Slow-worms in Kent: estimates of population density and post-translocation monitoring

Renata Platenberg* and Tom Langton[1],
*Christchurch College, The Mount, Stodmarsh Road, Canterbury, Kent CT3 4AQ and
[1]Herpetofauna Consultants International, Triton House, Bramfield, Halesworth, Suffolk IP19 9AE

1. Introduction

Slow-worms *Anguis fragilis* have a widespread distribution in Britain and are locally common in Southeast England. Due to increasing habitat loss, modification and fragmentation, slow-worms are declining in Britain. Although there is as yet no statutory protection for slow-worm habitats, the species is protected under the Wildlife and Countryside Act 1981 against intentional killing and injury. Every reasonable effort must be taken to avoid the unintentional death of any individual while carrying out an otherwise lawful operation. Developers, therefore, have an obligation to consider reptiles in any planning applications affecting areas where they are present, and as a result of the legal requirments to avoid killing, the remedial measures taken tend to involve the attempted translocation of all or part of the population in question. Numerous slow-worms are captured and removed from development sites each year. However, but there have been few provisions for monitoring the subsequent fate of the translocated individuals and populations. Slow-worms are long-lived (Smith, 1969) and they breed biennially (Capula, et al, 1992; Smith, 1990; Patterson 1983), taking several years to become sexually mature. Therefore, the presence of slow-worms on a translocation site in the following year does not necessarily indicate a successful operation in terms of the long-term survival of the translocated animals and their progeny.

Three slow-worm mitigation exercises took place at two locations in Kent during 1994 and 1995, one of which resulted in the translocation of a proportion of the population away from the site in question. Such mitigation exercises provide opportunities to gain information on reptile populations, and the data collected during these exercises will be included in a long term study on slow-worm ecology at Canterbury Christ Church College. The objective of this long term study is to assess translocation procedures and determine parameters for improving the success of such translocations. This paper will briefly discuss the case histories of the sites, describe the mitigation and monitoring methodologies used, and produce some preliminary results.

2. Background and site descriptions

2.1 Sites One and Two, Canterbury (PTA94 and PTA95)

Sites one and two are parts of a single area of habitat in Canterbury, which involved two separate translocations over two summers. The presence of slow-worms was discovered on a proposed small community housing society development site in Canterbury which had already received planning permission. The site, previously a garden nursery but left overgrown for several years, consisted of rough grassland mixed with sycamore and bramble scrub. Following concerns raised by local people and consultation between Herpetofauna Consultants International, English Naure, the Canterbury City Council, the local planning authority and including the period when the ground was being levelled in preparation for building construction, the developers agreed to postpone groundworks for four weeks, to allow the animals to be captured. An area of about 0.1 ha of the land (site 2) which would remain undeveloped was turned into a slow-worm refuge, and surrounded with drift fencing to deter the animals returning to the development site. Capture of slow-worms (PTA94) commenced at the end of July 1994 and continued through to the middle of October. Portions of the site were subjected to a destructive search for buried individuals; this being the slow removalof topsoil with a digger bucket and its subsequent examination for reptiles by hand.

The slow-worm refuge was the subject of intensive monitoring from February 1995. During the summer, ownership of the refuge area reverted to Canterbury City Council. Due to public pressure from local residents, the council decided to revert over two thirds of the reserve area to a recreational 'play area', retaining only an edge area for wildlife. In order to prevent overcrowding of slow-worms at the release site two, it was decided that about 100 slow-worms should be moved to another location. After site visits and surveys to find a suitable release site which did not already contain slow-worms, a nearby site was selected. The release site, a local nature reserve of 1.8 ha of open woodland with ponds and wood piles was surveyed for the presence of slow-worms and other reptiles for approximately two months before any slow-worms were moved. No slow-worms or lizards were found during this time. Movement of animals commenced in July 1995 and continued until mid-October (PTA95).

2.2 Site Three, Sittingbourne (SB95)

Site three was on the line of a proposed road link, also with planning permission, and consisted of overgrown gardens and disused allotments, bordered on one side by a railway embankment and on the others by back gardens and allotments in use. The area for road building was about 0.7 ha in area, and much of the area was the surface of an old rubbish tip containing glass bottles and pottery, and was subject to intensive digging disturbance from collectors. The site representated about one third of the total area of garden, allotments and railway embankment used by slow-worms in the immediate area. In April, the Kent Reptile and Amphibian Group (KRAG) informed the Kent County Council Highway Department, responsible for the development, that slow-worms were present on the site. Mitigation measures were immediately initiated through Herpetofauna Consultants International. Although chestnut paling fencing was placed to improve site security, it did not deter the bottle collectors. At the start of the mitigation procedure in April 1995, about half of the development area had been dug over, and by the time the capture period finished in June there were only small pockets of habitat remaining. All artificial refugia placed within the site to enable capture of the slow-worms were labelled with 'Ecological Survey, please do not disturb', along with a contact number, which seemed to reduce the amount of disturbance to them. The slow-worm capture period took place from April to June, and individuals were transferred from the construction area, which was surrounded by drift fencing, into the surrounding land. Prior to groundworks, a destructive search took place.

3. Methods

Artificial refugia were situated where slow-worms were considered most likely to be found within the land for road building. Refugia most commonly used were squares of corrugated iron measuring 70 x 70 cm ('tins'). Other refugia utilised were wooden boards, and old metal washtubs, wheelbarrows, dustbin lids, etc. Effective tin density on SB95 was approximately 63 tins per ha, while on PTA95 it was 260/ha. Other refugia brought the overall effective refugia density up to 71/ha at SB95 and 350/ha on PTA95. Tin density on PTA94 is unknown, because the tins were moved about regularly by the building contractors and the area of land available for tripping varied.

All sites were visited on a daily or twice daily basis for slow-worm capture. The intention was to visit the sites at the same time each day to reduce variability, but this was not always possible. On each visit, time of day, percentage cloud cover, soil temperature, relative wind speed, and general weather conditions were noted. Wind speed was placed into four groups: still, slightly breezy, breezy and windy. For each slow-worm encountered, its location on the site and presence of other slow-worms was noted. In addition, each individual was measured for snout-vent length, tail length, body circumference, mass, and body temperature.

The slow-worm refuge in 'site two' Canterbury (PTA95), with the translocated population PTA94, was monitored from February 1995 until the translocation programme began in July 1995, and daily visits continued until October. Numbered tins were placed randomly around the site. The site was visited daily and at the same time each day. In addition to the data collected above, current/maximum/minimum temperatures under and near tins were measured daily. All slow-worms were photographed using chin and pineal patterns to enable individual identification.

For the purposes of this study, age groups are defined by snout-vent length (SVL). Adult SVL was set at greater than 120 mm, subadult between 100 and 120 mm, and juvenile at less than 100 mm.

4. Results

The results presented here are preliminary, and awaiting statistical analysis. They are by no means complete, and are presented here merely to suggest possible trends.

Table one shows the numbers of individuals captured and translocated on the different sites. The sex ratio for the Sittingbourne site during the mating season (April - June) was 1.05, virtually one to one, while at the two Canterbury sites females were twice as numerous as males towards the end of summer (0.46 at both sites). The adult/juvenile ratio at SB95 was 2.5, while at PTA94 it was 4.0 and PTA95 it was 1.1.

Figure 1 shows the number of slow-worms captured at SB95. An average of 4.1 ± 2.94 slow-worms were caught per visit over 40 visits, with an average of 3.4 slow-worms captured per tin. By pooling the capture data of the 168 animals taken out of the enclosed site into trap periods of 11 days, it was possible to apply a removal model of population estimation (Zippin, 1958). The preliminary analysis produced an estimation of 415 (SE = 58.12) slow-worms on the site, giving an estimation of 593 slow-worms per hectare, before removal. The encounter rate of individuals during the capture period indicated a density of 237 slow-worms per hectare.

On PTA94 an average of 2.7 ± 2.73 animals were caught per day over 45 capture days (Figure 2). The total number of visits is unknown, because the translocation was carried out by several KRAG volunteers on a rota basis.

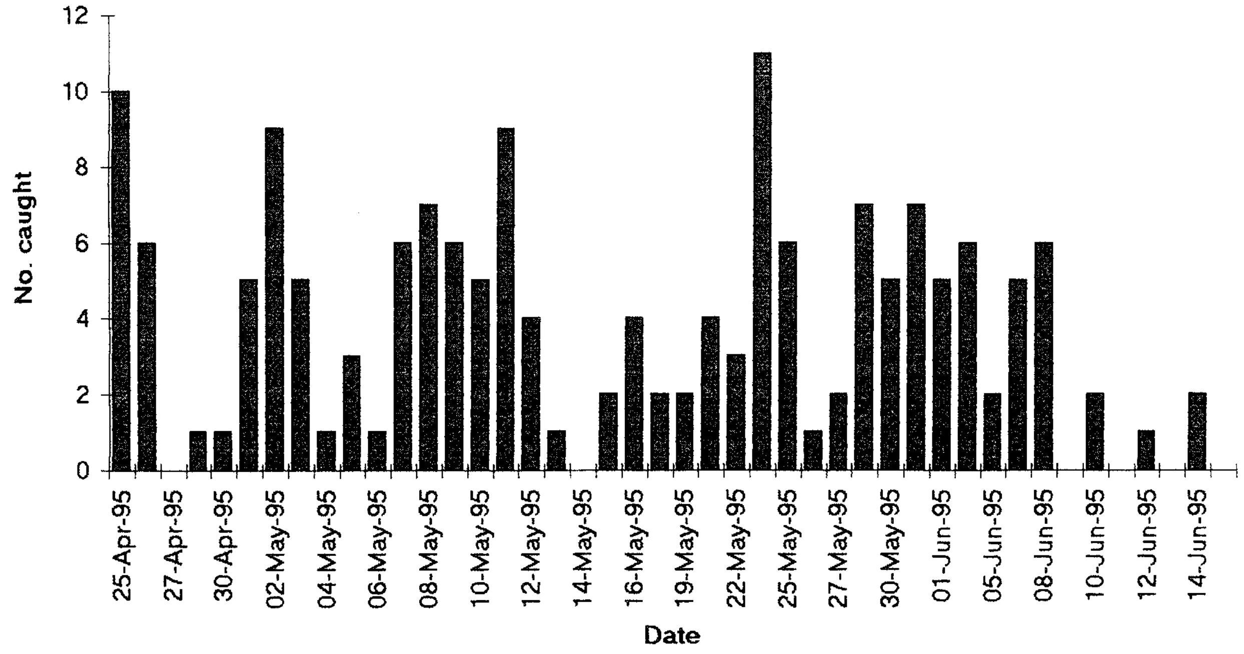


Figure 1. Daily slow-worm captures, Sittingbourne 1995

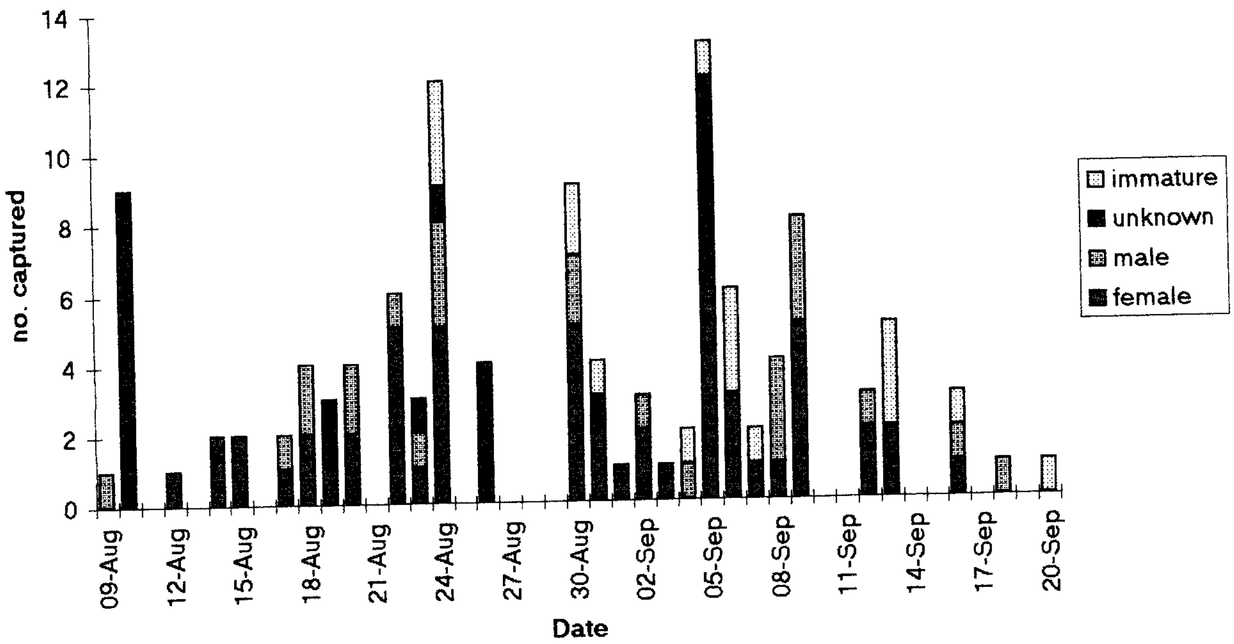


Figure 2. Daily slow-worm captures, Canterbury 1994

Figure 3 shows the total number of slow-worms encountered during the translocation period at PTA95, including the animals which escaped capture. An average of 1.7 ± 1.94 slow-worms were seen per visit during 75 visits over a three month period. Based on the number of animals removed, the population can be estimated at 1050 slow-worms per hectare (this number does not include the individuals which escaped capture). The Zippin model was not applied to this population, because the data did not conform to the assumptions of the model. Figure 4 shows the numbers of slow-worms encountered at different temperatures, measured under tins, while Figure 5 shows the average number of slow-worms seen at different times of day. Figure 6 shows the average daily sightings at PTA95 throughout the 1995 monitoring season.

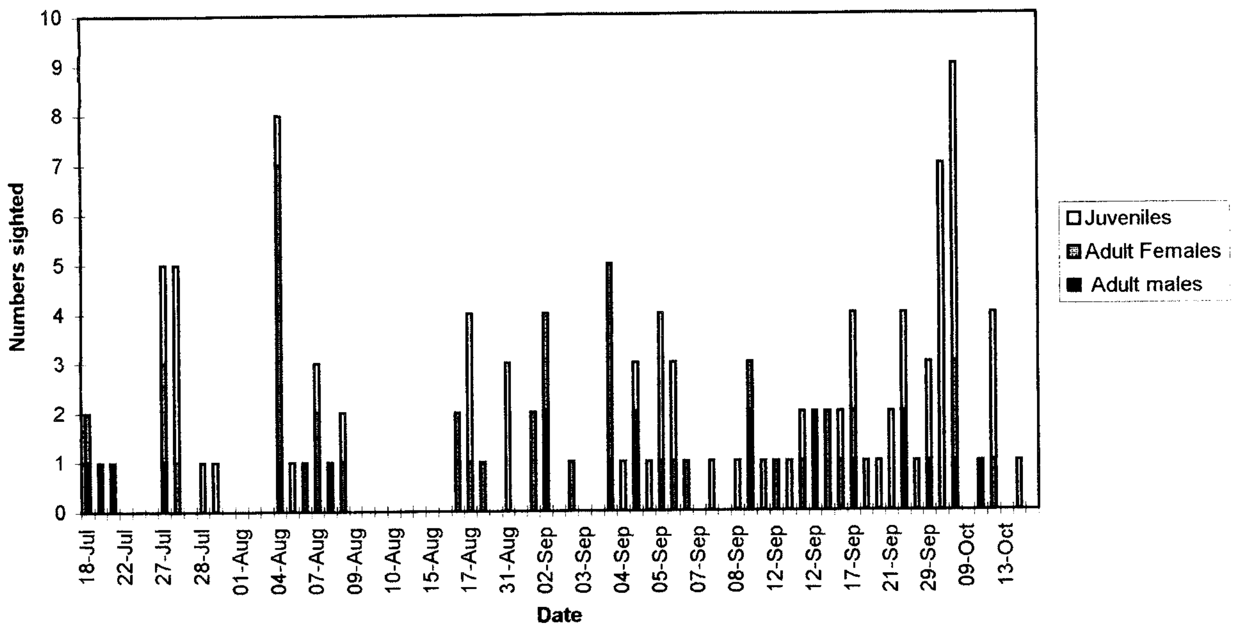


Figure 3. Daily slow-worm sightings during translocation period, Canterbury 1995

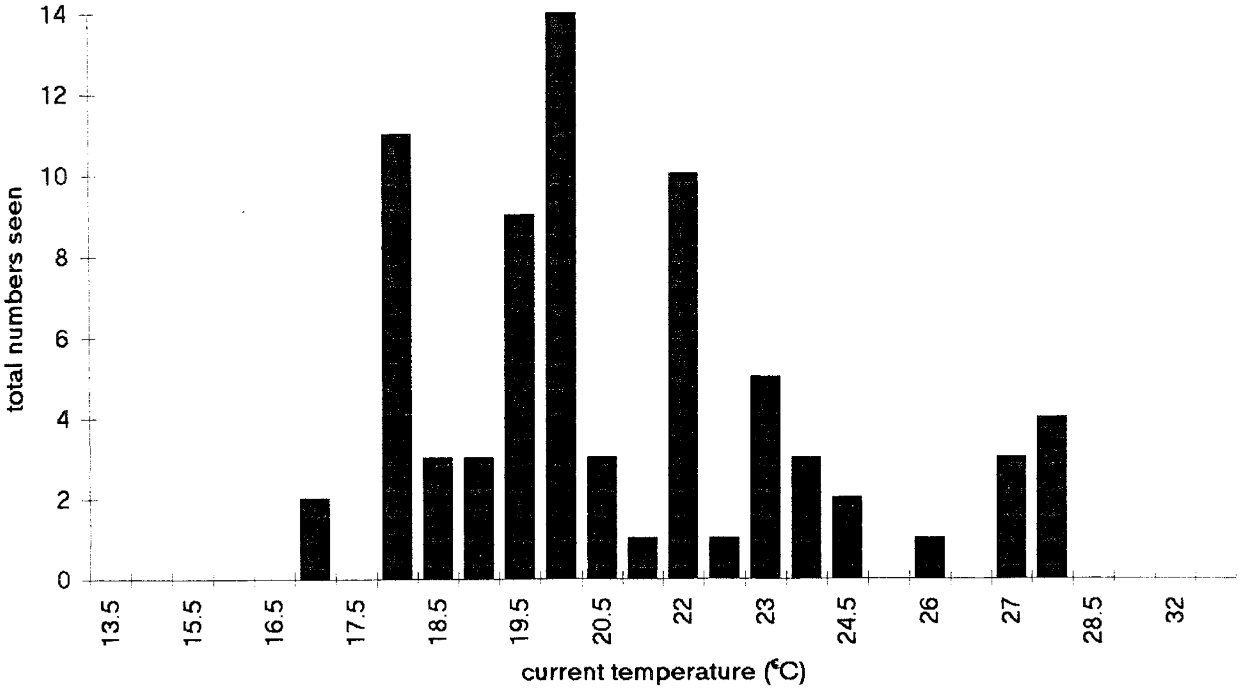


Figure 4. Total numbers of slow-worms seen under current temperatures

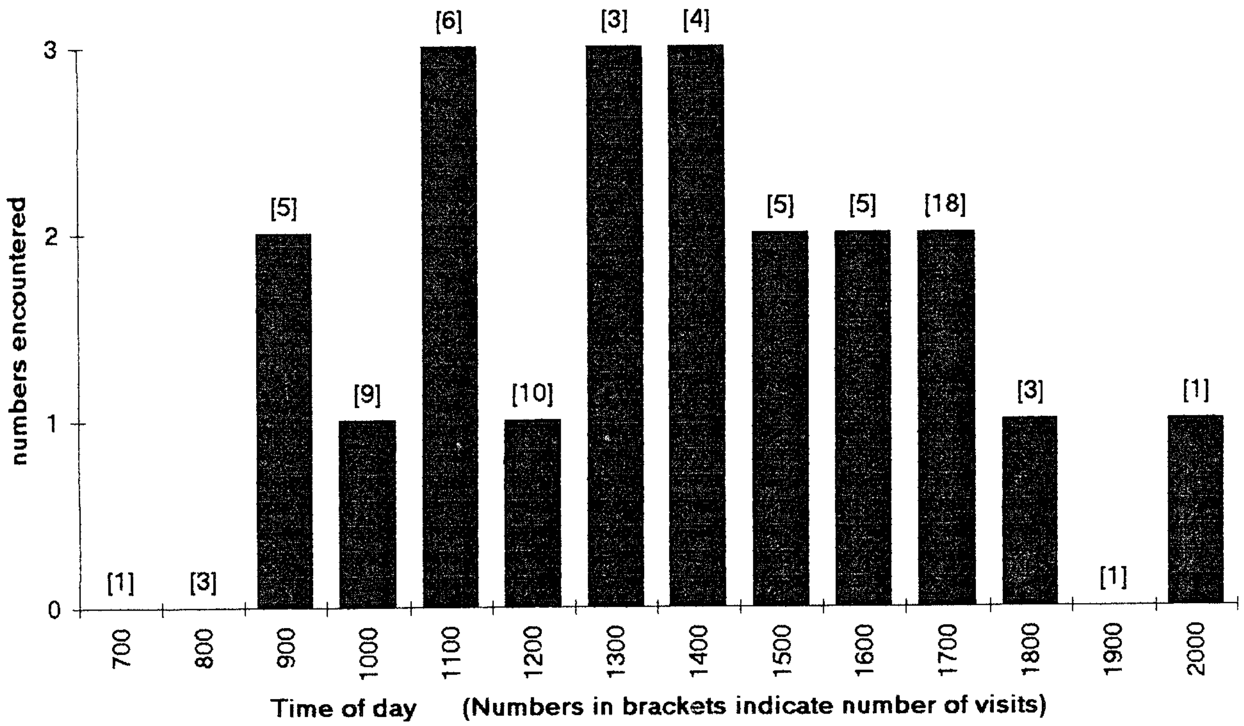


Figure 5. Average slow-worm encounters during July-September 1995, Canterbury

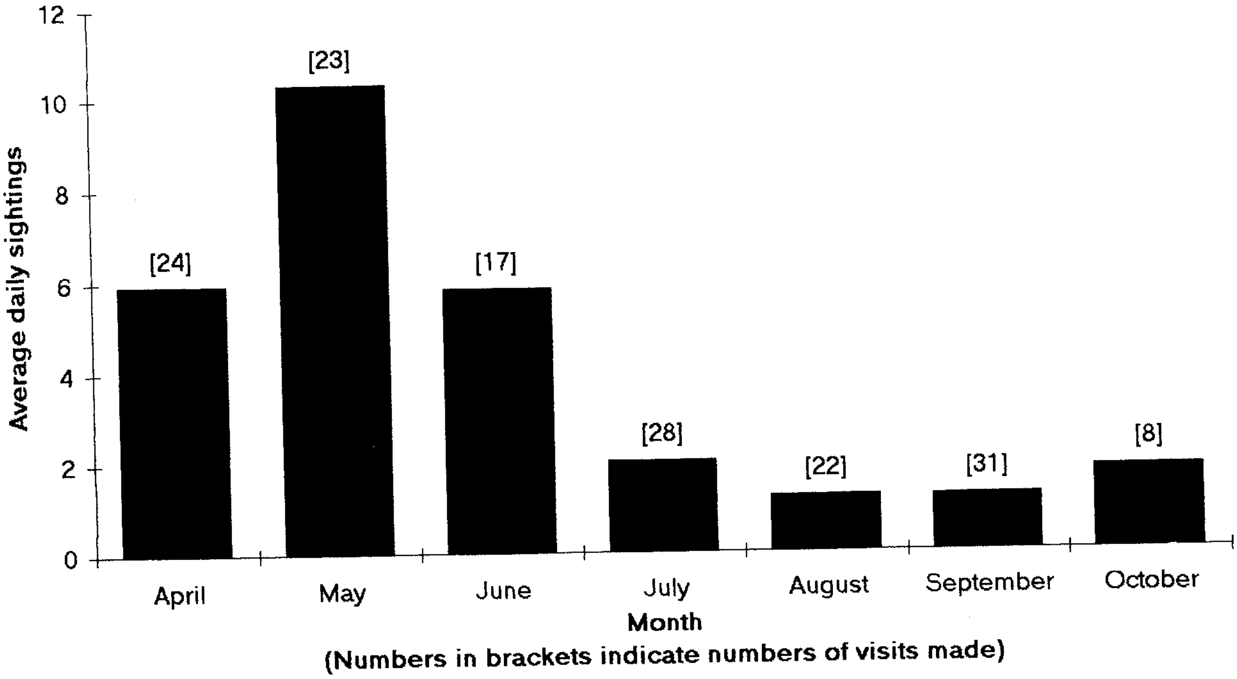


Figure 6. Average slow-worm sightings, Canterbury 1995

Table 1. Numbers of slow-worms translocated

Site	Adult Males	Adult Females	Subadults	Juveniles	Total
PTA94	33	72	*	26	131
PTA95	17	37	1	50	105
SB95	46	44	30	48	168

*no distinction made between adults and subadults

5. Discussion

5.1 Population estimation

It is difficult to apply population estimation models to slow-worms. They exhibit irregular behaviour, making predictions at best unreliable. It is also difficult to identify individuals in order to apply mark-recapture methods. Other methods used to determine abundance, such as transects and distance sampling, cannot be used on slow-worms because of their fossorial nature.

