BTO Research Report No. 102

The effects of the Wye Raft Race on the distribution of waterfowl broods

by

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September 1992

A report by the British Trust for Ornithology
under contract to the National Rivers Authority (Welsh Region)

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BTO Research Report No. 102
September 1992

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EXECUTIVE SUMMARY

1. This study was commissioned by NRA (Welsh Region) to:

   (a) locate and map the distribution of waterfowl broods along sections of the River Wye between Hay-on-Wye and Chepstow.

   (b) determine changes in the distribution of waterfowl broods before and after the Wye raft race.

   (c) identify the disturbance impacts of the Wye raft race on the distribution of waterfowl broods.

2. Eight sections of the River Wye, each of approximately 5km in length, were studied. Six of these sections corresponded to the three stages of the raft race, with the remaining two sections (upstream of Hay-on-Wye) acting as controls. Each section was visited on five occasions, twice before and three times after the race. The locations of waterfowl broods were plotted on 1:25,000 maps and broods were assigned an age category.

3. Observations at five spectator pressure points were made during the three days of the race. The interactions between spectators, rafts and waterfowl broods were examined.

4. Only four broods were located before the race, with an increase in numbers from the second week of May after completion of the race. Ross-on-Wye, an area regularly subjected to recreational disturbance, held the greatest number of duckling broods.

5. During the race, observations were made on three broods on two different sections of river. No actual loss of waterfowl broods was observed. Two broods were located before and after the race, one of which showed a marked decline in numbers in the days following the race.

6. Thirteen broods of waterfowl were reliably identified on more than one section visit. The majority of these (76%) moved an average of less than 60m per day between visits. The two broods located before and after the race showed a very similar pre- and post-race distribution.

7. The factors governing the onset of breeding and brood mortality are discussed with particular reference to the 1991 race. It is concluded that there is not sufficient information to suggest that this race was directly responsible for the claimed loss of 500 ducklings. Insufficient numbers of broods were located before the 1992 race to allow any meaningful conclusions to be drawn as to the disruption of waterfowl broods, and consequent mortality as a result of the Wye raft race.

8. Suggestions for minimising the potential disturbance caused by the race include ensuring completion by early May, limiting the number of entries, and curtailing pre-race practice runs on the Wye.

9. Recommendations for future work include further observations on the interactions between waterfowl broods, spectators and rafts; the possible use of colour marking and/or radio-tracking to further investigate the movements of waterfowl broods; and studies to assess the impact of other types of water-based recreation on broods.

1. INTRODUCTION

The three day Wye raft race has become a traditional May Bank Holiday event, attracting increased numbers of spectators. A record 77 rafts were entered for the 1992 race, with a foreign team included for the first time. This year, the race took place over the Mayday Bank Holiday weekend between May 2-4. Over recent years there has been increasing concern that waterfowl broods were being disturbed as a direct consequence of the race, and a loss of 500 ducklings was reported in 1991.

The first 12 to 14 days of a duckling's life are the most critical **(Clark *et al.* 1987; Hill & Ellis 1983).** Spring and early summer are very important times for their dispersal, and it is then that they are particularly vulnerable to predation. Disturbance to broods can lead to increased mortality and the raft race might contribute to this. The purpose of this study was to investigate the disturbance impact of the Wye raft race in 1992.

Duckling numbers vary annually, influenced by climate and the weather at the time of hatching **(Hill 1984a).** Cold, wet and windy conditions may have a deleterious effect by virtue of chilling and by delaying the emergence of adult Chironomidae, the main source of duckling food early in the season **(Hill & Ellis 1983).** The mean hatching date of Mallard clutches is later in years when the peak emergence of chironomids is delayed by poor weather **(Hill 1984b).** Levels of predation are another factor determining the size of duckling broods.

The objectives of this present study were:

1. To locate and map the distribution of waterfowl broods along sections of the River Wye between Hay-on-Wye and Chepstow.

2. To determine changes in distribution of waterfowl broods before and after the Wye raft race.

3. To identify the disturbance impacts of the race on the distribution of waterfowl broods.

2. METHODS

Eight sections of the River Wye, each of approximately 5km in length, were selected for the study. These were grouped as four paired sections. Three of these paired sections corresponded to the three stages of the raft race, and were chosen to include representative populations of breeding waterfowl and likely spectator pressure points. Selection of these sections was made using existing NRA data. The fourth paired section was situated upstream of Hay-on-Wye and acted as a control. Figure 2.1.1 shows the stretch of the River Wye which encompasses the study area and the course of the raft race.

Each section was surveyed by walking and visited at the same period of the day throughout the study *eg* morning or afternoon. Every effort was made to standardise the starting time of each survey. A visit to each section was made twice in late April before the race, and three times afterwards in May. The waterfowl broods were recorded on both the outward and return journeys of each visit. The dates of the five visits to the eight sections of river are shown in Table 1.

Additional observations were made during the race along five of the river sections, namely Bredwardine Bridge, Hereford, Hoarwithy Bridge, Ross-on-Wye, and Lower Redbrook. These were chosen as areas likely to attract large numbers of spectators during the race. At each point special attention was paid to:

(1) the interactions between the rafts and spectators on the waterfowl and their broods.

(2) the numbers, turnover, and distribution of the spectators along the river banks.

The observations made during the race are detailed in Table 4.

For every visit the locations of all the waterfowl broods were plotted as accurately as possible on enlarged 1:25,000 maps. Each brood was assigned an age category based on their plumage development, **(Gollop & Marshall 1954; Cordonnier 1984)**, and was carefully scrutinised for individual distinguishing features which would allow future identification. In many instances it was not possible to recognise the same individual adults and broods between the different visits but, occasionally, certain plumage and bill characters were of use. Changes in the size of the broods was recorded throughout the study. Care was taken to minimise disturbance to broods arising from the study methods, and survey work was not carried out under inclement weather conditions.

3. RESULTS

All the broods found during the visits to each section are plotted on Figures 3.1.1 to 3.1.12 and are detailed below. The broods of only four species of waterfowl were found during the surveys: Mallard, Moorhen, Mute Swan and Goosander.

3.1 Brood numbers

Symonds Yat

A total of eight Mallard broods was found on the survey section (Figure 3.1.1). The river is quite narrow along much of this stretch with relatively little cover for nesting and relatively high levels of disturbance from walkers and canoeists. A campsite is situated approximately halfway along the section. Additionally there is a strong current in the upper reaches of the section.

Lower Redbrook

Ten Mallard broods were located during the surveys (Figure 3.1.2). This stretch of the Wye is relatively undisturbed with only the occasional walker present. The area around Lower Redbrook is subjected to the greatest recreational pressures, especially at weekends. Normally there were anglers downstream of Redbrook throughout the week.

Ross-on-Wye

This section held the greatest numbers of breeding waterfowl with 36 broods of three species mapped (Mallard, Mute Swan, and Moorhen; Figures 3.1.3 to 3.3.5). Half of these were found on the relatively short stretch of river at Ross-on-Wye itself. This area is consistently subjected to high levels of human disturbance, but has ample nesting cover on the western bank. Another important area, also with plenty of nesting cover, included the bends towards the end of the section adjacent to the A40(T) (Figure 3.1.3). This was little disturbed except by the occasional angler.

Hoarwithy Bridge

A total of 11 Mallard broods was recorded on this section (Figure 3.1.6). Apart from the area immediately around Hoarwithy Bridge itself, there was very little human disturbance except by the anglers generally present along the southern bank of the river. There were several areas with dense riverside vegetation, in particular upstream of Hoarwithy bridge and the old railway bridge.

Hereford

Only nine broods of Mallard were recorded along this section of river (Figure 3.1.7). This was surprisingly low in view of the abundance of apparently suitable nesting habitat and favourable feeding conditions. There was a fair amount of human disturbance, including a rowing club, as well as many relatively undisturbed areas, especially upstream of the city.

Bredwardine Bridge

Five broods of Mallard and a single brood of Goosander were recorded during the five visits (Figures 3.1.8 & 3.1.9). There was a shortage of cover for nesting, with the most suitable areas being just upstream of the bridge itself, and along the NW part of the section. With the exception of the area immediately around the bridge, this was a very quiet section of river with no public access. Anglers were regularly present on both banks along the middle part of the section.

Boughrood (control section)

A total of eight Mallard broods was recorded along this stretch (Figure 3.1.10). The upper reaches of the section were fast flowing with small rocky outcrops, but there was good ground cover for nesting along the river banks and four broods were located. The middle of the section had little bankside cover, but this increased towards Boughrood Bridge. Human disturbance was virtually absent with only the occasional angler present.

Glasbury (control section)

Three broods of Mallards and three broods of Goosander were recorded during the five visits (Figures 3.1.11 and 3.1.12). Virtually all of these broods were within the middle part of the section where the current was slower and bankside vegetation present. The final 1km stretch above Glasbury was devoid of riverside vegetation and no broods were seen at all. There was virtually no human disturbance along any of the section, with any angling activity confined to within a half kilometre of the Boughrood Bridge.

3.2 Brood dates

The total number of Mallard and Goosander broods for each section at the end of each round of visits is detailed in Tables 2 & 3. The only broods of Mute Swan and Moorhen were found at Ross-on-Wye during the fifth visit. A total of four Mallard duckling broods, was located before the race weekend (*ie* May 2-4). An additional 16 broods were reported by NRA water bailiffs in late April and the start of May, but virtually all of these were outside the survey sections.

There was a marked increase in the number of broods on the paired sections of river from May 8 onwards, although the degree of increase varied between sites (Tables 2 & 3 and Figures 3.2.1 & 3.2.2). During the 1992 season, it would appear that the main hatching period for the waterfowl broods was after the raft race.

3.3 Observations during the race

Bredwardine Bridge

This was a popular viewing spot with 215 spectators counted, the majority of which were either on the bridge or just downstream along the West bank. A contingent of

40 raft supporters ventured upstream and followed their individual rafts down to the bridge. The overall turnover of spectators was generally rather slow with disturbance virtually limited to the western side of the river. In most instances, the rafts moved through singly, keeping to the centre of the river.

No duckling broods were seen during the race.

Hereford City

The race observations were made between the riverside park and the works 3/4km downstream. However, most of the survey section was covered prior to the arrival of the first rafts, in an unsuccessful attempt to locate waterfowl broods. A total of 168 spectators was counted, virtually all either within the confines of the park or on the old town bridge. Only very few of the supporters followed the rafts along the riverbanks.

The Mallard and Mute Swan on the river appeared unconcerned by the passage of the rafts, which often passed within a few metres, occasionally in small groups. Potentially the greatest disturbance was from the race safety boats due to their greater speed and the resulting wash. Generally, there were always undisturbed areas along the riverbanks available to the waterfowl.

Hoarwithy Bridge

Out of a total of 75 spectators, 40 remained on the bridge throughout, with a further 35 distributed along the west side of the river. This bank had virtually no riverside vegetation to conceal nesting waterfowl. It is likely that most waterfowl would choose the east side of the river for nesting, as there are dense thickets of overhanging vegetation. During the race, this side was not disturbed by spectators.

Some 3-4 minutes before the first raft appeared, a Mallard and 11 small ducklings (aged between 5-7 days) moved downstream in a purposeful, but leisurely manner. The brood continued to move as the first rafts passed and generally appeared unconcerned, initially keeping to the eastern side under the overhanging bankside vegetation. Although they had ample opportunity to remain hidden and undisturbed, they continued to move, occasionally feeding and crossing to the opposite bank. The brood eventually moved downstream of the bridge and out of view, having covered 1km in 45 minutes. It is probable that the family were moving for reasons other than disturbance, possibly to a better feeding area. The other waterfowl on the river (Mallard and Mute Swan) largely ignored the rafts, although several of the latter redistributed themselves upstream.

Ross-on-Wye

The park/recreation area was the busiest of the five sections visited during the three days of the race, with a peak count of 640 spectators along the eastern bank. The majority of these stayed for the duration of the race. A further 55 spectators viewed from and below the Wilton Bridge, at the western end of the park. Only 10 spectators actually ran through the recreation area in a bid to keep pace with their

particular raft. The western side of the river remained virtually undisturbed and provided abundant cover for waterfowl and their broods.

Two broods of newly hatched Mallard ducklings were located before the first rafts appeared. While feeding, both of these broods were fairly mobile, covering distances of 200m and 400m respectively. During the passage of the rafts neither brood appeared unduly concerned, both continuing to feed along the western side of the river. After the rafts had been passing for approximately 105 minutes it was noticeable that two distressed ducklings had become separated from one of the broods. The female and the remaining brood moved 150m upstream and after approximately two minutes, the family was reunited. Although the evidence is only circumstantial, it is possible that the brood disruption resulted from the race.

A pair of Mute Swans was nesting in the vicinity and while the incubating female was unconcerned by the race, the patrolling male bird became increasingly upset after the first 10 rafts had passed. Latterly, several of the rafts were actually attacked, with a crew member knocked into the river on one occasion.

There was no other obvious disturbance to the other waterfowl on the river.

Lower Redbrook

The observations were made from the old railway bridge and the riverside by the village. Before the race, an unsuccessful search for waterfowl broods was conducted for a kilometre downstream of the bridge.

As this site is on the main Monmouth to Chepstow road, there was a constant turnover of spectators following particular rafts. Fifty-five spectators were counted over a 60 minute period, with the majority remaining alongside the main road.

The rafts tended to move through in small groups and, as the Wye is relatively narrow along this stretch, the likelihood of disturbance was increased. Some of the rafts passed within a metre or so of Mallard with the duck showing no signs of distress. However, several other Mallard and two Mute Swans were visibly disturbed by the rafts and flew up and down a short stretch of the river before eventually settling down after the first 15 rafts had passed.

3.4 Comparison of brood size before and after the race

Only two broods were located before and after the raft race, both on the Ross-on-Wye section (Table 5). One of these broods was observed during the raft race, but the other was in an area not visited during the race. When originally seen on April 24, both broods comprised nine ducklings. The brood at Ross-on-Wye decreased steadily, with only two ducklings remaining by visit 4 (May 14). The decline in numbers just after the race was especially noticeable (Table 5). Conversely, the brood at the western end of the section lost only one duckling over the same period. Unlike Ross-on-Wye, there was unlikely to have been any spectator pressure at the western end of the section.

Throughout the summer at Ross-on-Wye, the waterfowl broods are regularly disturbed by large numbers of visitors and daily boat trips along the river. Despite this, more broods of waterfowl were recorded along this particular stretch of river than along any of the other sections. Consequently, it is unlikely that any additional race-related disturbance significantly contributed to brood loss along this particular stretch of river.

3.5 Movement of duckling broods

Thirteen broods of waterfowl were reliably identified on more than one section visit, and their movements plotted (Figures 3.5.1 to 3.5.13). Eleven of the broods were along sections of the river used by the raft race, with the remaining two along the control sections. Four broods were located on three different visits, but the majority were found on just two visits. With two exceptions, all the broods were located on consecutive visits.

The majority of broods (76%) moved an average of less than 60m a day between each visit, with 35% moving less than 20m (Figure 3.5.14). The degree of movement shown by individual broods varied considerably between the different visits. A family of Goosanders averaged 215m in four days between visits 3 and 4, but only an average of 50m between visits 4 and 5 (Figures 3.5.13 & 3.5.14). Similarly, a brood of Mallards averaged 182m a day between visits 3 and 4 and 91m a day between visits 4 and 5 (Figures 3.5.1 & 3.5.14).

Due to a very small sample size, meaningful comparisons between the control and race sections were not possible.

The two families located on the Ross-on-Wye section before the race showed a very similar post-race distribution (Figures 3.5.5 & 3.5.6). The brood subjected to the greatest amount of race disturbance moved 344m over the following 12 days. This is broadly comparable to the observations made during the actual race, when the brood regularly fed along a 400m stretch of the river. From these limited observations it would appear that the raft race made little difference to the longterm feeding distribution of the broods.

4. DISCUSSION

There have been relatively few studies on the effects of recreational disturbance to broods of waterfowl. The majority of these concern disturbance to adult birds on migration and on the wintering grounds *eg* **Belanger & Bedard 1989; Forshaw 1983; Cryer *et al.* 1987.** The effects on behaviour and distribution of waterfowl on a lake used for model power boat racing was investigated by **Bamford, Davies & Van Delft 1990.** A study on the effects of water-based recreation on the waterfowl on Loch Insh **(Hill, Bloor & Lambton 1987)** suggested that flocks of Tufted Duck and Goldeneye, and those individuals with young were most vulnerable to disturbance. Studies by **Watmough 1983** showed that disturbance induced movements by Tufted Duck are energetically costly. The present study allowed an investigation into the combined effects of both raft and spectator pressure on duckling broods.

