

AN ASSESSMENT OF POST-PLAGUE REINTRODUCED NATIVE WHITE-CLAWED CRAYFISH, *AUSTROPOTAMOBIOUS PALLIPES*, IN THE SHERSTON AVON AND TETBURY AVON, WILTSHIRE

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Introduction

In this article we report on the success of reintroducing native crayfish (*Austropotamobius pallipes*) in the Sherston and Tetbury Avon, following extinction of the population from crayfish plague. We describe and review the survey methods that were used and identify a survey technique that we found to be the most rapid and robust for monitoring crayfish populations. Such a survey technique could be adopted as a standard method.

Surveys of native crayfish were carried out during the summers of 1998 and 1999. The primary objective was to assess native crayfish numbers at the reintroduction sites and also to survey sites further upstream and downstream to ascertain if there had been any migration of crayfish from the sites used for restocking (Figs 1-3).

A pollution incident in April 1998, involving the synthetic insecticide cypermethrin, resulted in a significant reduction in the numbers of native crayfish - along the upper reaches of the Sherston Avon. This incident strengthened the need for a standard survey technique that could rapidly assess the health of crayfish populations in a watercourse. Our method has been incorporated into long-term monitoring strategies, to ensure the effective conservation of the last remaining native crayfish colonies on the Bristol Avon (Skinner 1998).

Crayfish plague on the Sherston and Tetbury Avon

Crayfish plague is caused by the fungus *Aphanomyces astaci*, resulting in 100% mortality of infected animals. The plague fungus has had a devastating impact on populations of native crayfish. The initial mortality on the Bristol Avon was recorded in 1981 at Hyam Farm on the Sherston Avon (Fig. 3). The upper limit of deaths was located at a weir in Easton Grey. Crayfish above this weir remained free from plague throughout 1982 and 1983 (Lowery et al. 1986). By 1983 crayfish plague had also reached the Tetbury Avon.

Previously thriving crayfish populations on the Avon tributaries had long been established, with no reported mortality in over 40 years. The effects of crayfish plague were dramatic; the riverbed was strewn with dead and dying crayfish (Alderman 1993). Signal crayfish *Pacifastacus leniusculus* are known



FIG. 1. Two sampling sites for crayfish. *Above*: Easton Grey on the Sherston Avon. *Below*: Merchants Farm on the Tetbury Avon.



FIG. 2. Sampling for crayfish on the Sherston Avon, using a quadrat (above) and a glass-bottomed bucket (below).

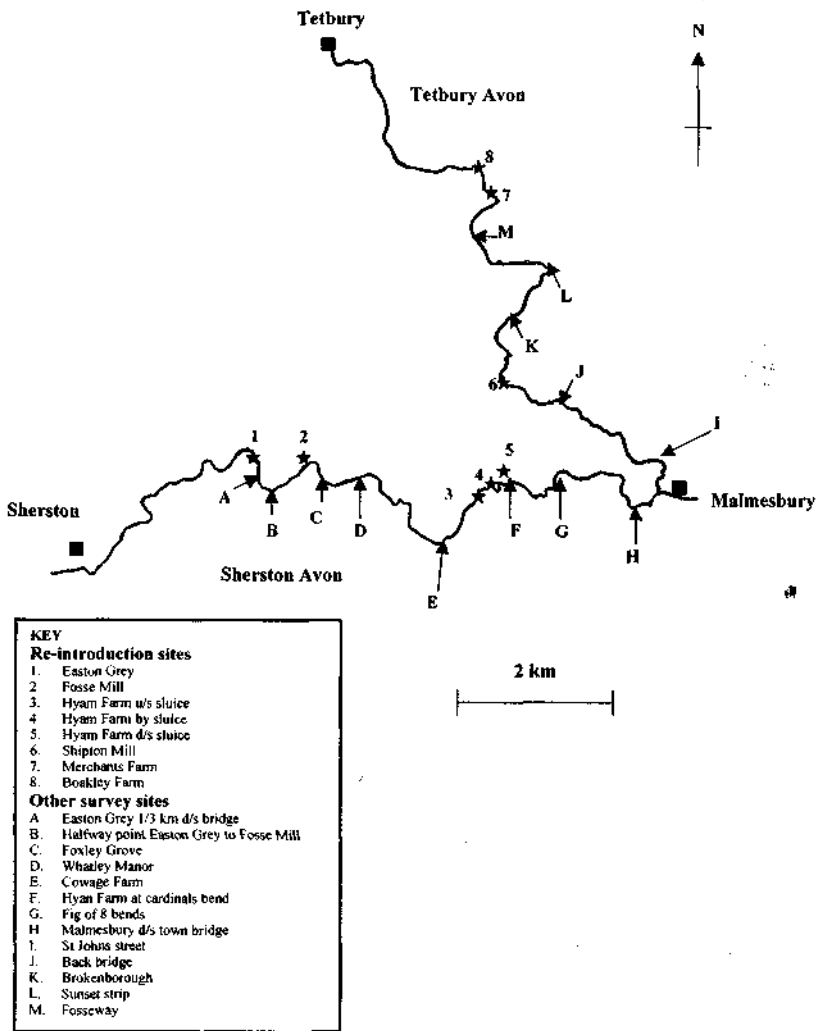


FIG. 3. Outline map of the Sherston Avon and Tetbury Avon, Wiltshire, showing the main river network and sites mentioned in the text. Malmesbury is downstream.

