

Guidance on works affecting white-clawed crayfish

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Summary

The white-clawed crayfish is our only native freshwater crayfish, but it is under threat from alien crayfish in much of its natural range in England and Wales. It is a protected species, but it needs practical help to maintain good quality habitats which are free of alien crayfish. A wide range of works in or adjacent to rivers may cause harm or disturbance to white-clawed crayfish. The guidance notes will help you plan works to avoid or minimise impact on crayfish and to improve habitats where possible.

Key points

- Find out whether there may be white-clawed crayfish on any watercourse where you are planning to carry out work.
- Consider whether your proposed work may affect the crayfish.
- Consult the Environment Agency on the works and how to protect crayfish.
- If the works could affect an SSSI or SAC, consult with English Nature.
- If outline permissions are obtained and there are white-clawed crayfish in the river, take steps to minimise the impact on crayfish and their habitat.
- Make sure works involving white-clawed crayfish, including surveys, are carried out with the required licence from English Nature.
- Maintain or re-instate crayfish habitat wherever possible.
- Avoid causing any pollution.
- Take precautions to avoid spreading crayfish plague if working in any watercourse with non-native crayfish.
- Do not allow non-native crayfish to be released back into the wild, even at the point of capture.
- Record the works done.

1. Purpose of the guidance

Although locally abundant in some areas, the white-clawed cray fish has declined dramatically in recent years and is under threat throughout its range. Whilst competition and disease from non-native cray fish are the principal causes of decline, any activity causing habitat disturbance and destruction has the capacity to seriously affect remaining populations. Rivers works on rivers with white-clawed cray fish populations should only be undertaken if unavoidable, and should be carried out in ways that minimise the impact on the species and its habitat.

The purpose of this booklet is to provide guidance to anyone planning to carry out works in watercourse which may have white-clawed cray fish present. It is likely to be relevant to river engineers, drainage contractors, canal managers, project managers and site engineers for new pipelines or other civil engineering projects involving crossing of watercourses, or work on river banks.

The guidance covers:

- cray fish: their status and the law;
- works which may affect cray fish;
- where they live and how to find out;
- planning and doing the work;
- restoration;
- illustrations of cray fish and some examples of works in progress.

The aim of this guidance is to help you take the needs of this protected species into account in the planning stages of a project, or when preparing a brief for contractors. Further guidance on white-clawed cray fish is available from the Environment Agency or English Nature, who will help you obtain specialist advice if necessary.

2. Nature conservation status

2.1 Designations

The white-clawed cray fish is scheduled under the Wildlife and Countryside Act 1981, listed under the EC Habitats Directive, included as a priority species under the Bern Convention and is on the IUCN Red Data List for endangered and threatened species. It is also a priority species under the UK Biodiversity Action Plan (BAP), with a BAP steering group for white-clawed cray fish (consisting of key organisations and individuals) overseeing the delivery of a national action plan.

2.2 Summary of threats

The white-clawed cray fish (*Austropotamobius pallipes*) is the only native species of freshwater cray fish in Britain. It is also found in France, Spain, Switzerland, Italy and further east to parts of the former Yugoslavia. It is under threat and declining in Britain and in much of the rest of its European range.

2.2.1 Introductions of non-native crayfish

Throughout its range the white-clawed cray fish is under threat from the deliberate and accidental introductions of non-native species, some of which are grown commercially. The American signal cray fish (*Pacifastacus lenisculus*) is now very widespread in the wild. American species frequently carry a fungal disease known as "cray fish plague". Signal cray fish are not usually badly affected by infection with cray fish plague, but white-clawed cray fish have no resistance to it. Whole populations of white-clawed cray fish can be killed within a few weeks of exposure to cray fish plague.

In addition, signal cray fish are able to out-compete white-clawed cray fish. This means even if signal cray fish are not carrying cray fish plague they can cause the loss of white-clawed cray fish populations over a few years.

2.2.2 Other threats

Like many other aquatic crustaceans and insects, the species is highly susceptible to permethrin-type sheep-dips. The white-clawed cray fish has a relatively slow reproductive rate and is slow to colonise new areas. Individual animals can live to more than ten years, but if a population is lost from a reach of river due to pollution it may take several years for it to recover.

Loss of habitat is another problem for white-clawed cray fish. Canalisation of river channels for purposes of flood defence, or siltation due to agricultural activities, dredging or construction can easily make lengthy sections of watercourse unsuitable for the species.

2.3 Current UK distribution

In combination, these factors have led to a reduction in the extent of white-clawed cray fish in Britain. The species is still widely distributed over much of the country. There are some areas of central and northern England where the white-clawed cray fish is relatively abundant. The south west of England has no records further west than East Devon. West Wales and Scotland also appear to lack white-clawed cray fish, due largely to the upland character and higher acidity of the river network. Although often found in chalk streams and limestone rivers, the white-clawed cray fish is not restricted to these. Some streams and rivers which drain the Pennines or the Lake District have white-clawed cray fish, as do streams on Midland clays. Even gravel pits may have good populations.

Within its natural geographic range populations are becoming increasingly isolated or lost. White-clawed populations are particularly scarce in southern England, where signal cray fish populations are most abundant. There is a declining number of catchments in England and Wales which are completely free from non-native cray fish.

