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The effects of the 1993 Wye Raft Race on the distribution of waterfowl broods

by

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EXECUTIVE SUMMARY

1. This study was commissioned by NRA (Welsh Region) and continues the work undertaken in 1992 (**Holloway 1992**). The aims were to:
 - (a) locate and map the distribution of waterfowl broods along the 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. The methodology employed and the sections surveyed were the same as in 1992 (**Holloway 1992**). During the current survey, each section was visited once before and once after the race by the project ecologist. Supplementary visits were made by NRA staff.
3. Observations were made at the same five spectator pressure points as in 1992 during the three days of the race. The interactions between spectators, rafts and waterfowl broods were examined.
4. A total of 43 broods were located before the race and 47 afterwards. No broods were located on the Bredwardine section prior to the race. The greatest number of broods was located on the control section of the Wye between Boughrood and Glasbury. Ross-on-Wye held the most broods within the race sections of the river.
5. During the race, observations were made on 11 broods and two incubating birds on five sections of the river. No actual loss of waterfowl broods was observed. Six broods were identified before and after the race, one of which showed a post-race decline in numbers. The three broods located on both visits to the control sections all showed a reduction in numbers on the second visit.
6. The six broods reliably identified before and after the raft race moved an average of 61m a day between visits (range 1-1000m). The three broods located on both visits to the control sections moved an average of <50m a day between visits.
7. It is concluded from the limited data available from two years of observations that the raft race is unlikely to have a major impact on waterfowl broods. The potential for disturbance is greatest along sections of river with little or no riverside vegetation and where large numbers of spectators gather. The mobility and secretive behaviour of some broods make accurate assessment of perceived losses hard to evaluate.
8. Suggestions for minimising the potential disturbance caused by the race include a recommendation that it is scheduled for late May, when the majority of broods are beyond the critical first two weeks of life, and the riverside vegetation is well developed, providing cover for broods.

9. Recommendations for future work include the continued monitoring of the interactions between spectators and broods during the race, with the possibility of some access control in the most vulnerable areas.

1.INTRODUCTION

The sixteenth three day raft race took place over the Spring Bank Holiday weekend between May 29-31, 25 days later than in 1992 (May 2-4). This year, a total of 65 rafts took part, 12 fewer than in 1992. The staging of the race was the same as in previous years with the exception of the first day's finish at Hereford. This is usually about 2km SE of the city, but this year was in the city park.

Despite the increasing concerns over the last few years that the race was leading to increased disturbance and subsequent loss of waterfowl broods, the survey carried out during 1992 (**Holloway 1992**) was inconclusive regarding the impact of the race. The additional observations made in 1993 aimed to clarify the situation.

For a discussion of the factors affecting the hatching dates and subsequent survival of young broods see **Holloway 1992**.

The objectives of this present study (the same as 1992) 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 the 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

Figure 2.1.1 shows the stretch of the River Wye which encompasses the study area and the course of the raft race. The sections surveyed and the methods used for this study were the same as those employed for the 1992 survey and are detailed in **Holloway 1992**. However, in 1993 only single visits were made by the project ecologist to each section before and after the race (late May and early June) with additional observations during the actual race. The dates of the visits to the eight sections of river are shown in Table 1, whilst the observations made during the race are detailed in Table 2.

Supplementary visits were made by NRA staff, before and after the race, to determine first brood dates and to record locations and sizes of broods of different species.

3.RESULTS

All the broods found during the two visits to each section are detailed below (broods known to have been recorded on both visits are included twice). As in 1992, the broods of only four species of waterfowl were found during the survey: Mallard, Goosander, Mute Swan and Moorhen.

3.1 Brood numbers

After the brood totals for the current year, the comparable totals for 1992, based on the five visits to each section, are given.

Symonds Yat

A total of eight Mallard broods was found along this survey section, the same number as in 1992. 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, and this was especially busy over the Bank Holiday week with several large canoeing groups present.

Lower Redbrook

Eight Mallard broods (10 in 1992) were located during the 1993 surveys. There was very little recreational pressure along the survey section, with only the occasional angler and walker noted.

Ross-on-Wye

As in 1992, this section held the greatest numbers of breeding waterfowl on the raft race sections of the river, with a total of 22 broods of two species, Mallard and Mute Swan. The 1992 total was 36 broods of three species. The centre of Ross-on-Wye held 41% of the Mallard broods for the survey section. However, this area is subjected to greater levels of disturbance from river craft and riverside recreational activities than any other part of the section. There is ample, relatively undisturbed nesting cover along the western side of the river, although two Mallards were found on low nests in trees along the eastern side, adjacent to the recreational area.