The raft race takes place over one of the two May bank holiday weekends, the date being decided by the timing of the tides along the final stretches of the race. The 1992 race was at the beginning of May, whilst that of 1991 was at the end of the month. The timing of the race in relation to the peak hatching periods of the waterfowl broods is important. The onset of breeding is governed by food availability in the early part of the season **(Owen & Black 1990).** This in turn may be influenced by the prevailing weather conditions. It is known that Mallard will begin their clutches earlier and continue laying for longer in years with high mean February temperatures **(Hill 1984a).** Conditions in 1992 were milder than those of 1991 with the season estimated to be two weeks advanced **(pers comm. fisherman and NRA Water Bailiff).** Despite these favourable conditions, very few broods were seen before the race, with numbers not increasing until the second week of May. Conversely, the later date of the 1991 race increased the likelihood of interactions between broods and the rafts.

During the BTO Waterways Bird Survey, several rivers were surveyed in Herefordshire, Gwent and Gloucestershire. This data, collected between 1980 and 1991, indicates that May 14 is the average date for first broods in this area. This and observations on the River Wye itself, suggest that potential disturbance could be reduced by completing the raft race by early May.

The levels of regular human disturbance on the Wye show considerable variation. Waterfowl broods born in Ross-on-Wye or Hereford are subject to higher levels of disturbance than broods along the more rural parts of the river. The raft race may have less of an effect on such urban waterfowl. Further work is required to compare the loss of broods within the different environments along the river.

The observations made, during the race, at spectator pressure points revealed that the disturbance was generally confined to just one of the banks. The less disturbed bank often held dense patches of vegetation, hiding any broods from both the rafts and spectators. Despite the availability of such cover, the broods observed during the race made little use of it.

The degree of disturbance of broods is also influenced by factors such as the width of the river and time of day. Early in the day,when all the teams are relatively fresh, the total passage time for the rafts at a given point is relatively fast. However, later in the day, fatigue substantially increases passage times, prolonging any potential disturbance by both the spectators and the rafts.

Safety cover for the race was provided by small motorised boats. These have the potential for causing serious disruption to broods by a combination of their speed and the wake produced. During the race, the majority of the safety boats kept pace with the rafts, but on at least two occasions, boats were seen to speed along stretches of the river. Excepting an emergency situation, the speed of the safety boats should be kept as low as possible.

The 1991 raft race was reported to have caused the loss of 500 ducklings **(CHAR 1992 souvenir programme).** Although extremely limited, the observations made during the 1992 race provided no evidence of losses directly attributable to the race. It is possible that several factors combined to depress duckling numbers during the spring of 1991. The cold, wet weather of April and May 1991 is likely to have reduced the availability of insect food, essential for the first two weeks of life **(Hill & Ellis 1983).** A prolonged period of heavy rain in the week before the race increased river levels by up to four feet **(pers comm. NRA).** The decline in the number of ducklings recorded may have resulted from broods being moved to new areas of the river where they were overlooked, or from mortality due to the weather conditions. Studies have shown that where fish populations are high, the numbers of invertebrates available to waterfowl are much reduced **(Hill, Wright & Street 1986; Giles *et al.* 1990).** Waterfowl broods moved further in areas with high fish densities and less in areas where the densities are low. The broods with the largest home ranges suffered the highest levels of mortality **(Hill, Wright & Street 1986).** Personal observation has shown that female Mallards can move their ducklings considerable distances along the Wye, in a relatively short period of time (section 3.3). Several anglers expressed concern over the number of canoes on the river, and the year round disturbance that these caused. Additionally, both Mink and Pike occur on the river **(pers comm. NRA),** and both are important predators of waterfowl.

Thus, it is likely that a number of factors, including the late date of the raft race, contributed to the loss of duckling broods in May 1991. However, the mobility of some broods could lead to many fewer being recorded, exaggerating perceived levels of mortality.

There are fears that the raft race is becoming too serious, with a professional foreign team entering for the first time in 1992. The overall number of entries has increased annually with a record 77 rafts this year. Some of the local teams now practice during the preceding weekends, prolonging the race-related disturbance along certain stretches of river. As the level and duration of race-related disturbance is dependent upon the number of participating rafts, it may prove necessary to limit the entries, and exclude professional teams in the future. Stricter regulations curtailing pre-race practising may also need to be considered.

5. CONCLUSIONS

In 1992, the Wye raft race took place before the main hatching period for waterfowl broods. Consequently, too few broods were located before the race to allow adequate comparison between disturbance impacts along those sections of the river included in the race and the control sections where no rafts occurred.

The observations of the few broods located both before and after the race are inconclusive with respect to the extent of disturbance effects due to the passage of rafts and/or the presence of spectators. However, there are indications of some disturbance related movements of waterfowl and disruption of broods.

6. RECOMMENDATIONS FOR FUTURE WORK

(1) Further observations should be made on the interactions between waterfowl broods, spectators and rafts at key pressure points. This would be particularly useful if the race is scheduled at the end of May, when there are likely to be large numbers of duckling broods on the river. Ross-on-Wye and Hereford would be two suitable areas for this work.

(2) Investigations into the movements of individual broods should be continued. It is possible that broods subjected to disturbance during the raft race become more mobile than those along the undisturbed stretches of river. The increase in mobility is likely to increase brood mortality. Ideally, these investigations would involve some form of colour marking and/or radio-tracking. Reliance on features such as bill markings and plumage patterns to identify broods is of limited use as there is close similarity between individuals.

(3) There are several forms of water-based recreation on the Wye. Recently, fears that canoeing is causing all round disturbance have been voiced. Studies into the interactions between waterfowl broods and canoes should be undertaken.

ACKNOWLEDGEMENTS

This study was funded by the National Rivers Authority Welsh Region. Thanks to Paul Hilder and Andy Neil for their assistance in the selection of suitable survey sites and for the provision of the relevant maps.

Dr Nigel Clark and Dr Rowena Langston gave much valuable help with constructive comments on aspects of both the report and the fieldwork. Dr Mark Rehfisch made comments on the draft copy.

Thanks to Tony Baker, warden of Radipole Nature Reserve Weymouth, for providing information relating to first brood dates. Also to Zul Bhatia, warden of Insh Marshes Speyside, for making available an unpublished RSPB report on the effects of water-based recreation on the waterfowl on Loch Insh.

The production of this report was aided by the secretarial support of Sophie Foulger.

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Paired section	River section	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5
1	Symonds Yat Lower Redbrook	22/4	27/4	9/5	13/5	17/5
2	Ross-on-Wye Hoarwithy Bridge	23/4	28/4	10/5	14/5	18/5
3	Hereford Bredwardine Bridge	24/4	29/4	11/5	15/5	19/5
4	Boughrood Glasbury	25/4	1/5	12/5	16/5	20/5

Table 1 Dates of visits to the sections of river surveyed

Visit	Ending	Symonds Yat	Lower Redbrook	Ross-on-Wye	Hoarwithy Bridge	Hereford	Bredwardine Bridge	Boughrood	Glasbury	Total
1	25/4	_	_	_	1	_	_	_	_	1
2	1/5	_	_	2	1	_	_	_	_	3
3	12/5	1	2	8	2	1	2	1	3	20
4	16/5	3	3	10	3	4	2	3	_	28
5	20/5	4	5	14	4	4	1	4	_	36

Table 2 Totals of Mallard broods recorded from each section after round of visits

Visit	Ending	Symonds Yat	Lower Redbrook	Ross-on-Wye	Hoarwithy Bridge	Hereford	Bredwardine Bridge	Boughrood	Glasbury	Total
1	25/4	_	_	_	_	_	_	_	_	_
2	1/5	_	_	_	_	_	_	_	_	_
3	12/5	_	_	_	_	_	_	_	1	1
4	16/5	_	_	_	_	_	1	_	2	3
5	20/5	_	_	_	_	_	_	_	1	1

Table 3 Totals of Goosander broods recorded from each section after round of visits

Day	Date	Location	Number of spectators	Number of broods
1	2/5	Bredwardine Bridge	215	–
1	2/5	Hereford Park	168	–
2	3/5	Hoarwithy Bridge	75	1 before rafts appeared
2	3/5	Ross-on-Wye	695	2
3	4/5	Lower Redbrook	55	–

Table 4 Summary of observations made during the raft race

Location	Number of Ducklings In Brood					
	Visit 1	Visit 2	During the race	Visit 3	Visit 4	Visit 5
Ross-on-Wye (Town)	–	9	7	4	2	Not Located
Ross-on-Wye (western end of section)	–	9	Not Covered	8	8	Not Located

Table 5 Changes in Mallard duckling numbers before, during and after the raft race

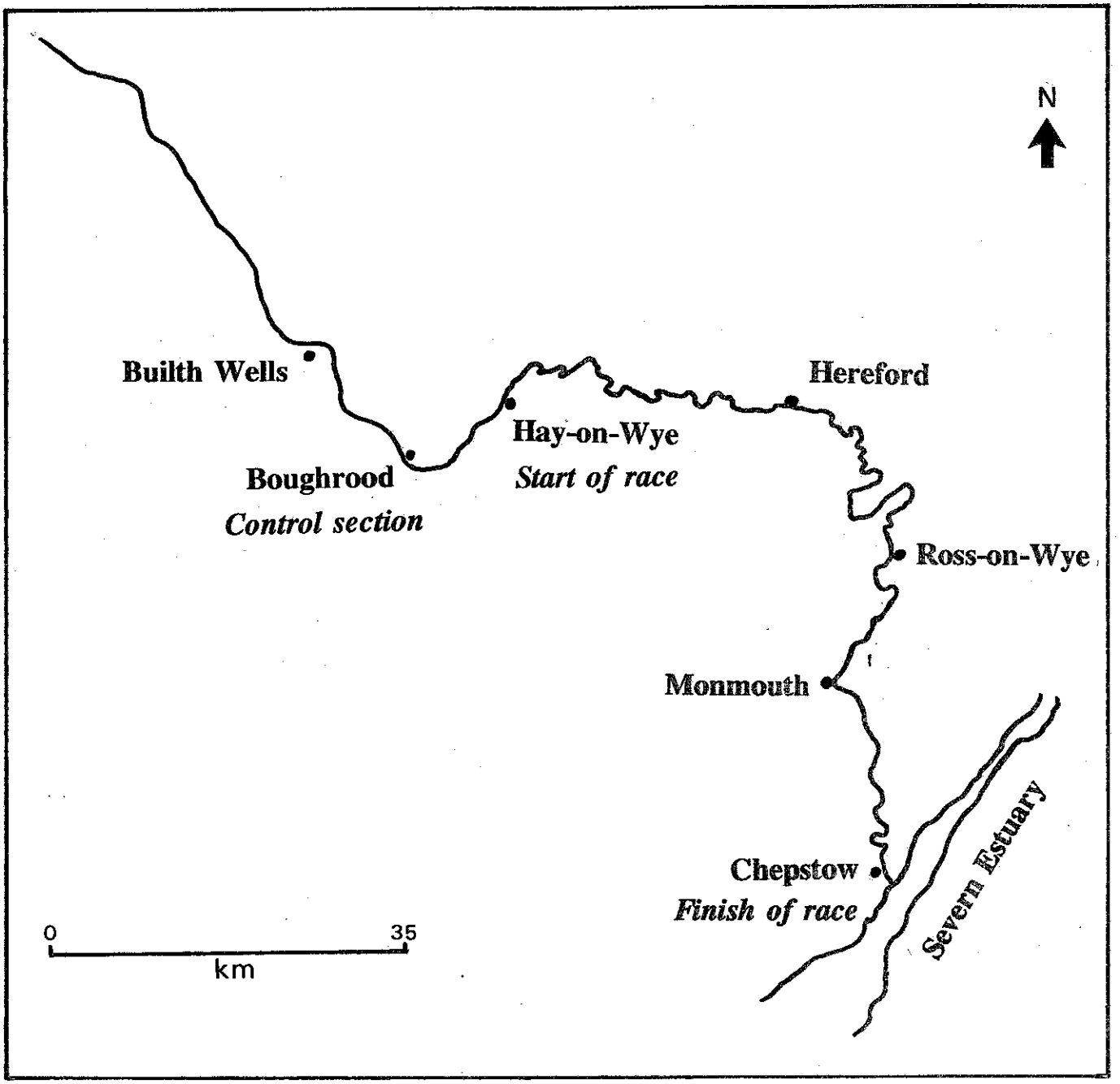


Figure 2.1.1 Map of the River Wye showing the study area and the course of the raft race.

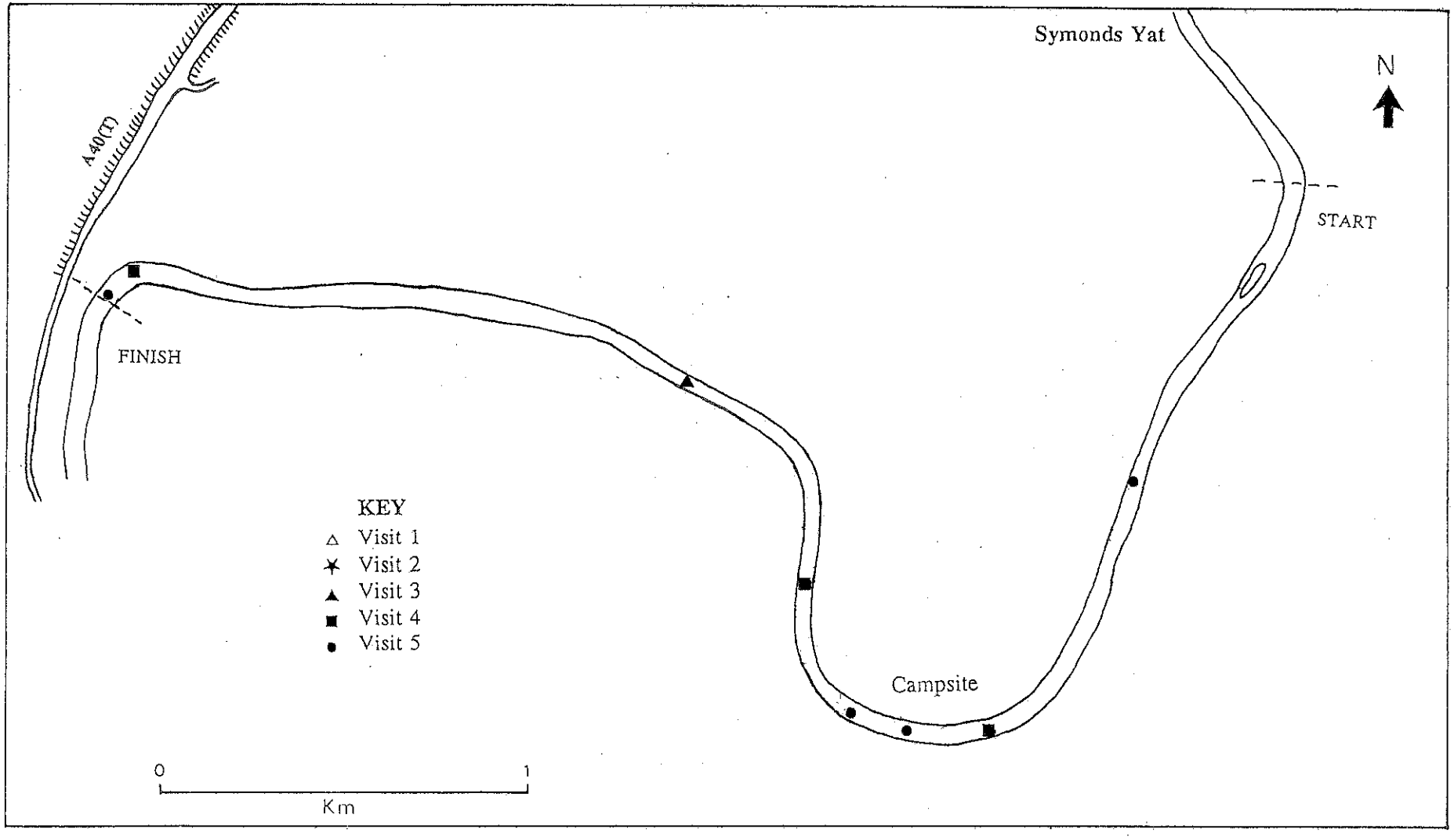


Figure 3.1.1 Distribution of Mallard broods at Symonds Yat.