3. Legal issues concerning crayfish and river works

3.1 Wildlife and Countryside Act 1981

Under the Wildlife and Countryside Act 1981 (as amended) it is illegal to take or sell white-clawed cray fish. Section 16(3) of the Act allows English Nature to issue licences for *conserving* the species. Licences may be issued for rescue operations in relation to

maintenance or engineering works *only if the activity is properly planned and executed and thereby contributes to the conservation of the population*. English Nature's Licensing Department would require evidence that the guidance in this document is complied with.

This Act is also the primary legislation for designating and protecting SSSIs. Activities that may impact upon the special interest of a site are listed as 'Operations Likely to Damage', and engineering works are listed on riverine SSSIs containing white-clawed cray fish. This requires that agreement is reached with English Nature that the activity will not have a significant impact on nature conservation interest. If works are permitted it would be necessary to conduct the operation in accordance with the guidance in this document.

It is an offence to release, or allow to escape, any pest species listed on Schedule 9 of the Act. Signal cray fish is on this schedule, requiring that any individuals caught during engineering works must not be put back into the wild.

3.2 EC The Habitats Directive

The white-clawed cray fish is listed under Annexes II and V of the EC Habitats Directive, implemented in the UK by the Habitats and Species Regulations 1996. Annex II listing requires that Special Areas of Conservation (SACs) are established specifically to conserve the species. Within SACs designated for white-clawed cray fish, agreement is again required with English Nature to undertake engineering operations that may affect the species. A highly precautionary approach is taken when considering the potential impacts of such operations on white-clawed cray fish and their habitat.

3.3 Duties of key organisations to further conservation

Across all rivers, key organisations involved in river works have general legal obligations to further the conservation of flora and fauna. The principal bodies are the Environment Agency, water companies, the Ministry of Agriculture, Fisheries and Food, local authorities and internal drainage boards. These obligations confer a responsibility to take the needs of species of high conservation priority into account. In respect of white-clawed cray fish and river works, this can be achieved by adhering to the guidance laid out in this document.

3.4 Who needs to be consulted when planning river works?

1. Under the Water Resources Act 1991, any works within 8m of a main river bank or floodbank require formal consent from the Environment Agency. Under the Land Drainage Act, consent is also required for any works that affect the flow in watercourses which are not main river. The Environment Agency is the authorising body, except on watercourses under the control of an Internal Drainage Board. The local Environment Agency office will therefore usually be the first point of contact when planning works.
2. If your operations may affect an SSSI or SAC, permissions are required from the relevant English Nature local team (the Environment Agency will be able to tell you if this is the case).
3. On any river, action involving the 'taking' of white-clawed cray fish will require a licence from English Nature's Licensing Service. Relevant activities are: 1) surveying

and 2) rescuing individuals prior to works (either for subsequent release to the same site or for transfer to another site). Licence application forms are available from the Licensing Service at English Nature's Head Office, Peterborough. Alternatively, a licensed cray fish handler may be employed who will liaise with English Nature as necessary.

4. You do not need to take any measures to protect non-native cray fish where the watercourse has solely a non-native (alien) species, but you must prevent the spread of disease to other waterbodies which may have white-clawed cray fish or drain to other waterbodies containing the species. You should notify the Environment Agency immediately if you find any non-native cray fish in a site which is not already known to have the species present. To identify alien cray fish, see the guidance leaflet "Freshwater Cray fish in Britain & Ireland", produced by the Environment Agency.

4. Works which may affect crayfish

4.1 Projects which may require consultation

The list of works below can potentially affect white-clawed cray fish. Some of the activities are maintenance works for which consultation may not usually be expected.

- Bank re-profiling, sheet piling, revetting;
- Installation or re-installation of gabions;
- Construction of bridges, outfalls, walls;
- Pipeline crossings;
- Dredging;
- Surfacing the bed (e.g. around outfalls);
- Channel diversions;
- Repair of bridges, aqueducts, canal wash-walls, locks and sluices;
- Removal of bankside trees;
- De-watering operations;
- Drainage of construction sites;
- Permanent removal of riverside stock fencing;
- Removal of established debris dams.

4.2 Works which disturb the river banks

Cray fish often prefer to shelter in refuges in or close to the banks of rivers or canals. Any works involving excavation of the banks may remove refuge habitat and kill cray fish. Some methods of bank stabilisation lead to permanent loss of cray fish refuges, e.g. construction of concrete walls, sheet piling, mortared stone, or earth banks of uniform gradient. Other methods can be a positive benefit to cray fish, e.g. large, un-mortared stone-revetting along the toe of a river bank; or use of woven willow hurdles, provided these are not too densely woven.

Gabion baskets can potentially provide refuges if the current is not too strong in the adjacent channel. They are usually constructed by fastening wire baskets together and filling them with stones. If it becomes necessary to remove or replace them, however, it is very difficult to do so without at least some of the baskets shedding their load of stone. It is likely to be impracticable to manually unload the baskets to retrieve cray fish and so losses may occur.

Cray fish like to hide among the roots of overhanging trees. Removal of trees, where this involves pulling out stumps, can remove habitat or risk injury to cray fish. In general, coppicing is preferable to removal of trees.