Hoarwithy Bridge

A total of 11 Mallard broods and one Moorhen brood was recorded. The corresponding totals for 1992 were 11 broods of Mallard and none of Moorhen. This section of the river had only low levels of recreational activity with occasional walkers and picnickers. Most of the latter were located around the bridge.

Hereford

Only five broods of Mallard were recorded on this section and similarly low numbers were noted in 1992, when there were nine broods. There is no obvious reason why the breeding numbers are so low as there is an abundance of dense riverside vegetation

along much of the survey section and especially within Hereford itself. Many parts of this section were undisturbed, especially upriver of the city. It is unlikely that the rowing club on the outskirts of Hereford exerts a major influence on waterfowl productivity.

Bredwardine Bridge

Only two broods of Mallard and a single brood of Mute Swan were recorded. This compares with eight broods of Mallard and no broods of Mute Swan in 1992. There is a general shortage of suitable nesting and feeding cover along most of the survey section. It is possible that some broods hatched along the section move to more suitable feeding grounds at a relatively early stage and are thus more difficult to detect during a limited number of visits. The areas with the greatest amounts of vegetation cover were just upstream of the bridge and along the NW end of the section. There was virtually no human disturbance with just a single angler noted along the middle stretches of the section.

Boughrood (control section)

Eleven Mallard broods (eight in 1992) were recorded along this section. The upper reaches of the section were fast flowing with small rocky outcrops. There was suitable nesting cover along much of the river, the middle section being the least suitable. Human disturbance was minimal, with only the occasional angler present.

Glasbury (control section)

This section held more broods than any of the others, with 16 broods of Mallard and three of Goosander (three of Mallard and three of Goosander in 1992). Although the broods were fairly evenly distributed, the greatest concentrations were between 1.5 and 2kms upriver from Glasbury. The final 1km stretch above Glasbury was nearly devoid of riverside vegetation and no broods were seen at all. There was little human disturbance along any of the section, with any angling activities confined to within one half kilometre of Boughrood Bridge.

3.2 Brood dates

The total number of broods for each survey section at the end of each of the two complete site visits is detailed in Table 3. A total of 42 broods was located before the race (*i.e.* before May 29-31), comprising 26 Mallard (with an additional 14 on the control sections), one Goosander (on the control section) and one Mute Swan. The equivalent total recorded before the 1992 raft race (*i.e.* before May 2-4) was four broods of Mallard.

An additional 48 broods were reported by NRA water bailiffs, 23 of which were on survey sections of the Wye. All but two of these broods were recorded before the raft race took place. In 1992, sixteen broods were reported before the race, virtually all outside the survey areas. However, as many broods lack any distinctive distinguishing features, the levels of identification will vary between observers.

From the information received from the bailiffs and from personal observations, the main hatching period for waterfowl broods in 1993 was between May 1-21 with the peak being between 11-20 May. Thus, the raft race took place within eight days of the end of the peak hatching period. Conversely, it was considered that the 1992 raft race took place before the main hatching period (**Holloway 1992**).

3.3 Observations during the race

Bredwardine Bridge

As in 1992, this proved to be a popular site with 229 spectators counted, slightly more than the 1992 figure. The majority of these were either on the bridge itself or a short distance just downstream, mostly along the west bank. A contingent of 60 raft supporters ventured upstream for some 750 metres along the west bank to follow the individual rafts down to the bridge. Contrary to 1992, the overall turnover of spectators was generally quite fast, with virtually all disturbance limited to the western side of the river.

A single Mallard brood with four ducklings was located approximately 300m upstream of the bridge 40 minutes before the first rafts appeared. Throughout this period of observation, the brood remained very secretive, mostly choosing to feed under dense riverside vegetation. When the first rafts appeared they merely disappeared back into cover and were not seen again. There was no evidence of the rafts or spectators causing panic or dispersal of the brood. A single Moorhen and two resting Mute Swan were also little affected by the rafts, the former disappearing into riverside cover and the latter remaining on the bank. After the twenty-fifth raft had passed, a Mute Swan (probably not either of the roosting birds) was noted moving rather swiftly downriver ahead of the next batch of rafts and appearing slightly agitated. It continued south of the bridge and therefore out of the survey section.

