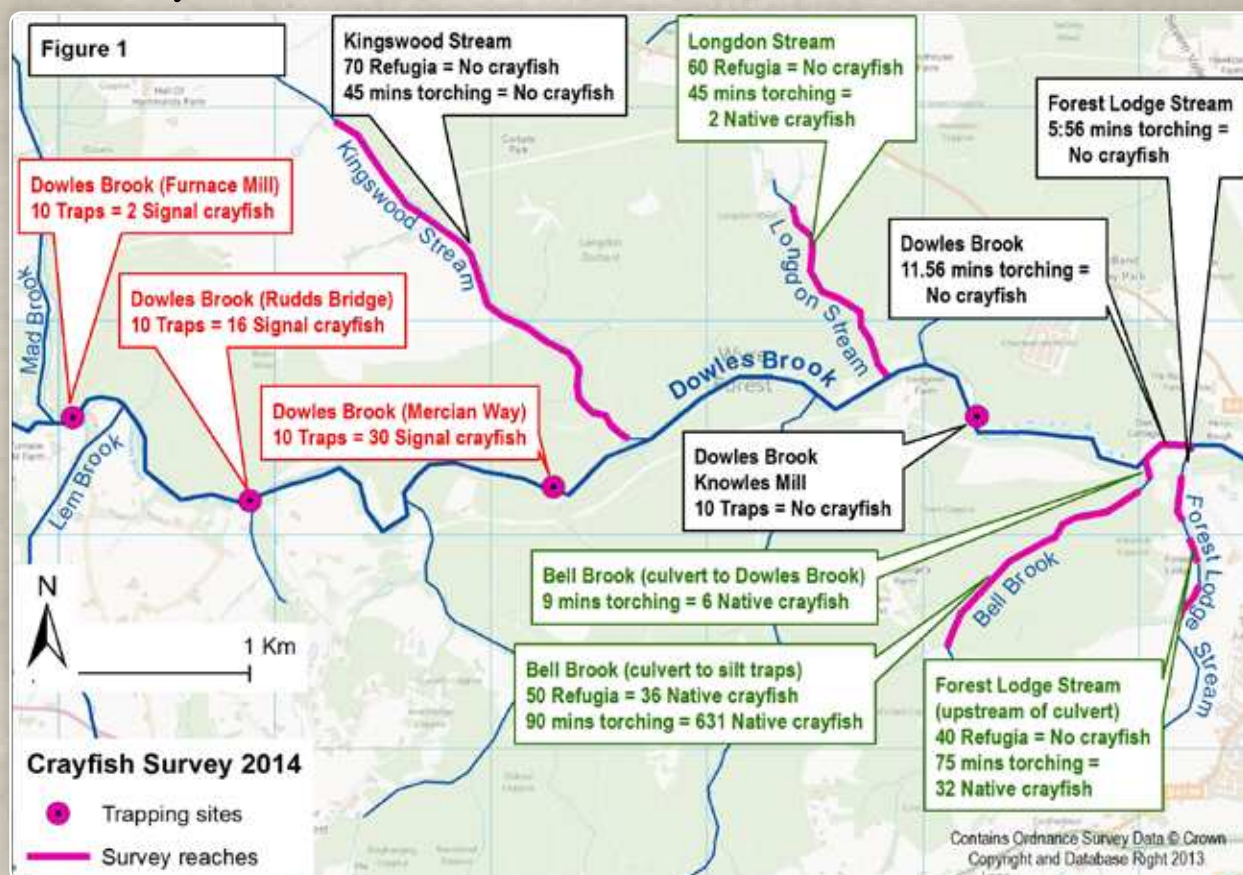


## Update on the White-clawed Crayfish within the Wyre Forest, 2014

ANN AND GRAHAM HILL



### Introduction

A programme of annual monitoring of the native White-clawed Crayfish *Austropotamobius pallipes* population in the Wyre Forest has been underway for the past five years. The study started in 2010 following the discovery of White-clawed Crayfish in a small stream in the forest. This article gives an update on the findings from the 2014 survey.

