tunnel was covered with plastic sheeting to ensure it remained dry. Wire mesh ('weld mesh') was fitted at both entrances with 5cm gaps to prevent access from larger non-target animals. The TS was sited between grazing land and fields of wheat.

## Video monitoring of rat activity

The study was conducted at Loddington, Leicestershire, a mixed arable, dairy and sheep farm. The site chosen for video monitoring showed a high level of rat activity and was close to a power source. Numerous rat runs were evident linking surrounding hedgerows to the farm yard and along a ditch. Existing rat trails were used as criteria for setting the video camera because rats often follow the trails deposited used by other rats (Galef & Buckley, 1996).

The video camera was sited to enable a record of the direction that rats moved around the trap system. The camera was a monochrome video camera (Model: NCL 1100 "Ultimate" low light, 0.02 lux) with wide angle lens sensitive to infra red light. A time-lapse video cassette recorder (Model: Hitachi 480 Lr VTL 2000E) was connected to the video camera and set at a recording resolution of 2 frames per second, giving 96 hours of continuous recording time from a 4-hour video cassette. A weatherproof infra red floodlight lamp was used to illuminate the area with 'black' light allowing observation of rat activity during darkness. The lamp was controlled by a photocell, which turned the light off and on automatically at dawn and dusk.

Video monitoring was carried out continuously for 57 days, representing 1,368 hours of recording time. The direction of rat movement was recorded from video recordings, along with the time and date and weather conditions observed via the camera. The direction of rat movements was scored in a series of seven categories (Table 1). During 57 days of observation, rat trapping was carried out on 21 randomly selected days using a Fenn trap. Any rats caught were removed from the tunnel on the following morning. A comparison of rat activity during periods of trapping and non-trapping was made.

**Table 1** The direction taken by rats as determined through video observation.

| Direction | Description |
|---|---|
| D1 | The rat moved out from the trap system and went to the right toward the farm yard. |
| D2 | The rat moved out from the trap system and went to the left toward the ditch |
| D3 | The rat moved into the trap system from the right. |
| D4 | The rat moved into the trap system from the left. |
| D5 | The rat moved from the right to the left without entering the trap system. |
| D6 | The rat moved from the right to the left without entering the trap system. |
| D7 | Other than D1 – D6 above. |

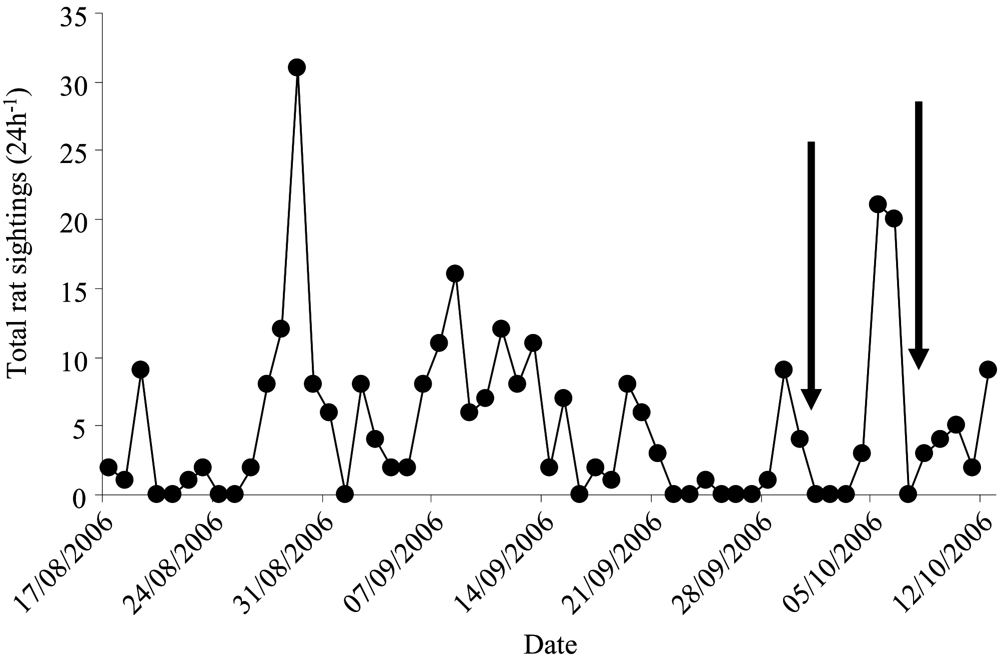


**Figure 1** The total number of rats that can be spotted through screen monitor in observation area. Arrows indicate the day that a cat was spotted.