The Zippin model applied to the SB95 population is considered inaccurate, because although the data could be manipulated to fit the assumptions of the model, the actual events did not conform. Throughout the capture period the numbers of slow-worms caught each day did not indicate a decline (Figure 1). It was apparent, however, to the field worker that the population within the capture period was declining, because on optimal days slow-worms continued to be found outside the drift fencing and not inside. If the population was not declining the rates of encounter would be expected to be the same on both sides of the fencing. The daily capture rate, however, was too low to be able to determine any trends.

Depletion models tend to only consider the individuals removed, and assume that other conditions remain constant. Because slow-worm behaviour is so linked with environmental conditions, a model that solely looks at individual numbers is unsatisfactory. A more useful model would have to consider such factors as weather conditions, habitat type and amount of time spent searching for the animals.

The standardisation of the use of tins would enable comparisons to be made more easily between sites, and allow the determination of relative density. However, the question arises as to where to place the tins. Slow-worms are not randomly distributed, but occupy patches within suitable habitat (*pers. obs.*), and the placement of tins relies on the objectivity of the field investigator.

As slow-worms breed biennially it is recommended that in a translocation exercise twice as many females are moved as males (Gent 1994). Therefore, one would expect the natural sex ratio to be on the order of 2:1 as well. The sex ratio of the two Canterbury sites, as measured in the late summer months, conform to that assumption, but the one measured at the Sittingbourne site in the spring months did not. The difference may be behavioural, with more females basking during the late summer months than earlier in the spring, or there may not actually be a difference in sex ratio among slow-worms. More research is clearly needed.

5.2 Optimal searching conditions

While it is not possible to directly compare the results from the three sites due to differences in area, habitat and time of year, these preliminary results illustrate that 'optimal' conditions for searching for slow-worms are as yet undetermined, due to their unpredictable behaviour and secretive nature. They do, however, suggest that the time of year may dictate the success of a slow-worm translocation.

The hot dry summer of 1995 coincided with the translocation period in Canterbury, giving very low encounter frequency. The population was roughly estimated at 150 - 200 adults and subadults on the PTA95 site, based on observations during the spring. However, only 105 individuals were located during the capture period from July to October, and half of those were juveniles born either during the translocation period or the previous year. The severe weather conditions are believed to be the most influential factor in the encounter rate decline, as slow-worms were still being seen during these months the previous year (Figure 2). Although not enough data is available to determine seasonal activity patterns, the results presented here suggest that the months of April, May and June are best for locating adult slow-worms (Figure 6).

While mid-morning and late afternoon on clear days and after rain are considered to be the best times to find slow-worms, they are found under a variety of seemingly unsuitable conditions (Figures 4 and 5). They can still be found at high temperatures, during the middle of the day, and into the evening.

When looking for slow-worms other things need to be taken into consideration, such as weekend disturbance. Some periodicity was found in the SB95 daily capture rates (Figure 1), with marked declines during the weekend periods. This was most likely due to increased disturbance from bottle collectors and children on the site during these times.

This work centred around the use of artificial refugia to enable the location of slow-worms. Only one slow-worm was found basking in the open on PTA95 during the entire monitoring period from March to October, despite careful searching. Although tins cannot be used in open public access areas, due to the danger of disturbance to tins and animals underneath them (and not only slow-worms!), some form of artificial refugia is required.

These results are part of a longer-term study on slow-worm ecology. Further research will focus on both translocated and natural populations, comparing activity patterns and demographics. In 1996 the three sites will continued to be monitored. The translocated population on the local nature reserve in Canterbury will provide a unique opportunity to test and develop population estimation models, as well as the examination of diel and seasonal activity patterns and dispersion.

5.3 Conservation implications

The studies at SB and PTA are indicative of a severe problem that exists with efforts to prevent the decline of reptiles in England. At both localities, plans to attempt mitigation had to be conceived hurridly, as the knowledge of the presence of animals in the planning authority occurred after planning permission had been granted and immediately prior to construction work commencing.

There can be no doubt that in the majority of instances still, the presence of slow-worms is not determined on development sites prior to site cleasrance and that no effort is made to mitigate. For this reason it is important that records of slow-worm and other reptiles are reported by amphian and reptile groups and others to regional and national data-base managers and that more local survey work is carried out to identify, map, and pass to planning authorities the location of reptile habitats.

The methods of reptile trapping and destructive search will be described elsewhere. Trapping efficiency or the numbers of the total population being caught requires further investigation, perhaps using a mark and recapture methodology on a slow-worm population when its translocation has been authorised by the appropriate authority.

Acknowledgements

KRAG assisted with the field work on PTA94 and SB95, HCI provided logistical support, HCIL provided invaluable advice, and Canterbury City Council has given their kind permission to use Bus Company Island as a study site.

References

CAPULA, M., LUISELLI, L. AND ANIBALDI, C. 1992. Biennial reproduction and clutch parameters in an alpine population of the Slow-worm, *Anguis fragilis* LINNAEUS, 1758 (Squamata: Sauria: Anguidae). *Herpetozoa,* **5**(3/4): 95-98.

GENT, T. 1994. Translocation of slow-worms. SPECIES CONSERVATION HANDBOOK. Peterborough, English Nature.

PATTERSON, J.W. 1983. Frequency of reproduction, clutch size and clutch energy in the lizard *Anguis fragilis*. *Amphibia* , **4**(2-4): 195-203.

SMITH, M. 1969. *The British Amphibians and Reptiles,* 4th ed. London: Collins.

SMITH, N.D. 1990. The Ecology of the Slow-worm (*Anguis fragilis* L.) in Southern England. PhD thesis, University of Southampton.

ZIPPIN, C. 1958. The removal method of population estimation. *Journal of Wildlife Management* **22**(1):82-90.

Evaluation of refuges for surveying common reptile species at two sites in Northamptonshire and Hampshire

Mabel Cheung* and Tony Gent[1]

*Royal Holloway University of London, Egham, Surrey TW20 0EX and [1] English Nature, Northminster House, Peterborough PE1 1UA

Abstract

A combination of line transect/distance sampling with attractive "refuges" was employed to evaluate methods for surveying reptiles in Britain, in two separate studies. One study, in Northamptonshire, investigated two types of grid transects : one used only of metal refuges ('Metal Grid') whilst a 'Comparative Grid' used various materials (wood, metal, rubber mat and asbestos). The second study, in Hampshire, employed a less regular transect with an equal number of both metal and wood refuges placed in pairs.

Visits yielded varying numbers of sightings of reptiles; on some occasions no reptiles at all were seen. There was an overall low rate of sightings of reptiles with an average of 1.35 reptiles per visit to the MG transect (equivalent to 0.43 per 100 m transect length) and 0.47 reptiles per visit to the CG transect (0.83 per 100 m transect) at the Northamptonshire site and 3.18 reptiles per visit (0.12 per 100 m transect)at the Hampshire site. Grass snakes were the most commonly recorded species at both locations, common lizards the least often recorded. Adders were recorded only at the Northamptonshire site while slow-worms were only recorded on the transect grids at the Hampshire site (though slow-worms were known to be present at the Northamptonshire site).

Metal sheeting was the most commonly used refuge material at both the Comparative grid at the Northamptonshire site (choice of four materials: metal, asbestos, wood, rubber matting) and at the Hampshire site (paired metal and wood refuges).

The optimal ambient air temperatures, OAAT (at which the total reptile count was highest) was in the 15-18°C category at the Northamptonshire site and was 23°C at the Hampshire site. The ambient air temperature range (AATR) was 8-25°C at the Northamptonshire site and was 14-33°C at the Hampshire site. There was a suggestion of differing optimal ambient air temperature OAAT and ambient air temperature range (AATR) during which animals were located. Cloud cover, affected reptile survey results in an inconsistent way in the different studies, but this probably related to different ranges of air temperatures being encountered. This emphasised the need to consider the interaction between environmental variables and the difficulties of looking at single factors.

Survey was most successful early in the year between late April and early June; though variation in survey success may occur in different months for the different species.

Introduction

Reptiles have generally been under-recorded, especially so when compared with other taxa. As a group they lack the popular appeal of birds and mammals; they are generally secretive and they tend not to show obvious aggregation behaviours, as are shown by amphibians for example, that allow survey to be better targeted. Consequently data on the distribution and populations of these animals are scant and it is difficult to assess the conservation status of the class.

With a view to addressing these shortfalls survey methods need to be refined. Methods need to be developed to increase the likelihood of finding reptiles so that survey effort can be best targeted. In addition it is important to see how different factors affect results so that comparisons can be made between different surveys.

Once more comprehensive and comparable survey data are obtained then it will be possible to investigate changes in status; for example it will be possible to determine whether reported declines of the species (eg Spellerberg 1975) have occurred and how the status is currently changing. Standard survey may allow the identification of 'key sites' which may be worthy of further protection.

This study attempts to make a preliminary assessment of surveys by looking at three different methods. All methods involved placing 'refuges', also known as 'lids', 'cover-boards' or 'tins', as an aid to finding reptiles. Reptiles can be found under these features, using them for cover, or may be seen basking on top of them (for simplicity of analysis, no distinction was made in this study between those animals found beneath the refuges or those found on top). Two 'grid transects' were set out at a site in Northamptonshire; a third transect was carried out at a site in Hampshire. The different methods allowed an assessment of success of using 'refuges' compared with observations in the open, the relative success of different materials as cover and the effect of weather and time of year on searching success.

Specifically the questions addressed by this project were:

- ❑ For each species present what is the optimal ambient air temperature (OAAT) and ambient air temperature range (AATR) for locating reptiles?
- ❑ Do daytime weather conditions matter?
- ❑ During which month does the greatest number of reptiles appear?
- ❑ Are artificial refuges necessary for reptile detection?
- ❑ In which weather conditions are artificial refuges most useful ?
- ❑ Which artificial refuge material attracts the most reptiles?
- ❑ Which of the methods used is most successful in finding reptiles ?

Location of the surveys

Fineshade Woods

This site was *c.*15 km north-east of Corby in Northamptonshire and owned and managed by the Forestry Commission. It is accessible to the public, dog walkers, etc. The woodland was mixed coniferous and deciduous planting with many open areas of ride edges and newly planted trees. Reptile survey was undertaken predominantly in these open areas. The habitats surveyed were predominantly open "tussocky" grassland, with bracken, scrub with few trees in a conifer/mixed plantation area. Five survey grids were established at different locations within the woods.

Frimley Hatches

This site was in Blackwater Valley, Hampshire on the Surrey/Berkshire county boundary and enclosed between a railway line and a major road. The habitat consisted of acidic grassland, heathland and scrub. A preliminary visit indicated that the site yielded sufficient numbers of reptiles to support a study.

This strip of land was used regularly by the public with a footpath running through it. One relatively large area was chosen for sampling at this site (*cf.* several smaller ones, as in Fineshade).

Materials and Methods

No attempt was made to or mark the reptiles that were found at either site, although a 'mark-release-recapture' procedure may have allowed population estimates to have been undertaken. No attempts were made at Fineshade to quantify the population size of reptiles and, for simplicity, reptile numbers were determined solely on the basis of numbers of individuals seen on each visit. An estimation based on distance sampling (Whitesides, Oates, Green and Kluberdanz 1988) was made of density of reptiles at Frimley Hatches.

Fineshade

Two types of grid transect lines were set up both with a zigzag route between the refuges.

1. The **comparative grid (CG)** (60m long and covering 144 m^2 ground surface) tested the efficiency of the different materials for attracting reptiles (Figure 1). Four of each wood, corrugated roofing asbestos, corrugated metal and rubber (car mat) were placed in a 'Latin square' 4 x 4 grid such that each material appeared once in each row and each column to minimise any environmental factors on site. The lids were spaced 4m apart. These materials were of approximately similar size; however it was appreciated that the different areas of the different materials used may have influenced their success in attracting reptiles (Actual sizes of materials were: wood - 61 cm x 61 cm; metal - 66 cm x 50 cm; rubber mat - 48 cm x 32 cm; asbestos - variable, but typically 75 cm x 45 cm). A total of three such grids were placed in different areas of the study site.

Tin 1	→ (4m)	Asb 1	→	Wood 1	→	Mat 1
(4m)						↓
Asb 2	←	Wood 2	←	Mat 2	←	Tin 2
↓						
Wood 3	→	Mat 3	→	Tin 3	→	Asb 3
						↓
Mat 4	←	Tin 4	←	Asb 4	←	Wood 4

Figure 1. Layout and refuge sizes of the Comparative Grid (CG) transect at Fineshade

2. The **metal grid transect (MG)** (315m and covering 3675 m^2 ground surface) consisted solely of nineteen corrugated metal sheets of uniform size (76 cm x 65 cm) painted black using 'Hammerite' paint. A polygonal grid was adopted (Figure 2) to give each tin an equal chance of attracting reptiles. This concept operates on the principle that there are no extreme points of the grid that will receive less chance of attracting reptiles (4 of which are present on the square grid). Two such grids were placed at the study site.

17.5m

A3 ← A2 ← A1

17.5m ↙

B7 → B6 → B5 → B4

↘

C12 ← C11 ← C10 ← C9 ← C8

↘

D16 → D15 → D14 → D13

↙

E19 ← E18 ← E17

Figure 2. Layout and refuge sizes of the Metal Grid (MG) transect at Fineshade

Transect walks were carried out on 34 different days for the Metal Grid transects and 25 different days for the Comparative Grid transects during two consecutive years (1994 - 1995); these days were selected arbitrarily throughout the months when reptiles are active March to November. Data for the MG transects were collected between 9 March 1994 and 29 October 1995; for the CG transects, due to a re-design of the experiment, from a shorter study period between 16 May 1994 and 29 October 1995. A total of 62 MG and 58 CG transects were made, yielding 120 transect walks in total.

The times at the start and finish of each grid walk were noted. Whilst walking along the transect route any reptiles found were identified to species Their location, whether on or under a refuge or between (ie not using) them, was recorded. No distinction has been made in this analysis between reptiles recorded on or under refuges.

Various weather data were recorded. At the start of each transect cloud cover (scored as eighths) and whether it was raining or not were noted. Temperature was also recorded occasionally with a hand held thermometer. A "Squirrel" data-logger (Grant Instruments, Cambridge) was placed in the field automatically taking a set of weather readings every half an hour. This was intended to be the primary means by which weather was recorded for the study and would allow both transect and 'incidental' observations to be related to prevailing and previous weather conditions. Measurements were taken, by thermistors, of ambient air temperature, and temperatures from under each of rubber mat, asbestos, wood and metal refuges, open ground (all refuges and open ground were placed in direct sunlight) and below ground (10 cm depth) and beneath thick vegetation. Sunshine intensity and rainfall were also recorded. In addition two "Tiny Talk" recorders (Orion components Ltd, Chichester) were placed next to the "Squirrel" thermistors to measure shade air temperature and temperature below tin to provide 'back up' data in the event of data not being recorded on the "Squirrel" recorder. These recorded temperature each 36 minutes. Reptile observations and transect walks were related to the closest set of weather data (in the case of "Squirrel" data these would be within 15 minutes, for the "Tiny Talk" data within 18 minutes, of the observation/ mid-point of transect).

Due to the remote location of the temperature recording equipment relative to the transect grids, and due to the fact that recordings were not taken at the exact moment a reptile was located or during the exact time a transect was walked, air temperatures were recorded only to the nearest 1°C. Due to difficulties with equipment, data using all three methods for measuring temperature have been included in these analyses (for the MG transect 46 visits had "Squirrel" data, 10 used "Tiny Talk" data and 2 relied on thermometer data; the corresponding figures for the CG data are 51, 6, and 1); in three cases (2 MG and 1 CG) no temperature data were recorded at all. Damage to thermistor probes, and the late addition of a thermistor below rubber matting, meant that some data are missing even when the "Squirrel" data logger was working. In consequence not all variables could be measured, this compounding the problem of small sample size, and the intention to study weather conditions prior to observations of reptiles was made difficult. As such only simple analyses of current air temperature and temperature below the 'sample' refuges were undertaken.

Frimley Hatches

A less rigid form of sampling was applied at Frimley Hatches than at Fineshade. An undulating transect line was followed to cover as much of the area as possible and totalled 1125m in length. A total of 40 lids were placed along the length. The lids were placed in 20 pairs, each consisting of one metal shelf part (50 x 70 cm^2) and one plywood piece (50 x 50 cm^2) to allow the reptiles a choice between the substrates. A space of around 1m was kept between the lids in any pair to prevent heat radiation from one affecting the other. These pairs were spaced widely so as not to influence the catchment area of the adjacent pair.

Distribution of the lids was not random. Disparate vegetation, and hence habitats, were deliberately sought for the placement of lids. Reptiles often occur in 'edge habitat' or the interface, of bushes and open low vegetation (Gent 1994). It was also necessary to compromise randomness in a second way, by placing the lids away from the main footpath to prevent disturbance. Beige and green car paints were sprayed on to metal to aid camouflage.

The site was visited between July and November 1995. A total of 40 transect walks were made. Thus this area was studied more intensively than Fineshade.

At Frimley Hatches, details of time and weather conditions were recorded at the start and finish. From direct observations made in the field, estimates were taken of the cloud cover (in eighths) and wind strength (out of 12). During a visit along the transect line the time of each reptile observation was noted, as was its situation and location. Also recorded was the type of refuge used, the surrounding vegetation, and whether or not it was in the shade. When a lid was not used, the distance of the reptile from the transect line was measured. The behaviour and spot temperature of the animal was gauged. The latter was measured by placing a thermistor as close as possible to the point at which the reptile was found, in direct contact with the adjacent substrate, until a stable figure was reached. The thermistor of the spot thermometer was held aloft, above shoulder height, to measure the current ambient air temperature.

A slow pace was adopted, taking about 2 hours for the 1125m transect line, so as not to disturb reptiles before they had been counted. It was necessary to focus on the ground directly in front, within 1 or 2m, for snakes and further ahead for lizards (Gent 1994). As the transect line is much longer a greater variety of features were encountered than the Fineshade grid transects. Debris, sheets of wood, mat and log piles, that were already present, were given particular attention as they often attract reptiles.

A data-logger was set up about 4 km away from the study site; the remote location was chosen for security reasons. Four thermistors were placed on open grass, in tree shade, under metal and under wood, respectively, in order to chart temperature changes during the day. Readings were taken every five minutes, with a down-load every one or two weeks.

Results

A. *Summary data: Fineshade and Frimley Hatches*

Information obtained during the study at both study sites is given in Table 1.

Table 1. General results of the sampling from the two locations

	Fineshade			Frimley Hatches
	Metal Grid	Comparative Grid	Both grids combined	
Period of study	9/3/94-29/10/95	16/5/94-29/10/95	9/3/94-29/10/95	13/7/95-14/11/95
Transect walks made (visits)	62	58	120	40
Total reptile sightings	84	29	113	127
Grass snake sightings	31	15	46	48
Common lizard sightings	17	7	24	36
Slow-worm sightings	0	0	0	43
Adder sightings	36	7	43	0
Reptiles using refuges	27	21	48	90
Reptile sightings independent of refuges	57	8	65	37

At the two study sites, different species were observed and these occurred in different proportions. Grass snakes were the most commonly recorded species at both locations, with 40.7% of observations at Fineshade and 37.8% at Frimley Hatches being of this species. At Fineshade adders (38.1% of observations) were almost equally commonly recorded. Slow-worms appear to "replace" adders in this respect at Frimley Hatches (33.9% of observations). Common lizards were the least frequently recorded of the three species present on the transects (21.2% at Fineshade and 28.3% at Frimley Hatches). Slow-worms were known to occur at Fineshade, yet they were not recorded on the transect grids during the study period.

In total, looking at both the MG and CG transects, more reptiles at Fineshade were found outside the refuges rather than utilising them; 57% were found away from the refuges. In contrast, a much greater proportion of reptiles (70.9%) observed at Frimley Hatches made use of the more strategically placed refuges.

B. *Results from Fineshade*

Summary data for the Comparative and Metal Grid transects

Sixty two transect samples (visits) were made to the MG transects : during 30 of these no reptiles were seen while 32 visits yielded sightings of at least one reptile. Three species were located as follows ; 31 observations of grass snakes during 19 visits; 36 observations of adders on 19 occasions and 17 observations of comon lizards on 15 occasions. During 12 visits a single reptile was seen; 7 visits had 2 observations of reptiles; 5 visits 3 reptiles; 1 visit 4 reptiles; 4 visits had 5 reptiles; 2 visits had 6 reptiles and a single visit yielded 7 reptiles on the MG transect.

A total of 58 transect samples (visits) were undertaken on the CG transects. Of these 41 yielded no reptile sightings at all; on 17 occasions reptiles were seen. Three species were located on the CG transects; seven observations of adders were made, one on each of seven walks; 14 observations of grass snakes were made on 8 different transect walks and seven common lizards were seen with a single lizard being seen on each of seven separate walks. Where reptiles were recorded, generally (11 occasions) only one animal was seen per transect walk; though on two occasions 2 reptiles were seen, on three occasions 3 were seen and on one occasion 4 were seen.

The Metal Grid (MG) transect yielded more observations of reptiles than did the Comparative Grid (CG) transect. A total of 84 sightings were found on the MG after 62 transect walks (visits); only 29 reptile sightings were made after 58 transect walks at the CG. Generally, the mean reptile sightings, for each reptile group, from the MG transect are higher than those from the CG transect (Table 2).