Hereford

The race observations were made between the waterworks museum and the riverside park, a distance of 1¼km. The first day of the 1993 race actually finished in the park instead of approximately 1½km downriver of the city as in 1992. This led to a marked increase in numbers of spectators in the park with 280 counted and a slow rate of turnover. The corresponding figure for 1992 was 168 spectators. There were an additional 50 spectators on the old town bridge and a further 40 scattered along the riverbank between the waterworks museum and the park. The majority of all the spectators were along the southern side of the river.

An easily identifiable duckling brood, (one yellow and five dark), located during the pre-race visit was present throughout the afternoon by the Victoria Bridge finishing point. They were not seriously worried by the rafts and continued to feed, sometimes disappearing under the riverside vegetation. Eight other Mallards were present within the park and none appeared especially concerned by the rafts although two were seen to fly a short distance downriver after the first three rafts had passed. Additionally, two Mute Swan and eight Mallard fed very close to the rafts throughout the race as they passed under the A49 road bridge (just upriver of the

park). On one occasion, a raft almost ran two Mallard down, but they rapidly moved a short distance and continued to feed quite unperturbed.

Hoarwithy Bridge

There were almost twice as many spectators than in 1992, with a maximum of 55 on the bridge, 25 just downstream and 60 scattered for $\frac{3}{4}$ km upstream of the bridge (giving an estimated maximum of 140 spectators at any one time). Virtually all of the bankside spectators were on the west side of the river. A rapid turnover of bridge spectators was noted whilst a fair proportion of those upriver followed "their" raft down to the bridge.

Three broods of Mallard, each containing between eight and nine ducklings, were located two hours before the first rafts appeared. During this period of observation, two of these broods remained more or less in the same part of the river, for the most part feeding under the overhanging riverside vegetation. The third brood however, proved very mobile. When initially located it was approximately $1\frac{1}{2}$ km upstream of the bridge, but within 10 minutes it had travelled several hundred metres towards the bridge. All three broods remained within this general area during the passage of the rafts, spending almost all the time hidden from view under the overhanging riverside vegetation. There was no indication that either the rafts or spectators caused any significant disturbance to the broods. There are several areas along this stretch of river affording good feeding and nesting cover.

In addition to the broods of ducklings, there were 47 Mute Swan resting by and on the river. The majority of these remained in the one area, continuing to feed and roost as the rafts passed. Two birds took off as the first rafts passed, whilst another two individuals were nearly mown down by one raft overtaking another, but swam rapidly out of the way at the last minute, remaining in the vicinity.

Ross-on-Wye

As in 1992, the park/recreational area was the busiest of the five sections visited during the raft race, with a maximum count of 730 spectators along the eastern bank (640 in 1992). The majority of these stayed for the duration of the race. Relatively few spectators ran through the park to keep pace with "their" raft, and the western side of the river was left virtually undisturbed. There was a lot of cover on both sides of the river, particularly along the western bank. The bulk of the rafts passed within a 40 minute period, with the entire race passing within 55 minutes.

A total of three Mallard broods were located before the first rafts appeared, one comprising three newly hatched ducklings. During the actual passage of the rafts, two of these broods remained hidden under riverside vegetation, along the eastern side. The third brood remained roosting on the western bank during at least some of the race. After the last raft had passed, the newly hatched ducklings were still in the same area as prior to the race.

A breeding pair of Mute Swan (the female incubating) remained throughout the race on the western bank. Similarly, a breeding Mallard remained incubating throughout the race, the nesting site being a riverside tree a few feet from many spectators.

The only observation of brood disturbance by the race concerned a Mallard and four ducklings, 4-5 weeks old, which were trying to cross the river between a group of rafts. The family ended up sat in the middle of the river, clearly bemused and not sure which way to swim. The female and three of the ducklings made a dash to the west side of the river but the fourth duckling became separated and swam back to the eastern side. The presence of large numbers of noisy spectators clearly frightened the duckling and it was pushed downstream, and further from the rest of the brood. After the last raft had passed, this duckling was feeding quite unconcernedly some 200m downstream and on the opposite side of the river from the rest of the brood. It began to move slowly upstream, feeding as it went, but apparently ignoring the rest of the brood. It was never actually observed to rejoin the brood but is presumed to have eventually done so.

Another feeding lone duckling (aged between 14 and 18 days) was located after the race. There were no signs of an adult nor other members of the brood and it is possible that the rafts had separated the family.