White-clawed Crayfish are classified as Endangered in the IUCN Red List of Endangered Species and their populations are declining throughout much of their range. It is predicted that the species will face extinction in much of their former range within the next few decades (<http://www.iucnredlist.org/details/2430/0>). White-clawed Crayfish populations are under threat from: a) a fungal-like disease, crayfish plague *Aphanomyces astaci*, b) direct competition from introduced alien crayfish species such as the American Signal Crayfish *Pacifastacus leniusculus*; and, c) biochemical and physical degradation of lotic/lentic habitats.

White-clawed Crayfish are protected under Schedule 5 of the Wildlife & Countryside Act 1981 (as amended). As an Annex II species under the European Habitats Directive, member states are required to maintain

favourable conservation status through the selection of a series of European Sites. The White-clawed Crayfish is listed as a Species of Principal Importance in England under Section 41 of the NERC Act 2006 and is a Priority species in the UK Biodiversity Action Plan (BAP) and the Worcestershire BAP. The UK BAP seeks to maintain the current distribution of the species through a combination of restricting the spread of non-native crayfish and crayfish plague, as well as providing suitable habitat features.

### Methods

A detailed description of the survey methods are given in the annual Wyre Forest Study Group Reviews for 2010, 2011, 2012 and 2013. The daytime manual search of suitable refugia and night-time torching of the watercourse followed published guidelines and best practice (Peay 2002). The 2014 survey replicated (where possible) the previous surveys with a similar team of surveyors, the same number and location of sample patches and the same amount of survey effort as surveys undertaken in previous years, Table 1. In 2014, in addition to the daytime manual searches and night-time torching, baited traps were used to survey four sections of Dowles Brook, to replicate surveys undertaken in 2011. The Environment Agency (EA)

**Table 1: Survey methods and unit size for white-clawed crayfish monitoring surveys in the Wyre Forest between 2010 and 2014.**

Site	Method	Unit			Unit			Unit			Unit			Unit		
		Refugia	Mins	BT	Refugia	Mins	BT	Refugia	Mins	BT	Refugia	Mins	BT	Refugia	Mins	BT
		2010			2011			2012			2013			2014		
Bell Brook (culvert to silt traps)	S	50	n/a		50	n/a		50	n/a		50	n/a		50	n/a	
Bell Brook (culvert to DB)	T	n/a	9.5	n/a	n/a	5	n/a	n/a	4.48	n/a	n/a	15	n/a	n/a	9	n/a
Bell Brook (culvert to silt traps)	T	n/a	120	n/a	n/a	90	n/a	n/a	90	n/a	n/a	90	n/a	n/a	90	n/a
Dowles Brook	T	n/a	45	n/a	n/a	38.4	n/a	n/a	19.5	n/a	n/a	31	n/a	n/a	11.6	n/a
Forest Lodge Stream (culvert to FL fence)	S	50	n/a		rescue			40	n/a		40	n/a		40	n/a	
Forest Lodge Stream (culvert and upstream)	T	n/a	95	n/a	n/a	92	n/a	n/a	70	n/a	n/a	75	n/a	n/a	75	n/a
Forest Lodge Stream (culvert to DB)	T	n/a	11	n/a	n/a	6.5	n/a	n/a	7.14	n/a	n/a	7.3	n/a	n/a	05:56	n/a
Kingswood Stream	S	n/a	n/a	n/a	60	n/a	n/a	60	n/a	n/a	150	n/a	n/a	70	n/a	n/a
Kingswood Stream	T	n/a	n/a	n/a	n/a	45	n/a	n/a	45	n/a	n/a	45	n/a	n/a	45	n/a
Longdon Stream	S	n/a	n/a	n/a	70	n/a	n/a	60	n/a	n/a	70	n/a	n/a	60	n/a	n/a
Longdon Stream	T	n/a	n/a	n/a	n/a	45	n/a	n/a	45	n/a	n/a	45	n/a	n/a	45	n/a
DB: Mercian Way	BT	n/a			n/a	10			n/a	n/a			n/a	10		
DB: Rudds Bridge	BT	n/a			n/a	10			n/a	n/a			n/a	10		
DB: Furnace Mill	BT	n/a			n/a	10			n/a	n/a			n/a	10		
DB: Knowles Mill	BT	n/a			n/a	10			n/a	n/a			n/a	10		