Table 2. Descriptive statistics of the reptile sightings from Comparative Grids and Metal Grids at Fineshade

Grid transect	Reptile group	Mean (sightings per visit)	Standard deviation	Median	Maximum
Comparative grid	Total reptiles	0.47	0.941	0	4
	Adders	0.12	0.308	0	1
	Grass snakes	0.25	0.779	0	4
	Common lizards	0.12	0.326	0	1
Metal grid	Total reptiles	1.35	1.847	1	7
	Adders	0.58	1.124	0	5
	Grass snakes	0.50	0.900	0	4
	Common lizards	0.27	0.548	0	3

Number of reptiles per refuge and per 100m for both grid transects

The number of sightings from both grid transects can be standardised for the number of reptiles found per refuge, and the number of reptiles found per 100m.

Number of reptiles per refuge

CG: 29 sightings ÷ 58 visits ÷ 16 refuges = 0.03 reptile sightings per refuge.
MG: 84 sightings ÷ 62 visits ÷ 19 refuges = 0.07 reptile sightings per refuge.

Number of reptiles per 100m

CG: 29 sightings ÷ 58 visits x 1.667 = 0.83 reptile sightings per 100m.
MG: 84 sightings ÷ 62 visits x 0.317 = 0.43 reptile sightings per 100m.

Number of reptiles per refuge per 100m

CG: 29 sightings ÷58 visits ÷16 refuges x 1.667= 0.051 reptile sightings/refuge/100m.
MG: 84 sightings ÷62 visits ÷19 refuges x 0.317= 0.023 reptile sightings/refuge/100m

Such standardisation may permit comparison between the different transects or between different sites. However strict comparison is not possible since this relies on the assumptions that a. all tins and refuges are equally 'attractive' to snakes and b. that there is an equal chance of locating snakes at any point on each transect. These assumptions are unrealistic. Due to small sample sizes, results from Fineshade are presented graphically and (with the exception of the analysis of the use of different refuge materials in the CG transect) no attempt at statistical comparisons have been made using data from this site.

Use of refuges

Of the 29 observations of reptiles at the CG transect, 21 were using refuges and 8 were on the grid transects between the refuges. Different materials in the comparative grids were used by reptiles to different degrees ($\chi^2 = 13$, 3 d.f., $p<0.01$). Metal tins were most frequently used by reptiles (Table 3); this then being followed in order of use by wood, asbestos and rubber matting. However, due tothe small sample sizes (n= 21), the χ^2 value should be treated with caution. Sample sizes were too small to allow separate analysis for the different species, for the different seasons or for different weather conditions.

Table 3. Occurrence of reptile on comparative grid transects at Fineshade showing number of reptiles of each species found between refuges and below different types of refuges. Numbers in parentheses show number of visits on which reptiles were found.

	Between refuges	Using (on / under) refuges			
		Wood	Tin	Asbestos	Mat
Adder	3 (3)	3 (3)	0 (0)	1 (1)	0 (0)
Grass snake	2 (2)	1 (1)	10 (7)	1(1)	0 (0)
Common lizard	2 (2)	2 (2)	2 (2)	0 (0)	1 (1)
All species	**7 (5)**	**6 (6)**	**12 (8)**	**2 (2)**	**1 (1)**

A total of 27 sightings were of reptiles using the refuges in the Metal Grid transect, compared with 57 sightings of reptiles independent of them. Combining the results from the CG and MG transects showed that more reptiles, 64 compared with 48, were found independent from the refuges than were found using them.

Shade air temperature associated with observations of reptiles using different refuge materials and being found in the open are discussed in the following section (and presented in Figure 6, below).

Effects of weather conditions

For the following analyses data from both Comparative and Metal grid transects are presented side by side; the different methods were considered too different to allow the data sets to be combined for quantitative comparisons. However, determination of the ambient air temperature range (AATR) used data from both transects since this statisitic relies only on 'presence' and does not need any measure of relative abundance.

Effects of Air temperature

Sampling, using the two different grid transects, covered a range of temperatures from 3 to 30°C (Figure 3). However some air temperatures within this range were not sampled, ie 4, 5, 6, 7 and 28°C. Reptiles were observed when the ambient air temperature range (AATR) was 8° to 25°C; no reptiles were observed during this study when air temperatures were 5, 9, 10, 22, 24, 27, 29 and 30°C. Each air temperature was not sampled equally. To allow for this uneven sampling, for further analysis the number of reptiles found for each temperature were divided by the number of visits to each transect made at that temperature. This yields an 'average number of reptiles' per visit at each temperature (or temperature category where data are pooled). These values allow an estimate of the optimal ambient air temperature (OAAT) at which the greatest number of reptiles are recorded by removing the effect of multiple visits.

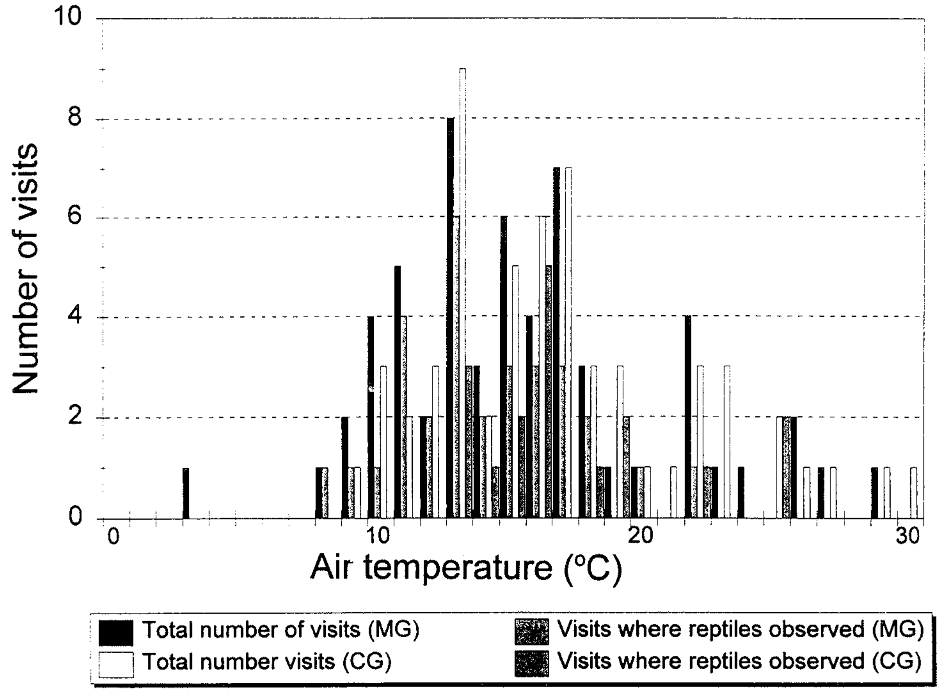


Figure 3. Number of visits and number of 'successful visits' (where one or more reptiles were obs erved) at each air temperature for the MG and CG transects at Fineshade Woods.

Data were pooled into 3° temperature categories to increase sample size; even so the number of visits in each category were small and so the results need to be treated with caution (for the 7 temperature categories from 3-6° to 27-30° samples sizes were 1, 7, 18, 20, 6, 4 and 2 visits for the MG transect and 0, 4, 16, 21, 8, 6 and 3 for the CG transect). Figure 4 shows that the highest average number of reptiles seen on the MG transect were during visits when air temperatures were 11-14°, followed by visits when the shade air temperature was 15-18°. The highest average number of observations per visit of reptiles using refuges on the MG transect were when air temperature was 15-18°. A greater number of animals on the MG transect were observed in the open at both 11-14° and 15-18° than were seen associated with the refuges. However the data on the CG transect yielded a less clear picture with reptiles only being seen in the open at 15-18° and 19-22°. A larger number of observations were associated with refuges with two 'peaks' at 15-18° and 23-26°.

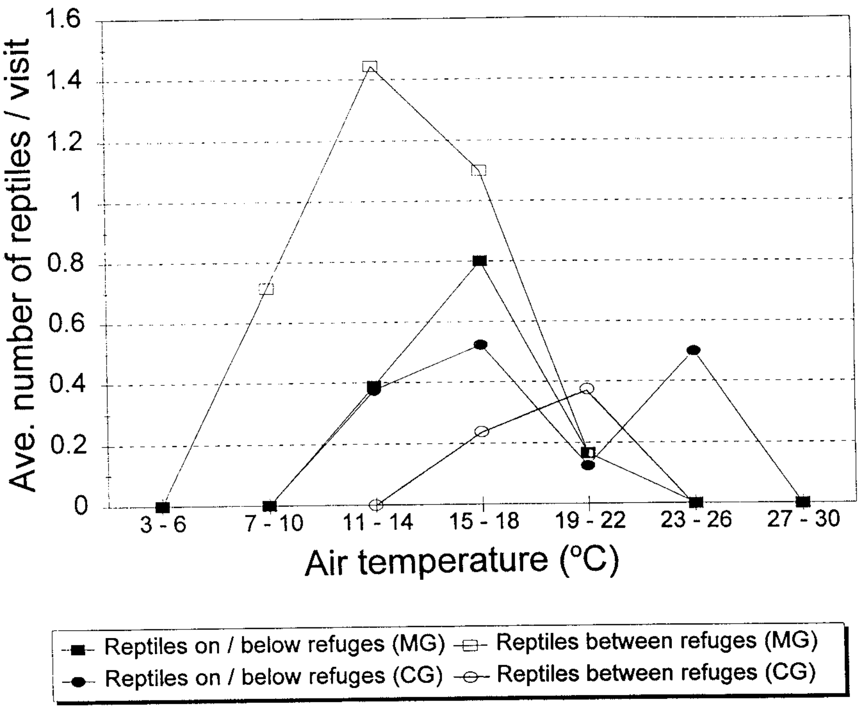
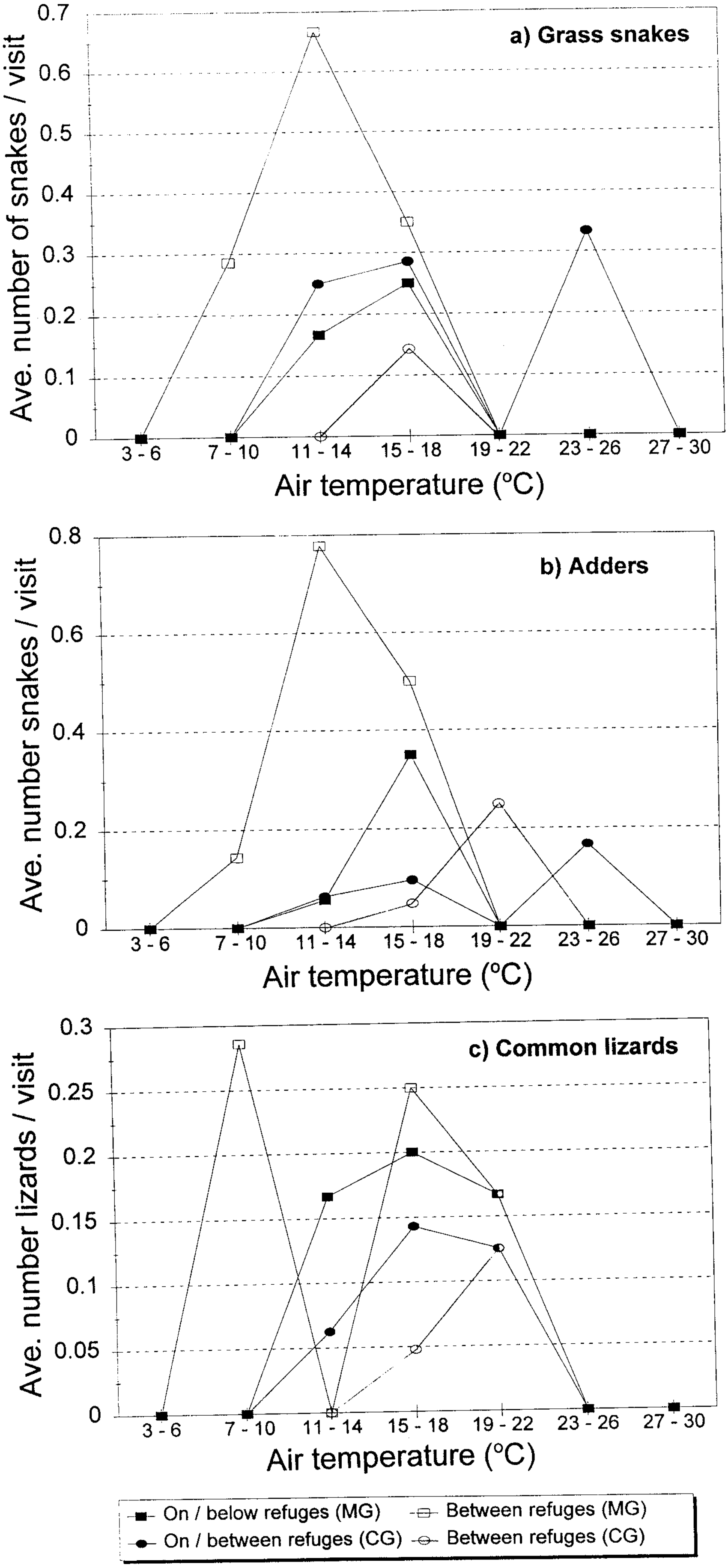


Figure 4. Average number of reptiles recorded per visit on / below refuges and between refuges at each shade air temperature category (4°C intervals) for the MG and CG transects at Fineshade Woods.

The frequency of observations for the different species of reptile are presented in Figures 5a. to 5c. Grass snakes (Figure 5a.) were seen on visits to the two types of grid transect when air temperatures were between 8° and 25°C (ie AATR = 8-25°C, n= 26 visits). This species was most frequently recorded in the open on the MG transects when air temperatures were 11-14°, though they were only recorded in the open on the CG transect at 15-18°. Refuges were used on both the CG and MG transects between 7-10° and 23-26° with a tendency for the greatest use when air temperatures were between 15-18°; however the greatest use of refuges on the CG grid was when air temperature was 23-26°. The location of adders (Figure 5b.) showed a similar pattern, with the AATR for this species also being 8-25°C (n= 24 visits). Most adders were seen in the open at 11-14°, though there were slightly more observations of adders than grass snakes at warmer temperatures. Use of refuges seemed to be greater in the slightly higher temperature category (15-18°), but again there was a peak of observations associated with refuges on the CG grid at 23-26°. Common lizards (Figure 5c.) were found between 9° and 22°C (n= 21 visits). They were more commonly seen between refuges in cooler weather on the MG with a decreasing rate of observation from 7-10° to 19-22°, while on the CG transect more were seen in the open when air temperatures were 19-22°. Use of refuges by common lizards on both the MG and CG transect was most frequent when air temperature was 15-18°.



Figures 5 a) - 5 c). Average number of reptiles seen per visit on / below refuges and between refuges at each shade air temperature category (4°C intervals) for a) grass snakes, b) adders and c) common lizards for the MG and CG transects at Fineshade Woods

From these data it is hard to determine optimal ambient air temperatures (OAAT) for survey for the different species, notably because of the apparently inconsistent observations between the MG and CG transects. Visual location of grass snakes away from refuges seems most likely between the upper end of the 11-14° and lower end of 15-18° category, while use of refuges seems to be more likely in the upper end of the 15-18° bracket. Adders have a similar OAAT category for visual observation, ie in the upper 11-14° / lower 15-18° range, though seemingly they can be seen over a wider range of temperatures. Use of refuges, likewise, seems to be more frequent in the 15-18° bracket. The OAAT category for visual location of common lizards cannot easily be determined, since the greatest number were recorded at 7-10° on the MG transect, but the majority of sightings, for pooled data were in the two categories 15-18° and 19-22°. Use of refuges though, peaked around 15-18° and this represents the OAAT category for this method of location.

Air temperatures and the use of different refuge materials

The use of different materials on the CG transect may be expected to vary with temperature, reflecting the different thermal properties of the materials. The average number of reptiles per visit seen associated with each material, for each temperature category, are presented in Figure 6 (data presented using 2° intervals). Reptiles were seen between refuges most commonly at 19-20°, though were also observed at 15-16° and 21-22°. Wood was used between 13-14° and 17-18°, but most commonly at 15-16°. Tin sheets were used over a wide range of temperature (13-14° to 25-26°), with a tendency for more use at the higher temperatures. Asbestos was most frequently used when air temperatures were 25-26°. The single occurrence of an animal under the rubber mat was at 19-20°.

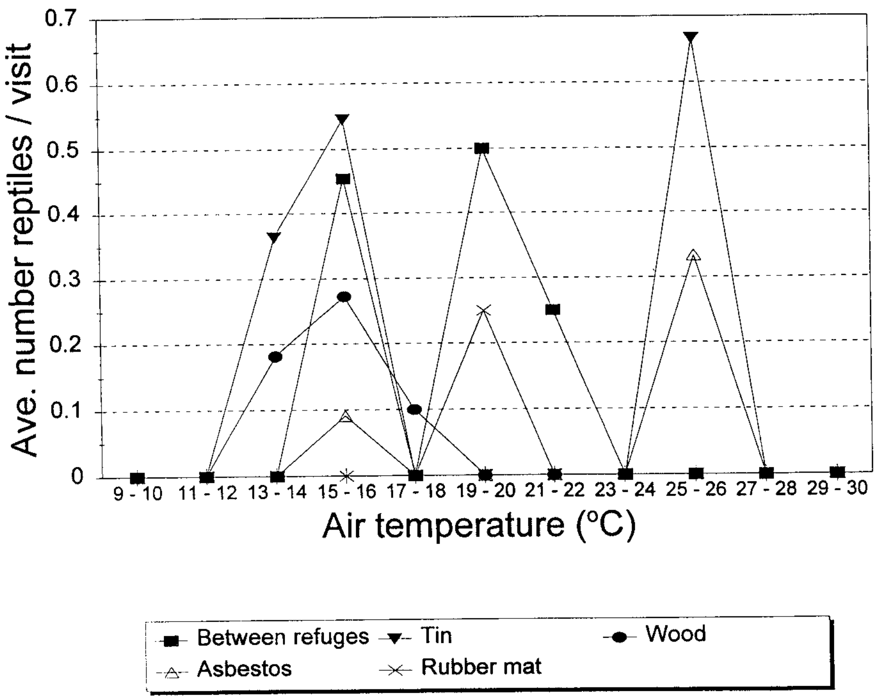


Figure 6. Average number of reptiles seen per visit between refuges, under tin, wood, asbestos and rubber mat refuges in each air temperature class (2°C intervals) on the CG transect at Fineshade Woods.

Effects of cloud cover

Visits were made during all different levels of cloud cover, though not all conditions were sampled equally. Most visits coincided with either cloudless (or almost cloudless) conditions or periods with almost total cloud cover. The frequency of visits to the MG and CG transects and the frequency of 'successful visits' (ie those in which at least one reptile was seen)for the different cloud cover conditions are presented in Figure 7. Reptiles were located during all different cloud cover conditions except when there was 6 eighths cover.

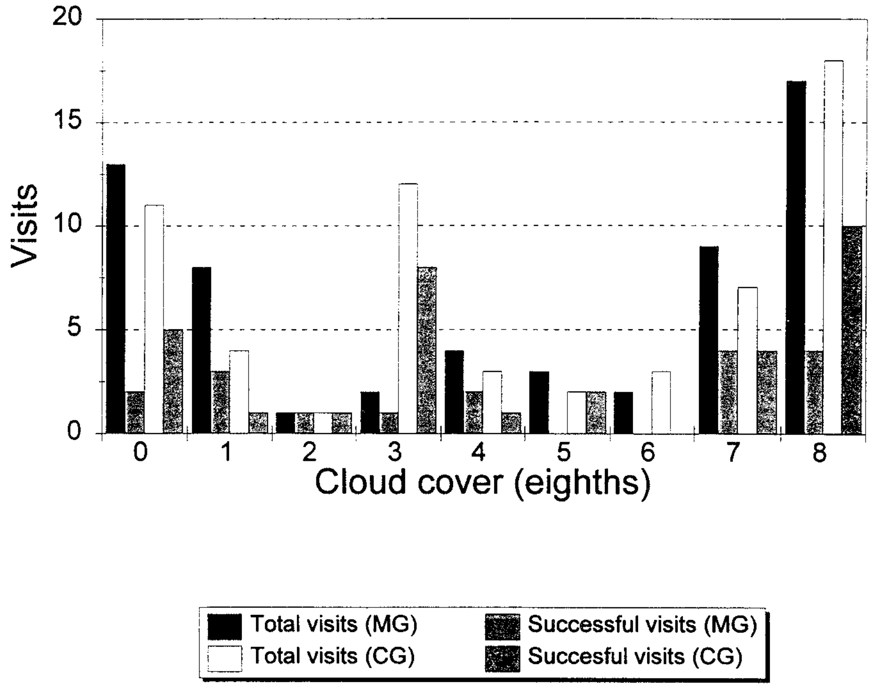


Figure 7. Number of visits and number of 'successful visits' (where one or more reptiles were observed) at each cloud cover category (eighths) for the MG and CG transects at Fineshade Woods.

Average numbers of reptiles seen were calculated for each level of cloud cover by dividing the total number of reptiles seen in each category by the number of visits made during those conditions. The average number of reptiles seen associated with refuges and between refuges for each cloud condition is presented in Figure 8. There was generally an evenly low level of sightings both on / below and between refuges in all the different cloud cover conditions. The use of refuges was generally higher with low levels of cloud cover (ie 1 to 3 eighths).

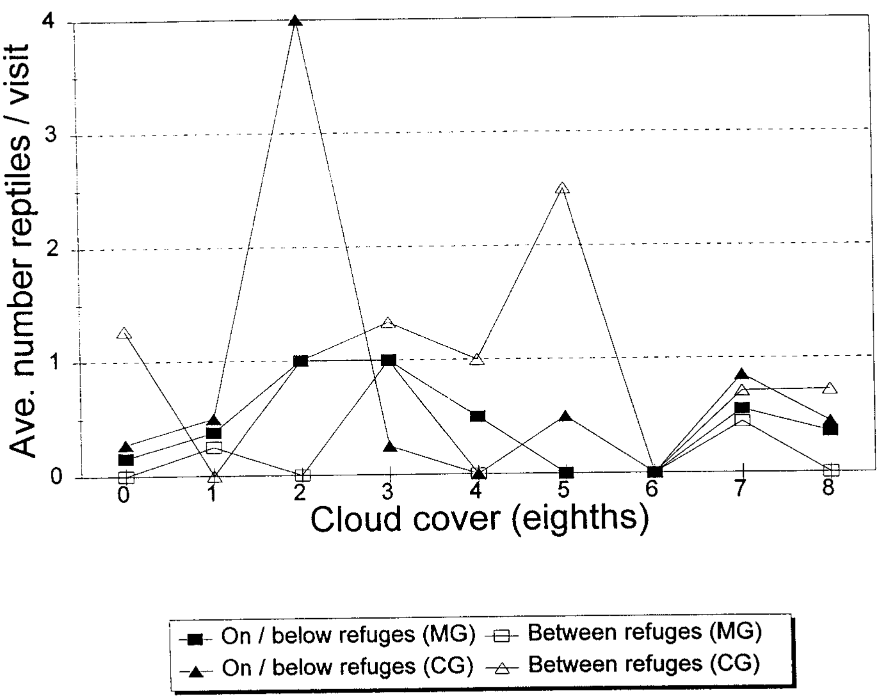


Figure 8. Average number of reptiles recorded per visit on / below refuges and between refuges at each cloud cover category (eighths) for the MG and CG transects at Fineshade Woods.