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 1km upstream of the bridge and for ½km downstream. However, there was dense riverside cover along the eastern bank of the river for several hundred metres either side of the bridge making detection of broods difficult. The river was high and flowing very fast due to heavy rain during the preceding 24 hours.

There were more spectators than in 1992, with a peak count of 98 (compared to a maximum of 55 the previous year). The majority of these remained on the old railway bridge, with a few scattered along both banks adjacent to the bridge. The turnover of spectators along the road was fairly rapid, as teams of supporters drove along following "their" individual rafts.

Due to the turbulent river conditions along the last few kilometres of the race at Chepstow, several raft teams withdrew. This left 60 to compete during the final day of the race. All the rafts had passed Redbrook within a 50 minute period, the bulk within 35 minutes.

There were no sightings of waterfowl broods during the race but within minutes of the final raft passing, two broods had appeared some 200m upstream of the bridge. These had apparently been hidden in the riverside vegetation throughout the race, showing no visible signs of disturbance.

3.4 Comparison of brood size before and after the race

A total of six broods and an incubating Mute Swan were located immediately before and after the race (Table 3). This compares with just two broods in 1992. Additionally in

1993, three broods and an incubating Mallard were initially found during the race and relocated in the subsequent visit. Conversely, a single brood was located before the race and observed during the race but was not subsequently reliably identified.

As in 1992, the Ross-on-Wye section held the most broods, with three reliably identified. Additionally, two broods were relocated at Symonds Yat and a single brood along the Hereford section.

Only one of the broods located both before and after the race showed any reduction in numbers (Table 3). This brood was along the Symonds Yat section, a stretch of the Wye used regularly by canoeing groups. Of the three broods first located during the race, and subsequently relocated on later visits, one had apparently lost a duckling. With the remaining two broods, it was uncertain that duckling numbers were accurately recorded either during the race or during the post-race visit, as the riverside vegetation was very dense. Consequently, it is not possible to draw any valid conclusions from these two broods.

On the control sections, three broods were located on both visits (Table 4). All the broods showed a reduction in duckling numbers between visits, with one Mallard brood apparently losing six ducklings (Table 4). The other two broods each seemed to have lost a single duckling. The River has little recreational activity along these sections, with only the occasional angler present.

3.5 Movement of duckling broods

Six broods of waterfowl were reliably identified before and after the raft race and their locations plotted (Figures 3.5.1 to 3.5.4). One of these broods and an incubating Mute Swan were seen before, during and after the race.

The average daily distance moved by the six broods between the two visits (*i.e.* over seven days) was 61m, very close to the 1992 figure of 60m per day. However, there was a large degree of variation with two of the six broods recorded in almost the same position on both visits, and two 1km apart (Table 5). The Mute Swan successfully hatched four cygnets several days after the race.

The three broods located on both visits to the control sections moved an average of 48m per day, the range being from 11-71m (Figures 3.5.5 to 3.5.7). In 1992, the average distance moved per day was 78m with the range being from 20-225m per day.

During both pre- and post- race visits to the survey sections, several broods were noted moving considerable distances within relatively short periods of time (Table 6). None of these movements were obviously induced by any form of disturbance; the families apparently merely moving to better feeding areas. The greatest movement noted was 1975m in slightly under two hours; 510m every half an hour. From these observations it is apparent that the "disappearance" of a brood from a particular stretch of river does not necessarily indicate disturbance-induced dispersal.

4. DISCUSSION

For a discussion of the factors affecting the onset of breeding and the subsequent mortality of waterfowl broods, see **Holloway 1992**.

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 1993 race was at the end of May, whilst that of 1992 was at the beginning of the month. The 1991 race was also in late May and was claimed to have led to the loss of 500 ducklings (**CHAR 1992**).

Conditions in the early part of the spring in 1993 were not especially mild (**pers. obs.**) and the season was not thought to be particularly advanced (NRA bailiffs estimated that the 1992 season on the Wye was approximately two weeks advanced **pers. comm.**). In 1992 only a very few broods were located before the race, but in the 1993 season a total of forty three broods were found. This allowed a better assessment of the interactions between the rafts and the waterfowl broods.