#### KEY

S=Standard; T=Torch; BT= Baited Trap; Mins = Minutes;

DB= Dowles Brook; BB= Bell Brook; FL = Forest Lodge

approval to trap was obtained and the dimensions of the trap design complied with EA rules for the measurements and type of trap. Ten identical traps were placed at each of the four locations. Working downstream from the upstream extent these locations were: a) between the bridge at Furnace Mill and the Lem Brook confluence, b) Rudds Bridge, c) Mercian Way, and d) Knowles Mill. The individual trap was baited with cat food. Traps were set in the afternoon and all traps were retrieved and the catch emptied within twenty four hours of the setting of a trap. All non-native crayfish caught in the traps were despatched.

Comparison of the observations across the years is interpreted using Catch per Unit Effort (CPUE) data as an index for the long-term monitoring of the crayfish populations. Standard units were used i.e. one minute time periods, one refuge searched by hand and/or one baited trap. Differences in observations across the years were investigated using the following statistical tests:

- The one-tailed t-Test was used to compare crayfish observations made during both standard and torching surveys during the five years 2010 to 2014 inclusive.
- The Mann-Whitney U test was used to determine if there was a significant difference between the medians of male and of female White-clawed Crayfish caught using standard survey methods during the five years 2010 to 2014 inclusive.
- The Kruskal-Wallis one-way analysis of variance

was used to test if there was a significant difference between the carapace lengths of White-clawed Crayfish caught using standard survey methods during the five years 2010 to 2014 inclusive.

All survey work was undertaken by two licensed surveyors and several assistants between the 5 and 29 August 2014.

## Results

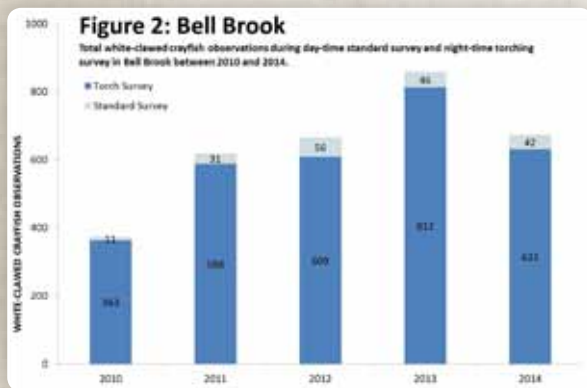
Both White-clawed Crayfish and the American Signal Crayfish *Pacifastacus leniusculus* were found during the 2014 survey. Evidence of White-clawed Crayfish was found in three tributaries of Dowles Brook. No evidence of White-clawed Crayfish was found in one tributary of Dowles Brook. No evidence of White-clawed was found in Dowles Brook although the watercourse was found to support a population of the non-native Signal Crayfish. No individuals were found to be infected with crayfish plague *Aphanomyces astaci*. The 2014 survey results are displayed in Figure 1 and described in the text below.

### Bell Brook

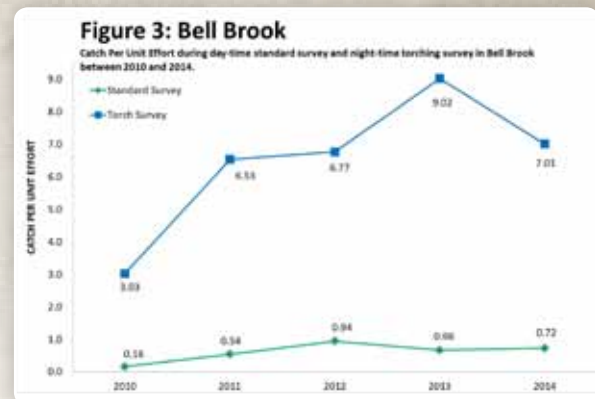
In 2014 there was little observed change in White-clawed Crayfish habitat along Bell Brook. The watercourse continued to support excellent and abundant in-stream refugia and frequent inaccessible refugia in tree roots and between rocks in the bank.