The average occurrence of each species relative to cloud cover is given in Figure 9. All species were located throughout the whole range of cloud cover conditions. There is a slight tendency for more observations of all species to occur during 'slightly cloudy' visits, ie 2 to 5 eighths cover.

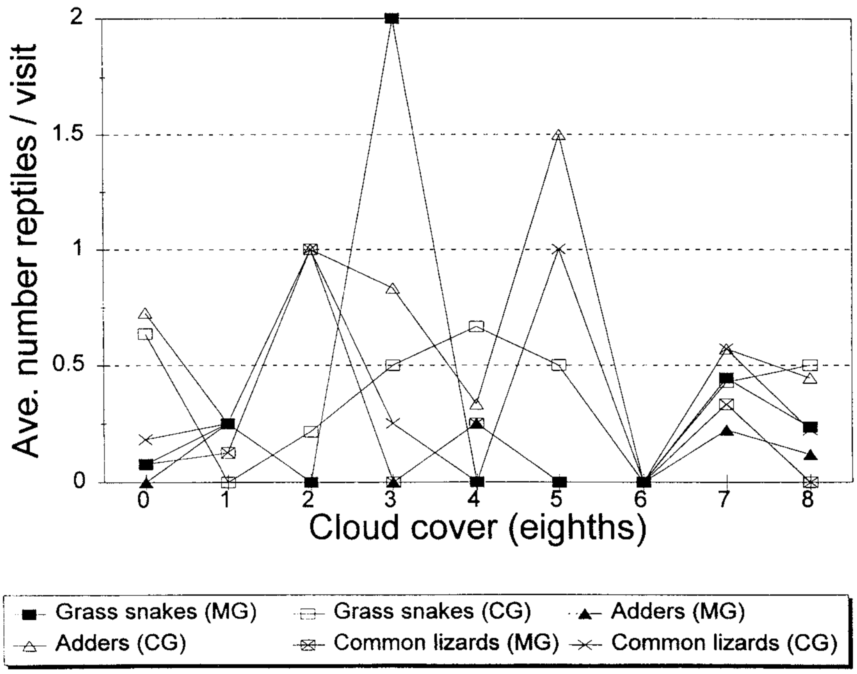


Figure 9. Average number of grass snakes, adders and common lizards recorded per visit at each cloud cover category (eighths) for the MG and CG transects at Fineshade Woods.

Abundance over the year

Uneven sampling effort over the months meant that more visits were made during early Summer (May and July) than at other times. There were notably fewer visits during late Autumn (October and November). Relative success, looking at the proportion of visits that yielded at least one observation of reptiles, was highest during May (Figure 10).

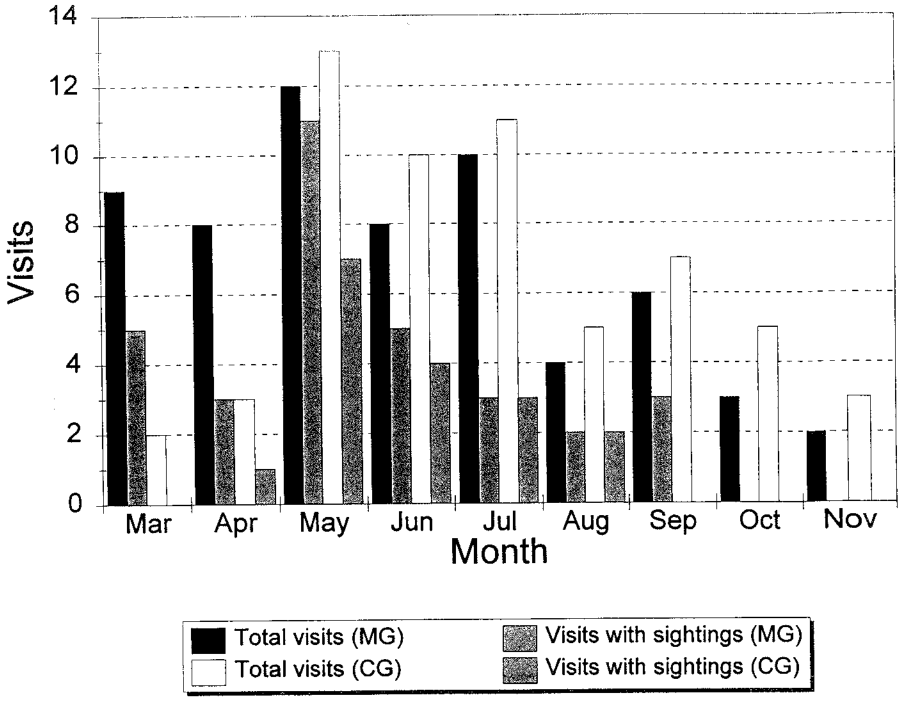


Figure 10. Number of visits and number of 'successful visits' (where one or more reptiles were observed) for each month for the MG and CG transects at Fineshade Woods during 1994 and 1995.

On the MG transect, more reptiles were seen per visit between refuges during the earlier months in the year, notably during April, while there was a general increase in the average number seen associated with refuges later in the year (notably August). However, on the CG transect June was the month with the highest average number of reptiles seen associated with refuges; data are too few to allow any similar comparisons for locations between the refuges on the CG transect (Figure 11).

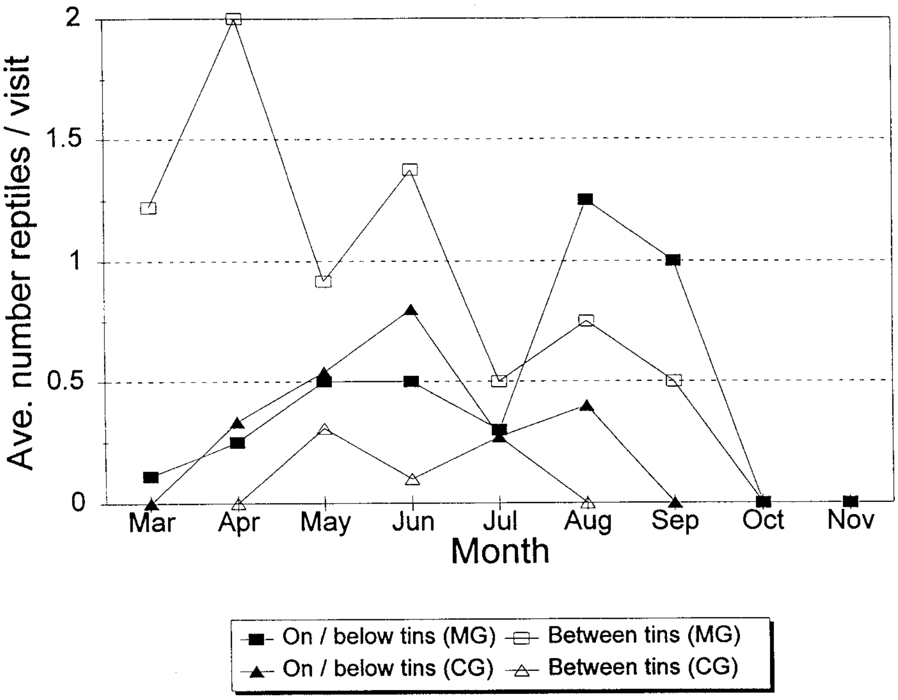


Figure 11. Average number of reptiles recorded per visit on / below refuges and between refuges for each month for the MG and CG transects at Fineshade Woods during 1994 and 1995.

The average number of reptiles of each of the three species observed during visits during each month are presented in Figure 12. No clear seasonal patterns emerge, with the exception of a generally reduced average number of animals seen during July, and an absence of records from October and November. The MG transect indicated a slight tendency for more adder sightings during April and September, while for grass snakes more reptiles were seen per visit in June and August. However these patterns are not clearly reflected in observations on the CG transect. Common lizards tended to be more commonly seen between May and June.

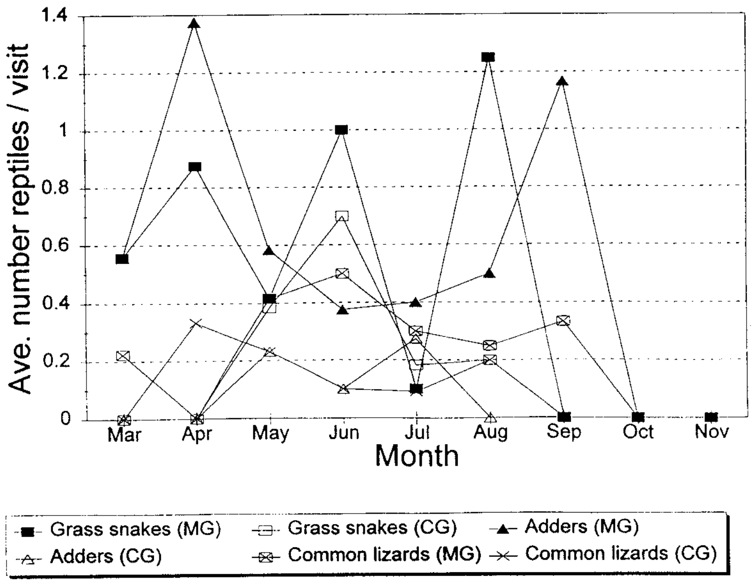


Figure 12. Average number of grass snakes, adders and common lizards recorded per visit for each month for the MG and CG transects at Fineshade Woods during 1994 and 1995

C. *Results from Frimley Hatches*

A total of 127 reptiles were observed at Frimley Hatches from 40 visits, averaging 3.18 reptiles per visit (Table 1). There were 48 observations of grass snakes, 36 observations of common lizards and 43 observations of slow-worms. No adders were recorded at Frimley Hatches.

All sampling took place from July to November during one year (1995); as such no attempt was made to make comparisons between sampling success in different months. Data were standardised to present data as sightings per 100m of transect length. The mean number of reptiles for each visit to the 1125 m transect were multiplied by 0.09 (Table 4).

Table 4. Descriptive statistics of reptile sightings, per 100m, from Frimley Hatches

	Reptile group	Mean	Standard deviation	Median
Frimley Hatches	All reptiles	0.1179	0.1543	0
	Grass snakes	0.0496	0.0695	0
	Common lizards	0.03095	0.0484	0
	Slow-worms	0.0405	0.0702	0

Effects of air temperature

All air temperatures from 14 to 33°C inclusive, with the exception of 16, 19 and 27°C, were sampled. Not all temperatures were sampled equally. Average number of reptiles seen at each air temperature, standardised for a 100m transect length, are presented in Figure 13. Variation between the species can be seen for each air temperature.

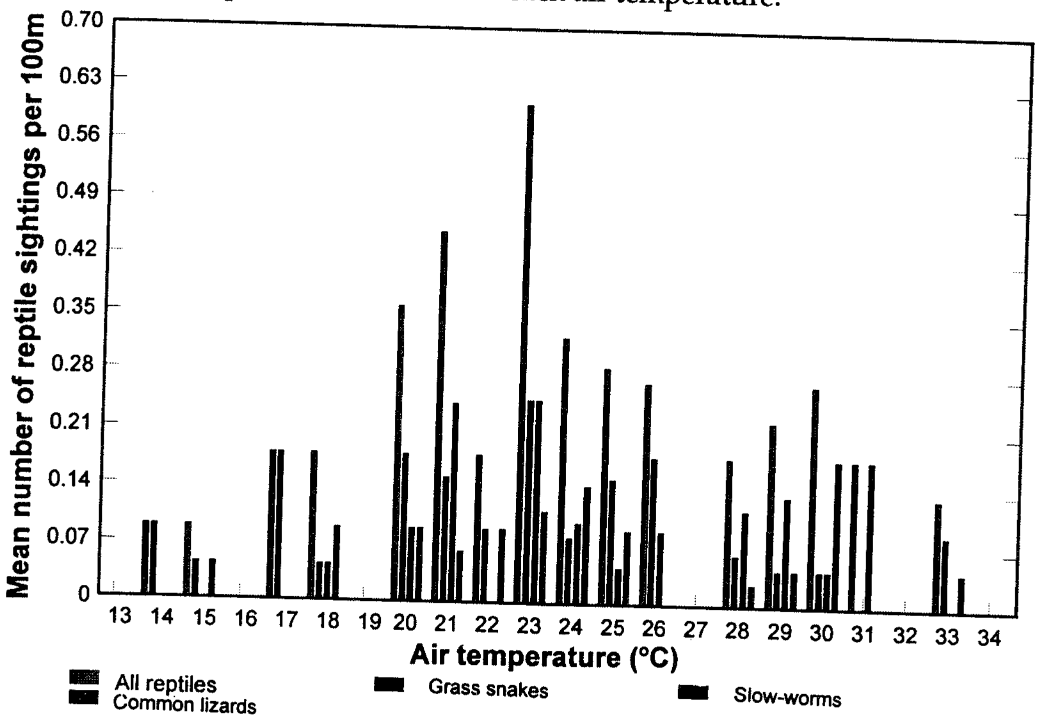


Figure 13. Average number of reptiles recorded per 100m per visit at each shade temperature for a) all reptiles, b) grass snakes, c) slow-worms and d) common lizards at Frimley Hatches.

Simple linear regression was considered inappropriate for studying the relationship between reptile observations and air temperatures. A Polynomial regression curve can be applied to give a 'parabola' curve (Zar 1984). The peak of this curve represents the optimal ambient air temperature (OAAT) at which more reptiles occur. The ANOVA of regression was applied to determine whether the data shows a significant correlation with the polynomial regression (if $p<0.05$ the data has a significant polynomial distribution).

The total number of reptiles found at Frimley Hatches had a modal frequency of 0.061 sightings, per 100m length of transect at the optimal ambient air temperature (OAAT) of 23°C (Figure 14).

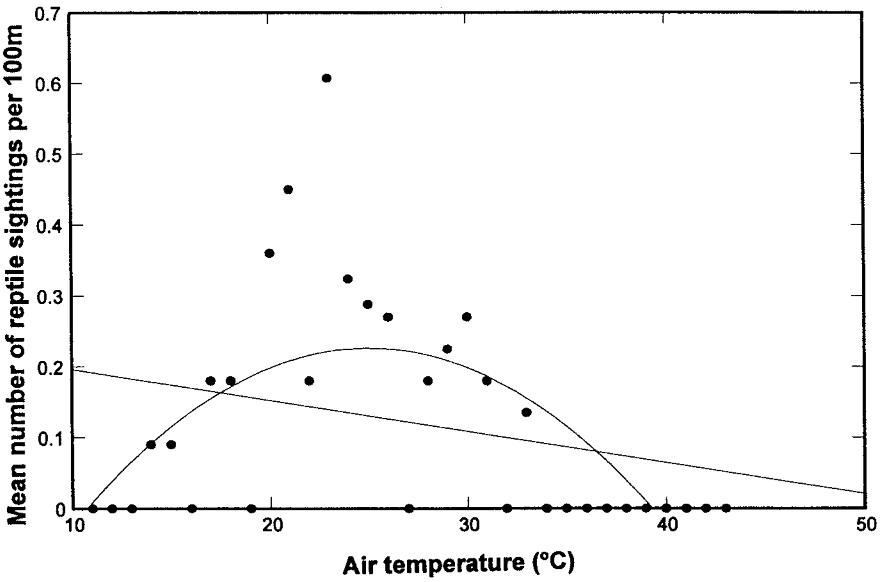


Figure 14. Relationship between air temperature and total reptile sightings per 100 m at Frimley Hatches.

Reptiles were found at the ambient air temperature range (AATR) of 14 to 33°C. There was a significant association between air temperature and the number of reptile sightings (Spearman rank correlation $p<0.05$). They also have a very highly significant polynomial regression (ANOVA $p< 0.001$).

Slow-worms had a modal frequency of 0.25 sightings per 100m at 23°C (Figure 15). Their AATR was 18 to 31°C, inclusive, though none were found at 22°C. There was not a significant association with air temperature (Spearman rank correlation $p>0.10$) but there was a significant polynomial regression (ANOVA $p=0.01$).

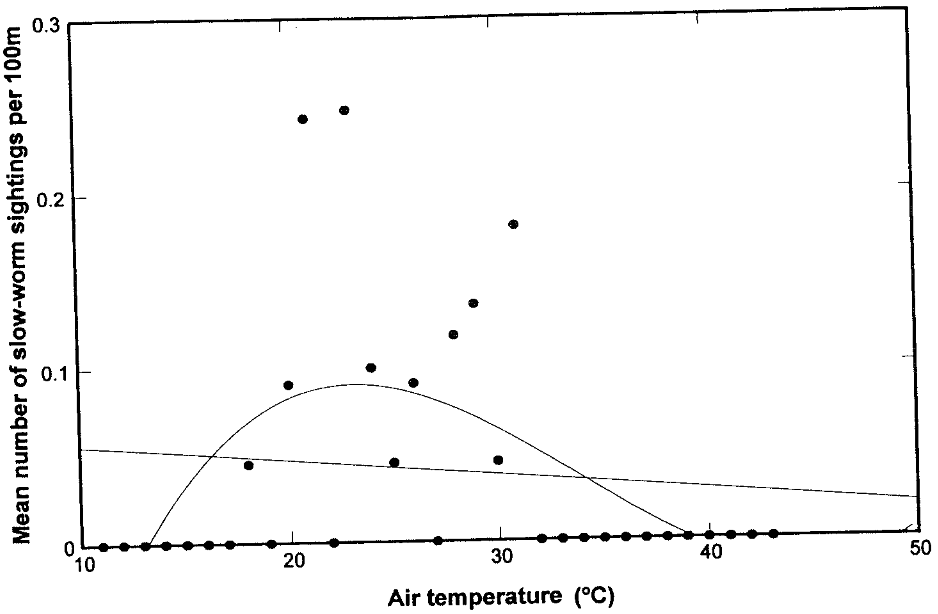


Figure 15. Relationship between air temperature and mean number of slow-worms observed per 100 m per visit at Frimley Hatches.

Grass snakes were most abundant with a modal frequency of 0.25 sightings per 100m at the OAAT of 23°C (Figure 16). The AATR was 14 to 33°C, although none were found at 31 and 32°C. There was a significant association with air temperature (Spearman rank correlation $p<0.02$). There is also a highly significant polynomial regression (ANOVA $p<0.005$).

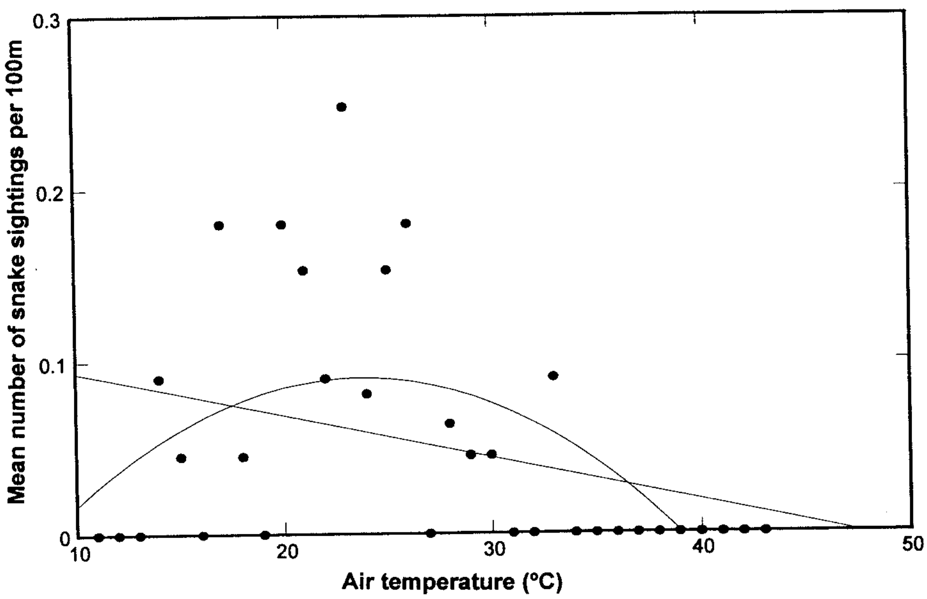


Figure 16. Relationship between air temperature and mean number of grass snakes observed per 100 m per visit at Frimley Hatches.

Common lizards had a modal frequency of 0.18 sightings per 100m at the OAAT 30°C (Figure 17). The AATR was 15 to 33°C, though none were seen at 17, 26, 31 and 32°C. Sightings had no significant association with air temperature (Spearman rank correlation $p>0.05$). There was a highly significant polynomial regression (ANOVA $p<0.01$).

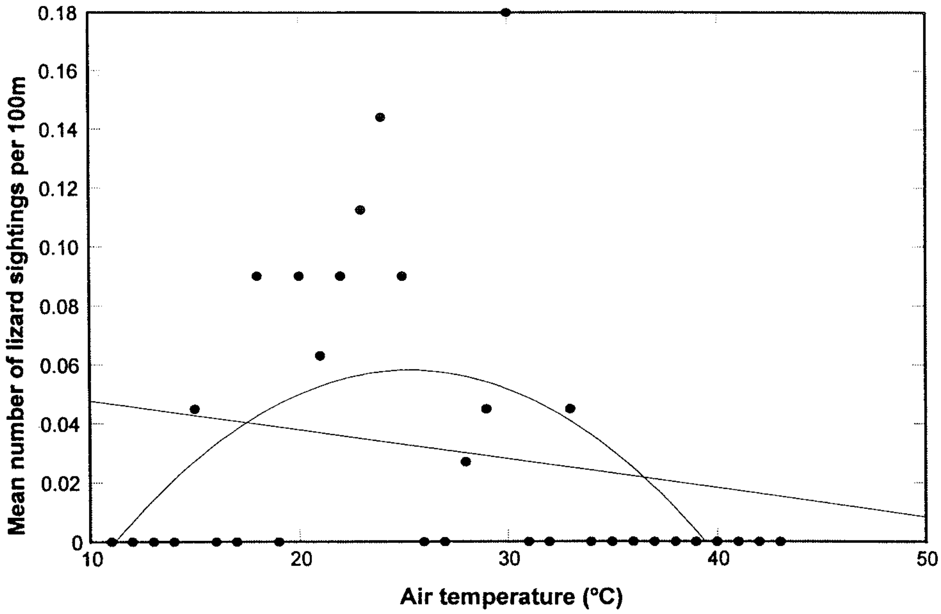


Figure 17. Relationship between air temperature and mean number of common lizards observed per 100 m per visit at Frimley Hatches

Spot temperatures

The spot temperature was taken of the micro-habitat for each reptile found at Frimley Hatches.

i. Grass snakes had a mean spot temperature of 25°C and an activity range between 14 to 41°C.

ii. Common lizards had a mean spot temperature of 26°C with a range from 11.4 to 43°C.

iii. Slow-worms had a mean spot temperature of 27°C and a range from 19.4 to 36.4°C.

The maximum recorded temperatures for grass snakes and common lizards appear excessively high; these values may have been caused by continued warming of the spot thermometer when held in sunlight or by a fault with the equipment.

Other environmental factors affecting reptile presence

The total number of reptiles found per transect walk was compared with rainfall, wind strength and cloud cover. There was only a significant positive association between reptiles and cloud cover (Spearman rank correlation $p<0.005$) (Figure 18).