carriers of the fungus, but none have been found in either the Sherston or Tetbury Avon and the source of the plague remains uncertain.

The reintroduction programme on the Sherston and Tetbury Avon

The reintroduction programme, the first of its kind in the UK, was carried out by one of us (MWF), a Fisheries officer of the Environment Agency. Frayling anticipated the need to encourage and try to restore native crayfish back to these tributaries. After consulting MAFF and English Nature, licensed reintroductions began in the 1980s and early 1990s, along both the Sherston Avon and the Tetbury Avon. Holding ("canary") cages were set up in both branches of the Avon, to check that crayfish plague had not returned. Ten healthy crayfish were placed into each holding cage, approximately 46x46x31 cm in size. The cages were inspected every few days over a period of a year on the Sherston Avon and over six months on the Tetbury Avon, and no crayfish became infected. It was concluded that plague had probably died out after the native crayfish population became extinct in the early 1980s.

The first reintroduction was in 1982, when 150 crayfish were directly released into the Sherston Avon at Fosse Mill. This paved the way for further reintroductions in 1986, 1987 and, finally, in 1994. Eight sites were used for reintroducing crayfish, five on the Sherston Avon and three on the Tetbury Avon (Table 1; Fig. 1). Crayfish released in the Sherston Avon were taken from this river between Pinkney and Sherston village, where the population had not been affected by plague. Those introduced on the Tetbury Avon were taken from the Mells River in Somerset, a site known to be clear of plague.

Table 1. Reintroduction sites on the Sherston and Tetbury Avon, showing locations, numbers of crayfish released (sexes where recorded; b = berried females) and the date of reintroduction.

Site of reintroduction	NGR	Numbers	Date of release
1. Sherston; Easton Grey	ST881873	55 (30♀b, 25♂)	10 May 1986
2. Sherston; Fosse Mill	ST887873	150	21 Aug 1982
3. Sherston; Hyam Farm u/s sluice	ST912868	50	8 May 1986
4. Sherston; Hyam Farm by sluice	ST913869	54	5 May 1994
5. Sherston; Hyam Farm d/s sluice	ST915872	54	8 May 1994
6. Tetbury; Shipton Mill	ST911913	127 (23♀b, 37♀, 67♂)	23 Apr 1987
7. Tetbury; Merchants Farm	ST913910	61	25 Oct 1987
8. Tetbury; Boakley Farm	ST913885	88 (42♀b, 6♀, 40♂)	22 Apr 1987

Survey of crayfish sites in 1998 and 1999

The five reintroduction sites on the Sherston Avon were sampled between July and August 1998. On the Tetbury Avon, two of the reintroduction sites were sampled in September 1998, and the third site was sampled in July 1999.

Attempts were also made to define the distribution limits of the native crayfish population, by surveying stretches of river between the reintroduction sites. All of the latter were known to support good populations before the 1980s, i.e. before the advent of crayfish plague (Fig. 3).

On the Sherston Avon, two survey methods were used to assess crayfish numbers at each of the reintroduction sites: turning stones by hand within 1 m² quadrats, and setting crayfish traps. Both methods are semi-quantitative and therefore give an indication of the relative numbers present at each site, rather than actual population sizes. Only quadrats were used on the Tetbury Avon, as time limitations prevented us from setting traps.

Quadrat sampling/turning stones

A 50 m stretch of river was measured alongside the site of reintroduction and five quadrats were placed on the riverbed at 10 m intervals. For each quadrat, the left, middle or right side of the channel was selected at random drawn from a bag. The same procedure was used on 50 m stretches immediately upstream and downstream. The riverbed within each 1 m² quadrat was searched while looking through a glass-bottomed bucket, which gave a clear view through the water. The operator moved in an upstream direction to minimise disturbance of silt, lifting stones carefully within each quadrat and placing exposed crayfish into a bucket (Fig. 2). The bucket contained aquatic plant material to provide cover for the crayfish. A standard pond-net was placed downstream of the quadrat, to catch crayfish that escaped or were picked up by the current. Within each of the quadrats the aquatic vegetation was removed, placed in the pond-net and searched for young crayfish.