In 2014 there was a decrease in crayfish observations made during both standard and torching surveys, Figure 2. A maximum count of 631 White-clawed Crayfish was recorded during one torching survey of Bell Brook. There has been a statistically significant difference between a) the standard observations during the five years 2010 to 2014 inclusive ( $t = 4.8455$  one-tail,  $n = 4$ ,  $P = <0.05$ ); and b) the torching observations during the five years 2010 to 2014 inclusive ( $t = 8.39785$  one-tail,  $n = 4$ ,  $P = <0.05$ ).



In 2014 the standard survey results showed an increase of Catch Per Unit Effort (CPUE) on 2013 although the number of observations was still lower than the CPUE recorded in 2012. Torching survey results showed a decrease of CPUE in 2014 compared with the previous year. Overall between 2010 and 2014 there has been a positive trend of CPUE based on both standard (range = 0.16-0.94) and torching (range = 3.03-9.02) survey methods, Figure 3. There has been a statistically significant difference between a) the standard CPUE during the five years 2010 to 2014 inclusive ( $P = 0.00466219$ ;  $t = 4.69769$  One-tail,  $n = 4$ ,  $P = <0.05$ ); and b) the torching CPUE during the five years 2010 to 2014 inclusive ( $P = 0.00129865$ ;  $t = 6.68939$  One-tail,  $n = 4$ ,  $P = <0.05$ ).



Every year, since the monitoring began in 2010, small numbers of White-clawed Crayfish have been found downstream of the culverts in the lower reach of Bell Brook, Figure 4. In 2014 six White-clawed Crayfish were recorded. The affected White-clawed Crayfish

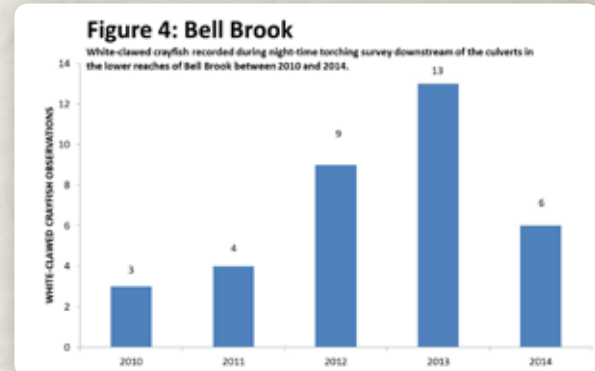


Photo 1. Site where White-clawed Crayfish remains were found on bank, 5 August 2014

Rosemary Winnall



Photo 2. White-clawed Crayfish remains found on stream bank, 5 August 2014

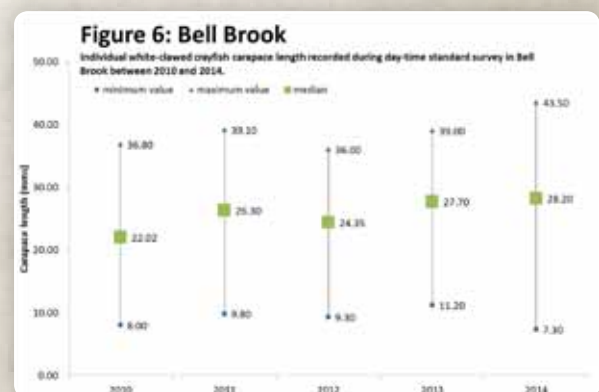
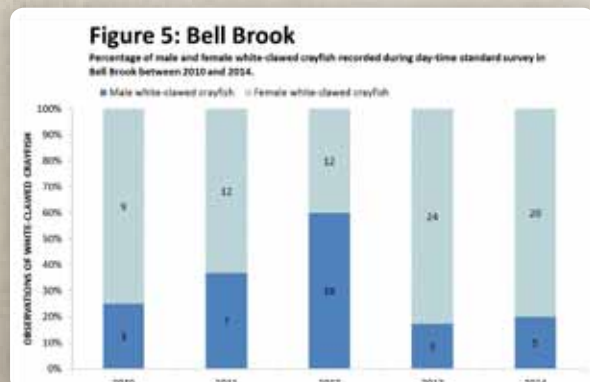
Ann Hill

are flushed downstream and along and out of the culverts: the vertical drop out of the lower of the two culvert prevents the White-clawed Crayfish from making the journey back upstream to the relative safety of Bell Brook.