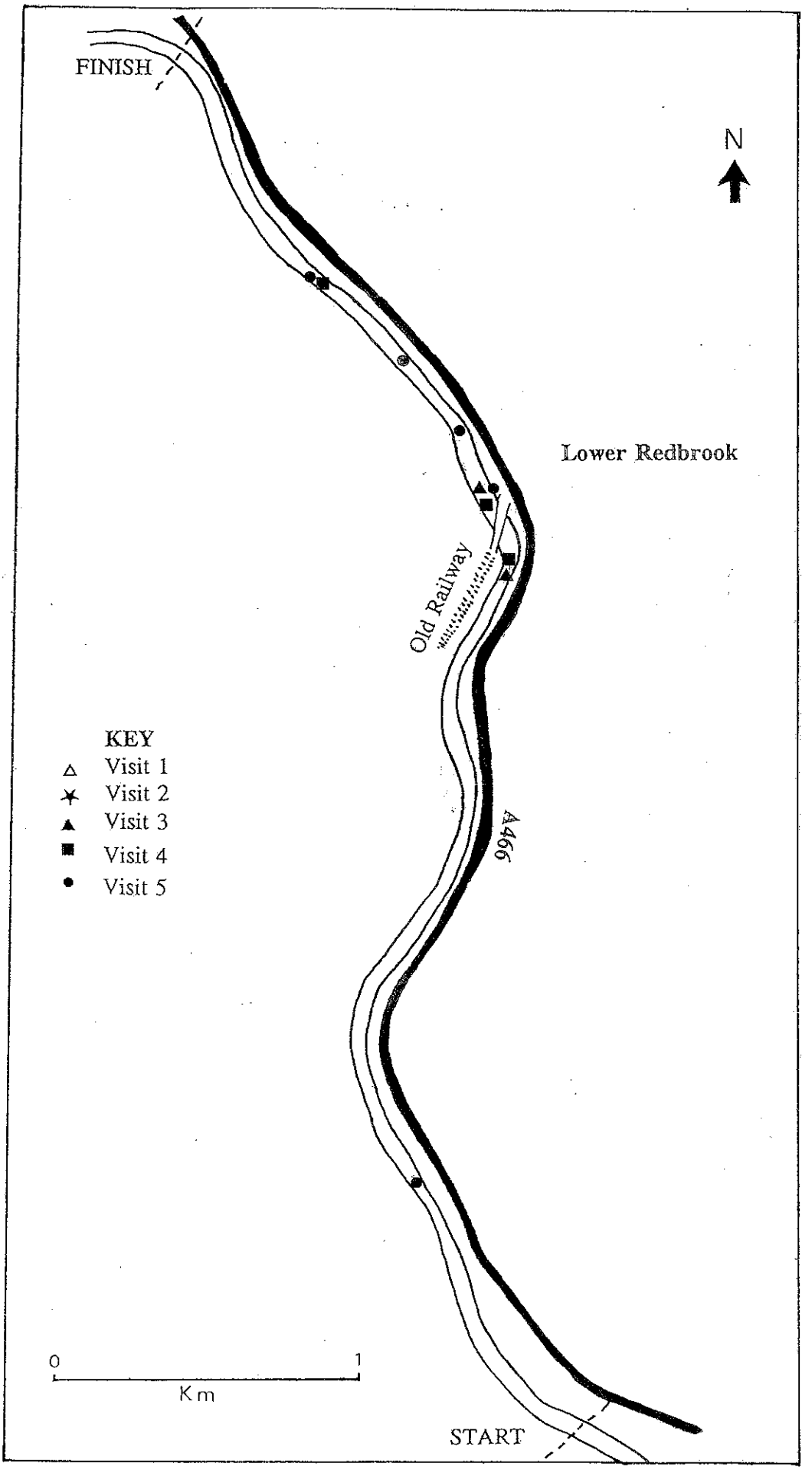


Figure 3.1.2 Distribution of Mallard broods at Lower Redbrook.

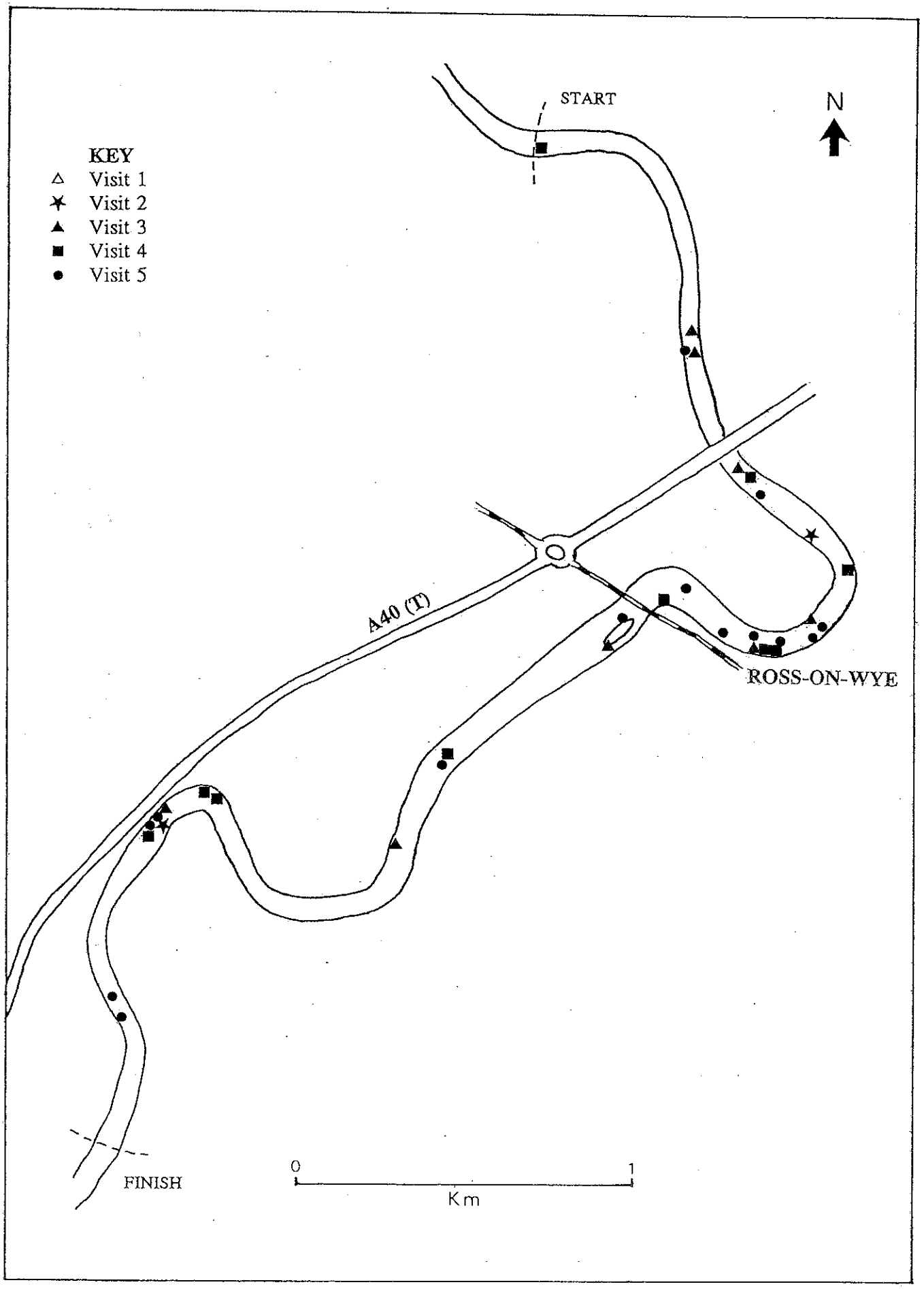


Figure 3.1.3 Distribution of Mallard broods at Ross-on-Wye.

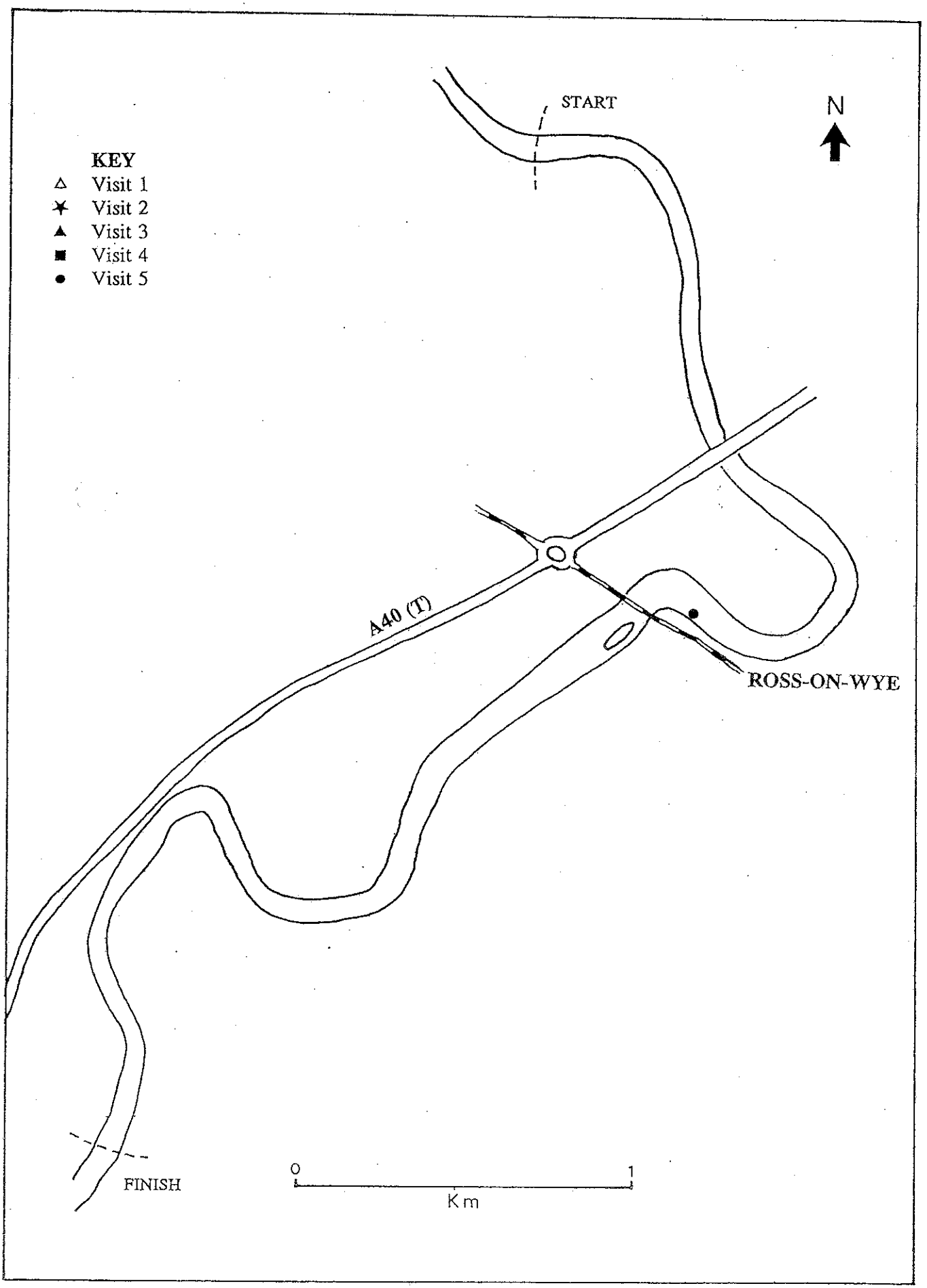


Figure 3.1.4 Distribution of Mute Swan broods at Ross-on-Wye.

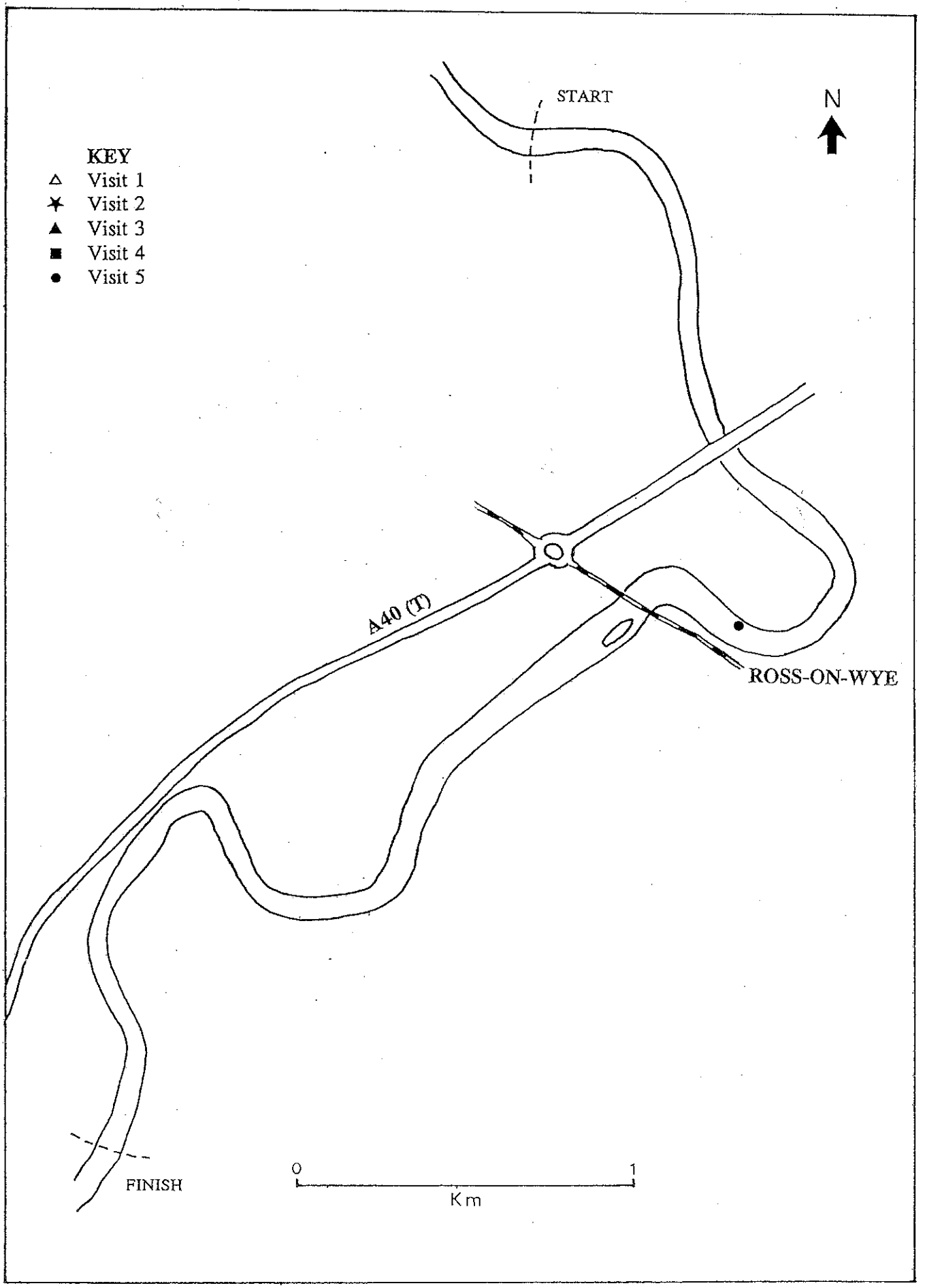


Figure 3.1.5 Distribution of Moorhen broods at Ross-on-Wye.