Cray fish sometimes take up residence in crevices and holes below the water line in old brickwork and stonework on bridges, weirs, dams, or canal washwalls. Insensitive repairs may trap cray fish inside and lead to permanent loss of habitat.

4.3 Works which disturb the channel bed

Pipeline crossings that are constructed by cut and cover cause localised and sometimes permanent loss of in-channel habitat. In addition, de-watering operations often affect areas well beyond the channel excavation, leaving cray fish exposed to predation by birds. De-watering can be particularly extensive in canals when whole pounds may be drawn down. Dredging activity is usually carried out in rivers that accumulate silt and do not provide very good habitat for white-clawed cray fish. Dredging can have a major impact on cray fish, especially if areas of sand, gravel and boulders are removed. Nonetheless, even silty rivers may have several thousand cray fish per kilometre. Even weed-raking to remove rooted aquatic plants can cause loss of cray fish.

As well as directly removing cray fish habitats, excavation work in the river banks or the bed can produce a lot of silt, which can fill up the refuges of cray fish. It may cause difficulty with breathing, as the gills of cray fish can clog up.

4.4 Works which have indirect effects

Work on construction sites near rivers can also be a source of silt. Another threat from construction sites is pollution from oil, fuel or spill chemicals. New concrete can leach strong alkali at first and new road surfaces are also a potential source of poor quality run-off, which can affect a range of river life in addition to white-clawed cray fish.

Deterioration or permanent loss of fencing next to water can have indirect impacts on cray fish. It allows access for cattle or other livestock, which if stocked at high densities denude the river margins of plants and trample the banks. The loss of vegetation and the accumulation of silt in the river both reduce the quality of habitat for cray fish.

Removal of debris dams is sometimes required for reasons of flood defence. However, over-tidying of water-courses can reduce the quality of habitat. Fallen branches and trees accumulate packs of leaf litter which are an important source of food for cray fish and many other invertebrates. The overall productivity of streams is increased by having woody debris present.

5. Where crayfish live and how to find out

5.1 Crayfish habitats

Even when there are records of white-clawed crayfish in a watercourse, they are not uniformly spread along the channel. The population can be highly localised, occupying only favourable sections of a river. The crayfish may also be localised within a channel cross-section. For example, the animals may be found mainly in the margins and may be sparse or even absent in the mid-channel. Table 1 shows the habitat preferences of white-clawed crayfish.

Table 1. Cray fish habitat preferences

Crayfish prefer	Crayfish tend to avoid
slow-flowing sections of stony rivers	uniform clay channels
boulder riffles in chalk or clay streams	areas of deep or soft silt
submerged tree roots	dense filamentous algae
debris dams	narrow fast-flowing channels
crevices in old or damaged submerged brickwork, stonework, cracked concrete, or rotten wooden structures	areas of sand and gravel, or bedrock, which are lacking in cobble or boulder (though they may feed in or walk through these areas)
un-mortared stone revetting which protects banks from erosion	pebble or cobble shingle regularly exposed by changing river levels
stands of submerged and emergent aquatic plants	areas of armoured bed, where the substrate is compacted by the river flow
old gravel workings and chalk pits	acidic streams or ochreous drainage
good water quality	poor water quality or salinity

5.2 Crayfish life-style

White-clawed crayfish eat a wide range of food including fallen leaves, aquatic vegetation, dead fish, aquatic invertebrates such as snails and caddis-fly larvae, and other dead or live crayfish. They have a wide range of predators too. Juveniles are eaten by fish, birds and invertebrate predators. Adults are taken by large predators; heron, otter and mink. The crayfish try to avoid predation by hiding in refuges by day and coming out at night, when most birds and fish are resting.

Crayfish activity varies seasonally, in response to temperature, river flow and the annual cycle of growth, breeding and periods of inactivity. Crayfish show little activity during the winter period (December to March), spending most of their time torpid in refuges. They become more active when the water temperature increases. Females carry their eggs over winter attached in a dense cluster under their tails. "Berried" females tend to keep hidden when they are carrying eggs. The eggs hatch while still attached to the "berried" females and the young remain attached for a period before being released.

The timing of release of young varies according to the geographic region and temperature. It usually occurs in June. It can occur in late May in the south and occasionally as late as early July in the north, or when conditions remain cold late into the spring. Signal cray fish have a similar annual cycle, but release their young 2-3 weeks earlier than the native cray fish, which gives them a competitive start. It is preferable to avoid handling female white-clawed cray fish close to the time of release of their young as they sometimes shed eggs or young prematurely. Holding a berried female in a way which keeps her tail tucked round her eggs, a natural posture, will minimise the chance of detaching any eggs or young.

July to September is the time of peak activity and growth and hence the best time for surveys. Cray fish have to moult their shells in order to grow larger. Juveniles moult several times in the first year, whilst adults moult only once or twice a year. Groups of cray fish tend to moult fairly synchronously, because they are very vulnerable when their shells are soft immediately after moulting. They are often much harder to find when a survey is done during a moulting period, but it is not usually possible to predict exactly when moulting will occur.