The observations from 1992 and 1993 indicate that the peak hatching period for waterfowl broods on the Wye falls within the first three weeks of May, peaking during the middle of the month. Thus, there is an increased likelihood of the race disturbing broods when it is scheduled for late May. Conversely, in a typical year, the average age of many of the ducklings disturbed in late May is likely to be greater than those disturbed by a race completed at the beginning of the month. It is known that disturbance induced movements by young Tufted Duck broods are energetically costly (**Watmough 1983**), and that the first 12 to 14 days of a duckling's life are the most critical (**Clark *et al.* 1987; Hill & Ellis 1983**). In consequence, disruption leading to a higher risk of mortality of waterfowl broods is likely to be reduced if the race is completed in late May.

Additionally, by the end of May, the riverside vegetation is better developed, providing much improved feeding and safe cover for the broods. This also means that brood detectability becomes increasingly difficult, with the associated problems in assessing potential losses.

The observations on the six broods located before and after the 1993 race indicate only small losses, one brood apparently declining by two ducklings between visits. The three broods identified on both visits to the control sections all suffered varying levels of loss, the greatest being six ducklings. The disturbance levels along these latter sections are likely to be negligible. Predators such as Mink and Pike are known to occur along the river, and to contribute to brood losses (**pers. comm. NRA**).

There were also few data to indicate that the race caused widespread redistribution of the six broods. Two were noted in virtually the same area on the pre- and post-race visits, whilst the greatest distance covered by any of the remaining four broods was 1100m. On the control sections, the greatest distance moved by a brood between visits was 500m. A number of observations on broods during the two visits revealed a high degree of individual mobility, **e.g.** a Mallard covering just over a mile in a little under two hours. This particular brood was apparently just moving to a new feeding area since no potential source of disturbance was observed.

The observations made during the race at five spectator pressure points revealed that disturbance was confined mainly to just one of the banks. There was generally enough vegetation along one or both sides of the river to provide sufficient cover for waterfowl broods, if required. Of the 11 broods actually observed during the race, only one was seen to suffer any distress, and no actual loss of ducklings was recorded. In the majority of instances, the broods remained hidden in vegetation until the rafts had passed. The five race safety craft generally passed at low speeds, but on two occasions were noted producing a substantial wash across the entire river. Although no direct interactions between these craft and waterfowl broods was noted, the potential for ducklings to be "run down" is evident.

As in 1992, it was noted that the passage time for the rafts at any given point depended on the degree of freshness of the crews (**Holloway 1992**). Additionally, river levels rose by up to one metre overnight of 30/31 May due to heavy rain (**pers. comm. NRA**), substantially increasing the rate of flow (**pers. obs.**). Thus, the total passage time of the rafts was likely to have been shortened, with an associated reduction in the potential disturbance period to waterfowl broods.

The information received from the NRA bailiffs relating to the effects of the raft race on waterfowl broods revealed considerable variation. The comment for the Ross-on-Wye to Monmouth stretch was of no apparent adverse effects. Conversely, along the Hereford to Ross-on-Wye stretch some broods were thought to have been lost altogether and others to have suffered a reduction in numbers. It was, however, noted that some broods were unaffected, probably as a result of hiding under dense riverside vegetation. It was also suggested that the numbers of riverside spectators were lower this year, probably as a result of the weather, and this lessened disturbance to the broods. The increased river levels during the race may have moved some broods considerable distances, possibly accounting for some of the reported total brood losses. From personal observations made in 1993 it is evident that some broods are very mobile irrespective of disturbance.

The 1993 conclusions differ from those drawn by the 1992 report, which recommended completion of the race in early May, so as to minimise the potential disturbance to waterfowl broods. With only two years of race observations, each over a different series of dates, it is not possible to reach a firm decision regarding the timing of future races. The main advantage of completing the race in early May is that fewer broods are likely to be on the river at that time. Conversely, those present are likely to be more susceptible to disturbance being, on average, less than 14 days old. Additionally, the riverside vegetation is not so well developed, providing less cover for the broods. This is likely to be of greatest importance in areas with large numbers of race spectators.

There are a considerable number of events taking place on the Wye during May and June, in addition to the three day raft race. The rowing and canoeing clubs also add to the activities on the river. The waterfowl broods are thus subjected to potential disturbance from a number of sources, and it is likely to be difficult to accurately attribute losses to any particular one. The other factors affecting brood mortality are discussed in **Holloway 1992**.

The 1993 race recorded a decrease in the number of entries, with 65 teams competing compared to the record 77 in 1992. There were no foreign or "professional" entries in 1993. There were, however, still regular practice runs on certain stretches of the river prior to the

race. Possible restrictions on the number of entries and the degree of pre-race practising are discussed in **Holloway 1992**.