The White-clawed Crayfish (and Signal Crayfish) is preyed upon by a large number of predators including fish (Perch, Chub, Trout, Pike and Eel), mammals (Mink, Rat and Otter), and birds (Grey Heron and Carrion Crow), particularly during low flows. It is interesting that during the monitoring study, White-clawed Crayfish remains have been found every year at the same location along Bell Brook, Photo 1. In 2014, the remains of at least ten carapaces were found, Photo 2. Closer examination under a stereo microscope found no evidence of teeth or claw marks on the shells.

Both male and female White-clawed Crayfish were present in Bell Brook in 2014: 75% were female

(20 individuals) and 25% were male (5 individuals). Curiously, recording more female than male individuals is a repeat of the findings of three out of the four previous years, Figure 5. Statistical analyses found that there was a significant difference in the proportions of male and female White-clawed Crayfish caught using standard survey methods during the five years 2010 to 2014 inclusive (Mann Whitney U test,  $<0.05$ ).

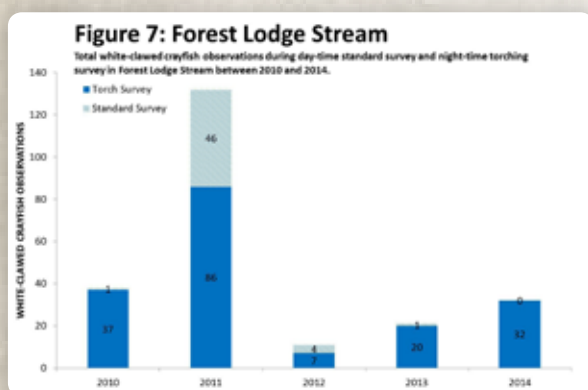


The percentage of the population classed as juveniles ( $<25\text{mm}$  carapace length from tip of rostrum to junction of carapace and tail) was 44%. Recorded carapace length ranged between a female with  $7.3\text{mm}$  carapace and a male with  $43.5\text{mm}$  carapace length (median  $28.2\text{mm}$  carapace length), Figure 6. Although there was variation in the recorded carapace length across the years, statistical analyses found no significant difference in carapace length of White-clawed Crayfish caught using standard survey methods during the five years 2010 to 2014 inclusive (Kruskal-Wallis,  $P = >0.05$ ).



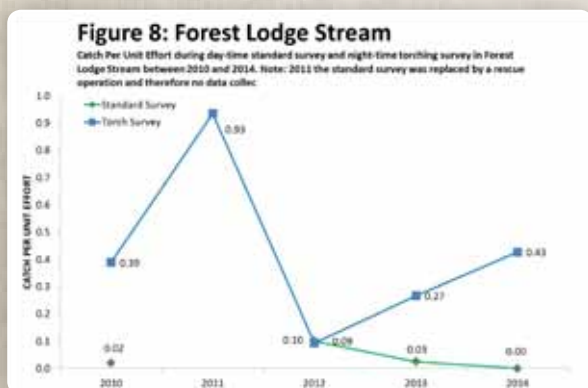
## Forest Lodge Stream

In 2014 there was little observed change in White-clawed Crayfish habitat along Forest Lodge Stream. Forest Lodge Stream continued to have abundant bank-side habitat (under cut banks, large tree roots) and locally abundant in-stream habitat (boulders, cobbles, tree roots, debris dams). Large woody debris was especially abundant in the upper reaches with fallen branches and trunks. The water level was low to moderate with flow along 95% of the watercourse surveyed.



In 2014, White-clawed Crayfish records continued to increase with a maximum count of thirty-two White-clawed Crayfish recorded during one torching survey of Forest Lodge Stream, Figure 7.