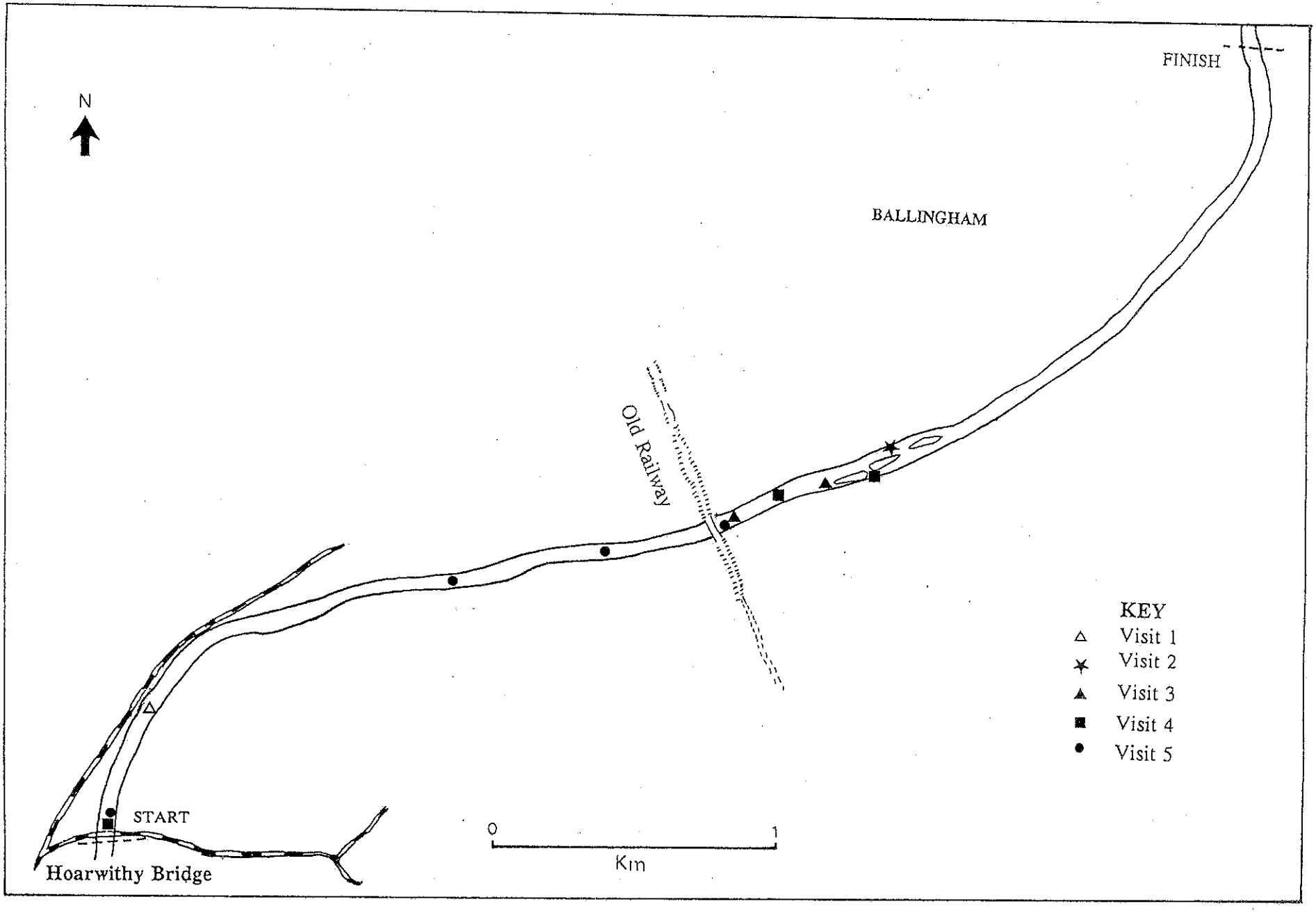


Figure 3.1.6 Distribution of Mallard broods at Hoarwithy Bridge.

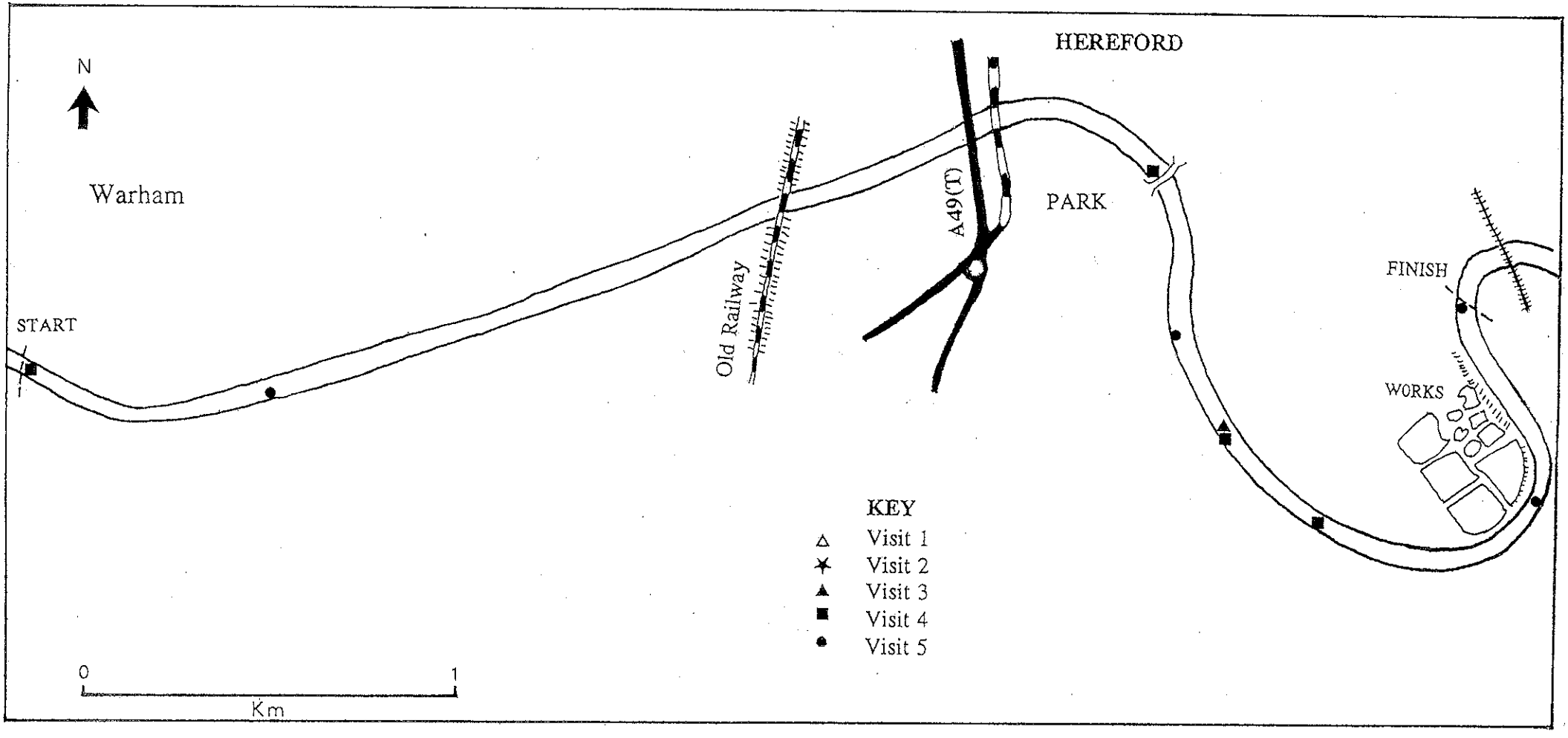


Figure 3.1.7 Distribution of Mallard broods at Hereford.

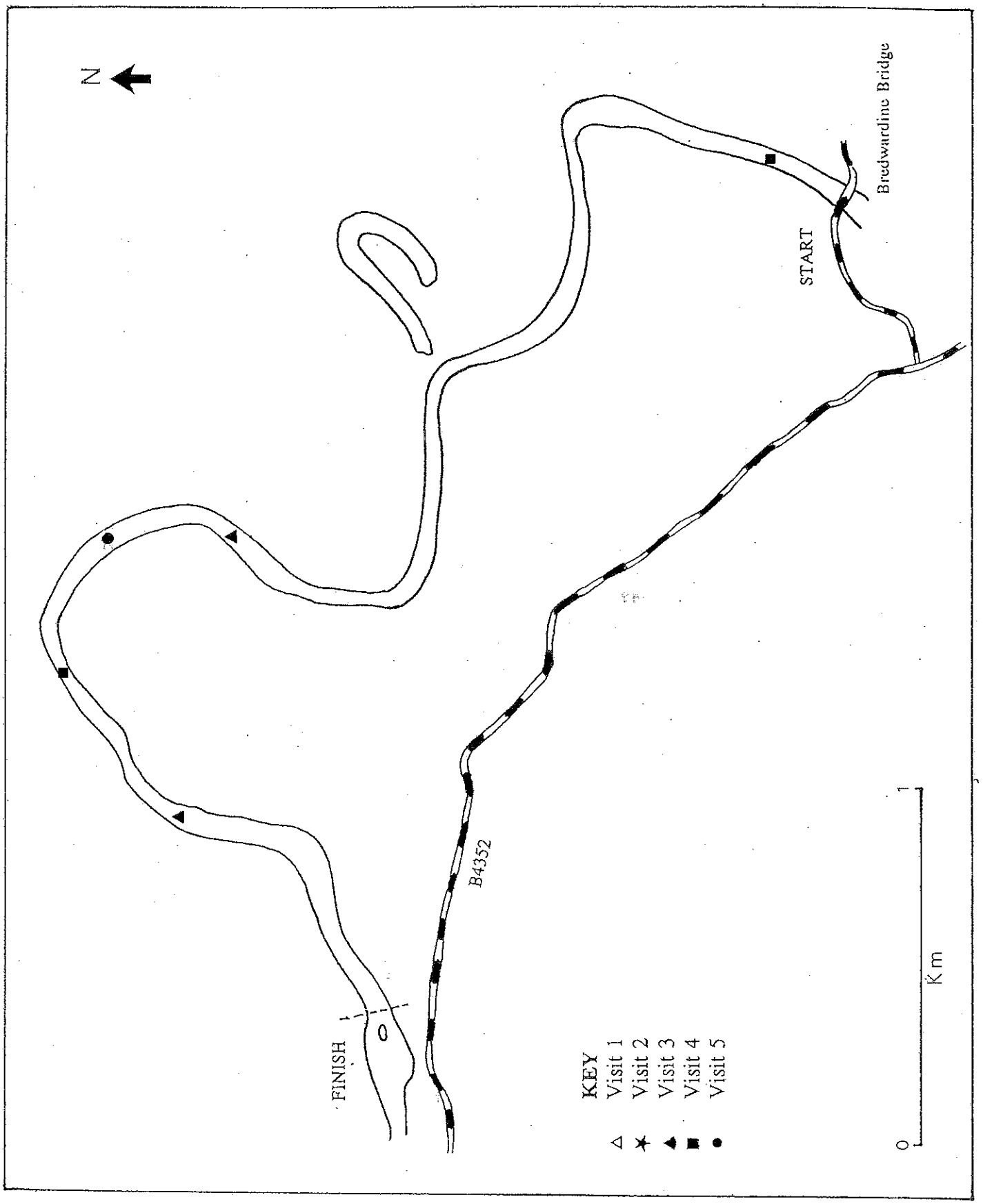


Figure 3.1.8 Distribution of Mallard broods at Bredwardine Bridge.

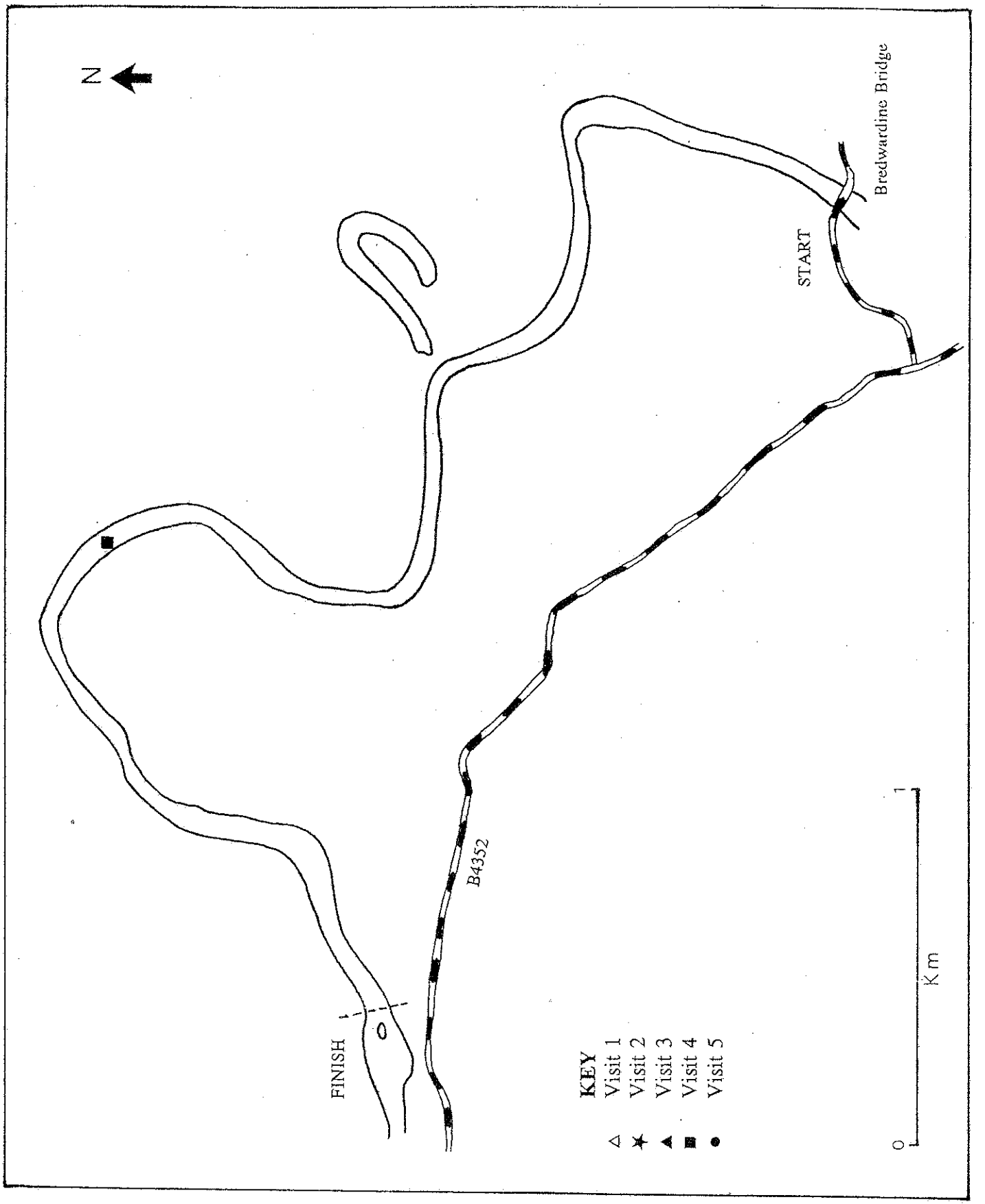


Figure 3.1.9 Distribution of Goosander broods at Bredwardine Bridge.

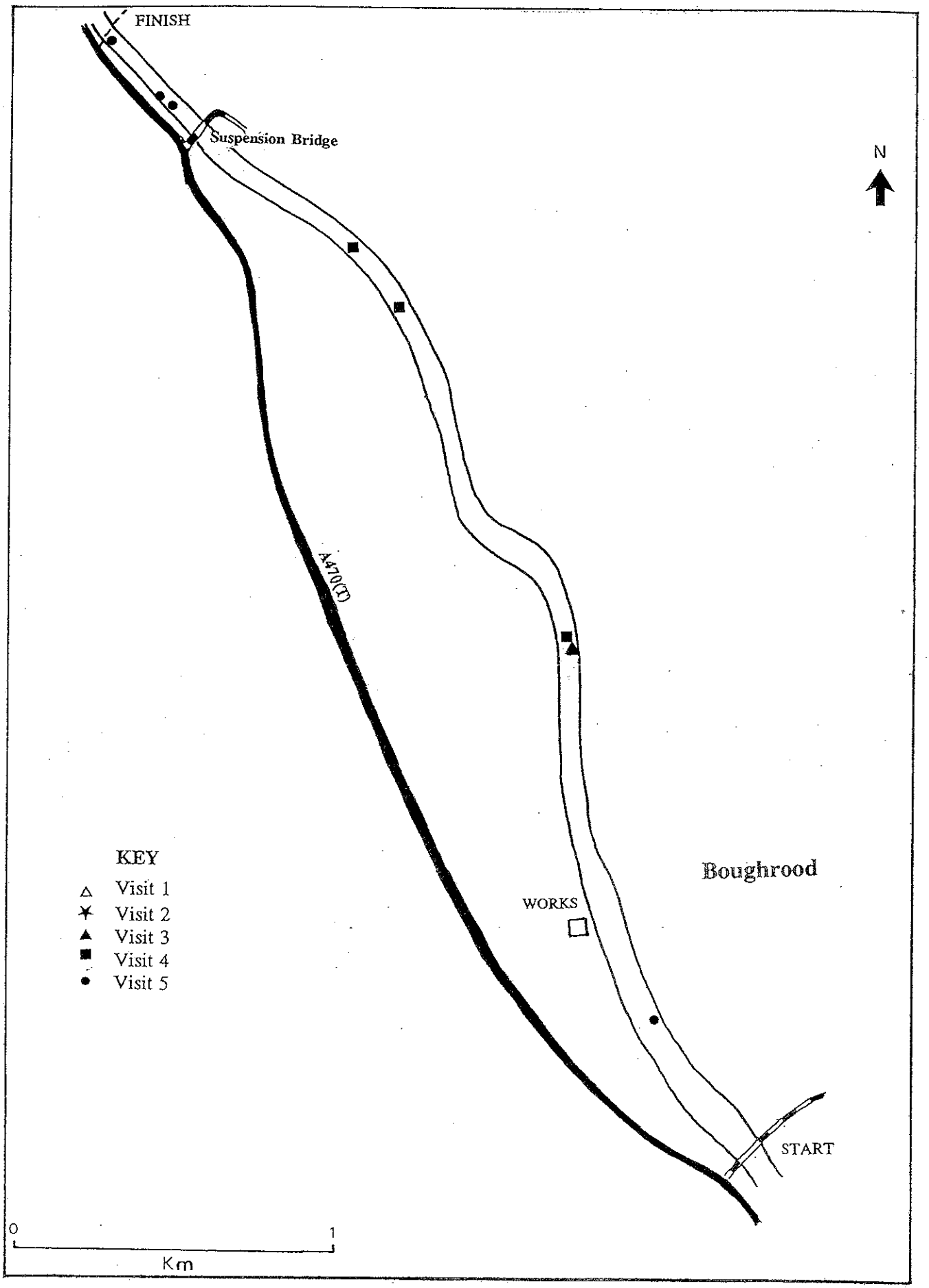


Figure 3.1.10 Distribution of Mallard broods at Boughrood.