White-clawed cray fish usually become sexually mature in their third year, sometimes earlier. Mating takes place in October and November. There is competition among the males for the females. After mating, females tend to hide away while they lay their eggs.

The pattern of seasonal activity determines when surveys can be undertaken successfully.

Table 2. Cray fish lifecycle and when to survey

Crayfish cycle	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Activity and growth												
Mating												
Refemales carrying eggs (berried)												
Can do surveys												

Key

Maximum	
Medium	
Minimum	

5.3 Records of crayfish

The Environment Agency keeps records of white-clawed cray fish reported in each region and will be able to tell you whether cray fish are known to occur in the river or catchment where you propose to work. The absence of past records does not necessarily mean there are no white-clawed cray fish in the river or canal. The animals are secretive and can easily be missed during the routine surveys for fisheries or biology.

Local riparian owners or anglers may also report having seen or caught cray fish. Increasingly, reports from anglers are of non-native cray fish. Signal cray fish take angling bait in areas where there is a high density of population and can be a serious nuisance to angling.

Broken shells can indicate where cray fish have fallen prey to otters or mink. Occasionally, cray fish or their remains, are seen by day after they have been washed out of their refuges by major floods.

The Environment Agency booklet "Freshwater Cray fish in Britain & Ireland" gives details on how to recognise the different species.

5.4 Should a crayfish survey be undertaken?

Whether you should undertake a survey depends on the type and scale of proposed work and whether there is any recent information about the status of white-clawed cray fish populations in the area. Figures 1 and 2 in Section 6 summarise the decision-making process.

Unless there are good reasons to think white-clawed cray fish are absent you should plan measures to prevent harm to cray fish. This may mean they need to be removed and re-located by a cray fish survey or under licence. If works are expected to be extensive, a cray fish survey is strongly recommended. If cray fish are present a project can be planned to minimise any adverse impact.

Proving absence of cray fish in surveys is a lot less certain than establishing presence. There has to have been sufficient intensity of survey to be reasonably confident that cray fish are truly absent, rather than under-recorded. For example, in a shallow, clear, stony stream, if there is a relatively high density of white-clawed cray fish (say, 2 m⁻² or more) a surveyor may find one or more within a few minutes of searching. In the same habitat with a low population density (0.1-0.2 m⁻²) it may take 45 minutes or more to find a cray fish. If there are few potential refuges on a stream bed, but plenty of crevices in the banks, it may not be possible to find any cray fish by manual searching. Likewise in water too deep to search manually, there may be cray fish present, but at a density too low to be recorded by trapping.

If the habitat is suitable but cray fish are not found, carry out the works with caution in case white-clawed cray fish are present at low density. Have a contingency plan ready just in case one appears during the work. Be ready to stop work immediately and call in the Environment Agency if you suddenly find cray fish unexpectedly. The same applies to works in areas which have poor habitat for cray fish. The chance of finding cray fish is much lower, but having a contingency plan is a sensible precaution.

If there is good habitat, cray fish are known to occur in the river or canal, or the works are extensive, a cray fish survey will help in planning mitigation work. It will help to provide answers to questions such as:

- How many cray fish may be affected?
- Do they need to be removed and if so, where to?
- Do they need to be moved back after the works, or can the area be left to re-colonise un-aided after the works?
- Where are the likely "hotspots" of good habitat?
- Can cray fish habitat be retained or re-created on the site?

5.5 Methods of survey

Ask the Environment Agency for advice on appropriate methods for the water course in which you intend to work. Remember that a licence is required from English Nature for most types of survey - the use of a licensed cray fish surveyor will make this process simpler. These notes are simply intended to give some guidance on the types of survey that can be undertaken, their advantages and limitations. No one method will tell you all about a cray fish population and survey requirements will vary depending on the conditions and the work you intend to carry out. Table 3 summarises the methods available.

5.5.1 Crayfish habitat survey

This type of survey involves an appraisal of the potential value of river habitats for cray fish. Some Environment Agency regions have River Corridor Surveys which map features of the channel. If available, this can be updated with additional notes on particular features of importance for cray fish. Alternatively, topographic survey maps, e.g. produced for engineering design can be used as a base for the survey. The habitat appraisal is often combined with selective manual searching, at sites where habitat is favourable and conditions are suitable for survey. The "minimum" survey is a map showing the channel which will be affected by the works, plus adjacent sections upstream and downstream, annotated with notes on features which are favourable and unfavourable as cray fish habitat.

5.5.2 Manual searching

This involves searching under stones for cray fish, sweep netting in vegetation and under tree roots. It is only effective in clear, shallow water, (up to about 60cm depth). Used selectively in suitable habitat, it can show if cray fish are present. Selective searches of 5 minutes per site have been used in some preliminary surveys, but cannot reliably detect cray fish populations, unless they are at very high density. Searching by an experienced surveyor for a minimum of 15 minutes is normally required. Selective searching for 45 minutes or more will be needed to detect a population at low density, even where conditions are suitable for manual searching. Note that refuges in banks are usually difficult to search and large stones may be too heavy to move. It is physically demanding work.

It can be done in winter if necessary, provided flow conditions are favourable, but cray fish are more likely to be deep in their refuges and will be harder to find. Quantitative surveys should not be attempted in winter. July to October is the best time for all methods of cray fish survey.