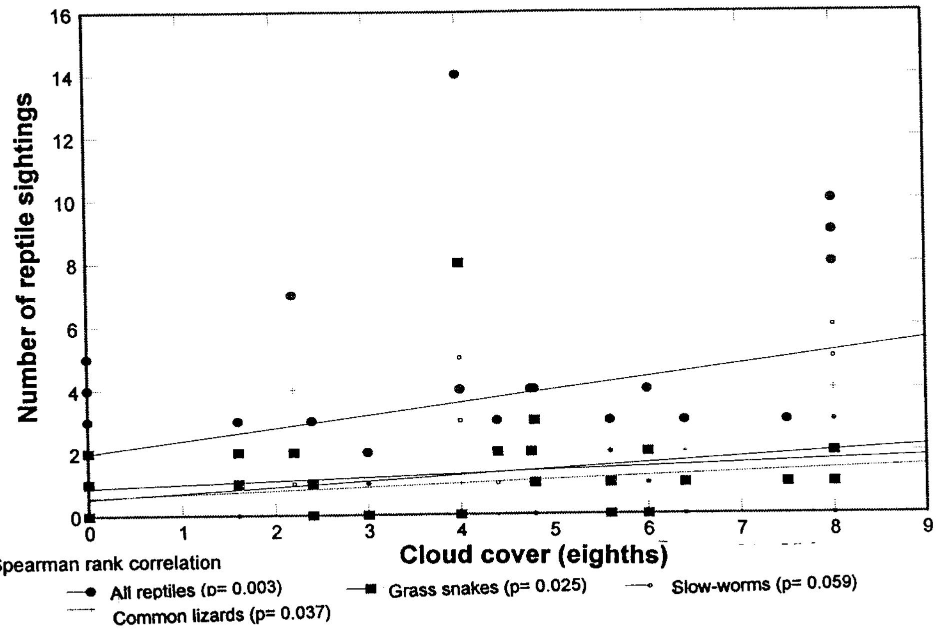


Figure 18. Relationship between cloud cover and number of reptile sightings per visit (total sightings per visit).

When cloud cover was compared to each species both common lizards ($p<0.05$) and grass snakes ($p<0.05$) showed a significant positive association. As cloud cover increases the number of reptile sightings also increased. Slow-worms showed no significant association ($p>0.05$).

Use of refuge materials and habitat type

More reptiles were found using refuges, usually sheltering under them, than occurring independently of them (Figure 19). The majority of individuals (49) were found under refuges previously present on site; 39 were on or under the metal refuges placed for this study. Only 2 observations were made of reptiles using the artificial wood refuges placed for this study. Of the 37 reptile sightings not using refuges, 24 were on logs, in grass or on heather (open vegetation). 13 were situated adjacent to or within tall, thick nettles, bracken, brambles or trees, where sunlight is limited at ground level (covered vegetation).

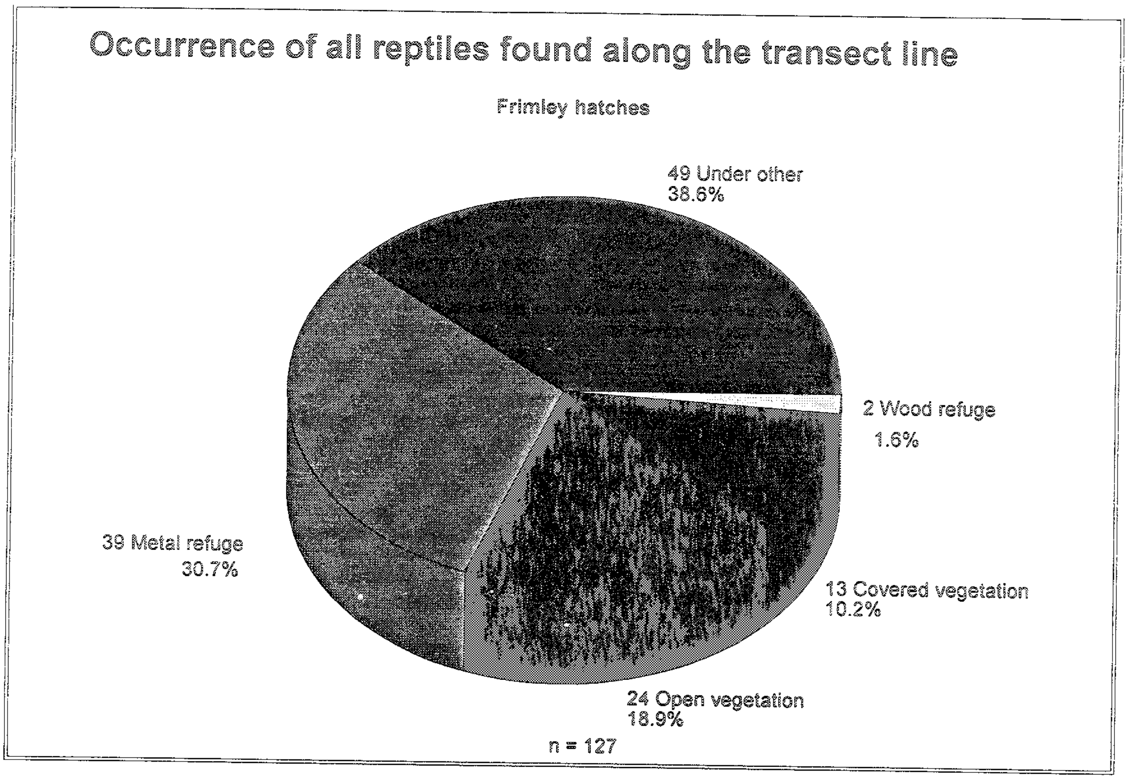


Figure 19. Use of habitats by, and association with refuges of, reptiles at Frimley Hatches.

There was no association between the use of refuges, by reptiles, and the habitat in which reptiles occurred ($\chi^2 = 2.745$, 2 d.f., $P>0.05$) (Table 5).

Table 5. The relationship between the use of refuges and the habitat type, for a chi squared test

	Open	Expected	Wood & metal	Expected	Under other refuge	Expected	Total
Open vegetation	24	22.39	29	25.5	26	31.1	79
Thick vegetation	13	13.61	12	15.5	23	18.9	48
Totals	37	-	41	-	49	-	127

Population estimation

There is a significant negative association between the number of reptiles observed and the distance at which they were found from the transect line ($p<0.05$) (Figure 20).

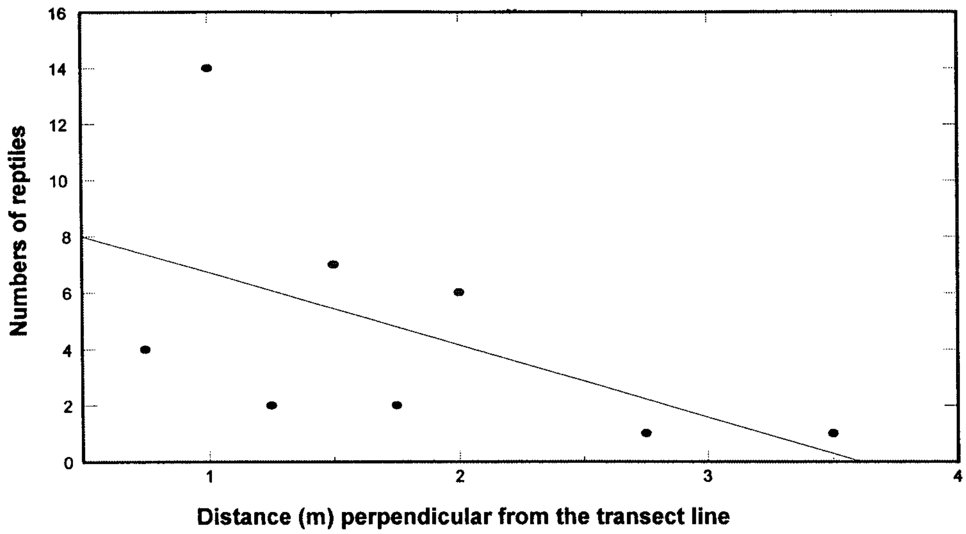


Figure 20. Distance at which reptiles seen in the open were located from the transect line at Frimley Hatches.

It would be expected that fewer reptiles would be seen the further you look from the transect line. Estimates of population density from transect samples can be made by calculating the number of animals within the area surveyed using: (i) the number of animals (or groups of animals) seen; (ii) length of the transect; and (iii) an estimate of the width sampled (Whitesides *et al* 1988). There are different methods for determining sample width, here the "effective width of transect" is taken as the distance after which there was a marked decrease, by half, in the number of reptiles found. This was 2m (Figure 20); as this distance was sampled on both sides of the transect line the total effective width is 4m. Hence the transect area is $4500m^2$ (4m width x 1125m length). In this area 35 sightings of reptiles were independent of refuges, giving a density of 0.78 reptiles per $100m^2$. Including all 127 sightings of animals (including both those found under and independent of refuges)a density of 2.82 reptiles per $100m^2$ is obtained.

Discussion

Limitations of the study methods

Drawing conclusions from the studies at both sites is made difficult by the small sample sizes in each case. Data collected by the different methods often gave unclear, and on occasions apparently contradictory, findings. It is probable that at any one time many factors that affect the behaviour of reptiles will be operating; these will include environmental parameters, such as air temperature, cloud cover and humidity; physiological condition such as the breeding, feeding and sloughing status of each animal and behavioural considerations, such as selection of different basking sites. On top of this there will be other 'inherent' factors influencing reptile behaviour such as differences between species, between sexes and ages within a species and differences in behaviour patterns that may occur during the course of a day or over a season.

The different methods and choice of different sites preclude pooling the data from the different transects at Fineshade and Frimley Hatches; it is also not possible to make comparisons between the two sets of data. However, these limitations serve to illustrate the problems associated with developing reptile survey methods since they will all be operating when surveys are being undertaken. The same constraints apply when trying to compare survey results from different sites and using different methods.

In attempting to identify factors that influence survey success it is important to be aware how these may relate to conditions experienced by the study animals. Shade air temperature is a simple parameter to measure but, due to the range of temperatures experienced on the ground on the basis of aspect and shading from vegetation and the ability of reptiles to actively thermoregulate, it may not truly reflect temperatures experienced by the reptile. Similarly the interaction of various factors, cloud cover, time of day (ie length of time the animal has been active) and preceding weather conditions will influence the behaviour of reptiles.

Notwithstanding these constraints, the collection of data that allows some targeting of survey effort is valuable.

Survey approach

Two approaches were used. One employed fixed grids of refuges, the other allowed a more flexible siting of refuges in areas that maximised the chance of finding reptiles. Associated with the positioning of the refuges is the choice of the transect walk between them. The fixed grid, while being placed in an area that was considered 'suitable' offered no flexibility for checking particular features likely to yield reptiles, such as log piles, banks, etc, unless they occurred within the grid. The more flexible system allowed such features, and other items of debris, etc, to be include within the transect walk.

That not all visits were successful demonstrates that repeat visits are necessary, even at good sites, to achieve the most basic level of survey information - ie. presence or absence recording. At Fineshade the MG and CG transects were successful on 52% and 29% of visits respectively; there are also low frequencies of sightings with, on average, 1.35 reptiles seen per visit on the MG transect (0.43 reptiles per 100m), 0.47 per visit (0.83 per 100m) at the CG transect and 3.18 reptiles per visit (0.12 per 100m) at Frimley Hatches. Furthermore the variation in numbers of reptiles seen during 'successful' visits shows that a series of visits are required if quantitative or comparative surveying is an objective.

These visits, though, covered a range of different temperatures, occurred at different to times of day and a range of weather conditions. Narrowing down survey to times and conditions when more reptiles are found should allow greater survey efficiency. This may also lead to a greater consistency of the data obtained and hence be more valuable for quantitative or comparative studies.

Defining survey conditions for standardisation requires the selection of easily measurable variables, such as air temperature or cloud cover. However in selecting these variables consideration must be given to how these variables actually affect reptile behaviour. The measurement of a single variable, or pairs of variables, will not necessarily allow a prediction of reptile behaviour.

Value of refuges

32 % of the observations of reptiles on the MG grid at Fineshade were associated with refuges; the equivalent figures for the CG grid and at Frimley Hatches were 72% and 42%. These

figures equate to 0.02 (27÷19÷62), 0.02 (21÷16÷58) and 0.03 (48÷40÷40) sightings on / below refuges per refuge per visit on the three grids respectively.

Different materials were used to different degrees; metal sheets accounted for 57% of the sightings of reptiles using refuges at the CG grid, with 29% using wood, 10% using wood and 5% under rubber mats. At Frimley Hatches where there was a choice between two different deliberately placed materials, wood and metal. Only 2 of 41 observations (5%) associated with refuges were on the wood; the remaining 39 (95%) were using the metal sheeting. A further 49 observations at this site were associated with other 'refuges' (debris, etc) already present on the site.

Increasing density of refuges may account for an increase in their use when comparing the CG and MG transects at Fineshade (with 0.11 refuges per m^2 [16/144 m^2] cf. 0.005 refuges per m^2 [19 / 3675 m^2] respectively), this despite the fact that some of the materials appeared less attractive than tin. At Frimley Hatches, assuming a 4 m wide 'grid', there were 40 refuges placed in 4500 m^2; thus a refuge density of 0.009 refuges per m^2. The relatively higher occurrence of reptiles using the refuges at Frimley Hatches though is probably related to the way in which the refuges were positioned. Selecting particular feature that are 'likely' to attract reptiles and positioning refuges there, will lead to an increased use of the refuges. The rigid 'grid' patterns adhered to in the MG and CG grid, allowed only a limited degree of flexibility in siting the refuges.

As well as providing a useful means for locating reptiles, refuges provide a useful means for standardising survey effort. Fixed grids allow for consistent and repeatable survey effort. Looking for reptiles under refuges is comparatively easy and requires less 'fieldcraft'. As such this method reduces observer bias.

Effect of weather

The use of polygonal regression analysis on the data collected at Frimley Hatches provided a means of identifying optimal ambient air temperatures for survey for the different species. Graphically displaying data collected at Fineshade, especially using pooled categories, did not allow such analysis but identified air temperature categories that yielded the most sightings (optimal ambient air temperature categories). These data are summarised, along with body temperature data collected in other studies, in Table 6. With limited data these figures should be treated with caution, however there is some indication that different species are found more frequently under different conditions. The ambient air temperature ranges (AATRs) collected for each species are valuable in defining the extremes of air temperatures in which reptiles are seen. Survey should not be undertaken outside these temperature ranges. Using the OAAT data as a further guide survey can be restricted to a more limited range of air temperatures.

Table 6. Preferred environmental temperatures of reptiles from Fineshade and Frimley Hatches, with reference to body temperatures

	Grass snake	Common lizard	Slow-worm	Adder	Total reptiles
Optimal body temperature °C	29.3[1]	29.9 - 34[2]	24.9[3]	33.2[1]	-
Voluntary mean (body) temperature[4] °C	26	32	23	30	-
Voluntary range[4] °C	15 - 36	22 - 38	14 - 29	20 - 38	-
AATR°C (Fineshade)	8 - 25	11 - 23	-	8 - 25	8 - 25
AATR°C (Frimley Hatches)	14 - 33	15 - 33	18 - 31	-	14 - 33
OAAT category °C in open (Fineshade)	11-18	15-22	-	11-18	11-14
OAAT category °C below refuge (Fineshade)	15-18	15-18	-	15-18	15-18
OAAT °C (Frimley Hatches)	23	30	23	-	23
Mean spot temperature °C (Frimley Hatches)	25	26	27	-	26
Spot temperature range °C (Frimley Hatches)	14 - 41	11.4 - 43	19.4 - 36.4	-	11.4 - 41

[1]Gaywood 1990; [2]Van Damme et al 1986; [3]Smith 1990; [4]Spellerberg 1976; OAAT=Optimal ambient air temperature; AATR=Ambient air temperature range;

Missing from this simplistic analysis is the effect of cloud cover, and other environmental factor, such as solar radiation. The amount of sun reaching a reptile has a major impact on the body temperature; more so than the ambient air temperature. The studies at Fineshade indicated a tendency for more reptiles to be found associated with refuges in low levels of cloud cover, but a general tendency for more to be seen during 'intermediately' cloudy days. However the results from Frimley Hatches indicate that more reptiles are seen in cloudy conditions. While these observations appear contradictory, they can be explained by looking at the conditions under which survey was undertaken. The Frimley Hatches data were collected mostly during a hot Summer and Autumn period; the Fineshade data, collected over two years would have encompassed a wider range of temperature conditions. Equally, the warmth received from the sun will be influenced by factors other than cloud cover (such as time of day, season, etc). These observations emphasise the importance of looking at the interaction between environmental variables.

Seasonal variation

The data collected at Fineshade suggest that more animals are seen early in the year, notably in April, and that more visits are successful during May. Adders seem to be most readily located during April and September; grass snakes in June and August. There are generally lower numbers of observations of reptiles made during July.

Reptiles have distinct activity seasons, usually from March through to October, although there is some variation between species. Within this period the likelihood of finding reptiles will be influenced by a combination of the animals physiological needs and the weather. Early in the year reptiles need to bask following their winter inactivity to allow the development of gametes prior to mating. The combination of this requirement and generally cooler weather, means that reptiles are often most easy to see during late March through to end of May. Increased activity and warmer weather result in a decrease in the time spent basking and a consequent reduction in numbers of observations. Usually later in the year, with cooling weather and an increased need to bask, especially by females of those species bearing live young, there is a second period when reptiles become more easily seen.

Conclusions

Reptile survey is difficult and repeat surveys are needed for even 'presence/absence' information, and more visits needed for quantified or comparative survey.

Survey can be assisted by placing refuges, which not only enhance data collection and reduce the need for 'field craft' but allow some degree of standardisation. Choice of material will affect success; this study indicates that metal sheeting is the best material to use. Selection of transect walk and positioning of tin to incorporate 'favourable' features can allow greater numbers to be seen which is valuable for 'presence/absence' survey or, if repeated for comparisons within one site. However this requires some pre-conception of 'favourable' habitat features and introduces observer bias. Fixed transects do not allow this flexibility and as such do not allow observers to maximise their chances of finding animals. However their strengths are that they are repeatable, comparable between sites and reduce observer bias. The choice of method used should depend on the objectives of the study.

Concentrating survey effort early in the year (between late April and mid-June) with a further series of visits in late August or September should prove most productive. In addition narrowing the survey period down to times when air temperatures are between 15 and 25°C, generally with less cloud cover at the lower end of this scale and more cloud at the warmer temperatures, will not only improve survey efficiency but should help allow a degree of standardisation of results for comparative and quantitative studies.

Acknowledgments

The authors are grateful for help from many people during the course of these studies. The Blackwater Valley team, James Bloomfield and Asher Minns advised on suitable sites. The Shepherd family and also Sean Dhadiala kindly provided transport for equipment. Thanks go to the staff of Forest Enterprise at Top Lodge, Fineshade, and in particular Keith Wilson, Jim Alexander and Richard Eckton, for permission to use the site and for assistance in the field. Thanks also to Nick Milton for assistance in the field and for collecting some of the data.

Thanks (especially from MC) to Kim, Meera, Dan, James H, Simon and Belinda for their moral support. Special thanks go to Dr. Pat Morris for his supervision, guidance and comments on 'early' drafts.

References

GENT, T. 1994. Survey and monitoring of reptiles. *Species Conservation Handbook, HERPS 3.1,* Peterborough: English Nature.

GAYWOOD, M. J. 1990. Comparative thermal ecology of British snakes. *Unpublished PhD Thesis, University of Southampton.*

SMITH, N. D. 1990. The ecology of the slow-worm *Anguis fragilis* in southern England. *Unpublished M. Phil. Thesis, University of Southampton.*

SPELLERBERG, I. F. 1975. *Conservation and management of Britain's reptiles based on their ecological and behavioural requirements: a progress report.*

SPELLERBERG, I. F. 1976. Adaptations of reptiles to cold. *In*: D'A.A. BELLAIRS & C.B. COX, eds. *Morphology and biology of the Reptilia.* Linn. Soc. Symp. Series. No. 3: 261-285.

VAN DAMME, R., BAUWENS, D. & VERHEYEN, R.D. 1986. Selected body temperature in the lizard *Lacerta vivipara*: variation within and between populations. *J. Therm. Biol. Vol. II. (4).*

WHITESIDES, G. H., OATES, J. F., GREEN, S. M. & KLUBERDANZ, R. P. 1988. Estimating primate densities from transects in a West African rain forest: a comparison of techniques. *J. Anim. Ecol.* **57**: 345-367.

ZAR, J. H. 1984. *Biostatistical analysis.* 2nd Ed. Prentice & Hall.

Discussion: The use of refugia in reptile surveys

Henry Arnold: Do you have data that shows the success rate for finding reptiles under the various different temperatures on which visits were made? I think in this way we can get a more precise measure of which are the best temperatures to survey in.

Tony Gent: There is a clear bias in sampling effort towards the middle of the temperature range and this is clearly a factor we should take into account when interpreting these results. However the results do show that there are proportionately more sightings in the middle of the temperature range even after sampling effort is accounted for.

Mabel Cheung: It's worth mentioning that these visits were made haphazardly, time was available, rather than setting particular times of the day to sample.

Tony Gent: It's true that this study doesn't have a particularly rigid experimental design but the sampling had to fit in around other activities. However I think it still provides some useful pointers and also serves as a useful comparison to Chris Reading's study in Wareham Forest.

Henry Arnold: Volunteers and members of local herp groups tend to work under the same conditions.

Jim Alexander: The local ranger who was helping Tony out on this project is under the impression that reptiles on the site have been in decline during the study period and do you have any evidence to prove or disprove this belief?

Tony Gent: My gut feeling would probably be the same. Interestingly I had the same feeling during my three year study for my PhD in the New Forest. In fact it wouldn't surprise me if intensive survey of the site actually discourages reptiles from using it.

Jim Alexander: I think you also have to be wary about putting out pieces of shiny metal. If studies are going to carry on over several years, more people may know about the refuges and this may cause further disturbance.

Tony Gent: This is a very valid concern and one of the recommendations for survey should be that tins should be removed immediately after the survey period has ended. Another suggestion would be to have smaller numbers of tins biased to where you are more likely to find reptiles but, at the same time, in places where people are less likely to find them. In the New Forest we also tried to camouflage tins which worked quite well.

Tom Langton: I would just like to pull together a number of points from all the talks we've heard. Jim introduced a rough method for assessing reptile populations which divided sites into three categories. This still requires testing and thre is still a need for more comments on assessing what you find during survey work. It may be possible to come to more agreement on what can be considered acceptable in terms of factors such as when to visit a site, the best time of day and best weather conditions. We've heard today that temperature can certainly have an effect and different species have different preferences. It seems to me that the one aspect we haven't yet covered is humidity. One of the things that I've noticed is that if you have a significant dry period and then you get rain and a sunny day then that's often the time when you'll see the most animals, both out basking and under the tins. Now I can see how we can quite easily standardise for temperature and for time of day and probably also for tin substrate and maybe we should be trying to standardise the types of material that people use but when it comes to humidity it may be a bit more difficult. It is so unpredictable, yet it's a very important factor. I believe that the depression in slow-worm sightings that we were seeing last summer was as much due to the lack of moisture as the temperature. However I don't know how we are going to deal with that. It's particularly difficult for people like ourselves who are asked to do short surveys at very short notice. I'd be very interested to hear if anyone does have any suggestions on how we could measure and deal with humidity.