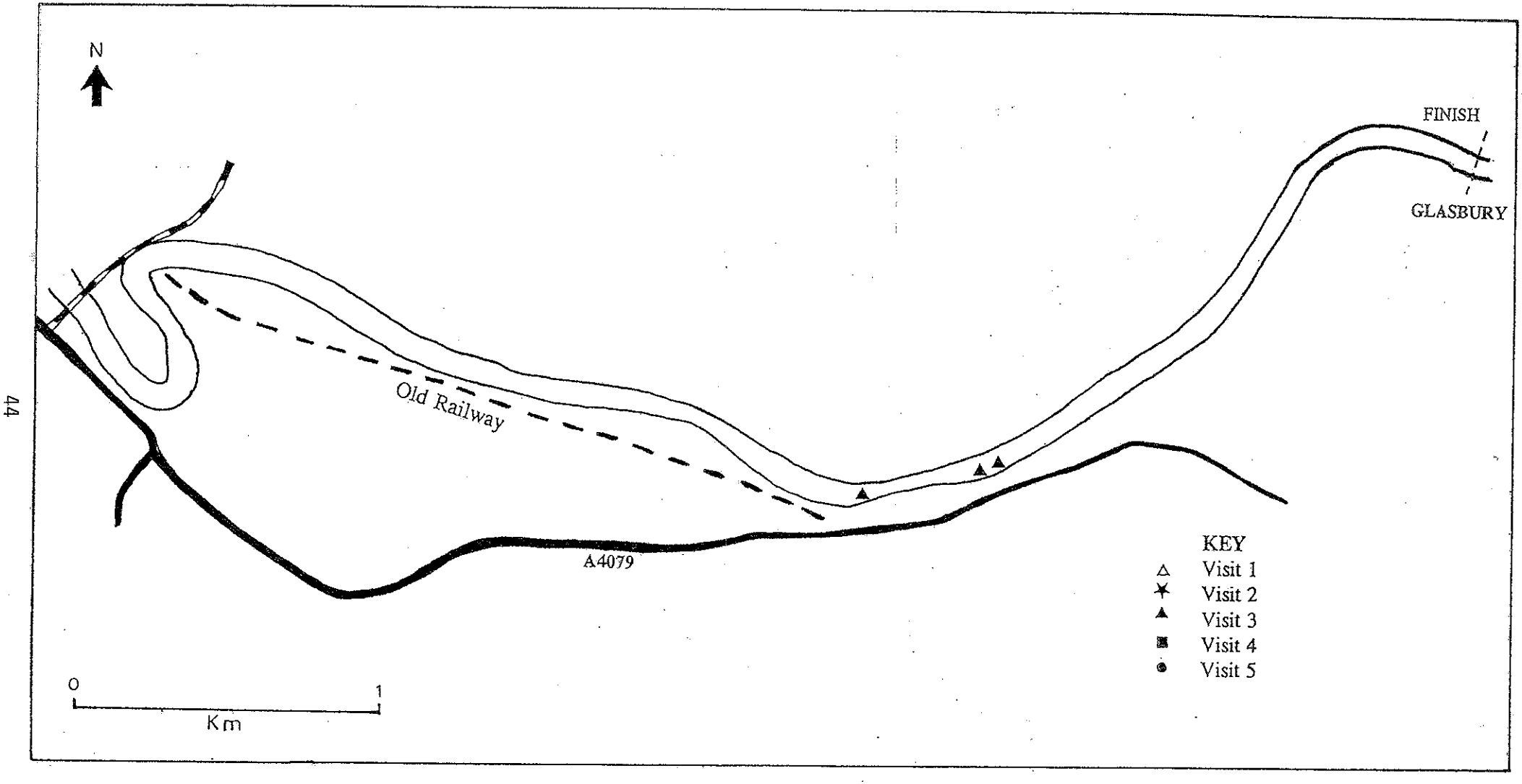


Figure 3.1.11 Distribution of Mallard broods at Glasbury.

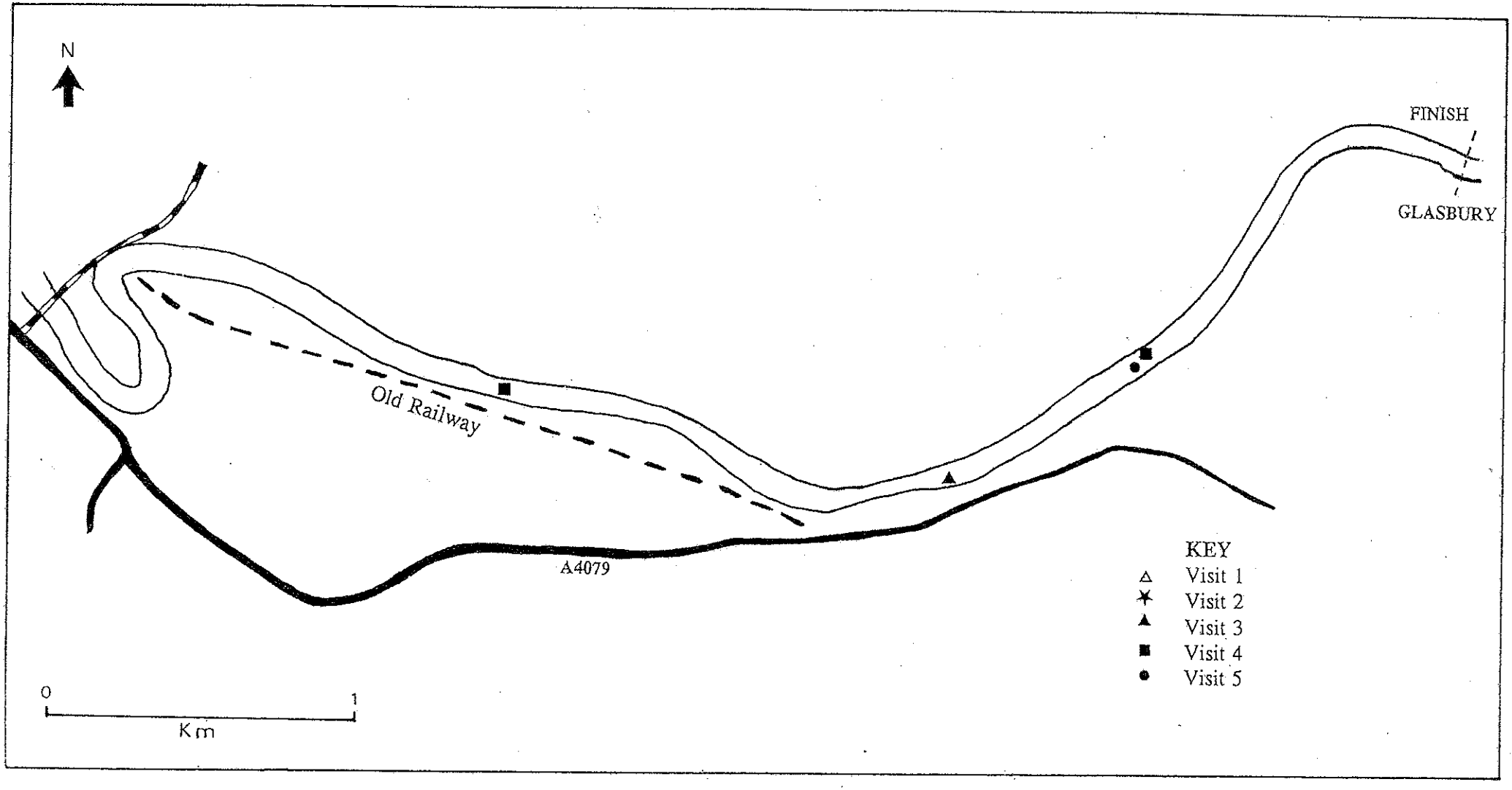


Figure 3.1.12 Distribution of Goosander broods at Glasbury.

Figure 3.2.1
Variation in the number of Mallard broods over the study period

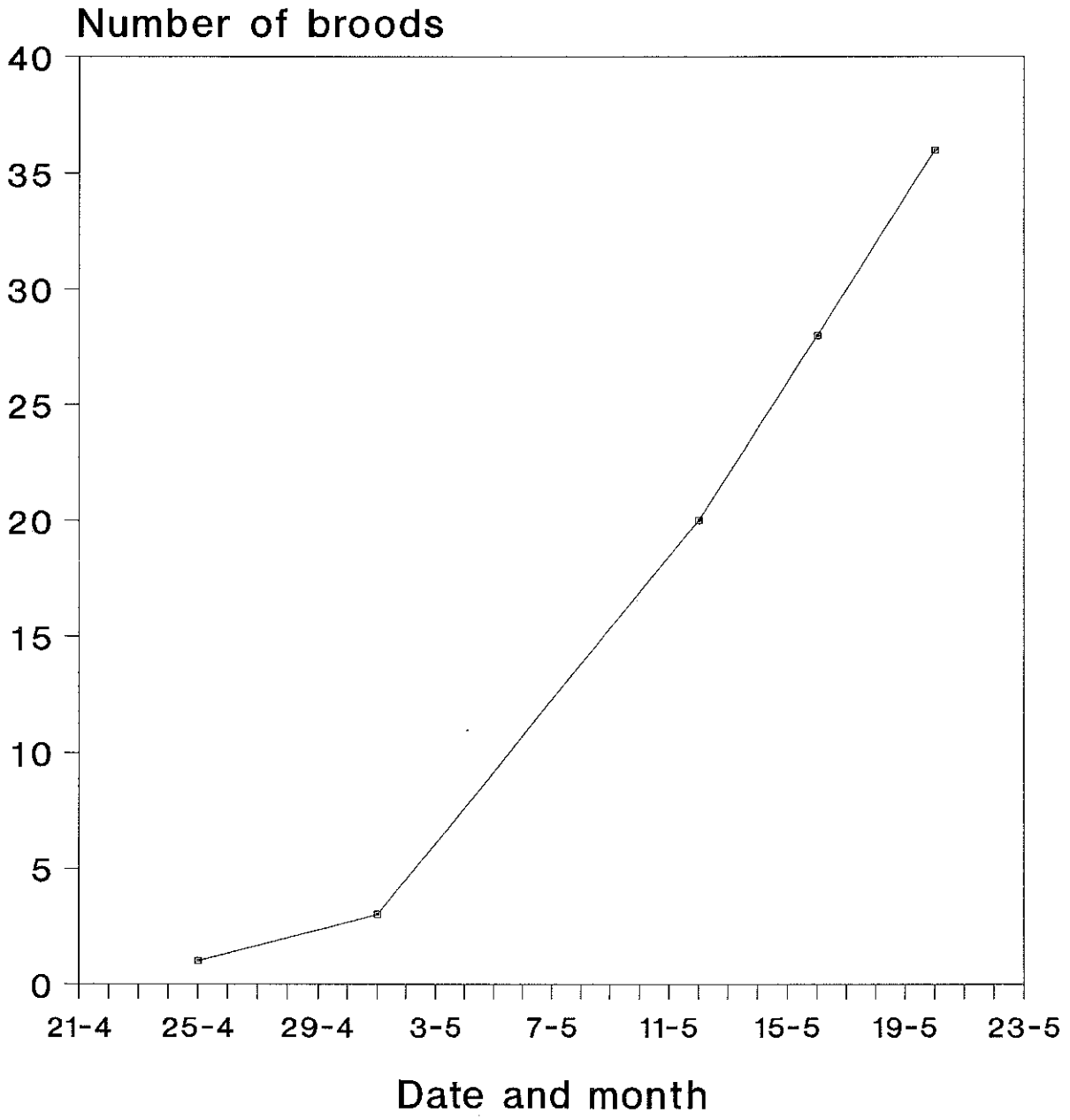
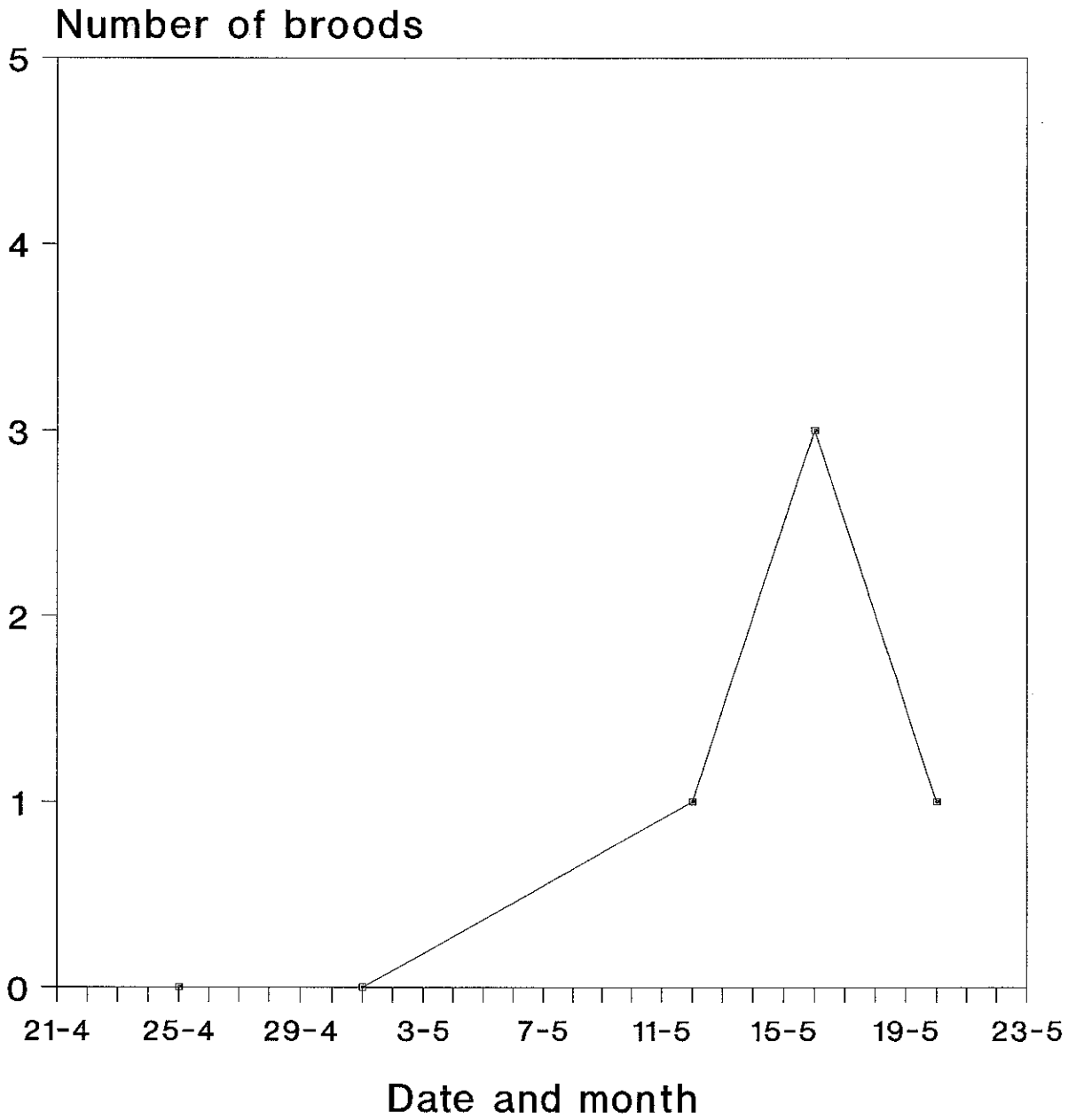