## Results

### Video monitoring of rat activity

Overall rat activity was relatively low. The total number of rats sighted each day using continuous surveillance ranged from 0 to 31 with a mean (sem) of 5.1 (0.81) sightings per day (Figure 1). There was no significance difference (ANOVA, $F_{2,54} = 0.14$, $p = 0.865$) in rat level of activity in August, September and October.

Weather conditions did not have a significant impact on rat activity. A comparison between still and windy conditions showed no significant difference in the number of rat sightings (ANOVA, $F_{1,61} = 0.01$, $p = 0.909$).

Total rat activity varied significantly at different times of the day (ANOVA, $F_{3,164} = 11.32$, $p = 0.01$). Rat activity was greater during daylight (between one hour after sunrise and one hour before sunset) and night (between one hour after sunset and one hour before sunrise) compared with dusk (between one hour before sunset and one hour after sunset) and dawn (between one hour before sunrise and one hour after sunrise) (Figure 2). However, a comparison of the rate of rat activity based on number of rat sightings per hour (rate), showed there was no significant difference among time periods (ANOVA, $F_{3,164} = 2.20$, $p = 0.09$) (Figure 3).

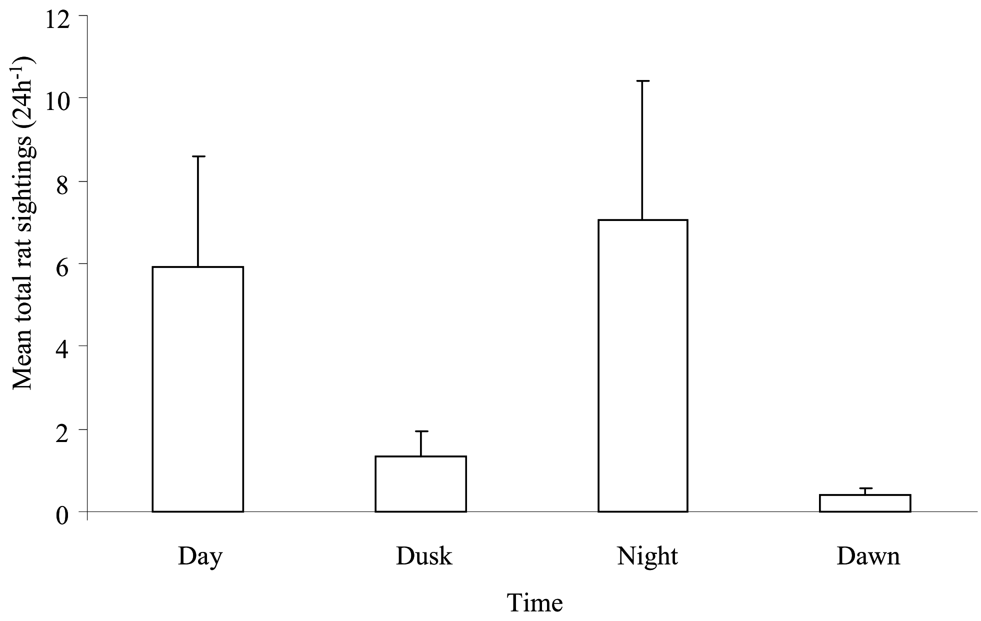


**Figure 2** Mean total rats sightings. Error bars are 1 sem.

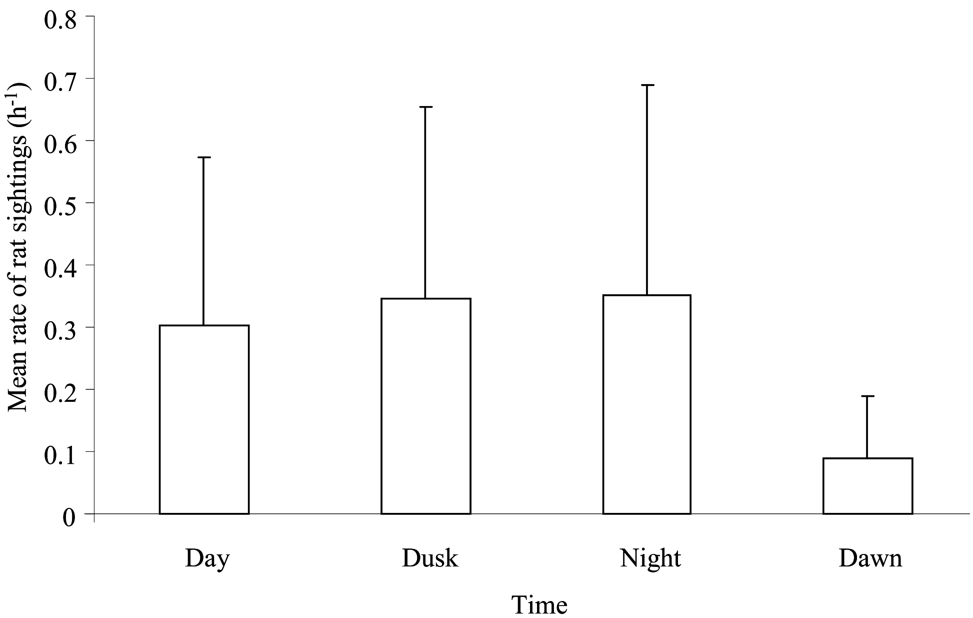


**Figure 3** Mean rate of rat sightings. Error bars are 1 sem.

The level of rat activity varied temporally (ANOVA, $F_{23,984} = 2.31$, $p$ <0.001; Figure 4). There were two peaks of diel activity. One was around midnight and another at early dusk. The lowest activity level was recorded at dawn.

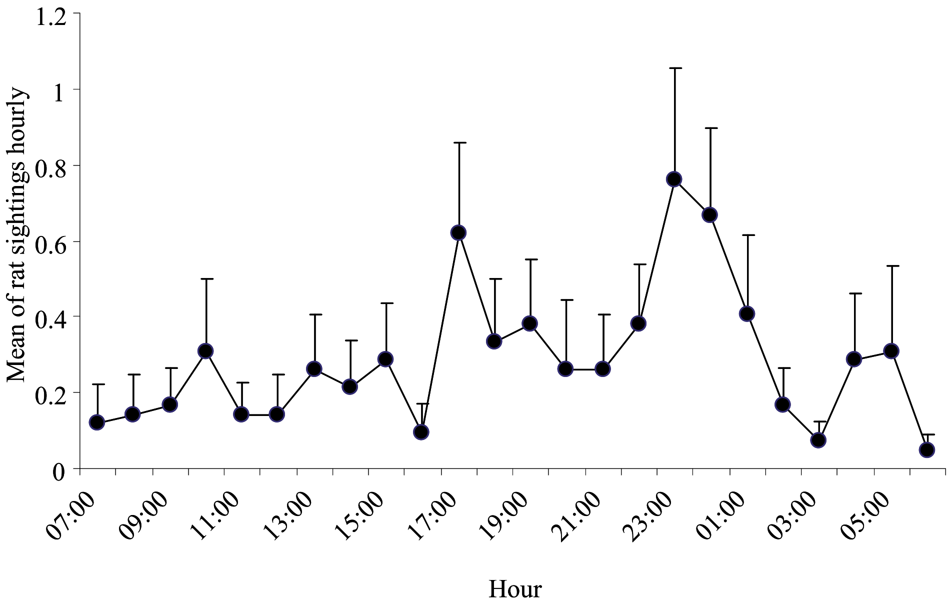


**Figure 4**Temporal variation in rat activity. Error bars are 1 sem.

The direction of movement of rats based on video observations showed no significant difference among direction categories (D1 to D6) (ANOVA, $F_{5,257}$ = 1.45, $p$ = 0.206). There was no significant difference in the rate at which rats entered or left (D1 – D4) or avoided (D5 – D7) the TS whether the trap was set or not (unpaired t-test, $t_{29}$ = 0.042, p = 0.649) (Figure 5).