Estimates of population density can be obtained by systematically searching defined areas of the channel, this is effective, but labour-intensive (e.g. 30-60minutes for a 10m x 0.5m transect). It can be useful as a guide to the likely size of the population to be moved. Also for work requiring clearance of the channel, e.g. pipeline crossings, it can be a guide to how long it will take to search and clear all potential refuges.

If trying to obtain estimates of population density, try to carry out a survey on more than one occasion if possible. Environmental factors and periods of synchronous moulting by cray fish can markedly affect survey results. A summer survey, with a follow-up check a week or two later will usually be sufficient.

Table 3. Methods for surveying crayfish

Crayfish survey method	Requirements for survey	Advantages	Limitations
Habitat appraisal	<ul style="list-style-type: none"> not in flood conditions, otherwise any 	<ul style="list-style-type: none"> predicts most favourable locations for crayfish can add to River Corridor Survey drawings 	<ul style="list-style-type: none"> does not record presence so need to combine with other method(s) less favourable habitat may still have low density populations
Manual searching	<ul style="list-style-type: none"> clear water not more than 60cm deep and safe for access reduced visibility only acceptable if bed suitable for kick-sampling (then low efficiency) 	<ul style="list-style-type: none"> can search actual refuges can catch juveniles and get details on population structure selective manual searching is generally the best method for initial surveys quantitative manual searching can give population density if do full search of defined area (transects, quadrats/Surber samplers) 	<ul style="list-style-type: none"> labour intensive, especially quantitative searching; cannot search bankside refuges or soft substrates effectively, requires experience to identify appropriate habitat to search, ability to spot the animals and skill at catching, safety issues entering and in water, disturbs habitat
Trapping	<ul style="list-style-type: none"> moderate to low flow temperature above 8°C traps must be left overnight 	<ul style="list-style-type: none"> can trap in deep and/or turbid water, can record active crayfish from inaccessible refuges, little effort required and may be able to work from bank only artificial refuges can be left in place for days or weeks as crayfish can come and go 	<ul style="list-style-type: none"> very low efficiency so only suitable for populations at high density, efficiency affected by many variables only for active adults in larger size classes, cost of traps and risk of vandalism/loss some risk to non-target species with most traps (fish, water vole)
Night viewing	<ul style="list-style-type: none"> moderate to low flow temperature above 8°C clear water not more than 1m deep, (otherwise need SCUBA and associated procedures) 	<ul style="list-style-type: none"> can cover more watercourse than by manual searching can record active crayfish from inaccessible refuges gives direct view of active animals, including behaviour where survey is possible 	<ul style="list-style-type: none"> relatively low efficiency, so may not record low population density, like trapping, affected by seasonal factors and crayfish response to environmental conditions, safety issues for

Crayfish survey method	Requirements for survey	Advantages	Limitations
		it is more effective than trapping <ul style="list-style-type: none"> • do not need to catch crayfish if only require numbers and location so gives option of least disturbance • no risk to any other species 	wading in water, same as by day, but obstacles less obvious on banks, <ul style="list-style-type: none"> • no good in turbid water.

5.5.3 Trapping

Trapping is the only way of finding out if cray fish are present in watercourses which are too deep or turbid for manual searching. The most common method is the use of plastic mesh traps with funnel entrances. These are usually baited with scraps of fish, although cat food is occasionally used. Funnel traps are normally set one day and inspected the next morning. Trapping efficiency is low. Trapping only records a small proportion of the larger, active animals, especially males. This means it will not detect cray fish populations at moderate to low density unless many traps are used (10's of traps). A density of 1 trap per 5m bank in favourable habitat will usually be sufficient to detect cray fish, especially if trapping is carried out on several nights. Even high density populations will not be recorded during periods of low activity, such as winter, or during high flows, or when a lot of cray fish are undergoing moulting. Traps can be expensive, need to be carried to the site and are prone to interference or theft in some areas.

Funnel traps sometimes catch water vole or water shrew. Water vole is also a protected species which is in decline in many areas, largely due to introduced mink. If these species are known to be present funnel traps should be avoided. Other survey methods should be used instead.

"Vole-friendly" traps can be used. These are not traps but artificial refuges, usually designed as clusters of short tubes of different diameter fastened together. They are placed in the watercourse in favourable habitat and retrieved some time later, when cray fish may have occupied them. They may be used by smaller cray fish than are recorded by funnel traps. The cray fish can come and go as they please from the refuges, so some care is necessary to lift them for inspection without the animals escaping. The refuges can be left in place for days or weeks at a time. They are most likely to be occupied when there are limited refuges in the channel.

5.5.4 Night-viewing

Like funnel-trapping, night viewing only records cray fish which are active at night, which tends to be predominantly adult animals. There is less bias toward males than with trapping. More of a watercourse can be covered than by manual searching, so per unit of effort it tends to be more reliable for detecting cray fish at moderate to low density. It can be a good way of seeing cray fish which use inaccessible refuges by day and provide a quick estimate of the density of active animals. It is dependent on having clear water and a channel which is safe enough to wade, although in some watercourses it is possible to view cray fish from the

banks. It is useful for observing cray fish behaviour and for mark- recapture methods of estimating population. It is a technique which should only be used by experienced cray fish surveyors (at least two people) and as a supplement to other methods rather than a replacement for them.