Figure 3.2.2
Variation in the number of Goosander broods over the study period



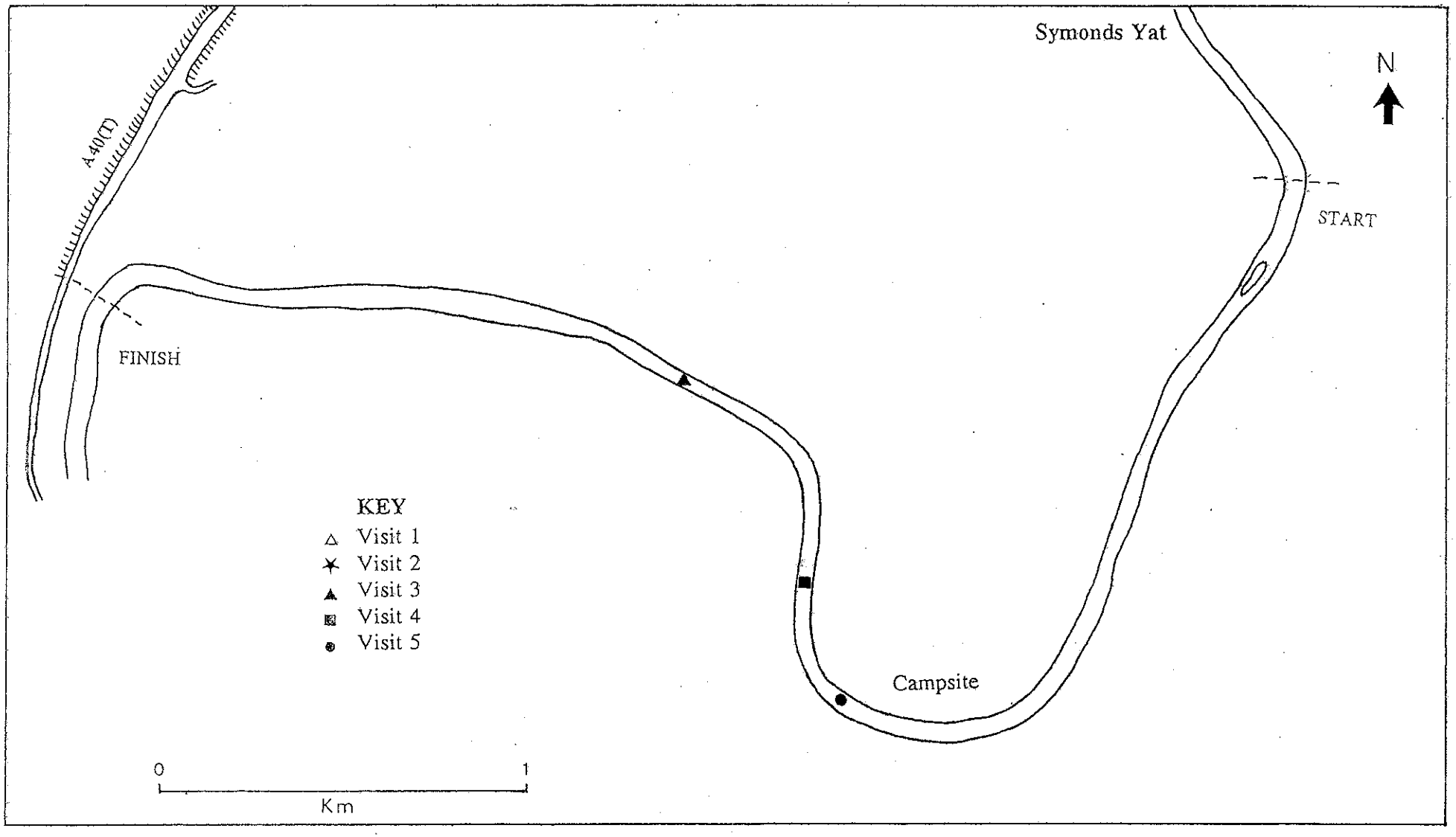


Figure 3.5.1 Movements of a brood of Mallard during 5 visits at Symonds Yat.

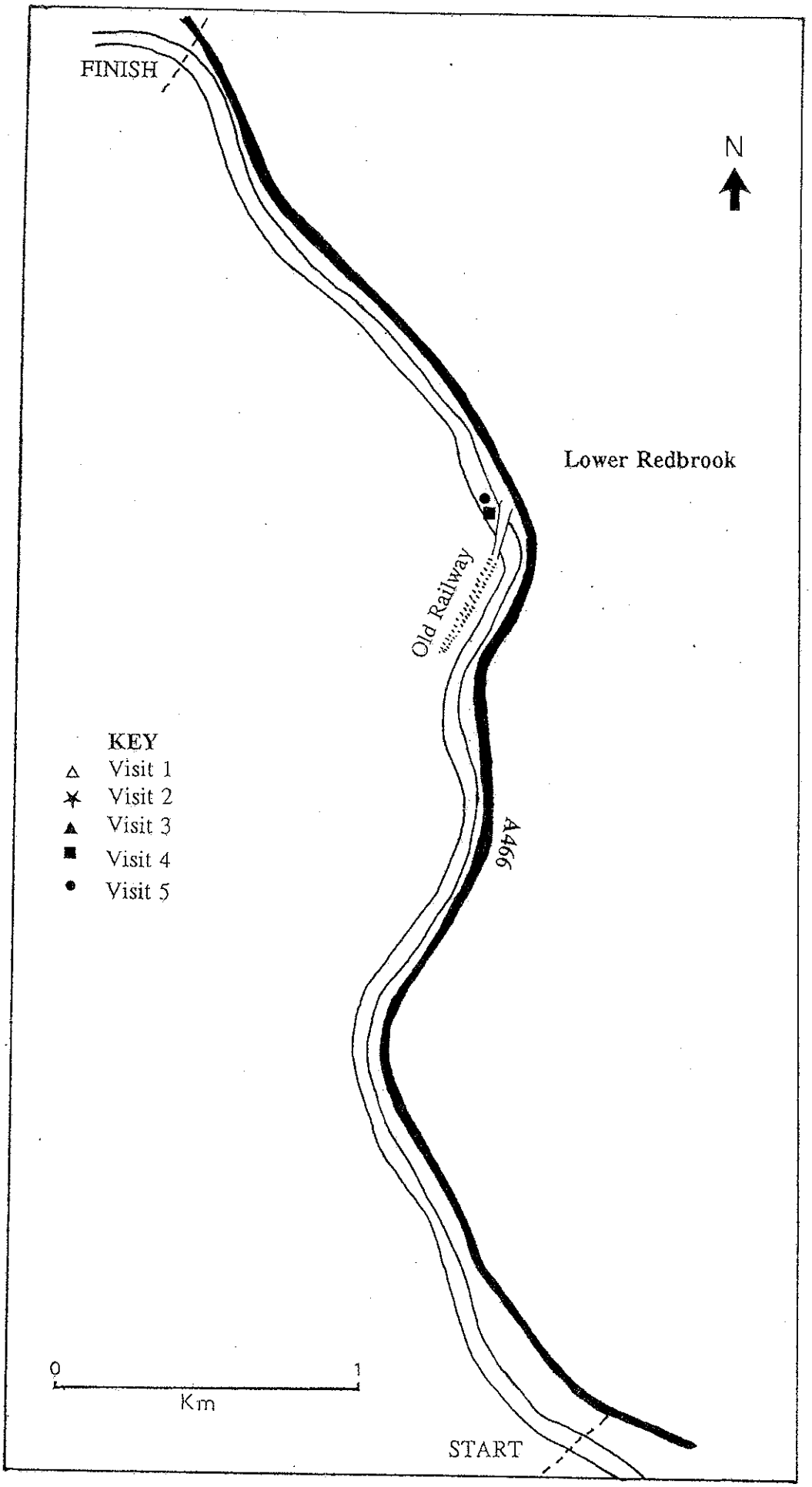


Figure 3.5.2 Movements of a brood of Mallard during 5 visits at Lower Redbrook.

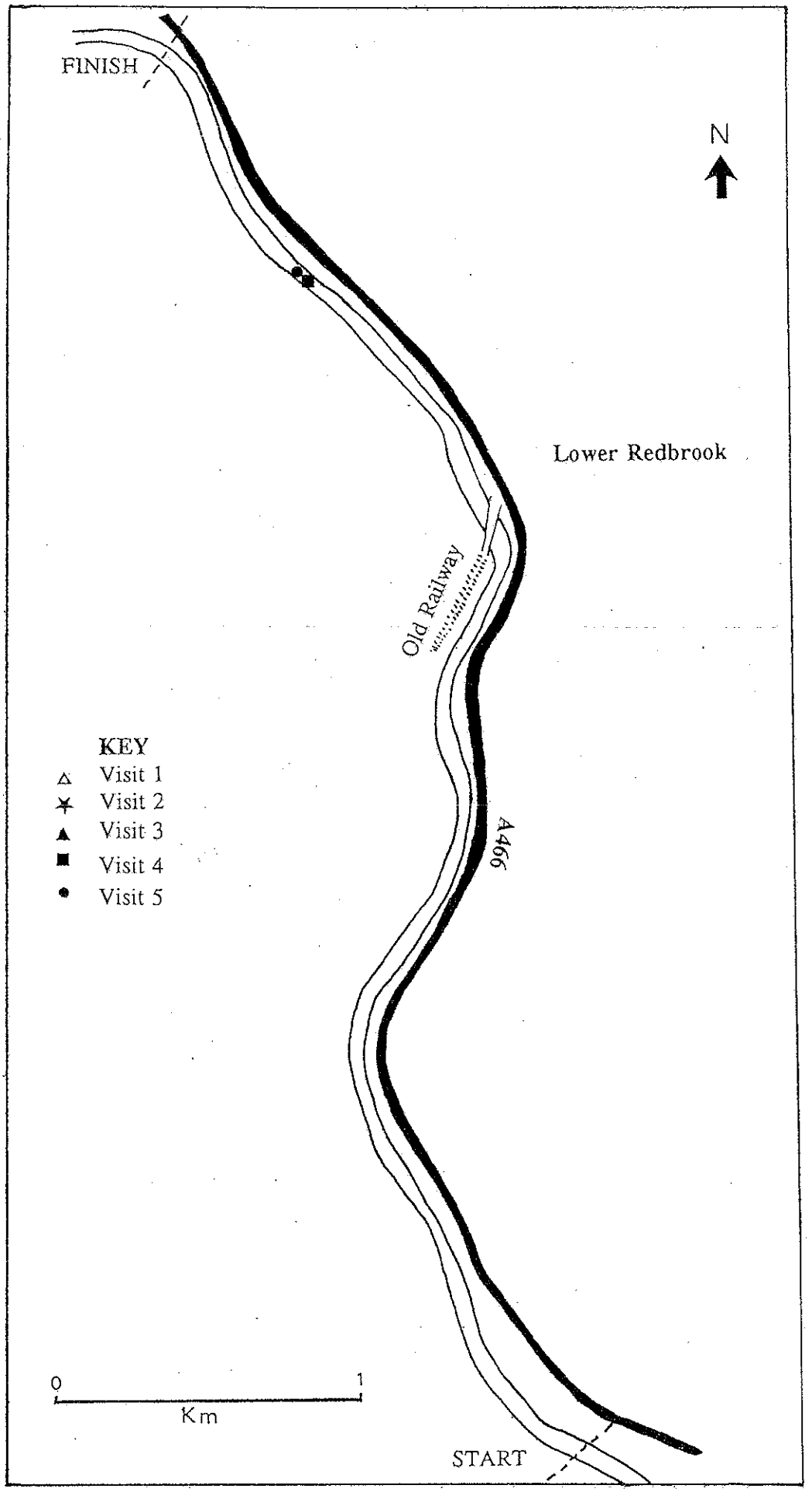


Figure 3.5.3 Movements of a brood of Mallard during 5 visits at Lower Redbrook.

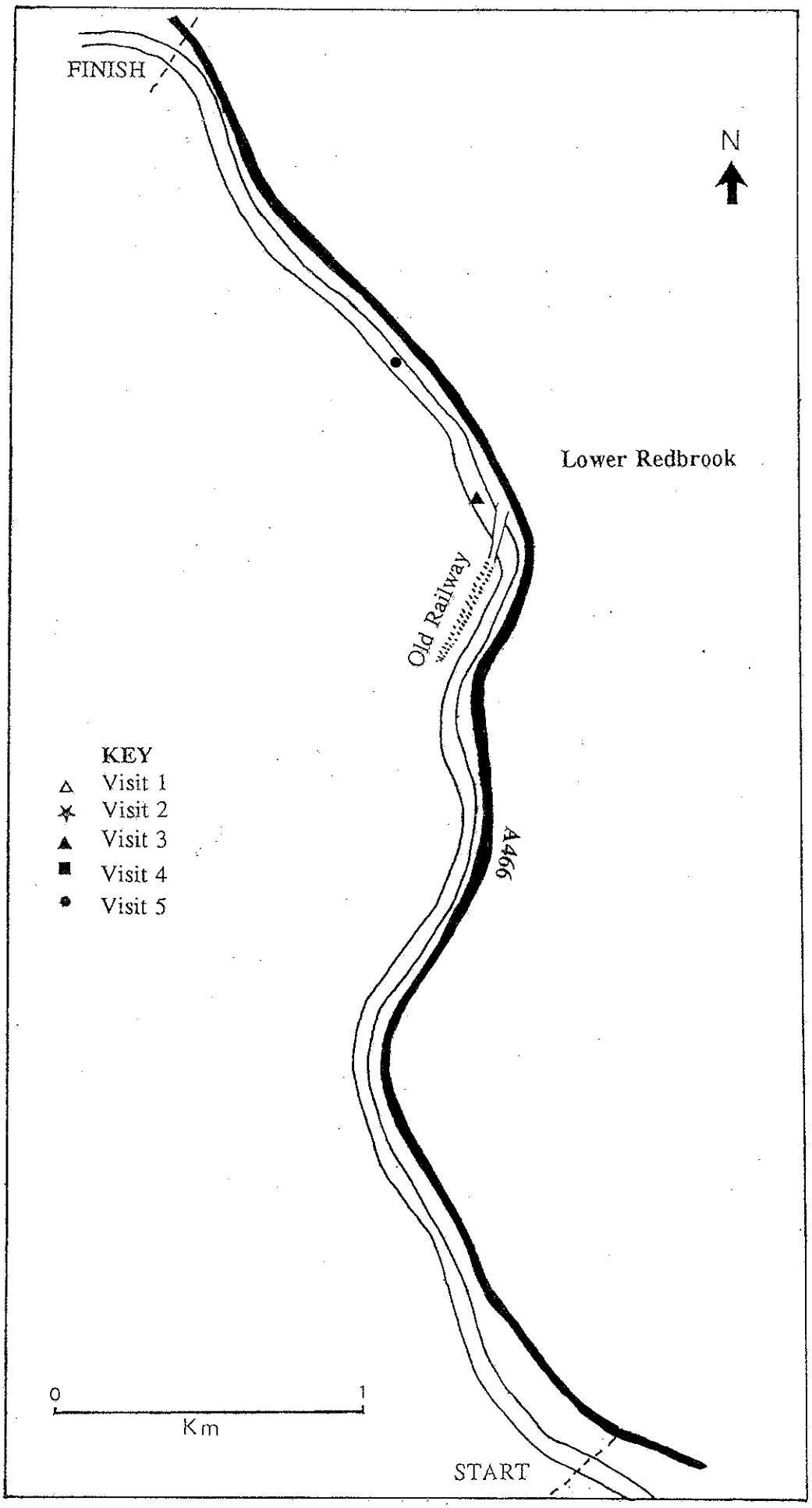


Figure 3.5.4 Movements of a brood of Mallard during 5 visits at Lower Redbrook.