For each crayfish caught, we recorded the following information: sex, carapace length (tip of rostrum to back of the carapace), claw absence/regeneration, stage of moult and disease incidence. Crayfish were then returned to the river. 50 m stretches were then surveyed above and below the middle stretch to ascertain the degree of crayfish migration from the point of reintroduction.

A manual survey by turning stones within 1 m² quadrats was also undertaken at sites interspersed between the reintroduction sites, except that only one 50 m stretch was sampled and no traps were set. Due to time constraints the same procedure was also undertaken at Boakley Farm on the Tetbury Avon.

Figure 4 shows the total numbers of crayfish caught in 5 m² of riverbed over each 50-m section on the Sherston and Tetbury Avon. On both rivers, crayfish appear to be found only where they were reintroduced, except at Hyam Farm downstream of the sluice, on the Sherston Avon, where no crayfish were recorded. The riverbed is silty at this point, perhaps encouraging migration of crayfish away from the site. A silty substratum might also explain the zero numbers recorded at some of the other 50 m sections at Hyam Farm. At

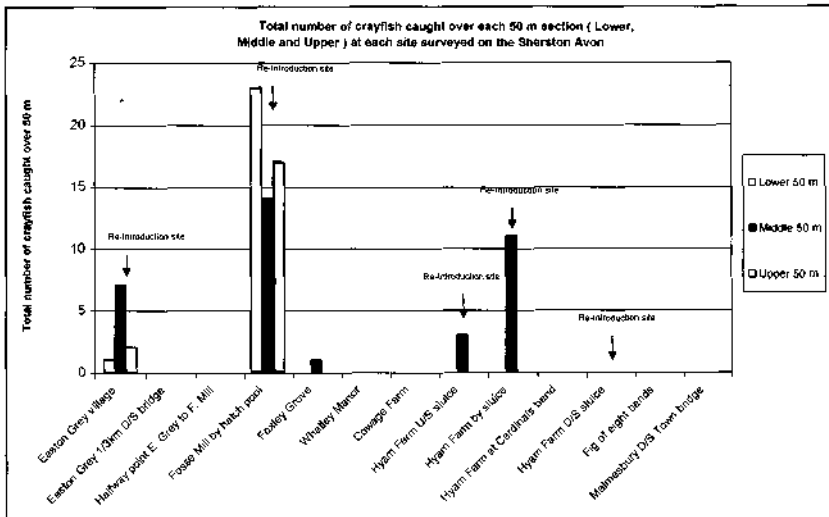
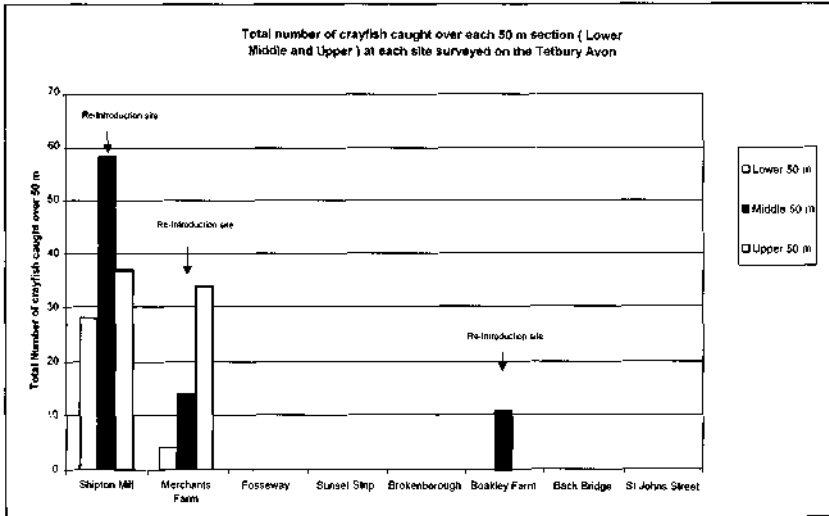


FIG. 4. Total numbers of crayfish caught in five 1-m² quadrats in 50 m sections of river at the site of reintroduction (solid bars) and above and below the site (open bars). Above: Tetbury Avon. Below: Sherston Avon.

Boakley Farm only one 50 m section was surveyed (at the reintroduction point) because the upstream and downstream sections were too deep for sampling.

The relatively high numbers of crayfish at Fosse Mill on the Sherston Avon and at Shipton Mill on the Tetbury Avon (Fig. 4), may be attributed to the good habitat conditions found here, and also might be due to the initial high numbers of crayfish reintroduced at these two sites. 150 crayfish were released at Fosse Mill and 127 at Shipton Mill, compared with fewer than 100 released at the other reintroduction sites.