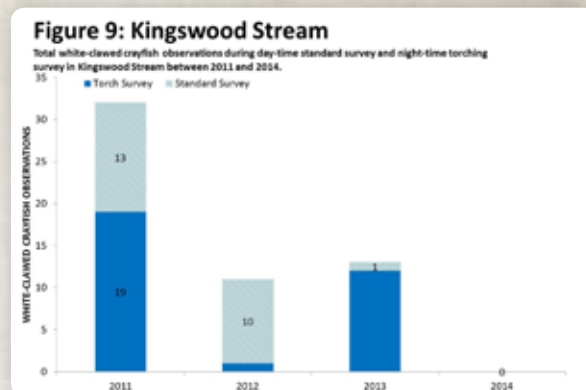
The CPUE from the torching survey showed the second annual increase in population abundance in 2014 following the dry summer and White-clawed Crayfish (and fish) rescue operation of 2011. No White-clawed Crayfish were recorded during the standard daytime survey in 2014, Figure 8.



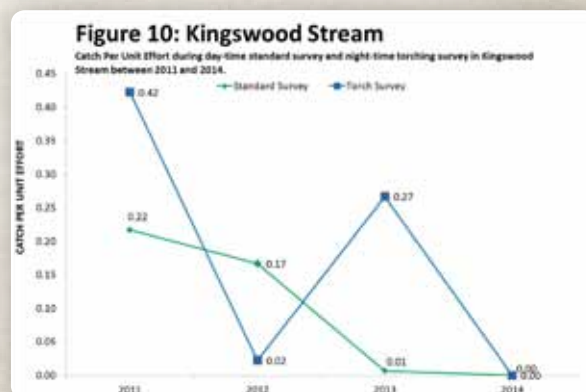
No individuals were caught during the standard manual survey so carapace size and the sex of individuals in 2014 is unknown but the percentage of the population classed as juveniles (juvenile = 25mm carapace length) recorded during torching of Forest Lodge Stream was 50% (2013 = 25% juveniles).

## Kingswood Stream

Bankside habitat and in-stream habitat was very variable but overall the habitat was good to excellent. In 2014 water clarity was poor to very poor and the high siltation levels and the lack of visibility prevented survey in the higher reaches (above the middle foot bridge).



Disappointingly, in 2014 no White-clawed Crayfish were recorded in Kingswood Stream during either the standard or torching survey. The observations and CPUE across the years are shown in Figures 9 and 10 for reference.



## Longdon Stream

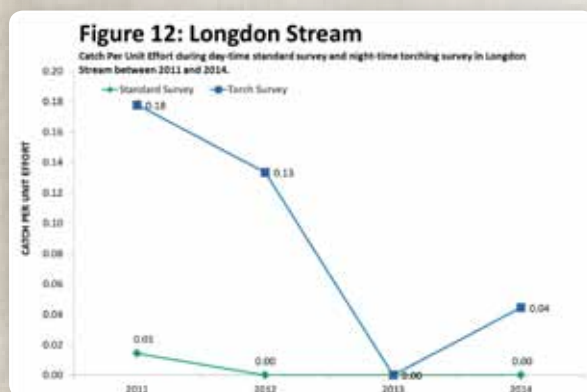
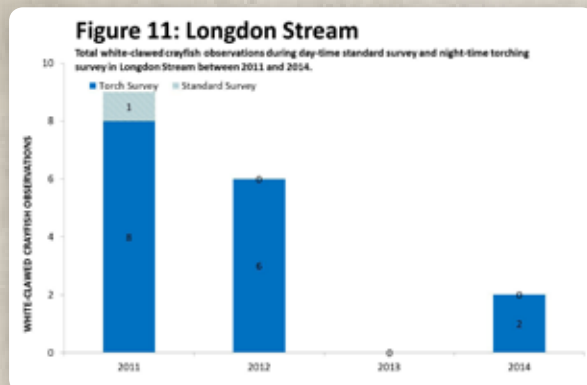
Longdon Stream had abundant in-stream and bankside habitat. Water clarity was moderate with some turbidity and extensive areas of siltation.

Two White-clawed Crayfish were recorded in 2014 which was a positive increase of the nil record made in 2013, Figure 11.