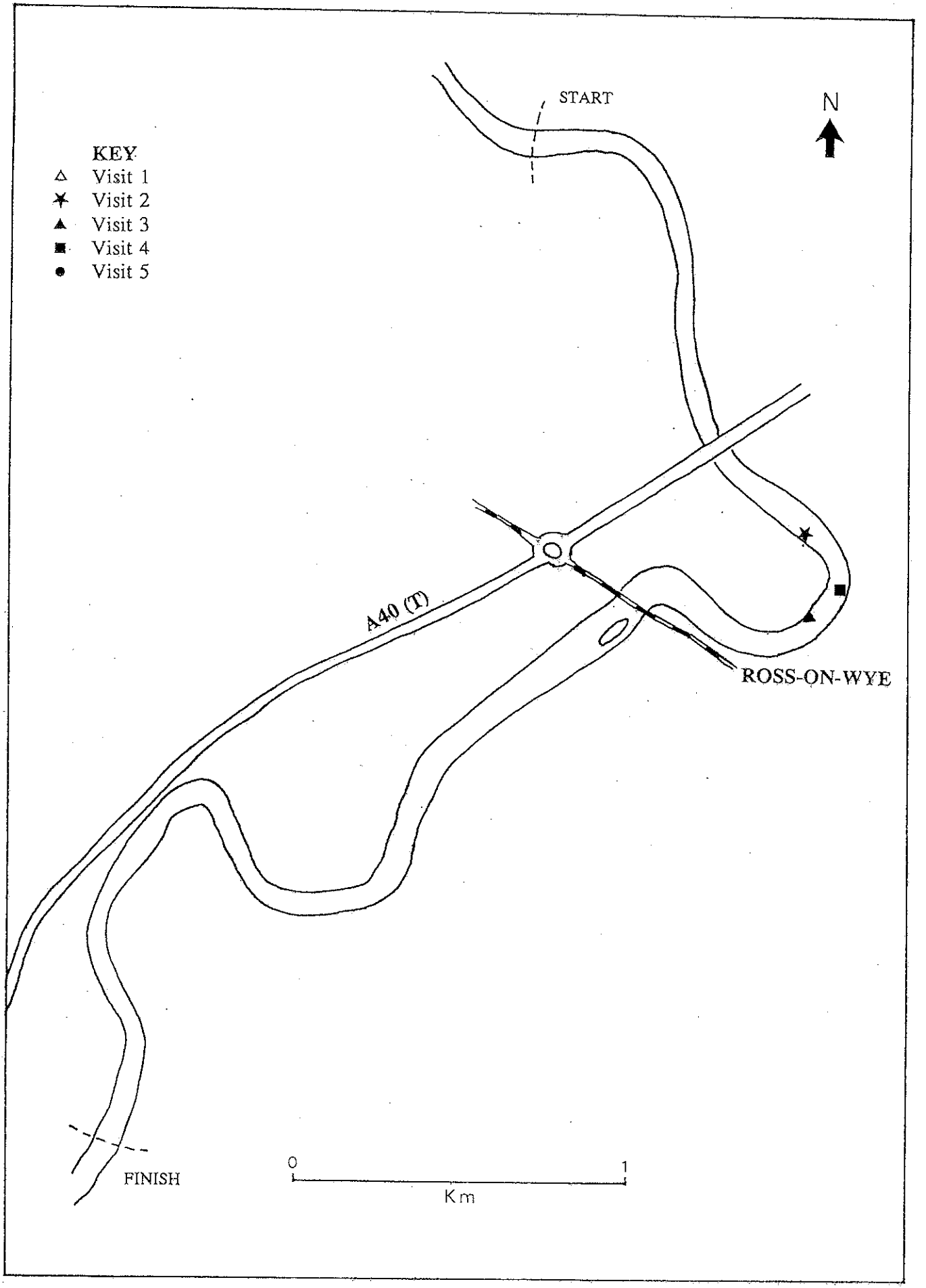


Figure 3.5.5 Movements of a brood of Mallard during 5 visits at Ross-on-Wye.

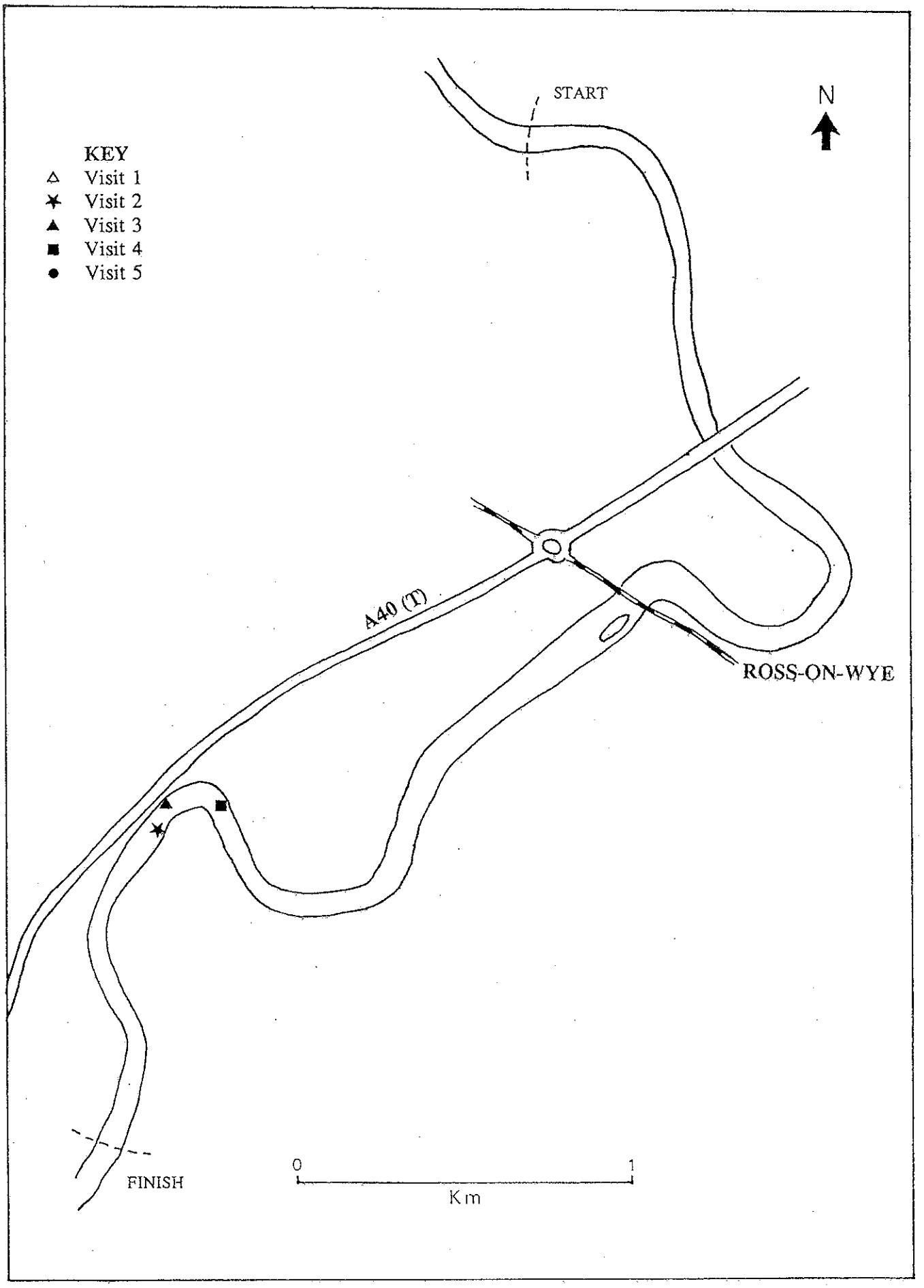


Figure 3.5.6 Movements of a brood of Mallard during 5 visits at Ross-on-Wye.

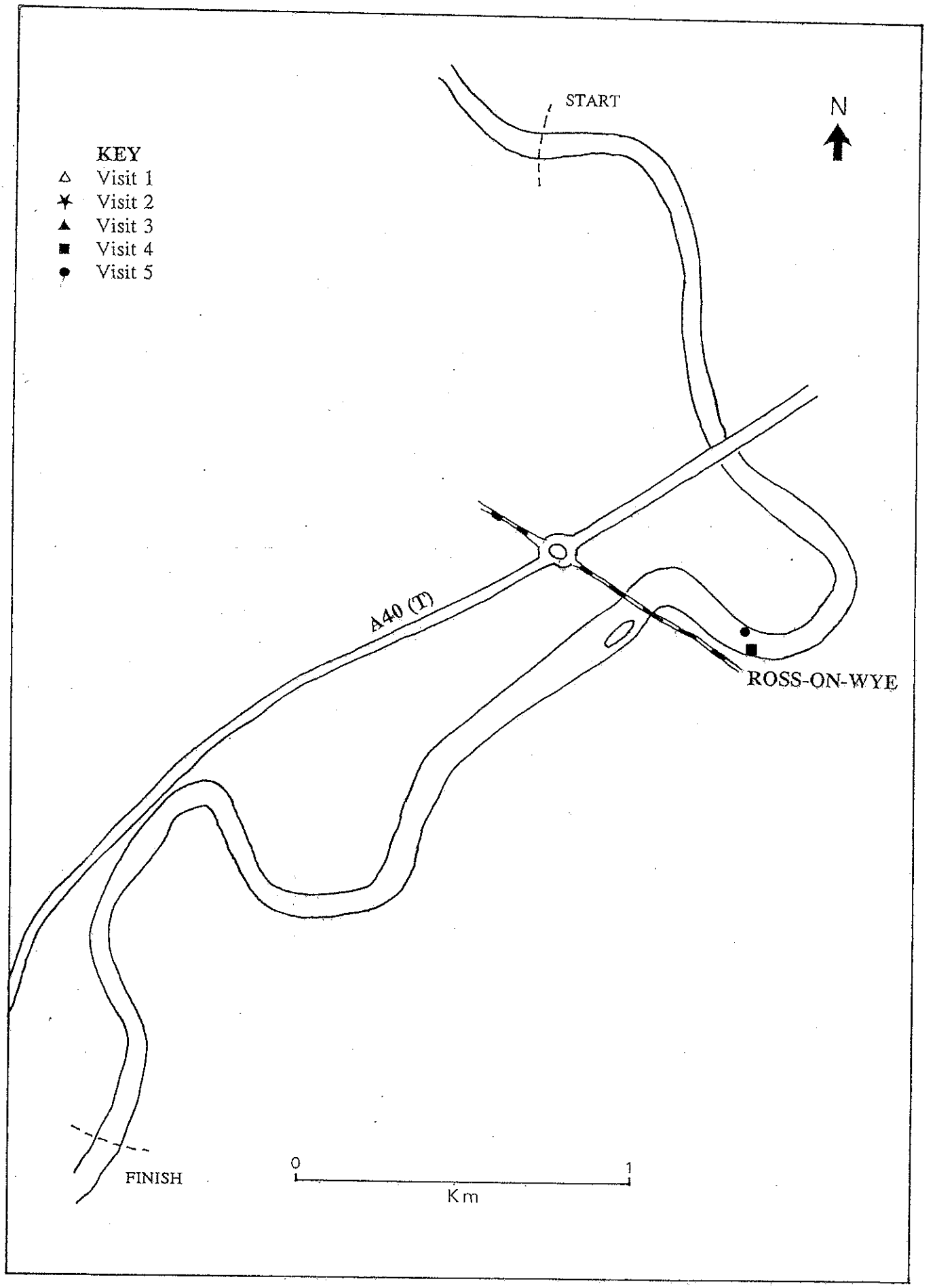


Figure 3.5.7 Movements of a brood of Mallard during 5 visits at Ross-on-Wye.

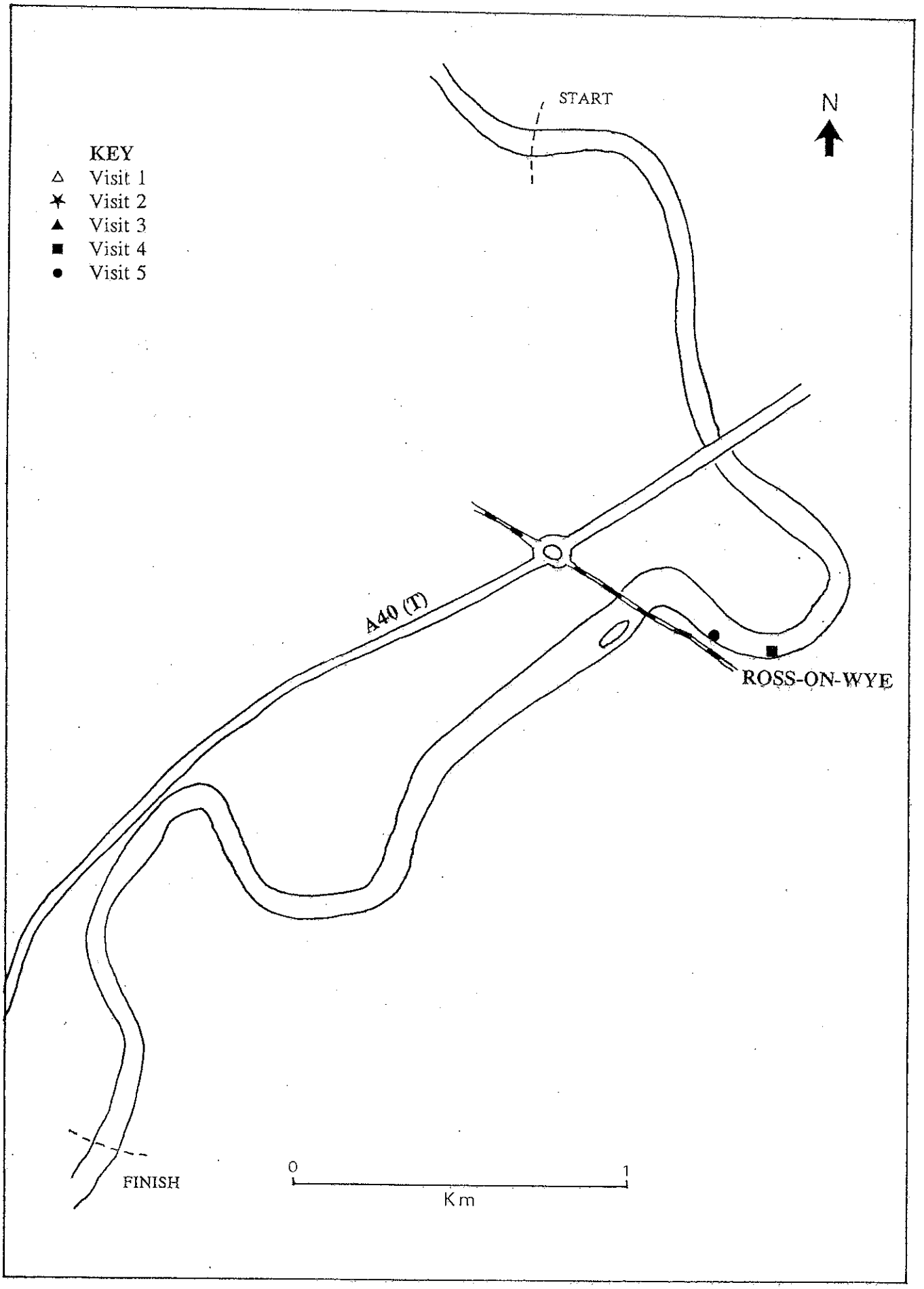


Figure 3.5.8 Movements of a brood of Mallard during 5 visits at Ross-on-Wye.

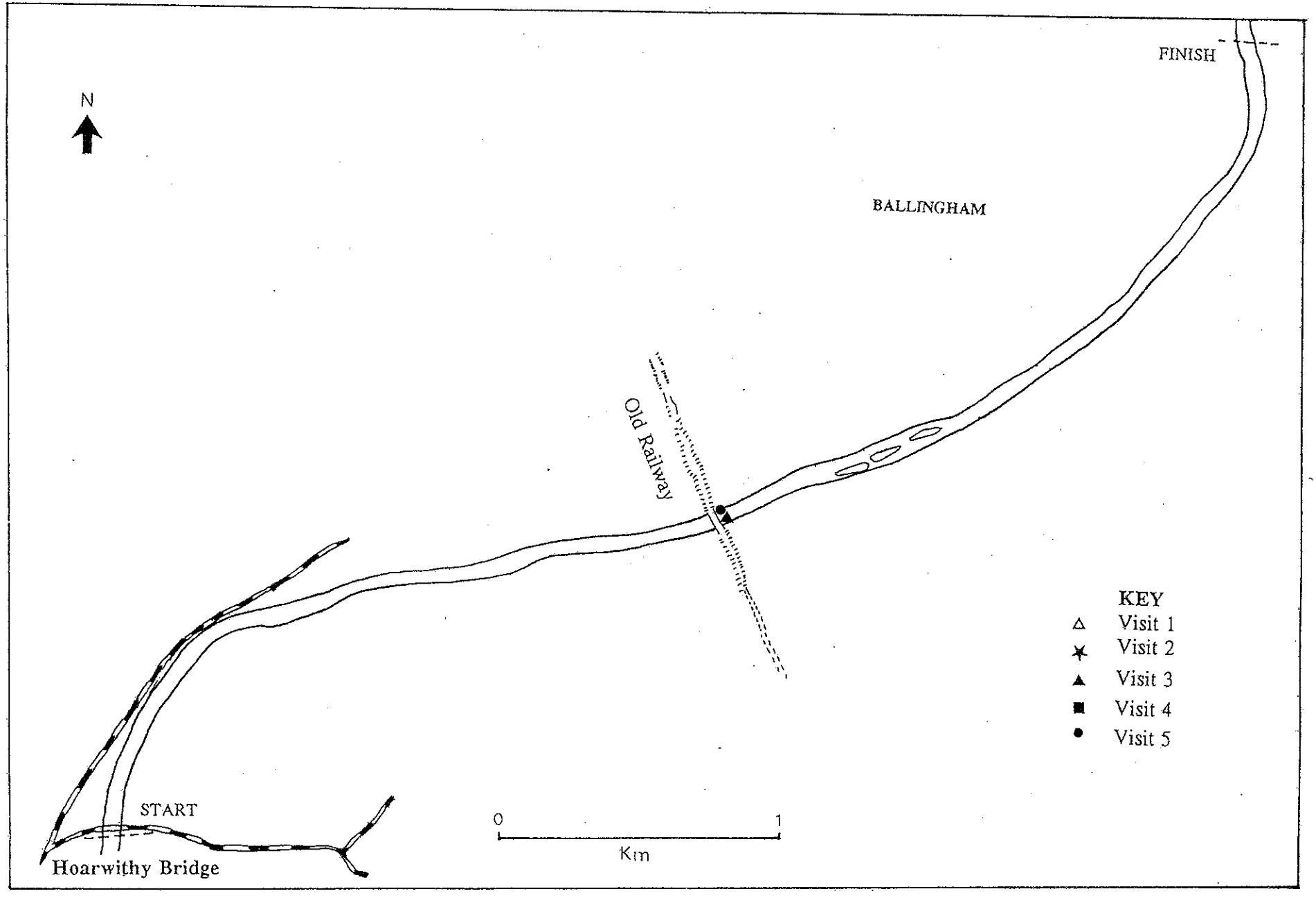


Figure 3.5.9 Movements of a brood of Mallard during 5 visits at Hoarwithy Bridge.