5.5.5 Do and Don'ts for Surveys

- Do avoid doing surveys or cray fish removals in late May or June, when the young are being released.
- Do consider surveyor safety when commissioning work - two or more surveyors are advisable, especially for any work in the channel.
- Do use more than one survey method if possible, especially if you need to know about the size of populations.
- Don't do surveys during high flows, or when flow is increasing; cray fish stay in their refuges so trapping and night viewing will give poor results; water will tend to be too turbid for good manual searching, and there are also safety considerations.
- Don't carry out surveys in the period December to the end of March; efficiency is very low (manual searching can be done, but catch will be low compared to summer).
- Don't do trapping or night viewing when water temperature is below 8°C, if possible, as the catches will be lower.

6. Planning and undertaking works

6.1 Planning the project

Figure 1 summarises the process of planning a project, assuming outline permissions have been obtained from the Environment Agency and English Nature (the latter if a SSSI or SAC may be affected). Starting at the top, the decisions to be made depend on:

- whether cray fish are known or are likely,
- the suitability of habitat in the area affected by works and adjacent to it,
- the extent of the works
- the results of a cray fish survey, if required

According to the results, you can plan measures to protect white-clawed cray fish and their habitat. Figure 2 shows the procedure if alien cray fish may be present.

This guidance is focused on white-clawed cray fish. There may be other protected species in the watercourse which will also need to be taken into account. The Environment Agency and English Nature will provide advice on combining mitigation measures for different species or habitats where this is appropriate.

6.2 Time-tabling the work

Allow plenty of time in your project programme to:

- commission and carry out a survey if required;
- carry out consultations with Environment Agency and English Nature;
- plan mitigation measures;
- get authorisations;
- prepare for work on site;
- carry out cray fish removal and re-location if required;
- inspect habitat condition after works.

The time required for this depends on the type and scale of the works. The preferred time for crayfish survey and removals is July to October. This is when the animals are most active. In addition, there are often periods of low flow which are good for surveys. River works also tend to be easier in low flows. Do not carry out works which will disturb crayfish during the period late May and June, when females are carrying eggs which are about to hatch or attached young.

Crayfish are most likely to be hiding deep in bankside refuges in the winter and so may be particularly vulnerable to works on the banks. Berried females seem to be particularly reluctant to emerge from banks in cold conditions during any drawdown in the channel. They can be removed manually during careful demolition of the banks, but if such work can be done during July to October this is preferable.

In summary, the guidance on timing of works is:

- do not undertake works in late May or June;
- preferred time for survey and works is July to October;
- work in November to March only if unavoidable - methods of working are limited.

6.3 How to minimise the impact

Ideally, works would not have to be undertaken in any watercourse with white-clawed crayfish. In practice, works may have to be carried out and all practicable measures must be taken to avoid or minimise the impact on white-clawed crayfish. The specific measures required will depend on the proposed project. Any project which affects white-clawed crayfish should aim to ensure the long-term survival of a breeding population. This means conditions after the works have been carried out should still be suitable for crayfish in the long term.

If crayfish have to be relocated for a period in order to accommodate works, the aim should be to rescue every animal. In practice this cannot be guaranteed as juvenile crayfish are difficult to spot and catch and it may not be possible to rescue all the young animals in their first year. The greatest efficiency of crayfish rescue will be in small, stony watercourses when it is possible to manually search and remove all potential refuges. Efficiency will often be lower when there is silt or clay which make the water turbid. Areas with submerged or emergent plants are also difficult to search and efficiency will be lower. Depending on the nature of the works, wet working may involve less impact on crayfish than draining the

channel, but if cray fish have to be rescued, it is much more difficult in a wet channel, especially if the water is deep or turbid or both.

You need to plan and implement the best possible solution to protect white-clawed cray fish.

Some general recommendations are given below.

a. General guidance on works

- Minimise the amount of disturbance to river banks.
- Minimise the length of channel affected by any drawdown/drainage.
- Where feasible, do works on bank or channel bed in short sections in succession, rather than all at once.
- Where feasible, move works to a section where habitat is unfavourable to cray fish.
- Install measures to minimise siltation (e.g. silt blankets or meshes).
- Prevent any pollution of watercourses (e.g. by using drip trays for pumps and checking machinery regularly for oil-leaks etc.).
- If using a pump in the watercourse, put on a mesh screen to avoid taking in cray fish, or fish.
- If digging in the bed of the channel, retain and store surface stone for channel re-instatement.
- If dredging, avoid doing it too thoroughly; leave some areas un-dredged, especially at the margins.
- If excavating gravel and cobble from the channel, back-washing the material can help increase the removal of small cray fish.
- Provide replacement habitat for cray fish if the works involve permanent loss of habitat; use natural or artificial materials to provide refuges.
- Include areas for aquatic and emergent vegetation in the channel design, where this is in character with natural watercourses in the area.

b. Protecting crayfish

- Keep cray fish in their watercourse of origin where possible, except where the population is under threat from non-native cray fish. Get approval from English Nature if cray fish have to be removed from their watercourse of origin (also consult Environment Agency if dealing with a mixed population of white-clawed cray fish and alien cray fish).
- If relocation of cray fish from a site is necessary, get the receptor site ready in advance.
- Any receptor site must have sufficient habitat present or installed for the moved cray fish.
- If there is suitable habitat, or it can be created, use the channel upstream of works for re-location in preference.