Keith Corbett: One comment is that, hopefully, last summer's drought was exceptional and that would have dried out anything. Also, the refuges you choose are going to have some bearing on the kind of humidity that you are going to provide. If you put down carpets you are going to create very sodden conditions, whereas if you put tins out, the conditions will be a lot more dry underneath and the wood will be in between that. Perhaps if you're looking at animals like the slow-worm which would have a higher moisture preference then you'd choose a substrate to match that requirement and this would differ from surveys where you were looking for, for example, adders or common lizards. You can only really test this experimentally. Where consultants or others are required to do a survey at short notice in a short period of time, this causes me concern, mainly because it applies to 'rescues' as much as it applies to a survey prior to the planning application process. HCT are insisting at the moment that any rescue has to involve a spring period. I think that from everybody's talks today, that spring is the time when you're going to find the most reptiles. However, I don't know if consultants can insist that their clients commission a survey with a spring period. I'd like to see that happen but it may not be practical.

Tom Langton: I wonder if we could possibly consider expressing survey results in relation to a number of days after last rain. This would be something you could find out from local weather stations. Although we should advise to survey when the weather's perfect, I think this may not be practical for the vast amount of planning matters which just won't be held up at present due to commercial pressures.

Tony Gent: The other way to handle this is to construct some of 'fiddle factor' which would account for the weather. You would survey on the days that you have to and then multiply up your findings by this factor. So, for example, if you were surveying early in the season and it was a cold day then you would see probably a small number of animals but you would then multiply that up by a factor to take into account the weather. Similarly you could have correction factors for different substrates. So, if you use wood which isn't so good as, say, tin then you can probably have a factor which equates to two kinds of substrates. So, although all the conditions you experience in the field will make survey results very variable, we can perhaps think of these correction factors to take into account all the various environmental factors to produce standardised results and this would be particularly useful if we were, for example, wanting to monitor changes in population size rather than simply presence or absence.

Howard Inns: I'd just like to make a general point about refuges. Certainly tins are very useful if you're trying to capture animals to move them or if you're using a site which has no public access, such as the one which Anne was talking about earlier. But in terms of looking at sites to try to assess their specific value, I think the point that Jim made earlier was very important and that was that you do put animals at risk by putting tins on a site. I think if we're recommending that people go out to find their important reptile sites then I think we should actually down-play the use of refuges. We should encourage people to go looking for basking animals rather than litter places with tin, wood or asbestos. I think that you would have to choose sites very carefully if you wanted to use refuges as a monitoring tool.

Jim Foster: I think the other point to mention about tins is that, if you are using them to monitor a site, the temptation is simply to wander between the tins and not to search areas between tins and therefore to reduce the time on site and miss basking animals.

Chris Reading: It also really depends on what you are after. If you are looking for an estimate of population size as opposed to presence or absence then by only looking in areas where you expect to find them you will be biasing your sample. You should really look at representative areas from the whole of the patch of habitat in question.

Tony Gent: I think the kinds of habitats that you would want to look in would also vary with species. For example, for sand lizards the way in which you would look would be very different to the way in which you would look for slow-worms and perhaps also the distribution of the animals themselves within that habitat would be very different. For example, in a patch of scrubby grassland slow-worms might be fairly evenly distributed around the site, whereas if there are any obvious features, banks or hedges then you may well get a concentration of animals. I wonder if anyone has any views on slow-worm sampling without tins.

Anne Riddell: Before I started the main study which I am talking about today, I did have four survey sites on the Reserve which were highly visible from nature trails and were prone to more public disturbance. On the issue of what materials to use, I would say that tins are highly attractive to people walking past. They are very obvious whereas, for example, old bits of carpet that blend in with the background don't attract so much attention. Certainly it was always the tins which were interfered with more on my site and those refugia placed near trees or a tree belt were the most successful.

Tony Gent: Betty, did you have any experiences with interference with your tins on your sites?

Betty Platenberg: If I wrote an obvious message on the tin saying 'please do not disturb' then in general people didn't interfere with them, but at one site young children were interfering with them too much. With reference to the earlier matter of whether it would be possible to do a survey for slow-worms without putting down refugia; I don't think in that instance you would get very good results because I have seen very few basking animals.

Anne Riddell: I scored very few encounters of basking slow-worms. Only 5 out of over 200 encounters of slow-worms in total, a very small percentage of all the animals that I saw.

Bill Whitaker: In the slides presented by the last three speakers, the tins appeared to be shiny. When we've done surveys, we tend to use rusty tins. My question is were you all using shiny tins or did you also try to use darker tins? Also, did you put the tins on what I would call a suitable herpetological feature and lastly, as a general point I'd like to make, you can use quite small tins. They don't have to be huge.

Mabel Cheung: We used brand new tins but we did spray them to camouflage them against the habitat. We also tried to place them in the same substrate.

Tony Gent: The site for the tins was chosen on a grid basis. So it would be interesting to look at the successes of different tins relative to features.

Anne Riddell: Mine were a mixture. Some were rusty and some were brand new. The tins were generally 80 cm x 80 cm but I did have some which were much smaller.

Betty Platenberg: My tins were primarily new, and not rusty, although there were a few old ones used. Next year I'd like to try spray painting them. I also tended to use other refugia such as wash tubs and buckets which were lying around on the site.

James Cadbury: I am not a herpetologist but I have been impressed by the need to get better quantitative data. Anne pinpointed the importance of identifying individual animals using individual patterns. This is a technique which has been used in some bird species. I think this is useful because it provides another dimension and it is an important one because it provides a way of finding out how many individuals are on the site without resorting to more expensive methods such as pit tagging. I wonder how much mark-release techniques are used in herpetology. This would obviously give you ideas of population size. The point about the tins is that they are really collecting aids and using them you learn very little about the ecology of the animals. I would imagine there's a lot more to be learnt about, for example, where the animals hibernate, where the immatures disperse to and so on.

Bill Whitaker: Generally speaking, refuges are ideal for establishing presence or absence, particularly when different kinds of refuges are used. My main reservation against tins is that I have found them to be of very little use for common lizards or sand lizards but it seems that roofing felt is better for lizards from what we have heard today. Even finding the animals on some sites can be difficult so I would say that, once you've determined the presence of any species on a site, the site should be identified for conservation purposes.

Tony Gent: I wonder if Chris would like to comment on the use of individual marking techniques.

Chris Reading: I would only like to comment that toe clipping for individuals has a limited use. It might be of use for marking cohorts perhaps. That's certainly a technique I've used for toads but I would not mark individuals because it involves taking too many toes off. I'm a little unhappy about looking for patterns for individuals. It's a method I haven't used myself and the main reason for that is that I have doubts about how the patterns may change with time. When you're dealing with large populations, the speed with which you can recognise individuals also worries me. As we've heard, pit tagging can now be used for individual recognition but it's not so good for some species. For example, I don't think it would work for slow-worms. It cannot be applied to common lizards because of their body size. It may be applicable to sand lizards but I have reservations because of their size. It certainly can be used in all three snakes. It can be used in frogs and toads and perhaps in great crested newts but again there might be a problem with body size there. As a method I think it's very good. It's not obvious that the animal has been marked. You can visit the site year after year and identify individuals without doubt; that is the major benefit of this method.

Keith Corbett: I think we have to be clear about whether we are dealing with a population study such as that described by Anne or a more general survey or monitoring exercise. Anne's study is very interesting and definitely a population study of slow-worms is required. I think her methods are very valid but they require an immense input of time and effort and, with the number of sites that BHS and HCT have to monitor each year, we just can't afford to put the amount of time and resources in each year to collect such detailed quantitative data.

Tom Langton: I'd like to come back to the idea of setting standards for refuge surveys. I accept that there are risks in that tins can be disturbed by people and I think perhaps people could be camouflaging tins more than they do at present. Maybe there is even a standard way that we can camouflage tins. Tin size is another factor which could be standardised. I feel quite strongly that tin is the right material to stay with. Tins perhaps aren't so good for the legged lizards, although I have myself seen a lot of common lizards sitting on top of tins.

With the snakes and the slow-worm you get occasions where the tins become too hot for them to remain under them. One of the main reasons we use them is to extend the chance of finding the animals when the conditions become colder. So I would suggest that we should stick with tin or perhaps decide on tin as a standard. Corrugated tin varies in dimensions when you buy it from manufacturers and it also comes in different gauges: thicknesses and weights. What I suggest is that we try and work out a standard surface area for a piece of tin and we should also try and stick to a certain gauge of tin. I propose that we should decide on a national standard for the size of tin that people could follow. Though I do accept that on some very sensitive sites you may need to have a second, smaller recommended size.

Monitoring sand lizards in Dorset under the Species Recovery Programme

Keith Corbett and Nick Moulton
Herpetological Conservation Trust, 655a Christchurch Road, Boscombe, Bournemouth, Dorset BH1 4AP

Sand lizard *Lacerta agilis* monitoring was undertaken in spring and autumn in order to compare the results obtained from a pre-assessed route taking account of features likely to be used by *L. agilis* (termed 'Sand lizard' transect) and a straight line route (termed 'Random' transect) in the same area of Town Common, Dorset. It must be stressed that the object of this exercise was not to establish the presence or absence of the species, and indeed this area of Town Common was already well known in terms of reptile distribution, but more to test the practicality for repeated monitoring of a 'Pollard Walk' (as often designated for butterfly monitoring) with the more usual straight line transect method. In this context, it was decided that for regular monitoring it was essential to visit those habitat types and features most likely to support sand lizards in contrast to the 'Random' route which would cross optimum, sub-optimum and unsuitable habitats. It should be noted from previous habitat associated work from different parts of the sand lizard's UK range, that this species tends to be localised within sites, a fact underpinning all practical survey. It does, however, indicate that for regular monitoring each site might therefore have to have its own individual monitoring route or routes defined.

This area of Town Common was selected to reduce bias in that both transect routes could be planned to traverse the same general area and aspect of heathland, essentially from the higher dry to the lower wet. Two experienced herpetologists surveyed each route alternately and at the same time which also minimised observer bias. Whilst the 'Sand lizard' route was chosen to include mature heather, topographical irregularities, sandy paths etc, the 'Random' route also touched or crossed some of these same features.

A total of 10 surveys were undertaken, ie five in both spring and autumn in favourable survey conditions. The results of these surveys are summarised in Table 1.

Table 1. *L. agilis* transect monitoring Town Common, Dorset, spring-autumn 1995

Spring 1995	'Sand lizard'	'Random'
L.a. ♂	3	0
L.a. ♀	4	0
L.a. ♂ Imm. (93)	1	1
L.a. ♀ Imm. (93)	1	0
L.a. Imm. (94)	8	0
Total	17	1

Spring 1995	'Sand lizard'	'Random'
L.a. ♂ Imm. (93)	2	0
L.a. ♀ Imm. (93)	2	0
L.a. Juv. (95)	9	0
Total	13	0
Total L.a.	30	1

These results are being analysed statistically by Dr D Tamarind together with some habitat association data with a view to publication elsewhere. However, even without statistical interpretation the results strongly suggest that the straight line 'Random' transect concept for reptile monitoring is invalid and that accordingly individual site routes now need to be considered for relevant sites or parts of sites.

From simple comparison the 'Sand lizard' route had a 30:1 ratio of positive *L. agilis* sightings compared with the 'Random' route. It is also worth noting that even those animals identified along the 'Sand lizard' route were note evenly distributed but occurred in 'hot spots' that were predominantly associated with localised topographical features covered with mature dry heath and proximate to areas with a high proportion of sand. No *L. agilis* were found anywhere on this route where such habitat conditions were absent.

The only *L. agilis* found along the 'Random' route was also associated with a dry heath dominated topographical feature although there was no evident exposed sand within *c.*50 m of its sighting. This could probably be related to the immature stage of the animal concerned as it is then that *L. agilis* exhibits any disperals away from its population *foci* perhaps to colonise or subsist in sub-optimum localities.

It is equally significant that the only Juveniles found were along the 'Sand lizard' route and again associated with optimum habitat and especially with the exposed sand on paths and exposed banks etc.

We were also able to carry out some analysis using positive results for other reptile species and those lizard sightings unidentified during the survey - see Table 2 below.

Table 2. Transect monitoring Town Common, Dorset for other reptile species and unconfirmed reptiles: spring-autumn 1995

	'Sand Lizard'	'Random'
Spring 1995		
L.v. ♂	1	2
L.v. ♀	3	2
L.v. Imm.93	0	0
L.v. Imm.94	4	2
L.v. Total	**8**	**6**
Unidentified *Lacertids*	3	5
N.n. Imm.94	1	0
Autumn 1995		
L.v. ♂	2	0
L.v. ♀	3	0
L.v. Imm.	1	2
L.v. Juv.95	6	2
L.v. Total	**12**	**4**
Unidentified *Lacertids*	2	5
L.v. Combined Totals	**20**	**10**
Unidentified Totals	**5**	**10**
N.n. Totals	**1**	**0**

The 'Sand lizard' : 'Random' results of 20 : 10 positive sightings of *L. vivipara* was less contrasting. However, as *L. vivipara* are known to become scarce or absent at *L. agilis* colony locations, it might have been expected that a higher ration of *L. vivipara* would have occurred along the 'Random' transect route as a reflection of the other habitats utilised more by this species.

The ratio of 5:10 unconfirmed Lacertids in favour of the 'Random' transect has yet to be explained but may reflect problems of disturbance when transecting through deep vegetation.

Discussion

Keith Corbett: I think it's actually very difficult for us to come up with a method to pass on to other organisations which don't have experience of reptile survey whereby they can assess the size and distribution of reptile populations.

Chris Reading: We have to be clear about deciding between a survey to establish whether animals are present on site and a survey where we try to assess how many animals are present, and here I'll come back to my previous comments. That is, if you bias your sampling effort to areas where you expect to find reptiles you will make a good job of establishing whether reptiles are present. However, it will tell you nothing about the population size. I think we also have to bear in mind that, for example, sand lizards do have certain spots that they will use for breeding but they will use many other parts of a site for other activities at various other times of the year.

Keith Corbett: We consider that where you have optimal habitat then you are likely to have breeding, living and hibernation areas in close proximity to each other. Where the habitat is sub-optimal then it may be that to breed the animals have to travel several hundred metres. The problem is that if you wanted to find out exactly many sand lizards were on a site, you'd have to search absolutely everywhere. So we consider that the best use of our time is to concentrate on the best features that we term *foci.*

Chris Reading: But again that would only tell you about presence or absence. It wouldn't tell you about population size because you have a biased sample effort.

Keith Corbett: So how would you get an idea of population size without biasing your sample?

Chris Reading: The problem is that with a biased sample you will not be able to.

Monitoring the effects of stock-grazing on reptiles

Stuart Graham, Wildlife Enhancement Project Officer, English Nature Dorset Team, Slepe Farm, Arne, Wareham, Dorset BH20 5BN

Background

English Nature launched a Wildlife Enhancement Scheme for the Dorset Heathlands in August 1994. Its aim was to return the Dorset Heathlands to traditional management including stock grazing and scrub removal. The purpose of the grazing is to reduce the dominance of purple moor grass in the valley mires, provide tracks and poached ground, and reduce the rate of succession to woodland. Private landowners are encouraged to sign three year positive management agreements. English Nature pay the full costs of scrub removal, bracken treatment and enclosure of grazing units. The budget for the financial year 1995/96 was £236,000. In 1995/96 there were 30 Wildlife Enhancement Scheme Agreements encompassing 2,000 ha. A further 1,000 ha of adjacent heathland was enclosed within grazing schemes. By the end of 1996 English Nature estimate that 2,000 ha of heathland will have been returned to grazing - this is quarter of the total area of Dorset's heathland.

The need for re-introduction of stock grazing

Stock grazing has maintained the heathland ecosystem since the Iron Age. Historical evidence would suggest that low density extensive grazing by cattle and ponies was common on the Dorset Heathlands until earlier this century. Light stock grazing maintained the biodiversity of the heathlands by reducing the dominance of purple moor-grass in the bogs. The stock movements created bare ground and trackways on dry heath, a habitat favoured by many invertebrates and reptiles. Stock cause poaching of damp ground, especially around water holes maintaining valuable microhabitats absent in ungrazed heathlands.

Research into Dorset's heathland flora carried out during the 1930's by Professor Good (data held by Institute of Terrestrial Ecology, Furzebrook, Dorset), and repeated during the 1990's (Byfield, Cox & Pearman 1995), has demonstrated a dramatic decline in heathland botanical diversity during this period. These losses reflect the loss of habitats previously maintained by low density grazing. These habitats are crucial for the survival of both heathland plants and animals.

Monitoring the effects of grazing

English Nature has implemented a 10-year monitoring strategy to assess the effects of stock grazing on many plants and animals including reptiles.

There is a need to monitor change to:

1. determine the desired optimal grazing intensity required to produce desired changes in habitats;

2. achieve desired habitat diversification;

3. demonstrate the impact of grazing on various indicator species.

The monitoring programme involves an intensive study of Hartland Moor NNR in Dorset. This study will be repeated annually for 10 years. In addition to the Hartland Moor survey, data will be gathered from a number of other heathland sites in Dorset.

The main areas of monitoring are listed below:

Reptile Surveys	Sand lizard, smooth snake, all other species encountered.
Orthoptera Survey	Heath grasshopper, bog bush cricket, all other species encountered.
Butterfly Survey	Silver studded blue, grayling, all other species encountered.
Botanical quadrats	Dry heath, damp heath, valley mires and fens.
Birds	Dartford warbler, stonechat, woodlark, nightjar, hen harrier.
Aerial photography	At 1:3000 scale of Hartland Moor and eight other grazing schemes.
Habitat change	Vegetation heights and type.
Stock grazing patterns	Grazing patterns, daily wanderings and distribution of droppings.
Deer movements	Deer grazing patterns, tracks and distribution of droppings.

These species were carefully selected to act as indicator species. Their presence or absence and relative abundance throughout the duration of the monitoring programme will give an indication on the general condition of the various habitats. This is intended to demonstrate increased heathland biodiversity resulting from grazing without having significant detrimental effect on the species present prior to grazing.

Grazing impact on reptiles

We need to link the effects of grazing to the reptile population throughout the 200 ha Hartland Moor NNR. We have therefore record the population and distribution of the reptiles and the vegetation height and type prior to the re-introduction of grazing. These surveys will be repeated annually for 10 years.

Reptile survey method

The reptile survey method can be divided into four categories:

1. Recording casual observations of reptiles including species and dates to build up a distribution map of the reserve over a number of years.

2. Walk transect across dry heath with good reptile populations prior to grazing. The walk includes both grazed heathland and a plot excluded from grazing of equal area. The survey area was selected to ensure topographic similarity between the grazed and ungrazed heath. The walk includes 15 tins evenly spaced within the grazing unit and 15 tins outside the grazing unit. A number of sand patches and a sandy fire break are

also included within the transect. These will hopefully increase the reptile populations allowing easier comparisons between grazed and ungrazed heathland.

3. Sand lizard egg laying scrapes on areas of bare sand are recorded. This work is carried out by Herpetofauna Consultancy under contract from English Nature. Areas of bare sand, tracks and rabbit burrows are identified from aerial photographs and from scanning the study site with binoculars. These areas are visited seven times during the egg laying season between 0930 hours and 1730 hours. Two observers are used to cover either side of tracks and firebreaks simultaneously. A late visit during July is designed to record any second clutches. The observations are recorded on 1:10,000 base maps. Heavy rain can cause problems as signs of egg laying can be rapidly obscured. One female sand lizard may make a number of burrows, therefore when estimating the sand lizard population from the number of egg laying scrapes one burrow does not equal one sand lizard.

4. Sand lizard hatchlings are surveyed during the autumn. The sand lizard scrapes identified earlier in the year are targeted during late August and early September and numbers and locations of hatchings are recorded.

Stock grazing survey method

The grazing unit of 375 ha incorporates dry heath, bog and acid grassland. The area is grazed with 32 cows and 19 New Forest ponies. This gives a grazing density of 7.4 ha (19 acres) per animal.

The stock grazing survey can be divided into four categories:

1. The stock grazing patterns are recorded on a daily basis by the stockman. Volunteers record the daily wanderings and behaviour of the animals for up to eight hours a day.

2. The vegetation structure of the site is determined by more than 1500 measurements of vegetation height and type at various places throughout the reserve. These measurements are at fixed points along transect lines and can be repeated on the annual basis. Fixed point photograph provides a visual record of the site.

3. Detailed botanical surveys using nested quadrats on plots with pre-grazing data or exclusion plots will be repeated on an annual basis and will pick up subtle changes in the vegetation communities.

4. Aerial photographs of a number of grazing schemes will be flown at 1:3,000 on a five year basis. This will pick up any large scale changes in habitat and will show changes in deer tracks as well as the development of cattle tracks and bare ground.

Progress

It would be premature to draw meaningful conclusions from the two summers of survey data collected so far. However, the stock grazing patterns exhibit a very strong preference for valley mire, damp heath and former improved grassland. The majority of favoured reptile habitat has as yet no recorded visits by grazing stock.

Sand lizard breeding success declined significantly from 1994 to 1995 due to the drought conditions following egg laying. Such variations in breeding success provide further support for the need for a long term study. Long term trends will be more significant to this study than annual variations which can be dependent on a number of factors.

References

BYFIELD, A., COX, J. & PEARMAN, D. 1995. *A future for Dorset's heathland flora.* Internal report. English Nature, Peterborough.

What can be learned from a month's intensive transect study?

William Whitaker
Herpetological Conservation Trust, 655a Christchurch Road, Boscombe, Bournemouth, Dorset BH1 4AP

Abstract

For a month during the spring recognised as being one of the best times of the year for seeing reptiles, a selected transect route was monitored almost continuously. Survey was carried out during any possible weather conditions judged, subjectively as being 'marginal' to 'sunny and fine'.

After evaluation the results show that, as best as can be judged, 12 adult/subadult sand lizards had been seen using the transect, and the overall average chance of seeing an animal was calculated as 3:1. The chances of seeing any particular individual varied between 4:1 and 600:1.

The maximum percentage of this population seen on a single occasion was only 25%, and the chance of recording this 143:1.

The average daily rate of reptile sightings per hour was not higher than 0.54 for sand lizards and 1.2 including all other species. Peak ratios during particularly suitable conditions were as high as 7.3 on only two occasions. These conditions were noted.

Popular theories held by herpetologists as to what might constitute 'best or ideal conditions' for seeing reptiles were considered with respect to the results. Generally speaking the results were inconclusive. A notable fact that emerged was that the highest reptile sighting per hour ratios were recorded shortly after commencement of 'the first decent sunny spell' of the day.

The summary conclusions of this study are that despite the efforts made

i. the rate of encounter of reptiles, even at a good site, is variable and frequently low. Often a lot of effort is required to record lizards;

ii. reptiles were recorded over a wide range of weaker conditions. From the data collected it was not possible to define 'optimal conditions' for seeing sand lizards or other reptiles;

iii. only small proportions of the estimated population were seen at any one time and this limits the value of the method employed for studying reptile behaviour.

Aims and objectives

- ❑ To attempt to determine the number of animals using a suitable herpetological feature (SHF) and to compare the lengths of time that each animal was seen.

- ❑ To attempt to identify the best weather conditions for seeing them.

- To provide an overview of the likelihood of finding sand lizards using transect methodology.

Introduction

Normally an experienced field herpetologist would not use a rigid transect method to attempt to monitor the population of sand lizards on a site. Generally one such would identify all the potential SHFs of a site and then 'armed' with this knowledge, the herpetologist would when visiting that site at any particular time of the day under weather conditions deemed suitable, concentrate his search on those features having favourable aspect at that particular time. As such he or she would pay less attention to the rest of the habitat He or she would have to approach each feature by a route suitable to that time of day. The obvious reason for adopting this sort of approach is that experience has shown that one's best chance of finding basking reptiles is to look 'with the sun' at features with sunny aspect. This, of course, varies according to the time of day.