5. CONCLUSIONS

The 1993 Wye raft race took place after the main hatching period for waterfowl broods (the middle of May). From the observations of broods identified both before and after the race on the survey sections, brood losses were low and most ducklings were beyond the age when they are most susceptible to the effects of disturbance. It is unlikely that the raft race seriously altered brood distribution.

On balance, the 1993 observations indicate that the completion of the raft race at the end of May will reduce the potential for increased brood disruption, which can lead to increased mortality of ducklings.

In areas where there is a lack of riverside vegetation, there is an increased risk of disruption to broods, particularly along the sections of river where spectators are concentrated.

6. RECOMMENDATIONS FOR FUTURE WORK

- (1) The interactions between spectators and broods should be monitored during the race. If brood losses are thought to be attributable to disturbance by spectator pressure in areas of the river with little or no vegetation cover, some degree of control might be advisable (*e.g.*) cordoning off certain areas.
- (2) With the increasing pressures of various water-based activities on the Wye, an overall review of all recreational usage within the context of the river's biological importance would be useful.
- (3) Although the numbers of rafts competing in the 1993 race was lower than in recent years, the numbers competing over the next few years should be monitored. It may prove necessary to impose an upper limit in the future.
- (4) The only way to ascertain, critically, the effects of disturbance on birds is to carry out detailed studies of avian energetics. There are obvious constraints to this approach, not least in establishing experimental controls.

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REFERENCES

- CHAR 1992. *Fifteenth annual 100 mile charity raft race*. Reprodux Printers Ltd., Hereford.
- Clark, N.A., Varley, T.A., Evans, T., & Wright, G.A. (1987). Breeding success of Mallard *Anas platyrhynchos* at Loch Leven National Nature Reserve. *Bird Study* 34: 129-134.
- Hill, D. & Ellis, N. (1983). Survival and age related changes in the foraging behaviour and time budget of Tufted Ducklings, *Aythya fuligula*. *Ibis* 126: 544-550.
- Holloway, S.J. (1992). The effects of the Wye Raft Race on the distribution of waterfowl broods. *A report to the National Rivers Authority (Welsh Region)*.
- Watmough, B. (1983). The effects of recreation on waterfowl. *Unpublished Report to the Sports Council/NCC*.

Paired section	River section	Visit 1	Visit 2
1	Symonds Yat Lower Redbrook	25/5	1/6
2	Ross-on-Wye Hoarwithy Bridge	26/5	2/6
3	Hereford Bredwardine Bridge	27/5	3/6
4	Boughrood Glasbury	27/5	3/6

Table 1 **Dates of visits to the section of river surveyed.**

Day	Date	Location	Number of spectators	Number of broods
1	29/5	Bredwardine Bridge	229	1
1	29/5	Hereford	315	1
2	30/5	Hoarwithy Bridge	140	3
2	30/5	Ross-on-Wye	730	3
3	31/5	Lower Redbrook	98	2

Table 2 Summary of the observations made during the raft race.

Location	Brood size visit 1	Brood size visit 2	Apparent loss
Symonds Yat (Biblins)	7	5	2
Symonds Yat (Western end)	1	1	0
Ross-on-Wye (town)	3	3	0
Ross-on-Wye (Western end)	5	5	0
Ross-on-Wye (Western end)	5	5	0
Hereford (town)	6	6	0

Table 3 Changes in brood numbers before and after the race.

Location	Brood size visit 1	Brood size visit 2	Apparent Loss
Boughrood	8	2	6
Glasbury	8	7	1
Glasbury	4	3	1

Table 4 Changes in brood numbers during two visits to the control sections of the river.

Section	Days between observations	Distance moved (m)	Daily rate of movement (m)
Symonds Yat	7	1100	157
Symonds Yat	7	0	0
Ross-on-Wye	7	300	43
Ross-on-Wye	7	1050	150
Ross-on-Wye	7	0	0
Hereford	7	100	14

Table 5The distance moved by broods identified before and after the raft race.

Date	Section	Time between observations (mins)	Distance moved
25/5	Symonds Yat	110	375
25/5	Lower Redbrook	110	875
30/5	Hereford	115	1975
3/6	Hoarwithy	12	475

Table 6 The distance moved by four broods observed during a single visit.

Figures