Two White-clawed Crayfish were recorded during the night-time torching which increased the CPUE for the torching survey, Figure 12. One was a female adult White-clawed Crayfish but the other escaped capture.

## Dowles Brook

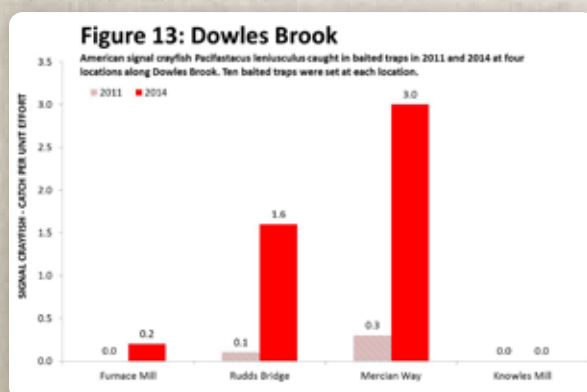
The 2014 survey confirmed the continued presence of



the non-native American Signal Crayfish *Pacifastacus leniusculus* population in Dowles Brook, Figure 13.

In 2014 ten baited traps were set between the bridge at Furnace Mill and the Lem Brook confluence and two adult female non-native American Signal Crayfish were caught. No crayfish of any species were caught in 2011. In 2011, no evidence of crayfish was found at this location.

In 2014 ten baited traps were set at Rudds Bridge and five adult female and eleven adult male non-native



American Signal Crayfish were caught. In 2011, one adult female non-native American Signal Crayfish was caught in one trap plus the bait was eaten in one trap: the bait in eight traps appeared to be untouched.

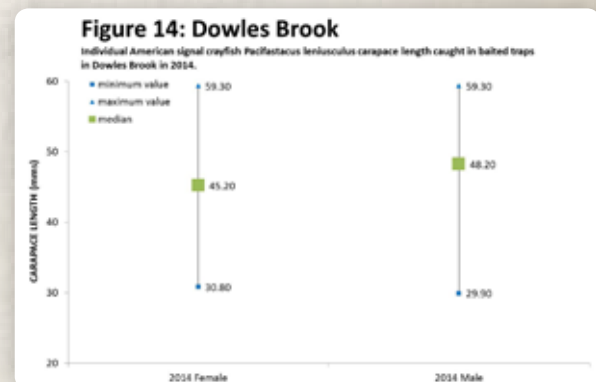
In 2014 ten baited traps were set at Mercian Way and

nineteen adult female and eleven adult male non-native American Signal Crayfish were caught, Photos 3, 4, 5. In 2011, three adult female non-native American Signal Crayfish were caught in one trap plus the bait was eaten in four traps. The bait in five traps appeared to be untouched.

In both 2011 and 2014 at Knowles Mill, no native White-clawed Crayfish were caught in any of the ten baited traps and no crayfish of any species were caught.

In 2014, a total of forty-eight American Signal Crayfish were caught in Dowles Brook compared with four American Signal Crayfish in 2011.

There were twenty-six female and twenty-two male American Signal Crayfish caught in the baited traps. All the Signal Crayfish caught were adult: no juvenile American Signal Crayfish (i.e. with a carapace greater than 25mm) were caught, Figure 14. No American Signal Crayfish measurements were taken in 2011.



## Discussion

The results across all watercourses were similar to previous years. Bell Brook had a stable population of White-clawed Crayfish *Austropotamobius pallipes*. The population density and health was in favourable condition (male, female and juveniles were present) with a high population abundance and the finds from the surveys are thought to be representative of the population abundance. Significant differences in the size of the population over the years are probably due to increasing surveyor expertise and natural shifts in population abundance. The White-clawed Crayfish population was found to have increased in Forest Lodge Stream. The population was in a favourable condition (male, female and juveniles present) with a variable relative abundance related to high and low flow conditions (which continues to be a constant and unpredictable threat to the population). Forest Lodge Stream results are likely to be an under-estimate of population size due to difficulty of sampling i.e.



frequent to abundant inaccessible refugia, unstable terrain etc. However, the population appears to be resilient in the face of adverse environmental factors.