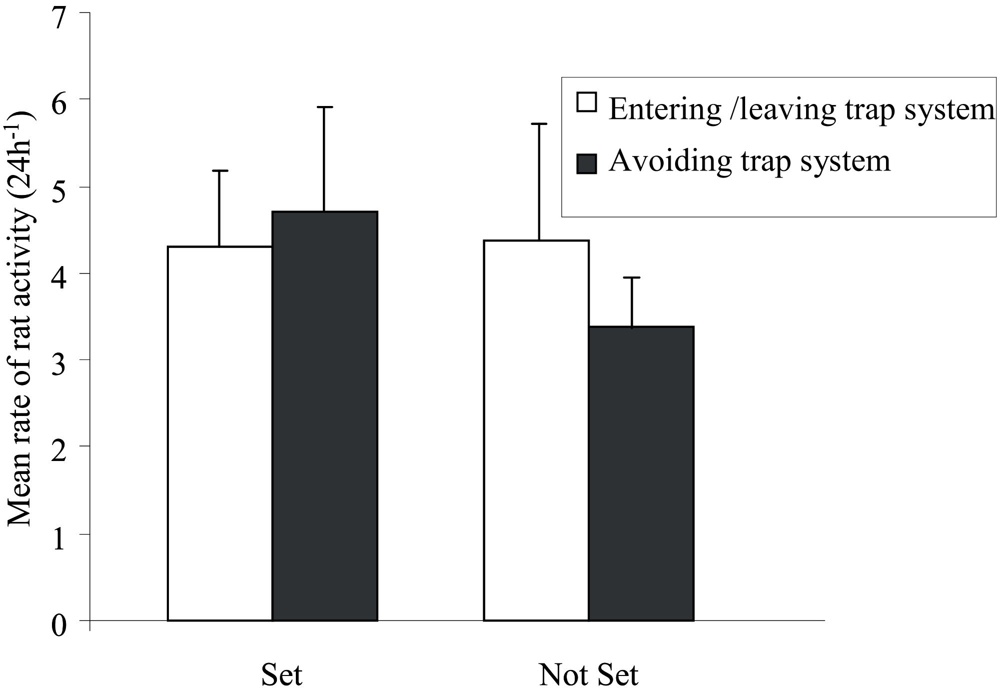


**Figure 5** The rate of rats using or avoiding the TS when Fenn traps were set and not set. Error bars are 1 sem.

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## Discussion

In this study, data for rat activity are potentially pseudoreplicated since it was impossible to identify rats individually from video footage. The measurement of activity is used as an index of activity for the population only, and is not an estimate of population size. Recordings showed no sign of neophobia towards the trap system by rats. The trap system was built six months before video surveillance study began thus recordings were likely to provide an unbiased view of the normal daily activity.

Still and windy weather had no effect on rat activity in the study area. However, there was no sign of rat activity during rain, even though this species is commonly associated with water. Recht (1988) also noted that brown rats usually ceased their activity above ground during rain. The overall level of rat activity based on video monitoring was relatively low (Brakes, 2003). This situation may be related to a small population inhabiting the area. Based on trapping results, the trap system monitored by video yielded the highest number of rats caught in spring and autumn; i.e. 30% and 22.9% of the total catch respectively, thus the number of rats in the immediate vicinity of where recording took place did not appear to have been low. Another factor that might have affected their activity could be associated with the activity of farm cats in the area. The monitoring area was less than 50 m from farm buildings and several domestic cats lived in the farm area. Video images showed two incidences of cats trying to enter the tunnel system. A study by Bramley *et al.* (2000) demonstrated that rats showed strong aversion to predator odour. Field and laboratory studies also show that predator odours have distinctive behavioural effects that include (1) inhibition of activity; (2) suppression of non-defensive behaviours such as foraging, feeding and grooming; and (3) shifts to habitats or secure locations where such odours are not present (Apfelbach *et al.*, 2005). Thus, although rats were clearly present in the area, their level of activity may have been constrained due to the presence of potential predators.

The activity of brown rats outside burrows is generally nocturnal and normal activity is at a minimum during daylight hours, with feeding in particular a mainly night-time activity (Meehan, 1984). In this study, there were two main peaks in activity from 17:00 – 18:00 and 23:00 – 24:00 hours. However, rat activity was not confined to darkness; 44.7% of rat activity was observed during the day and dusk (1 hour before sunset). Brown rats can change their behaviour to a diurnal phase to avoid competition (Recht, 1988). Changes in food availability, risk of predation and seasonal changes can cause shifts in the timing of animal activity (Alcock, 2005). Webster (2001) reviewed the effect of *Toxoplasma gondii* infection on behavioural changes in brown rats and showed that the pathological condition causes an increase in rat activity. Infection also reduced the normal aversion to cat odour, which instead became a mild attractant (Berdoy *et al.*, 2000; Vyas *et al.*, 2007). A study of the feeding patterns of brown rats on a farm by Klemann & Pelz (2006) also showed that rats frequently forage during the day.

The direction of rat movements based on video observations showed no consistent pattern. In this respect video monitoring at a single trap system was less informative than trapping, which gave broad patterns of seasonal movements. Video monitoring of rat activity was on a relatively small scale and data derived in this way probably only gives an indication of local exploratory movements. Brown rats live in a relatively small home range and their exploratory behaviour is usually confined to their nest or breeding area so, their movement patterns are localized (Davies, 1953). Lambert (2003) and Brown (2007), however, have shown occasional long-distance movements using radio telemetry, which cannot be detected using the video monitoring system adopted here.

## Conclusion

First, video monitoring of a single trap system provided evidence that rats are active during both day and night. The level of activity was relatively low in this study with an average of 5 sightings per day. Their direction of movement was not consistent. Secondly, trapping appeared not to change rat behaviour.

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