Sampling stretches of river between the reintroduction sites revealed no crayfish, with the exception of Foxley Grove on the Sherston Avon. At the reintroduction sites where crayfish numbers are relatively high, the population has spread for about 150 m on both sides but additional survey work, traversing further upstream and downstream, would be required to determine the precise distances travelled. The migration distance was not sufficiently extensive to allow convergence of crayfish populations between the reintroduction sites. Poor habitat conditions could be a possible explanation.

Soon after the pollution incident on the Sherston Avon in 1998, numerous crayfish were seen dead or dying in the upper reaches of the river. However, although mortalities were noted at Easton Grey and Fosse Mill further downstream, the numbers there appeared to be small.

Trapping survey at the reintroduction sites

The trapping survey was carried out only on the Sherston Avon. Traps were baited with mackerel and left in suitable crayfish habitats, i.e. alongside vertical banks or in deep pools. Traps were tied to branches or stones to ensure that they were not carried away in the current and were left fully submersed in the water.

A triple catch survey was employed; i.e. traps were set at the same place for three consecutive trappings over a period of about 2 weeks. Traps were left overnight and collected the following day. Captured crayfish were removed from the traps and marked with a number, using a permanent marker pen; the same details for each crayfish were recorded as in the manual survey. Crayfish were immediately released back into the location where they had been caught. Traps were then removed for a period of 5-6 days, as this was thought to reduce the chance of crayfish becoming habituated or "trap happy" and therefore they would be sufficiently hungry to feed again; traps were then set again in the same place. From these triple-catch recordings, a crayfish population estimate at each site was obtained using Bailey's modification of the Peterson estimate (or Lincoln Index) (Holdich 1990).

Due to low numbers of crayfish at the three reintroduction sites at Hyam Farm, a mark-recapture study could not be conducted. Therefore results are presented only for Fosse Mill and Easton Grey (Table 2).

Table 2. Estimated numbers of crayfish at two sites on the Sherston Avon.

Sampling site	Numbers estimated from traps	Numbers caught in 15 quadrats = 150 m ²
Fosse Mill	140	54
Easton Grey	75	10

Evaluation of sampling methods

Numerous variables are associated with trapping and monitoring crayfish populations. Our results indicated that, in general, traps caught larger individuals than when turning stones by hand, suggesting that the two methods have sampled different age-classes within the populations. This size selectivity may occur due to the different habitat preferences of adults and juveniles. The latter are more likely to be found in the shallow, gravel marginal areas (Blake & Hart 1993) whereas the older, trappable crayfish tend to shelter either in deep pools and/or in burrows and tree-root systems. Up to certain depths it is possible to sample these deeper pooled sections by hand, if a dry suit is worn.

Brown & Brewis (1978) found a significant three-fold underestimation of population size when using mark-recapture estimates, and therefore strongly recommended that trapping should be used only as an auxiliary sampling method in population studies. Woodland (1967) reviewed crayfish behaviour in response to trapping. Not only the responses to the trap itself and crayfish already within it will be important in trap-behaviour, but also whether the animals are exposed to a trap at a suitable sampling time; e.g. reproductive females may remain in their hides and are not sampled.

Turning stones by hand within a 1 m² quadrat appeared to be effective. Very few crayfish were seen evading capture. However, it is limited to relatively clear, shallow water and it is not possible to sample depths greater than arm's-length; the maximum depth sampled using this method was 70 cm. Sampling methods such as stone-turning are not subject to the same limitations as trapping. In theory, all animals present in the sampled area have an equal chance of being caught. Therefore this sampling method is much less biased, and all year-classes are sampled (Brown & Bowler 1977). The most accurate method of estimating population size and density is to drain the site inhabited by crayfish, and collect and record all of the animals revealed. However, few sites containing crayfish would be suitable for complete draining and consequently this method is of limited practical use (Hogger 1988).

Concluding remarks

This study has revealed that the first attempt at a restocking programme by Frayling in the 1980s and early 1990s, following the destruction of the native

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- Holdich & R. S. Lowery), pp. 115-144. Chapman and Hall Ltd, London.
- Holdich, D. M. (1990). *A preliminary impact assessment of an invading signal crayfish population upon both the native population and general stream ecology of Broadmead Brook, Wiltshire*. Unpublished report, Nottingham University to the Environment Agency.
- Lowery, R. S., Hogger, J., Polglase, J. L. & Alderman, D. J. (1986). Crayfish mortalities in UK rivers. *Freshwater Crayfish* 6, 234-238.
- Skinner, A. (1998). *Freshwater crayfish on the Bristol Avon*. Unpublished M.Sc. report.
- Woodland, D. J. (1967). *Population study of a freshwater crayfish Cherax albidus Clark*. Unpublished Ph.D. Thesis. The University of New England, Armidale, New South Wales.