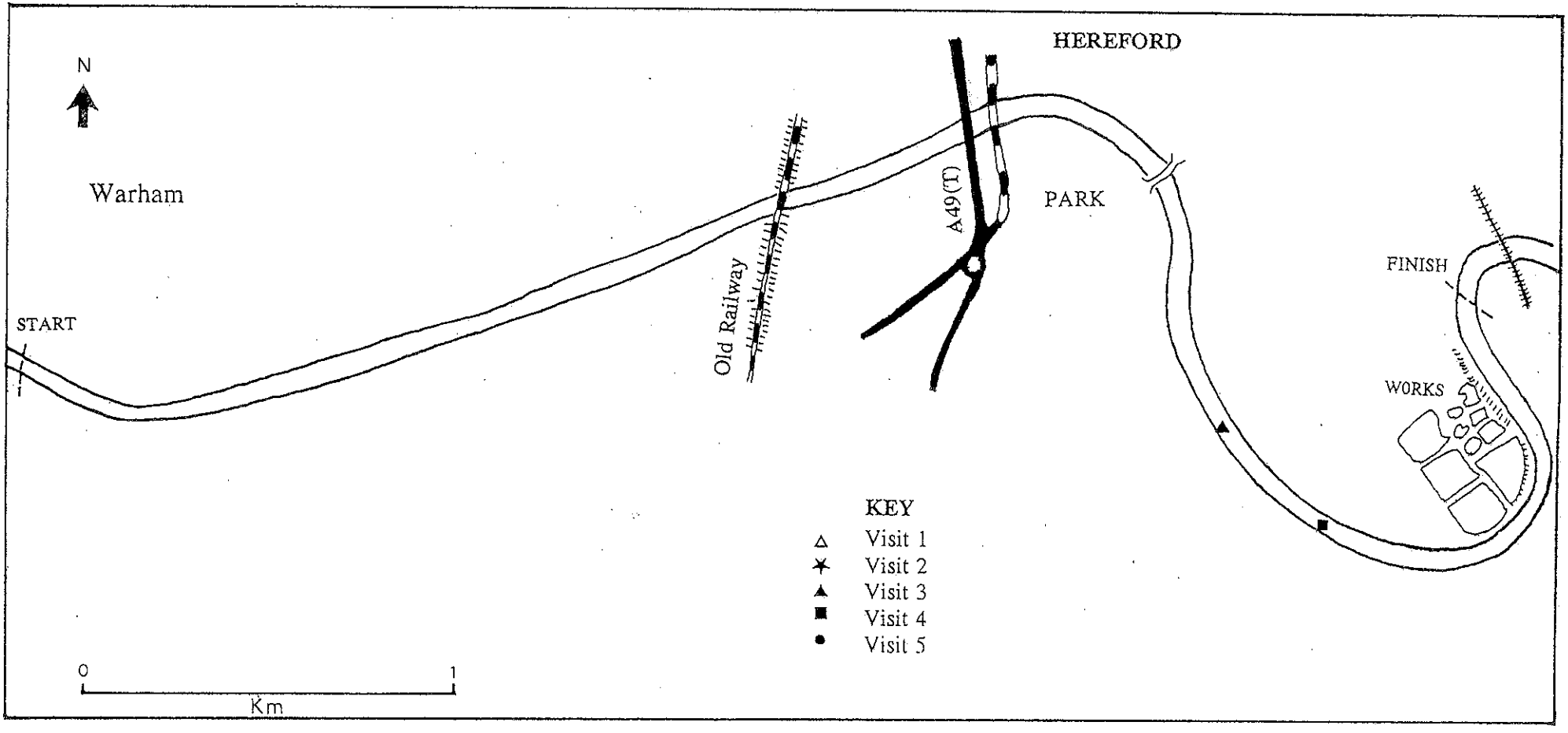


Figure 3.5.10 Movements of a brood of Mallard during 5 visits at Hereford.

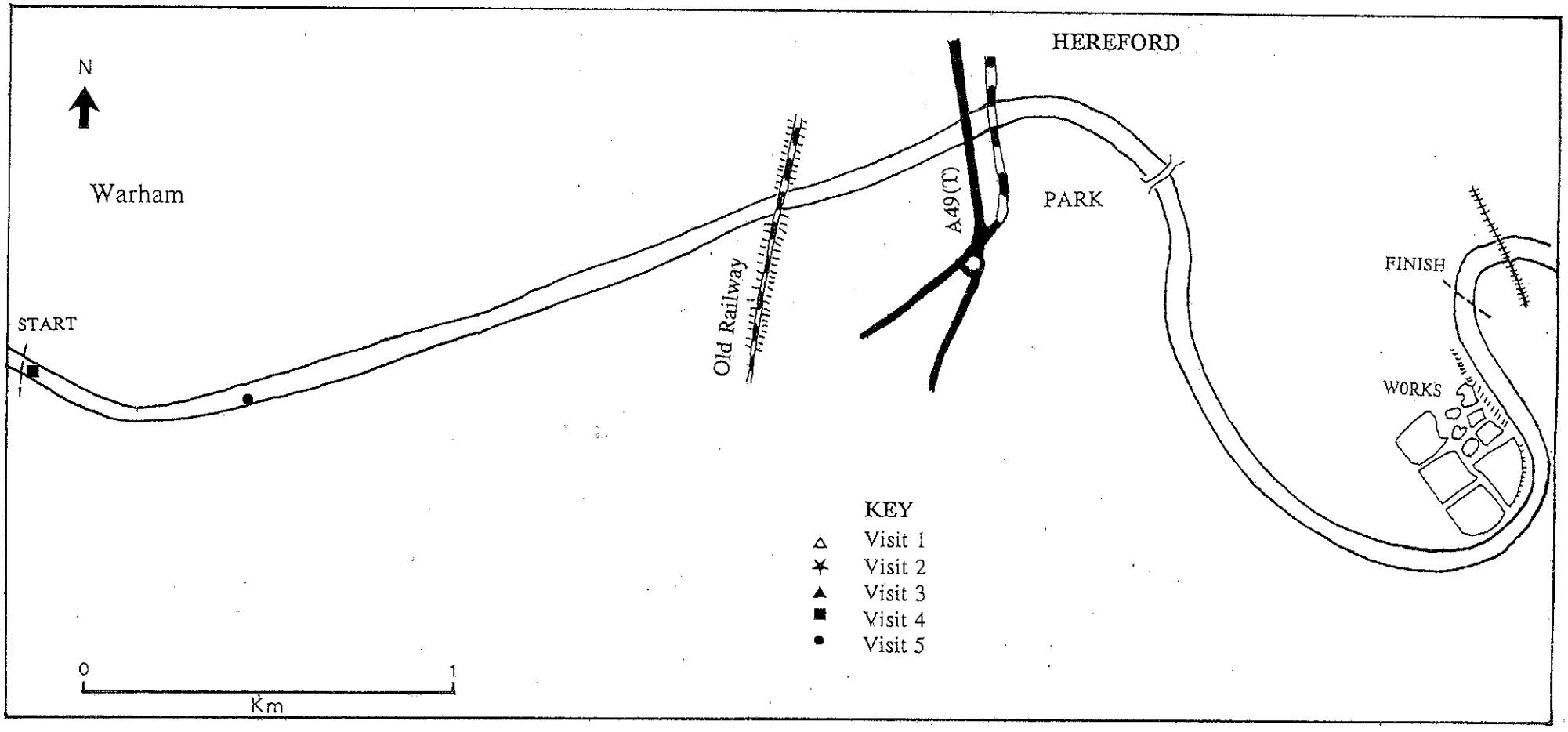


Figure 3.5.11 Movements of a brood of Mallard during 5 visits at Hereford.

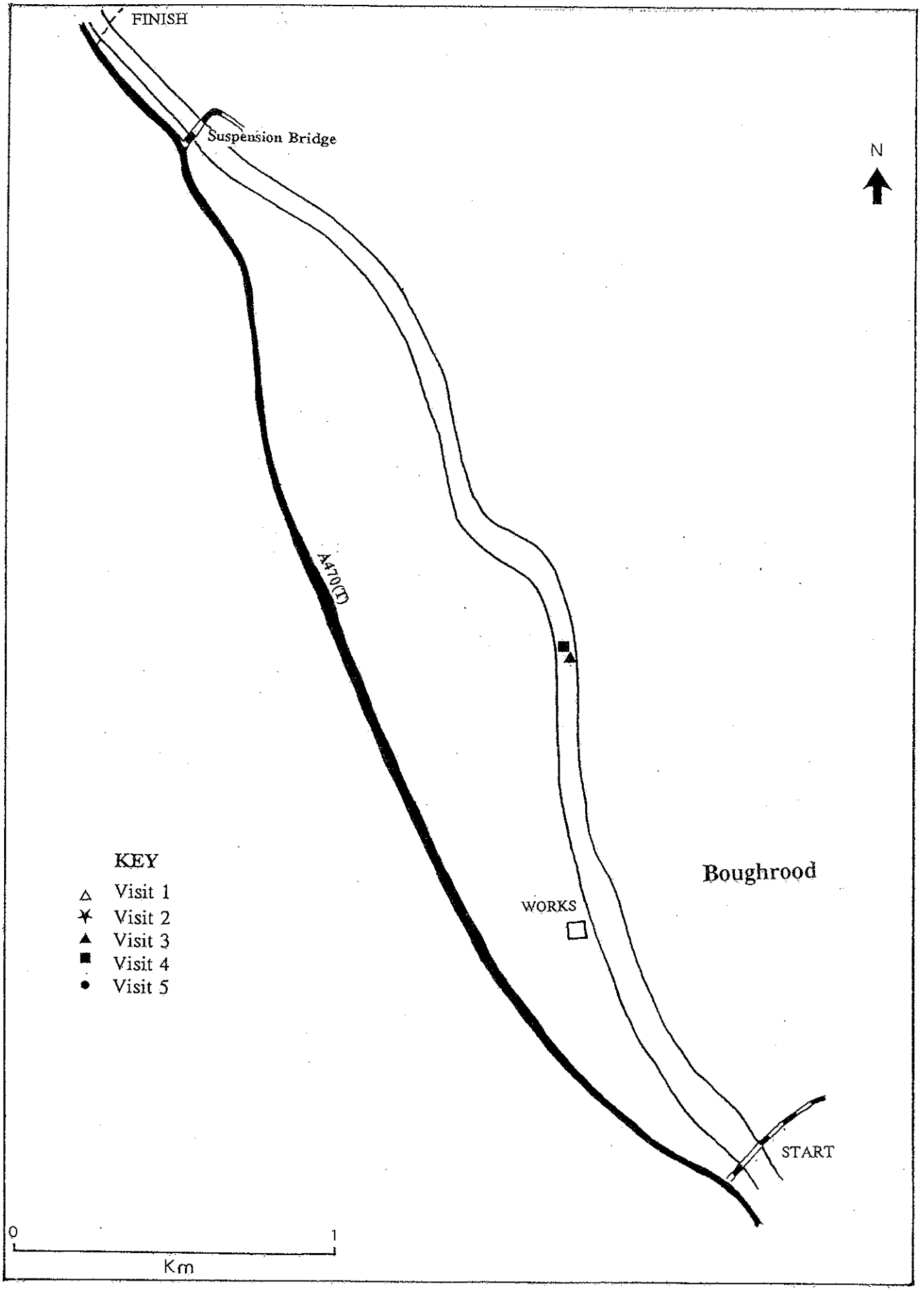


Figure 3.5.12 Movements of a brood of Mallard during 5 visits at Boughrood.

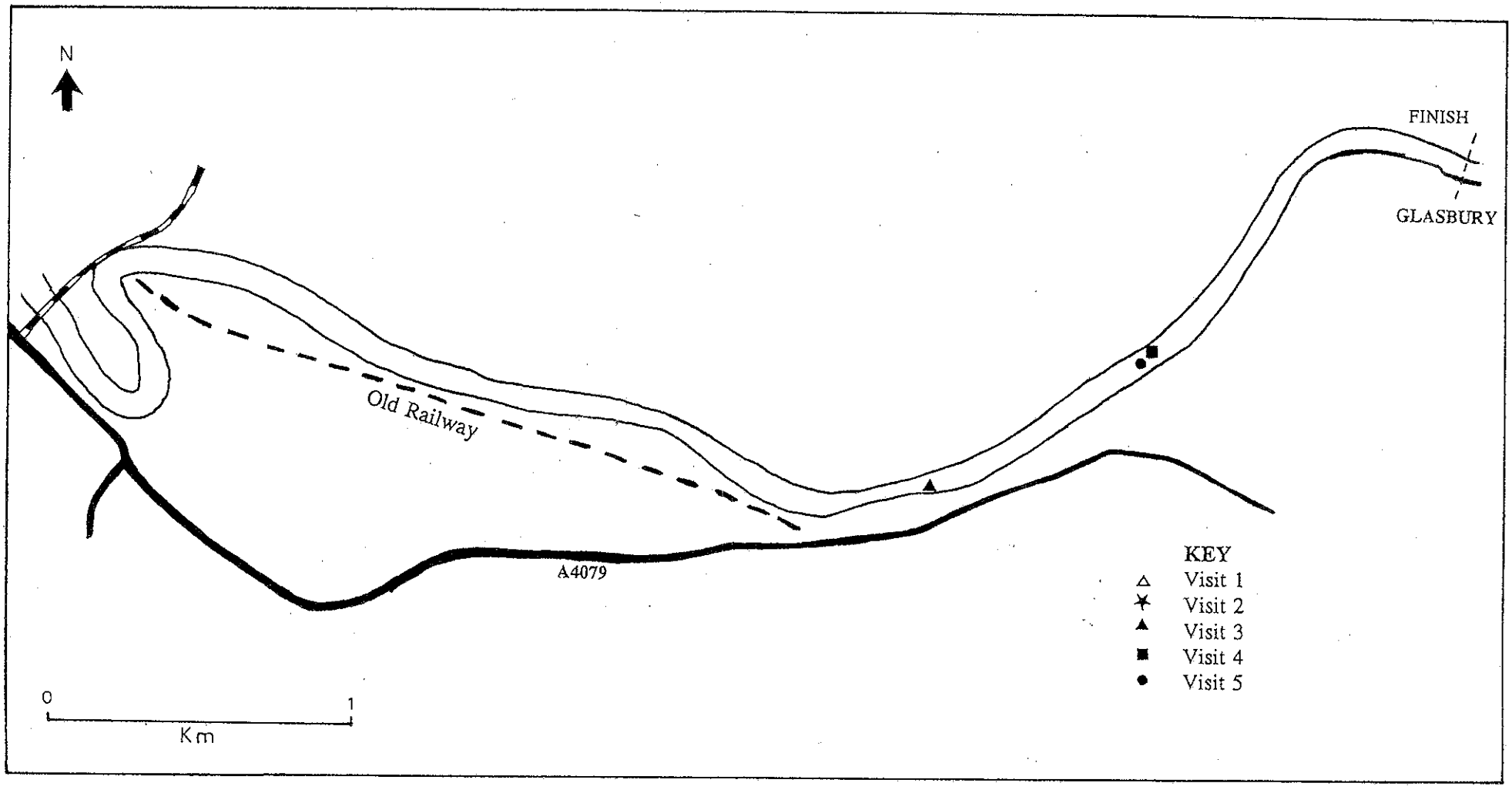


Figure 3.5.13 Movements of a brood of Goosander during 5 visits at Glasbury.

Figure 3.5.14
Average distance moved per day by the duckling broods