For a study as intensive as is reported here, such an approach would probably result in such damage to the habitat as to be unacceptable, additionally the potential interference through disturbance with the animals natural behaviour patterns could be excessive.

It is obvious that the results of a transect (a chosen fixed route) through a site will yield only a proportion of the animals inhabiting the site. That proportion will depend on several factors, among them:

a. the area of the site;

b. the area of suitable habitat;

c. the area of the transect;

d. the precise route through the site, since the bigger the percentage of SHFs along the route, the greater should be the number of reptiles likely to be seen.

Therefore, in order to conduct this exercise with maximum advantage the transect chosen would need to be, virtually, a complete SHF.

Factors affecting the choice of site and transect

The transect selected was chosen because:

- it was virtually a complete SHF, being a southern aspect boundary bank of a site known to host a population of sand lizards;

- it could be monitored continuously in an ethically acceptable manner, ie with minimal risk of interfering through disturbance with the animals' natural behaviour, because the whole feature was bordered by a sandy footpath and therefore damage to the animals habitat through trampling could be avoided, and it would be possible to approach the bank very quietly.

The selected transect was a 200 m stretch of boundary bank varying in height between 0.4 and 1.8 m. The angle of the slope of the face varied, being in some places precipitous with an overhang and in others no greater than 45°. The bank was covered in a mosaic of *Calluna vulgaris* and sand. Past experience had shown it to be used regularly by sand lizards for basking and as an egg laying site. The depth of the bank that could be monitored varied along its length; in places where the bank was high only the face and the gully at its base immediately in front could be seen, but in other places where the bank was low one could see 'over the top' and into the site a few extra metres.

The adjacent broad sandy footpath from which the SHF, and for this particular site would be expected to produce a higher yield of information than would any other transect of the chosen site of the same length. In my opinion it was the best site for carrying out the exercise.

Methods

Animal identification

It was anticipated that it would be probably possible to identify each animal on a regular basis by its unique back pattern. In order to study this closely for recording purposes use was made of a pair of 8 x 30 Zeiss Deltrintem binoculars.

Preparation of site diagram

It was also anticipated that some of the animals would be seen using the same basking spots at different times of the day and that more than one animal at a time would be seen basking on the same 'pass'. Therefore, if one had an accurate map, the relative positions of the animals on the pass could be recorded, facilitating determination of any 'territorial' behaviour and over any given period of time the variation in use of the bank by individual animals could be derived.

Preliminary visits to the site in late March and early April were made in order to prepare a scale diagram of the whole feature with all the readily identifiable reference features, eg trees, shrubs and stumps adjacent to the front edge marked on it.

The actual diagrams prepared scale 1:100 were not primarily for field use but the information from each monitoring visit was to be plotted on maps each day for subsequent analysis.

In the first instance the reference features were to be used to record animal positions with an accuracy of one metre on each and every sighting (see below).

The animals monitored

During the preliminary visits whilst concentrating on the sand lizards seen, it seemed sensible and advantageous to include reptiles of all ages and species in the monitoring exercise.

Information and data to be recorded

For each animal seen on each pass, the exact time, its position and behaviour. Wet and dry shade temperatures were taken before each pass (to allow calculation of humidity) and measurements of wind velocity using a hand held anemometer where taken when measurable wind velocities were experienced. Additional notes on the amount of cloud cover and/or sun strength, eg haziness etc were also recorded as appropriate.

Monitoring procedure

Monitoring commenced whenever possible before any animals started basking each day, and continued until after the last animal had stopped using the feature at the end of the day. As far as it was possible to do so the sun was kept behind the observer. As a rule the transect was walked from east to west in the morning from west to east in the afternoon.

In the event, complete continuous monitoring on several days was found to be impracticable. It was impossible to sustain the necessary level of concentration for the time periods (in some cases 10 hour) required to monitor the habitat, and to walk carefully to approach animals without disturbing them.

On some of the monitoring days, therefore, the intended monitoring regime was modified during the day to be less onerous, the following type of reduced regime being adopted.

In the morning before and while animals were being seen, continuous passes *c*.20 minutes average were carried out, and then as sightings decreased, eg after two passes when no animals had been seen the regime was changed to one pass per hour until such time that experience dictated a return to be made to continuous monitoring.

Results

Visit schedule, data analysis, table preparation

Monitoring visits were carried out between 3 April and 5 May. Twenty-nine (nominal) visits were made, most of them covering the whole day, with virtually complete coverage from the 11 April to 5 May. Within this period, the weather was so bad on two of the days that no visit was made and one day was 'lost' because of illness. On two other days within the period, though visits were made, no reptiles were seen because the weather was not good enough for reptiles to be active. This information is summarised in Table 1, which gives the visit schedule and a brief comment on each day's weather.

Table 1: Schedule of visits

No	Date	Purpose/coverage	Weather summary
1	21 March	Site recce/assess mapping requirements	Reasonable, cool
2	3 April	Mapping/monitoring 1000 to 1540	Good, sunny
3	6 April	Map final check/monitoring 0930 to 1645	Sunny pm
4	8 April	Monitoring 1545 to 1710	Good sunny
5	10 April	Monitoring 1125-1530. Late on site	Cloudy, clearing
6	11 April	Monitoring 0840 to 1504	Good, sunny
7	12 April	Monitoring 0825 to 1700	Good, sunny
8	13 April	Monitoring 0805 to 1720	Good, sunny
	14 April	No monitoring due to illness	Good, sunny
9	15 April	Monitoring 0845 to 1600	Cloudy, little sun
10	16 April	No monitoring, poor weather	Poor, cloudy
11	17 April	No monitoring, poor weather	Poor, cloudy
12	18 April	Monitoring 0945 to 1600	Some good periods
13	19 April	Monitoring 0830 to 1645	Some good periods

No	Date	Purpose/coverage	Weather summary
14	20 April	Monitoring 0830 to 1715	Good, sunny
15	21 April	Monitoring 0830 to 1720	Good, sunny
16	22 April	Monitoring 1445 to 1545	Poor, cloudy
17	23 April	Monitoring 0930 to 1600 by R Callf	Reasonable am
18	24 April	Monitoring 0900 to 1430	Poor, cold
19	25 April	Monitoring 0800 to 1800	Good, sunny
20	26 April	Monitoring 0800 to 16530	Poor am, dull
21	27 April	Monitoring 0810 to 1745	Bright
22	28 April	Monitoring 0810 to 1645	Poor am, improved
23	29 April	No monitoring, poor weather	Poor, dull
24	30 April	Monitoring 0755 to 1740	Marginal/improved
25	1 May	Monitoring 0800 to 1710	Good, sunny
26	2 May	Monitoring 0750 to 1700	Sunny, very warm
27	3 May	Monitoring 0745 to 1740	Sunny, very warm
28	4 May	Monitoring 0730 to 1750	Sunny, very warm
29	5 May	Monitoring 0725 to 1740	Sunny, very warm-

At the end of the day called a 'visit', a day's summary diary or reptile history record for each animal was compiled (Table 2). From these, for each species the locations of each animal were plotted on the prepared 1 to 100 maps as 'species maps' adopting adapted British Trust for Ornithology Common Bird Censusing conventions and methodology. Subsequent cluster analysis coupled with records of multiple sightings on the same pass, and the individual back patterns noted enabled provisional linear movement ranges along the transect to be assessed over the whole survey period, and also the number of passes that each animal was seen have been calculated for each day and over the whole survey period.

Table 2. Animal summary, day history. 12 April 1995 Visit No. 7

	Time	Map position	Comment
1. Male sand lizard	0830 0904 0957 1029 1348	B 20.5 B 21 C 12 C 13 B 12	on top of bank on top of bank, moving left (west) on top of bank on top of bank moving right (east)
2. Common lizard	0830 0903	B 2 B 2	half way up gully base bank still there
3. Male sand lizard	0846 0921 0929 to 0946 1006	H 12.5	moved left to H13.5 seen at H 4.5 seen to move right hunting? Finish at G 7.5 still there
4. Juvenile adder (Little red)	0915	G 10	half way up gully bank, half 'mosaic' basking
5. Slow-worm	0925	H 27	basking half buried
6. Juvenile sand lizard 1994	1006	G 7	(not far from its dad?!!!)
7. Immature common lizard	1011	H 16	half way up side of gully
8. Juvenile sand lizard 1994	1320	H 17.5	in short heather, base of gully

Following this analysis, complete individual animal summary information sheets were prepared, eg Table 3.

Table 3. Complete animal history, female sand lizard

	Time	Map position	Comment
Visit 24, 2 May	0906 0916	E 23 E23	disturbed, moved away into cover

And from these, an adult sand lizard time history and frequency record Table 4.

Table 4. Adult sand lizard activity

	Animal No.	Linear range of movement observed m	Days seen	Periods seen	Total time seen Hrs	Mins	No. of passes seen	%
Males	1	16	3	4	5	10	16	2.7
	2	55	20	37	46	05	138	24.2
	3	5	2	2		40	2	0.35
	4	8	4	6	5	45	17	3.0
	5	9	3	3	1	45	5	0.92
	6	35	5	6	2	35	8	1.4
	7	44	7	7	8	00	24	4.2
Females	1	<1	2	2	2	10	7	1.1
	2	2	6	7	6	30	20	3.4
	3	<1	1	1		20	1	0.18
	4	3	2	2	1	00	3	0.53
	5+	7.5	2	2	1	20	4	0.70
	+ = sub adult		Max. 29	Max.	190	15	Max 571	

Also, monthly summary tables of the number of animals seen on each visit for:

a. Adult sand lizards — Table 5

b. All adult reptiles — Table 6

c. All reptiles including juveniles — Table 7

Table 5. Number of adult sand lizards seen each day and time spent looking

Visit No.	Male	Female	Sub-adult	Total	Hrs Mins	Av. ans/hr
1				0	2 00	
2	1	1	1	3	5 40	0.53
3	2	1		3	7 15	0.41
4	1			1	1 25	0.67
5	2			2	4 05	0.50
6	3			3	6 25	0.48
7	2			2	8 35	0.24
8	5			5	9 15	0.54
9	1			1	7 15	0.14
10	No monitoring poor weather					
11	No monitoring poor weather					
12	3			3	6 15	0.48
13	2			2	8 15	0.24
14	2			2	8 45	0.23
15	4			4	8 50	0.45
16	Poor weather			0	1 00	
17	1			1	6 30	0.15
18	Poor weather			0	5 30	
19	1		1	2	10 00	0.20
20	1			1	8 30	0.12
21	2	1		3	9 35	0.32
22	2	1		3	8 35	0.35
23	No monitoring poor weather					
24	2	1		3	9 45	0.32
25	2	1		3	9 10	0.33
26	0	1		1	9 10	0.11
27	3	1		4	9 55	0.40
28	3	2		5	10 20	0.49
29	2	1		3	10 15	0.29

Table 6. Number of adult reptiles seen each day and time spent looking

Visit No.	La	Lv	Af	Vb	Total	Hrs Min	Av. Ans/hr
1					0	2 00	
2	3				3	5 40	0.53
3	3	1			5	7 15	0.69
4	1		1		2	1 25	1.6
5	2	1	1	1	5	4 05	1.2
6	3	4			7	6 25	1.2
7	2	2	1		5	8 35	0.58
8	5	1		1	7	9 15	0.77
9	1				1	7 15	0.14
10	No monitoring poor weather						
11	No monitoring poor weather						
12	4		1		4	6 15	0.64
13	2				2	8 15	0.24
14	2	3			5	8 45	0.57
15	4				4	8 50	0.45
16	Poor weather				0	1 00	-
17	1	1			2	6 30	0.31
18	Poor weather				0	5 30	-
19	2	1			3	10 00	0.30
20	1	1			2	8 30	0.28
21	3	3	2		8	9 35	0.84
22	3				3	8 35	0.35
23	No monitoring poor weather						
24	3		2		5	9 45	0.51
25	3	1	1	1	6	9 10	0.65
26	1			1	2	9 10	0.22
27	4	1	1		6	9 55	0.60
28	5	2			7	10 20	0.68
29	3	1			4	10 15	0.39

Table 7. Number of reptiles (including juveniles) seen each day and time spent looking

Visit No.	La	Lv	Af	Vb	Total	Hrs	Min
1	1				1	2	00
2	7	1			8	5	40
3	3	2			5	7	15
4	1		1		2	1	25
5	3			2	7	4	05
6	5	4			9	6	25
7	4	2	1	1	8	8	35
8	6	1		2	9	9	15
9	1				1	7	15
10	No monitoring poor weather						
11	No monitoring poor weather						
12	4		1	1	6	6	15
13	2				2	8	15
14	5	3			8	8	45
15	5				5	8	50
16	Poor weather				0	1	00
17	4	1			5	6	30
18	Poor weather				0	5	30
19	5	1			6	10	00
20	1	1			2	8	30
21	5	3	2		10	9	35
22	3				3	8	35
23	No monitoring poor weather						
24	3		2		5	9	45
25	5	1	1	1	8	9	10
26	3			1	4	9	10
27	9	1	1		11	9	55
28	8	2			10	10	20
29	6	1			7	10	15

Also shown in these tables is the number of hours spent monitoring and the average reptile/hour ratios.

Table 8 shows the earliest temperature each day that the first animal basking was seen and its species.

Table 8. Temperature/time information for first animal seen

Visit no.	Date	Time	Temperature	Identity
1	21 Mar	12.15	8.5	La juv 94
2	3 Apr	10.13	12	La male
3	6 Apr	13.00	14.5	La male
4	8 Apr	16.00	10	Af
5	10 Apr	12.26	14	La male*
6	11 Apr	08.45	11	La male
7	12 Apr	08.30	8.5	La male*
8	13 Apr	08.13	5	La male
9	15 Apr	12.50	12.5	La male*
10	16 Apr	Poor weather, no monitoring		
11	17 Apr	Poor weather, no monitoring		
12	18 Apr	11.38	7.5	La male*
13	19 Apr	08.59	4	La male*
14	20 Apr	08.42	2.5	Lv
15	21 Apr	08.39	4.5	La male
16	22 Apr	Poor weather, no animals seen		
17	23 Apr	10.18	10	La juv 94
18	24 Apr	Poor weather, no animals seen		
19	25 Apr	09.22	11	La male
20	26 Apr	14.47	10	Lv
21	27 Apr	09.43	7	La male*
22	28 Apr	11.07	8	La male*
23	29 Apr	Poor weather, no monitoring		
24	30 Apr	10.05	10	La male*
25	31 May	08.15	8.5	La male*
26	2 May	09.04	14	La female
27	3 May	07.50	14	La juv 94
28	4 May	07.47	15	La male*
29	5 May	08.17	18	La juv 94

* denotes same animal

Weather reports and forecasts

A disadvantage of the chosen site was that it was used by the public, and a comprehensive on-site weather station to record daily survey information was not a feasible proposition. Weather forecasts and summary weather reports for the survey period as published daily in the press have been filed and are available if required for further study. The daily data for London are recorded in Table 9. The other nearest place with published information was Littlehampton. The nearest site for which records could be made available was Gatwick but in my opinion the site was not close enough to justify the extra costs involved bearing in mind the completely different geography of the site as compared with Gatwick.

However, in considering the results of the survey below, frequent reference to the weather conditions at the time or that of the previous day are made, together with some on site measurements, and observations.

Table 9. Summary weather reports for London

Date	Sun hours	Rain (inches)	Temperature (°C)	Comment
3 April	10.6	nil	18	Sunny
4	5.2	nil	16	Sunny am
5	5.2	nil	15	Bright
6	4.3	nil	19	Sunny pm
7	9.1	nil	19	Sunny
8	10.6	nil	12	Sunny
9	9.8	nil	14	Sunny
10	2.1	nil	16	Cloudy
11	10.0	nil	19	Sunny
12	11.8	nil	15	Sunny
13	11.5	nil	15	Sunny
14	10.5	nil	18	Sunny
15	0.8	nil	10	Cloudy
16	1.8	nil	13	Cloudy
17	nil	nil	11	Cloudy
18	7.6	nil	10	Showers?
19	10.8	nil	11	Sunny am
20	10.3	nil	13	Sunny
21	12.2	nil	13	Sunny
22	2.5	0.09	12	Rain am
23	4.5	nil	15	Bright am
24	nil	0.14	10	Dull
25	9.3	nil	19	Sunny
26	2.3	0.18	9	Dull
27	5.3	nil	11	Bright
28	3.0	nil	13	Cloudy

Date	Sun hours	Rain (inches)	Temperature (°C)	Comment
29	0.3	nil	12	Dull
30	2.7	nil	17	Cloudy
1 May	9.2	nil	18	Sunny
2	8.7	nil	23	Sunny
3	11.4	nil	24	Sunny
4	12.8	nil	27	Sunny
5	13.6	nil	27	Sunny

The survey was carried out during a period when one would expect a high level of reptile visibility, ie early April to early May, and the survey concentrated on looking for and recording that activity to see what could be learned.

Discussion, observation and comments

a. Sand lizard activity - Table 4

In Table 4 , 'Periods seen', the number is sometimes higher than 'days seen' because on some days more than one period of activity was observed, eg an animal might be seen basking for one hour, and later in the day 'foraging for food' for 20 minutes, and this would make two periods seen.

'Number of passes seen' is the number of passes (average time interval, 20 minutes) that that animal was seen over the survey period. In some cases this is not an exact counted figure because some approximations and assumptions have been made when the 'pass interval' was other than the 20 minute approximate 'norm', eg Conversations with 'passers by' could easily take 10 minutes or so thus interfering with the monitoring regime. The total possible number of passes was 571. This is a nominal calculated figure based on a 20 minute pass and assumes that the bank was monitored continuously for the entire survey period. This was not always the case; on several days after the morning activity waned, a reduced monitoring regime, one pass instead of three passes per hour being adopted.

However, for animal comparison purposes, the different ratios rather than absolute numbers are more important.

Similarly the 'total time seen' column gives the individual total time recorded for each animal out of a theoretical maximum of 190 hours 15 minutes. This is the total amount of time spent on site monitoring irrespective of the suitability of the weather. As can be seen from Table 7 on visit 16 no animals were seen in one hour's monitoring, and on visit 18 none were seen in five and a half hours.

Obviously one could adjust the time spent monitoring downwards to take account of this but as stated above the actual totals are less important than the animal to animal comparisons when they were seen. It was important too to justify the 'no visit days', visits 10, 11 and 12 when a visit was not made because of the inclemental weather, by visiting in similar weather to make the point that visits on those days would have been a waste of time.

One might equally have quoted a nominal hour's monitoring per day figure, eg 12 hours between 0600 and 1800 and multiplied by the total number of visit days to arrive at a nominal total. The effect of this would be to reduce all the percentage results by a common factor.

The calculated percentage figures are interesting. The percentages are the same whether one calculates on the basis of passes or total time. For male sand lizards the range is between 0.92 and 24.2% (n=7) and for females between 0.18 and 3.4% (n=5).

Another way of indicating this is to quote the odds of seeing particular animals, these range between 4 to 1 (best chance) and 600 to 1 (worst chance). It should be noted that for seven of the 12 animals, 58% of the 'population, these odds were greater than 71 to 1, each animal being seen for less than 1.4% of the total survey time.

The total number of adult and subadults seen to use the feature during the whole survey period was 12. It is possible that another male was seen, because on one pass an animal was seen in a place not 'used' before or after; and it was not seen long enough or well enough to establish or record the back pattern. It may have been a different animal or it may not, but in either case the statistics reported in this report will be not entirely correct and subject to modification because of this uncertainty. It may be anticipated that over a longer period of survey, additional animals would be seen. If one calculates percentages of animals using the feature on any one day or in any hour or on any pass the results would tend towards a lower % rather than higher figures.

For the purposes of this survey, however, population of 12 animals using the feature has been assumed. Animals were found using virtually the whole feature during the survey period. So the average theoretical space occupied was 200 m divided by 12 animals, this is approximately 16.5 m. The average 'walk rate' along the feature was 200 m in 20 minutes, so one had a theoretical chance of seeing a sand lizard every one minute forty seconds.

In the entire survey period, on only four passes out of 571 were three adult animals seen at the same time, ie there was only a 143 to 1 chance of seeing 25% of the population on any one pass. On no occasion was a higher percentage of the population seen.

However, to see 17% of the population, two adults at the same time, the odds shorten to 10 to 1, which might be regarded as quite reasonable.

And the chance of seeing at least one sand lizard, 8% of the population, on any pass was as good as 3 to 1, ie one per hour. However, it should be borne in mind that these figures are almost entirely dependent on the fact that one particular animal was seen for a 'very high' 24% of the total time, more than the combined total of all the others. Without this animal the overall chance of seeing an animal would have been 5.5 to 1, ie approximately one every two hours.

On four days of the survey, five animals (42%) twice, and four animals (33%) twice, of the population were seen but one would have needed to be on site on each occasion for eight to 10 hours n order to see them all.

Three of the adult females, numbers 1, 2 and 4, were each seen on only two days of the survey period. It was noted that the *Callunetum* habitat where these animals were seen was extremely limited, the 'strip width' of the SHF greater, generally speaking, being less than three metres wide, and all this habitat was within the field of view and under constant surveillance.

The adjacent area had very little cover. As such it was considered that the animals were anywhere other than in the strip surveyed yet they were largely unseen. One of these was only seen when sloughing and being courted by a male.

At this time of year males are apparently more active, certainly they are seen more frequently, than females. However, one of the males (animal number 7) again occupying a 'thin' stretch of the SHF not backed by a *Callunetum* habitat was not seen at all for one period of 11 days despite virtually complete observation of the available habitat at 20 minute intervals.

Observations made of other easily recognised reptiles seen during this survey provide additional supporting evidence to confirm how little time they are actually seen, remaining hidden within the habitat being surveyed.

Firstly, the example of an immature ('little red') female adder. It was seen on visits 5, 7, 8 and 10. On the first three visits it was only seen on one pass, but on the last it was seen on four. The animal was always in the lower half of the face of the bank. The interesting fact about this animal was that on each of the three subsequent occasions after it was first seen it was always seen to the west of the previous position; the sequential distances separating these four positions were only 3, 1 and 6 metres. A possible explanation of this animals behaviour was that it was methodically foraging for food over the period it was seen.

Secondly, the records of melanistic common lizards. Of 20 common lizard encounters, three were of melanistic animals. These wre seen on visits 6, 12 and 26, on each occasional on only one 'pass'. The distances between the respective positions were 52 and 144 metres respectively. Even though the possibility that the records were of the same individual in three widely different places cannot be discounted, the infrequency of actually seeing such a distinctive animal/animals in relation tothe whole survey period confirms the general point being made.

b. Sand lizard range of movement - Table 4, column 3

This study without providing definitive information yielded interesting data for several individuals. The third column in this table shows that linear movements of 35, 44 and 55 m were recorded for three of the males. If one arbitrarily defines the width of the *Callunetum* habitat as 4 m, being the approximate width of the SHF at the places where these animals were seen, then the 'territory' each occupies might be roughly estimated as between *c.*140 to 220 square metres.

c. Definition of the best weather conditions

Average daily adult reptiles seen per hour ratios are shown in tables 5 and 6. For sand lizards these range between 0.11 and 0.53 and between 0.22 and 1.2 when including all other reptiles. These ratios are for all weather conditions varying between marginal to good. Generally the higher ratios were noted on the sunny days.