The very small White-clawed Crayfish population in Kingswood Stream and Longdon Stream continued to give cause for concern. No evidence of White-clawed Crayfish was found in Kingswood Stream although it should be noted that the survey may not record where population abundance is low and hence there is uncertainty as to the extent of the population. When sampled in 2013 no evidence of White-clawed Crayfish was found in Longdon Stream. However, resampling in 2014 found that White-clawed Crayfish were present in low numbers. This illustrates the point that the sampling method can give an indication of relative population levels but does not show the absence of White-clawed Crayfish. Localised declines in the native crayfish population in Kingswood Stream and Longdon Stream may be as a result of water quality issues i.e. pollution from agriculture, sedimentation and eutrophication. Detailed water analyses of these two watercourses would provide a valuable insight in to whether water quality is a major threat to White-clawed Crayfish in Kingswood Stream and Longdon Stream.



Photo 3. Signal Crayfish in trap

Rosemary Winnall

Disappointingly, a healthy population of the American Signal Crayfish was confirmed as still present in Dowles Brook. The number of American Signal Crayfish recorded increased between 2011 and 2014 and were found to have spread further upstream than previous records indicated. Some of the increase in catch may be a reflection of the type of trap used. The surveyors have found from experience that different styles of trap are more efficient than others. Nevertheless, the presence of American Signal Crayfish in Dowles Brook is a major threat to the White-clawed Crayfish population in the Wyre Forest, fish species and the whole of the Dowles Brook ecosystem. Invasive crayfish are aggressive predators for food and habitat, and often prey upon the White-clawed Crayfish and eradication of non-native crayfish in Dowles Brook would be difficult, if not impossible.

The results clearly demonstrate that the White-clawed Crayfish population fluctuates across the years and across watercourses.

The monitoring study is starting to produce a substantial dataset on the crayfish population in Wyre. However, it has to be considered that the results to date may be an artefact of a small data set and/or the survey methods. Variables that may possibly affect (both positively and negatively) efficiency and replication continue to be human factors (i.e. increasing age, decreasing mobility of the surveyors and increasing awareness of habitat and species) and environmental factors (natural change in channel structure, flow and habitats (i.e. land and tree slippage), difficult and unstable terrain, temperature etc.). The programme of annual monitoring is planned to continue and it is envisaged that additional data collected in future years will more accurately reflect the population and strengthen and increase the robustness of the analyses.

The torching survey method continues to provide an indication of population abundance but how much of the population are we actually recording? The scale of difference between standard and torching CPUE was found to be markedly greater in Bell Brook than in the other three watercourses. Bell Brook certainly had excellent and abundant bank-side and in-stream habitat for crayfish to hide in (which may affect the survey results) but similarly so had the other watercourses. Do the excellent and abundant refugia affect the survey results, especially of the standard daytime survey method?

There was no obvious reason as to why more females than males have been recorded in the past five years. Is this normal: what is the expected ratio of females to males in a crayfish population? More research is required.





Photo 4. Female Signal Crayfish underside

R. Winnall

Finally, what is the predator in Bell Brook? Or have the crayfish died following a natural event such as a high stream-discharge? The abundance of refugia in Bell Brook should reduce the vulnerability of crayfish to predation: though, at the location where the shells have been found there are limited refugia so making the species exposed to predation.

In conclusion, whilst there was not much change found in 2014 in the White-clawed Crayfish habitat and population of the Wyre Forest, the presence of the American Signal Crayfish *Pacifastacus leniusculus* in Dowles Brook is a direct and serious threat to the existence of the existing native populations. In addition, biochemical degradation of the aquatic habitat in Kingswood Stream and Longdon Stream is an increasing concern regarding the White-clawed Crayfish populations.

## Acknowledgements

We are grateful to the Wyre Forest Study Group and



Photo 5. Female Signal Crayfish upperside

R. Winnall

Forestry Commission who provided local knowledge and access details, Natural England and private landowners for access permissions and the volunteers, especially Mike Averill, Jane Scott and Rosemary Winnall, who assisted with the survey work.

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Crayfish monitoring team, 5 August 2014

Rosemary Winnall