- If appropriate, provide supplementary food as a temporary measure (par-boiled vegetables) to encourage cray fish to stay put in the receptor area, rather than disperse rapidly.
- Avoid doing any works in late May or June, when cray fish are releasing their young.
- Avoid any disturbance of the channel, other than is required for cray fish survey, until the cray fish rescue is carried out.

Consider whether it is appropriate to try to remove cray fish in advance, or as the first stage of construction before work begins. If all the work is done in the wetted channel without any drawdown and the watercourse is too deep for manual searching, it may be necessary to trap as much of the population as possible immediately in advance of the works. Low trapping efficiency means only a small proportion of the total population can be rescued in this way. A lot of traps will be required and several to many nights of trapping. For example, a 20m section of canal which yielded one or two cray fish per trap per night, might reveal 300 or more cray fish during a drawdown.

If part or all of the channel is to be drained, it may be possible to remove some cray fish and as many refuges as possible immediately in advance of the drawdown and then collect cray fish as the water level is reduced.

Select any receptor site carefully and agree it with the Environment Agency and English Nature (note that English Nature will require evidence of the suitability of the receptor site before issuing a licence). The best option may be to carry out habitat improvements in advance, with the aim of making degraded river sections with low densities of white-clawed cray fish capable of supporting a larger population.

6.4 Avoiding the plague

Cray fish plague, carried by signal cray fish, is a serious threat to white-clawed cray fish. It can eliminate whole populations of white-clawed cray fish within weeks. Plague can be carried on wet nets, boots and other gear.

- If working on several sites, work on those with white-clawed cray fish first.
- After working on any site which has alien cray fish, ensure all equipment and vehicles which have been in water are cleaned of mud.
- After working on any watercourse with alien cray fish disinfect with hypochlorite bleach or an iodophor (at least 100ppm available iodine). If this cannot be done, ensure all machinery and other equipment is thoroughly cleaned and allowed to dry completely.
- If carrying out any re-stocking with fish in any watercourse which may have white-clawed cray fish ensure the fish come from a source which is free of alien native cray fish; or seek advice from EA on disinfection to avoid risk of cray fish plague.
- If stocking with aquatic plants during habitat restoration, do not use material from stockists or watercourses which have alien cray fish.
- If you find any alien cray fish at a site where the species is not already known to the Environment Agency, report it immediately.

- If working on any watercourse with alien cray fish, make sure everyone knows it is illegal to move them to any new site. Introductions can cause severe, long-term damage to the other life in watercourses.
- Signal cray fish can also badly affect angling interests when they reach high densities.

6.5 Preparations

As with most projects, the key to success is good planning and preparing to deal with contingencies which may arise.

- Make sure all the required authorisations for work are ready well in advance, including
- cray fish licence.
- Inform everyone who needs to know when works will be carried out.
- Ensure key site staff are well briefed on what works are required and when and the specific Health and Safety precautions to be followed in the operations.
- Make sure pollution control measures are ready in advance.
- Make sure any materials required to create cray fish habitat are available and ready before work starts.
- Take weather forecasts into account in advance (Environment Agency may be able to provide flow forecasts too.)
- If drawing down a section of watercourse make sure you have ample pump capacity and pipe-work. Plan for contingencies such as increasing flow, or leaking bunds.
- Other than for cray fish survey, keep out of areas likely to have cray fish until the cray fish removal is carried out. Do not allow site staff to trample favourable habitat or operate machinery in the channel until then.
- Make sure there are enough helpers to carry out the cray fish removal effectively and they know exactly what to do. Everyone involved needs to be able to recognise and handle cray fish correctly.
- Make sure your cray fish specialist is ready on site in time to carry out the removal of cray fish - don't start any drawdown before the cray fish team is ready.

6.6 Crayfish removals

- Retain material for re-use in re-instating habitat.
- Minimise the time between cray fish removal and other works.
- Have a contingency plan to deal with a cray fish which is found in a place where it was not expected.
- If planning to do a drawdown anywhere there may be a population of cray fish at high density, be prepared to cope with a large number of animals appearing in a short period of time.

6.6.1 Advance removal

If doing construction work on the bank or bed in a shallow watercourse it may be possible to search and remove refuges from the channel or bankside in advance of the excavation work.

Removal of stones allows them to be retained for re-use in the re-instatement. It also shows the working area that has been searched. For a shallow watercourse with a predominantly stony bed, search and clearance may be in the order of 5m² per hour for a cray fish surveyor, with a couple of helpers working behind to remove the rocks off the bed.

Carry out cray fish removal on the same day as the start of works if possible. This will minimise the chance of cray fish moving back into the area overnight. The cray fish surveyor should search the area again before works start if there has been any night between cray fish removal and the start of works. It may be possible to use a temporary barrier to prevent access by cray fish from the adjacent channel.