Occasionally, herpetologists relate experiences they have had when they have recorded 'purple patches', or 'champagne moments', when they have seen many animals, usually basking, over a short period of time, in contrast to the more usual experience of finding animals at the approximate average frequency of 1 or 2 per hour. Generally in this study the reptile time ratio was <1. It was therefore, the intention of this study to try to pinpoint and define the best conditions for seeing reptiles.

Some herpetologists recommend looking for reptiles under bright sunshine conditions shortly after a shower of rain, as being 'good' for seeing them. Others have noted that after a long spell of cool weather they see good numbers of reptiles on the first sunny day thereafter.

April weather is traditionally a time of sunshine and showers which ought to be ideal for testing the first of these premises, however in 1995 the weather was completely atypical. Table 9 shows that rainfall over the survey period was extremely low.

Notwithstanding this, as best as one can attempt to do so, these points are considered in examining Table 9. The summary weather report, and Tables 5, 6, and 7, what was actually recorded on the visits, together with some information extracted from the individual summary daily records (on file). In considering this matter, the data for all reptiles including juvenile animals is examined from two viewpoints. Firstly by considering those occasions when the highest reptile/hour ratios were experienced to see what, if any, common weather conditions could be identified, and secondly to consider the numbers of reptiles seen on the 'better' days after previous 'poor weather days', to see whether the theory was borne out on this study.

i. *Highest reptile/hour ratios*

The three highest reptile per hour ratios were noted on visits 21, 28 and 6. Taking these in order, the details were:

Visit 21. 27 April

Seven reptiles were seen between 0934 and 1034. The reptile/hour ratio was 9.3. The reptiles were a male and a female sand lizard, three common lizards and a slow-worm. The temperature rose from 7°C to 8°C over this period.

The daily summary record for this day was 5.3 hours sun, rain nil, maximum temperature 11°C, bright.

Comment: Observations had begun on site at 0810 : the first reptile was seen at 0943. The day could be described up as being a 'better day after a poor one'. In all, 10 reptiles were seen over the whole day, the second equal highest total for the whole study.

Visit 28. 4 May

Seven reptiles were seen between 0747 and 0832. The reptile/hour ratio was 9.3. The reptiles were a male, a female, and three juvenile sand lizards, and two common lizards. The temperature rose from 15°C to 19°C during this period.

The daily summary record from this day was 11 hours sun, rain nil, maximum temperature 24°C, sunny.

Comment: This day was 'one of the same' well in to a spell of fine warm settled weather. In all, 10 reptiles were seen over the whole day, the second equal highest total for the whole study.

Visit 6. 11 April

Six reptiles were seen between 0845 and 0935. The reptile/hour ratio was 7.2. The reptiles were two male and a juvenile sand lizards, and three common lizards. The temperature rose from 11°C to 12°C during this period.

The daily summary record for this day was 10 hours sun, rain nil, maximum temperature 19°C, sunny.

Comment: This day can be classified as 'the first day after a poor one'.

Had one adopted the criteria for the best day, the highest number of reptiles seen, then visit 27 (3 May) was the best, when 11 reptiles were seen. There were four adult and five juvenile sand lizards, one common lizard and a slow-worm. This day was a very warm day of unbroken sunshine during the settled spell of fine weather at the beginning of the month. Maximum temperature that day was 24.5°C.

In summary, none of these occurrences come anywhere near qualifying as 'champagne moments'. However, they do indicate is that during this survey, it was best to be on site 'early rather than late' in order to record the highest reptile sighting frequencies. There were no real points of similarity common to all three of the instances examined that could be picked out in order to identify or predict them.

ii. *'Better days after poor ones'*

Adopting this alternative method of considering the results, and selecting the data from Table 9 for visits 12, 17, 19 and 25 which might be expected to be good.

Visit No	Date	Sand lizards (inc juveniles)	Total (all reptiles)
12	18 April	5	6
17	23 April	4	5
19	25 April	5	6
25	1 May	5	8

All one can say is that the results, though usually better than the previous days, are nothing spectacular and are not substantially different.

d. Daily earliest sighting records

Table 8 shows the time, identity, and shade temperature when the first animal was seen each day.

It is interesting because many of these are single figure numbers as low as 2.5°C. On several days there had been quite heavy overnight frosts and whilst monitoring it was noted that where the suns rays had not fallen on the ground it had not melted. The main factor affecting the lizards desire to bask was obviously the strength of the sun rather than the shade air temperature.

It should be noted that one particular male sand lizard was the first animal to be seen on seven of the 23 days that reptiles were seen indicating that these results can be heavily biased by one individual animal.

e. **Longest periods of observed behaviour, weather conditions**

Male sand lizard number 2 in Table 4 could be seen for 24% of the entire survey period. This was because it used two principle basking areas, both of which were identified. The size of these areas were approximately 400 sq cm. There was plenty of cover within these but it was not deep and the animal could often be seen either mosaic basking or with only a part of its body or tail exposed when one knew where to look. Obviously this animal spent much time basking but it was also a very active animal and may well be regarded as a 'dominant' male.

This animal exhibited the largest linear foraging distance, ie ± 27m. On one occasion it was seen fighting the next adjacent male; this encounter lasted more than 35 minutes, and though both animals after disengagement appeared to be without obvious injury, the other male was not thereafter seen at all. On another occasion this animal was observed carefully killing and devouring a large bumble bee. It was also seen courting two different female animals.

The longest continuous daily total time period this animal was seen was 7 hours 30 minutes, covering different activities, mainly basking (two period) and courting. Two other animals were also seen for extensive period that day; a female, which the male was courting, this was seen for 2 hours 30 minutes, and another male some 50 m away, also seen mainly basking, also for 2 hours 30 minutes. If the 'best reptile day' measurement criteria was measured by summing a 'reptile hours visible' index then this day would have been the best day in the entire study period even though only five animals (all adults) were seen. It was this day that the 'highest percent of the population on a single pass figure' was measured, because two males were basking and a female was basking and being courted by one of the males.

What was significant about the weather on this day (visit 24) was that it was warm but with generally 8/8 cloud cover. The sun was trying to 'come through' but hardly succeeding.

The following field note book comments make the point:

At 0900 the weather notes read 'cloudy, cool, and a light wind'. The temperature was 9.2°C. The first male animal was seen at 1005. At 1108, another male was seen. At 1127, the weather note was 'sun trying hard to come through', the temperature having risen to 12°C. At 1153, another weather note said 'sun trying hard to come through again', and at 1203, 'sun seen'. At 1215 a female sand lizard was seen, so there were now three animals all 'wishing to bask'. At 1205 with the temperature now at 13.5°C, a weather note reads 'sun coming through at last'. Further notes read at 1445, 'still mainly cloudy', and at 1524, 'clouded over again, little sun', and at 1604 'no sun'.

Summary general conclusions

In summary, reptiles (all species) were seen on 23 days, with a maximum of 11 (all species) and including several juveniles on 3 May. On two of the days, only one animal was seen when conditions were 'marginal'.

In any reasonable weather, provided one was willing to monitor thoroughly for a few hours, one had a good chance of seeing a sand lizard. The animals were found along the whole transect length starting within 5 m of the eastern end and up to the western limit.

The earliest time an animal was seen was 0747 on 3 May, and the latest 1800 on 25 April, even though all direct sunlight falling on the spot had ceased 45 minutes earlier.

Care needs to be taken when interpreting these results; an 'observation' is not synonymous with 'activity'. Only a small amount of reptile activity is ever observable. **Most of the time the animals will be unseen even at this time of the year.** Conseuqently this method is severely limiting for drawsing conclusions about 'behaviour'.

Within the period of the field work, it seemed that there were no 'ideal' monitoring occasions when most of the sand lizards could be seen on a single occasion; as the highest percentage recorded was only 25%, and the chance of actually recording this, 143 to 1. It was therefore not possible to arrive at any conclusion as to what constitutes 'ideal' monitoring conditions.

If there are such occasions as 'purple patches' or 'champagne moments', how often do they occur? Can they be predicted (if so, how far in advance) in order to be able to take advantage of them? Such occasions are obviously not important as far as the animals are concerned, they make best use of the conditions that they experience.

The transect methodology employed in this study as applied to reptiles has the advantage that it will limit the damage to habitat and interference with the natural lifestyle of the animals, ie it can be 'ethically acceptable'. Its chief disadvantages are that it can only assess a sample intermediate percentage of a population on a site, and for different animals one can only ever have a chance of studying a part of each's activity, depending on the percentage of its 'home range' lying within the 'field of view' of the transect. On a site with a low population bordering on the viability level, one probably needs to maximise one's chances of finding animals rather than placing limitations on one's chances.

The results of this study were heavily influenced by the behaviour of one particular animal, seen for a longer period of time than all the others combined. The figures calculated and quoted therefore can only be used as a 'one off' example. Whilst animal comparisons can be made legitimately, the results in general serve only to indicate the scale of the problem that would be observer faces.

Survey methodology for British reptiles: a practical proposition?

Howard Inns
British Herpetological Society Conservation Committee, 'Newstead', Lodge Hill Road, Lower Bourne, Farnham, Surrey GU10 3QW.

This paper summarises my initiative this year to establish a standard methodology for surveying for British reptiles The objective of establishing such a methodology is to get more people out looking for reptiles by making surveying for reptiles more prescriptive. This might help ensure we don't overlook good sites for reptiles.

The formula, put simply, consists of finding a potential site, laying tins or other refuges (I suggested about 5 tins per hectare), waiting until the season starts (the suggested date being 1 April), making a minimum of four visits during the active season in certain weather conditions to look for basking reptiles and to look under the tins.

The weather window recommended attempts to narrow down to the conditions in which you are likely to see reptiles of any species by taking the three key variables :

- temperature (11 - 19°C)
- sun or hazy sunshine
- little or no wind

I have added one recommendation about the interrelationship of variables, namely sun after rain or cloudy weather is particularly good.

In reality there are more variables - time of day, time of year, site aspect, vegetation structure and the relationship between variables is complex. To attempt to introduce more variables and describe their interaction would distract from the main objective - to encourage people to monitor for reptiles by making it sound easy.

A monitoring rate of 1 to 1.5 hours per hectare was suggested as part of the methodology; this was the subject of significant debate. Because it is so subjective and so dependant on site topography and vegetation structure it is probably not a particularly important guideline.

Testing the methodology was the objective for the 1995 season I chose one of the best sites in Surrey, with all six species and good numbers of snakes. In an attempt to eliminate or compensate for other key variables, I suggested rating observer skill and rated my own as 7/10. Again because this is so subjective, it is probably too ambitious to include it.

I chose a fenced area of south facing heath of 0.75 hectares and laid 3 tins approx 0.5m square in March. Immediately to the west of the site and continuous with it is a further area of approximately the same size and topography although the habitat is younger (19 years old as opposed to approx. 48 years old). My pre-survey assessment of the relevant abundance of species is described as follows :

"The best site in Surrey" :

Adder	-	Moderate
Grass snake	-	Abundant
Common lizard	-	Present
Slow-worm	-	Moderate
Sand lizard	-	Moderate
Smooth snake	-	Present

Six visits were made; during these 1 adder, 3 grass snakes, 1 common lizard, 1 slow-worm and 2 sand lizards, but no smooth snakes, were seen. Nothing was found under tin on any visit. The results are summarised as follows:

Date	Time	Temp (°C)	Sun	Wind	Result	Additional information
2nd April	10-1100	9.5 - 12	Hazy	Light	Nothing	Conditions felt favourable
21st April	17 - 1800	13.5	Hazy	Breeze	Nothing	Conditions felt wrong - too breezy and it had been warm all day
14th May	09-1000	10 - 14	Bright	Light	1 x La 1 x Af	The very bright sun did not feel favourable.
10th June	15-1600	16	Hazy	None	Nothing	A humid afternoon which felt as though it could have been good
17th June	10-1100	16 - 18	Bright	None	3 x Nn 1 x La 1 x Lv 1 x Vb	Felt right - and was very miserable the day before.
21st Oct	12-1300	17	Bright	None	Nothing	A little late in the year although hatchling sand lizards were still active.

La = sand lizard; Af = slow-worm; Nn = grass snake; Lv = common lizard; Vb = adder

In respect of my test site, despite the fact that it is a reknowned reptile site, 2/3rds of my visits were negative. This low degree of 'success' is something that potential reptile surveyors should beasr in mind.

However, each visit involved walking through the immediately adjacent habitat. More animals were seen in this part of the site than test site. The total number of observations for the test site and the adjacent habitat were as follows : 8 adders, 9 grass snakes, 1 common lizard, 1 slow-worm and 7 sand lizards. Including this extra area, only one visit was completely negative and this was made in conditions that 'felt' wrong.

Whilst I did not find smooth snakes on the site, one was found during the year, within the test area. If this record is added to the result from the entire site, the result closely matches the original assessment.

My conclusions as a result of testing the methodology myself and from the experience of others who have also tested it are summarised as follows:

- **No instant results (4/6 visits negative):** Surveys undertaken particularly by novices or those undertaken in reptile poor areas, should expect the majority of visits to yield negative results. Because of this as much information as possible should be assembled before the survey starts from landowners, neighbours, local naturalists and other users of the site.

- **Variables are not simple but interdependent:** The interdependence of some of the variable is important and more guidance should be included. For example in the spring reptiles bask in significantly lower temperatures. At times you can 'shift the temperature window down' from that originally proposed.

- **Importance of good weather after poor:** Good weather after rain or cloud provides exceptional monitoring conditions, but often only for a short period. It is important to be able to recognise these conditions and be on site when they occur.

- **Bin the tin!:** Well, at least don't rely too heavily on it. The use of tin should be very carefully considered. It is very valuable for finding slow-worms and all other reptiles do use it. However it must not distract from looking for basking animals and the security of animals is of the utmost importance which will prevent the use of tin on sensitive and important sites such as urban snake sites.

- **Species specific:** The guidelines I have suggested are most suitable for sand lizards. It is important to broaden the methodology by providing guidelines for each species rather than a single prescription. Sand lizards and smooth snakes are not the target species for the methodology and so should not be specifically covered in species specific guidelines.

- **Guidelines, not prescriptions:** Overall, the methodology should be regarded as a guideline rather than a prescription. This means that the qualitative assessment that it will be capable of producing is probably no more than establishing that a species is present or that a species is present in good numbers.

Therefore whilst it may be possible to build a picture of the amphibian population at a particular pond in one night (certainly in one season), to do the same for reptiles will take several seasons and many more visits. Because this knowledge is hard won, perhaps it will encourage amateur herpetologists to guard important reptile sites as jealously as they guard important amphibian ponds.

Attached as an appendix are guidelines that have been revised following the seminar and including some ideas picked up during a workshop at the Herpetofauna Worker's Meeting held in Edinburgh in February 1996.

Appendix: Survey Guidelines for the Widespread British Reptiles

Howard Inns
British Herpetological Society Conservation Committee

Introduction

This document presents a set of guidelines that can be used as a standard survey methodology for the four more widespread British reptiles species:

Common lizard	*Lacerta vivipara*
Slow-worm	*Anguis fragilis*
Adder	*Vipera berus*
Grass snake	*Natrix natrix*

These guidelines aim to determine species status by site as follows:

- ❑ Present - at least one individual of the species found.
- ❑ Viable - different individuals and evidence of breeding found in more than one year

The primary recommended monitoring method is to search for basking reptiles and as a secondary measure to look under refuges of corrugated iron or roofing felt.

These guidelines are aimed at the four more widespread species but in general they also apply to the sand lizard, *Lacerta agilis* and the smooth snake, *Coronella austriaca*. Surveys of sites where either of these species might be found must be coordinated by the Herpetological Conservation Trust and require a licence from the appropriate country agency.

Guideline 1 - Site selection

All four species favour open, sunny, undisturbed, well drained habitats, particularly south facing slopes. Typical reptile sites are as follows:

Heathland (wet and dry heath)	Rough Grassland or Commons
Chalk downland	Open woodland
Coppiced woodland	Immature forestry plantations.
Woodland Edge	Forest Rides
Pylon lines through woods and forests	Sea cliffs
Sand dunes	Moorland
Dry Stone Walls	Railway embankments
Roadside verges	Hedgerows
Disused allotments	Disused quarries, chalkpits or sandpits
Suburban wasteland	Derelict farmland
Golf course roughs and out of play areas	Overgrown or wild gardens and orchards

Grass snakes can also be found near canals, reservoirs, dykes, lakes, ponds, gravel pits, water meadows and slow flowing rivers. Adders will also use wet habitats in the summer and common lizards can tolerate wet conditions and thrive in habitats such as heathland bogs.

Guideline 2 - Time of year

Reptiles can be found at any time during the active season which lasts approximately from March to October inclusive. However, the three best months are April, May and September. August is also a good month to look for common lizard hatchlings. Refuges can produce results all the way through the active season although they are not as attractive to reptiles in very hot weather.

Guideline 3 - Time of Day

The best time to look for reptiles is between 8.30 am and 11.00 am and between 4.00 pm and 6.30 pm. By the end of May, reptiles may be active earlier than 8.30 am and later than 6.30 pm. Good weather conditions immediately after rain or dull weather are likely to yield good results at any time of day.

Guideline 4 - Weather Conditions

Reptiles are most likely to be found basking during the following weather conditions, a general description of which would be fine, warm, spring weather.

Temperature: 9 to 18^{o} C
Sun: Bright sun up to 15^{o}C , hazy or intermittent sun above 15^{o}C.
Wind: Still or light breeze.

During April, reptiles are particularly keen to bask. At this time of year, Common lizards may be found early on sunny mornings from temperatures of approx 4^{o}. Also at this time of year Adders are quite tolerant of extremely hazy, even cloudy conditions and can be found attempting to bask when there is only a hint of sun or warmth. Grass snakes prefer to bask in bright sunshine. Slow-worms do bask, particularly early in the season, but not as freely as the other species.

Common lizards in upland habitats are much more tolerant of poor weather and can be found in misty or cloudy conditions, even at the lower end of the above temperature range.

Reptiles are often active in thundery conditions when they can be found, normally on the move, at higher temperatures than the range suggested above.

Reptiles are very difficult to find when it is hot and dry or windy.

Reptile basking behaviour is strongly influenced by the sequence of weather. Sunshine after days or even hours of rain or dull weather provides exceptional monitoring conditions and it is important to try and take advantage of such conditions if possible. Reptiles seem less keen to bask if they have enjoyed several days of good weather.

Refuges can yield results in a much wider variety of weather conditions, even during rain. However reptiles seem to avoid refuges that are extremely cold or extremely hot.

Guideline 5 - Where to look

The objective of reptile monitoring is to see and identify basking reptiles before they are disturbed. Reptiles rarely bask completely in the open. They chose basking positions that are exposed to the sun yet sheltered and close to deep cover. Look carefully at breaks in the vegetation where sunlight can get to ground level. Reptiles, particularly grass snakes will also bask underneath open structured vegetation such as leafless bramble stems. Slow-worms usually bask partially concealed in the vegetation often with just a single coil of their shiny body exposed to the sun. Common lizards, especially 'hatchlings' often bask on logs, stones or general debris in the vegetation.

Concentrations of reptiles often occur on sunny features such as boundary banks, tumuli, embankments, gullies and ridges and at the interface between two habitats such as woodland edge. These features should receive special attention. Grass snakes in wetland habitats often bask amongst the vegetation on the banks of water bodies.

Snakes hibernate communally, often in disused rabbit burrows, and use the same hibernacula year after year. These are often situated on sloping, south facing, well drained sites, frequently with some tree cover. Snakes will stay in the area of the hibernaculum for approx one month after emergence and will undergo their first slough of the year in the area. The discovery of freshly sloughed snake skins during April could indicate the presence of a nearby hibernaculum and warrant more intensive monitoring.

Grass snakes can also be observed in the water. Good results can be achieved, even in weather conditions warmer than those indicated above, by sitting motionless watching for hunting Grass snakes swimming across the surface of a pond.

Female Grass snakes are attracted to piles of rotting vegetation in June and early July in order to lay their eggs. They often stay in the vicinity of the egg laying site for several days and in suitable weather conditions can be found basking on or near the pile. At this time of year it is also possible to find snakes and their newly laid eggs by carefully turning over the material in the pile but this should generally be avoided as it may destroy the pile's effectiveness as an incubator. Outside the incubation period (June to September) it is possible to find empty egg cases from previous hatched clutches. Potential sites include compost heaps, grass cuttings (golf courses in particular) stable manure heaps, sawdust piles and waterside piles of reeds or rushes. Compost heaps are also frequently used for shelter and foraging by slow-worms

Guideline 6 - How to look

Reptiles are easily disturbed. Keep the sun behind you, walk slowly, treading as lightly and gently as possible and look approx 2m-3m in front of you. Basking reptiles will be disturbed by a shadow passing over them so look beyond your shadow or to the side of it. Stop frequently to scan likely basking sites using close focus binoculars if available. Do not conduct the whole search from the path, walk into the vegetation (wear Wellingtons as a precaution against Adder bite) but avoid disturbing it too much and observe local regulations. Listen for rustles in the vegetation. Do not attempt to find retreating animals by searching through the vegetation but mark the spot, retreat immediately and return very cautiously approximately ten minutes later.

Search carefully on the second pass as the animal may not have returned to bask in exactly the same position.

Guideline 7 - The use of refuges and other monitoring aids

Refuges should be used as an additional aid to monitoring rather than the primary method. Light gauge corrugated iron or heavy gauge (38kg) roofing felt can be used although other material will also work. Rectangles of up to 1m by 1m are sufficiently large but small enough to be transported to site. Between 3 and 8 refuges per hectare should be sufficient to yield results. Refuges must be used extremely discretely and must never be used if there is a risk that reptiles may be collected or the refuges trampled by people or livestock. They should be removed immediately if there is evidence of them being disturbed. They should be numbered, labelled with your name and contact details and must be removed at the end of the survey period. Site owners or managers should be informed of their presence and purpose.

Refuges should be laid well in advance of the survey season, and left in place for the duration of the survey. They should be positioned in the sun but deep in the vegetation so that the underside is as close as possible to the soil surface. It is wise to place them so that they cannot be seen from paths. Dark painted or rusty tins attract less attention and may warm up better than bright shiny ones. Place them on or near the sort of features you would monitor for basking reptiles.

Common lizards and adders will bask on top of refuges so approach as if looking for basking reptiles and check the surface of the refuge carefully before turning. To avoid the risk of Adder bite it is wise to lift the edge of the refuge with a stick. The use of refuges is particularly important to determine the presence of slow-worms as they are more frequently found in this way than whilst basking. Both snake species will use refuges but common lizards do so only occasionally.

When looking for common lizards in habitats without any obvious basking positions, it may be useful to introduce logs or stones deep in the vegetation but exposed to the sun for them to bask on.

Guideline 8 - How many visits to make

Sites should be visited at least five times a year, more if possible, and monitoring should continue for several seasons. It is not unusual, even on very good sites, for at least half of the visits to be negative. Try not to be discouraged by negative results. It is best to monitor a small number of sites well than try and cover a large number of different sites.

Guideline Summary

1. Select a sunny, dry, south facing site with natural vegetation.
2. Look for reptiles in April, May and September.
3. Early to mid morning and mid to late afternoon are best.
4. Chose warm (but not hot) still days with some sun, especially after rain.
5. Seek out banks, ridges and gullies and look in sunny spots in the vegetation.
6. Walk very gently and stop to look often. Come back to investigate rustles.
7. Keep refuges hidden and don't rely on them alone. Check the top first.
8. Visit at least five times a year for several years. Expect some negative results.