6.6.2 Draining the channel (drawdown)

If draining the channel, make sure the cray fish surveyor and any helpers are ready on site before there is any reduction in water level. Cray fish in bankside refuges may start to emerge within about 10 minutes of a sudden drop in water level and you may find tens or hundreds appearing at once. Have plenty of helpers and buckets on hand! Long-handled nets, plus poles or sticks to gently guide the cray fish into the nets will help in the more inaccessible areas. If there are a lot of potential refuges in the banks, e.g. in a stone-revetted bank, you may need one helper every 5-10m of bank. Catch each cray fish as soon as it commits to coming out of its refuge and before it can walk down to receding and often muddy water. Search all available refuges as soon as they are exposed.

Consider in advance how to access the bed during a drawdown. Will the helpers be able to walk on it or will the surface be very soft? Will you need crawl-boards or other safety gear? Any cray fish which do not appear within an hour and a half of their refuges being exposed will probably not come out voluntarily until much later. Try searching again after dark, if it is safe to do so.

A structure such as a bridge which has to be repaired without being dismantled may have cray fish in crevices in old brick or stonework. Cray fish may not all emerge during a single drawdown, especially in winter. In some instances it may be feasible to refill and drawdown again later. This will increase the proportion of the cray fish population that can be rescued. It may take two or even three drawdowns to get most cray fish out of bankside refuges.

If river banks or structures which potentially have cray fish refuges in them have to be dismantled, do as much of it manually as possible, with continual checking for cray fish. This applies only to areas which are usually below water. White-clawed cray fish are generally within about 0.5m of the surface, unless there are obvious deep fissures for them to hide in. After removing some material from the bank, a short pause often encourages cray fish to start crawling out.

Carefully check any rubbish from the channel. If refuges are limited (and sometimes even if there are plenty), cray fish may hide in old tyres, cans, traffic cones, leaf-filled supermarket trolleys and other refuse!

If carrying out a fish rescue at the same time, try to keep fish and crayfish separate to reduce the risk of de-oxygenation occurring in buckets during the removal. If fish are removed in advance by electro-fishing or netting, remove and relocate any crayfish that are disturbed and caught during the process. Note that crayfish are less susceptible to electro-fishing than fish and this is not an effective method of carrying out a crayfish rescue.

6.6.3 Dredging

When dredging channels, keep banksides undisturbed wherever possible. Try to retain some patches of aquatic plants. Take a series of shallow scoops first, to remove vegetation and a thin layer of the bed. Put this down thinly on the bank and immediately search through it for crayfish. If material is piled thickly, it will be too heavy for the crayfish to crawl out of and they will suffocate. Have water available to wash off the mud - crayfish need clean gills to breathe. Put the washed crayfish in clean water. Don't dredge faster than the crayfish helpers can search the surface material thoroughly.

It may be useful to back-wash materials from the bed or bank to flush out crayfish from the spoil, especially in coarse gravel. This can be done either in the channel, or when material is excavated. Make sure measures are in place to deal with washwater where necessary.

6.6.4 Recording

Record details of all the crayfish caught (sex, carapace length, any sign of damage or disease and whether breeding - note any dead ones too, including cause of death if this is evident). This recording is usually a condition of the licence held by a crayfish surveyor. Include notes on where or how the animals were captured. How big an area did the catch come from? What was the method used? Record environmental conditions too, e.g. weather, flow conditions and water temperature.

Information on population densities in different types of habitat and caught by different methods will be useful for future projects. For example, in a small stream, crayfish may be removed from an area by manual searching, but there might be twice as many which appear from bankside refuges during a drawdown.

In addition, English Nature and the Environment Agency will usually ask for a report on the works as carried out. A candid report on what worked well and what didn't will help other projects in future.

6.6.5 Re-location

Re-locate crayfish as soon as practicable. You can keep 50 or so crayfish in a bucket of clean water for an hour or two if it isn't too warm. They can be held for a little longer if you divide them among several buckets with clean water and some cover - submerged aquatic plants, or even a clean kitchen cloth will do for short-term use. Consider providing aerated tanks containing artificial habitat and a supply of clean water if there may be delays in the relocation, especially in warm conditions. To keep aggression down, keep density to no more than 20 crayfish per square metre if holding them for more than a few hours, preferably grouped by size. Large crayfish will eat small ones if they are kept in close proximity without sufficient refuges.

If it is not possible to relocate cray fish locally during works in a channel, they can be removed and kept in captivity off-site. The conditions required are known from commercial farming of alien cray fish and from a few cases where keeping and rearing of the native species has been carried out. The details are beyond the scope of this guidance. It should only be undertaken with the approval of the Environment Agency and English Nature and where other options are not available.

6.6.6 Habitat restoration

Where possible, re-instate the bank and channel with natural materials which are in keeping with the character of the watercourse.

Remove materials which may be a source of siltation downstream. In stony streams if pipeline crossings are capped with clay, re-instate the surface with gravel and other mixed stone as appropriate. If sand-bags are used to dam off an area, retrieve them intact if possible.

White-clawed cray fish prefer refuges which will stay put in high flows. Bankside refuges are favoured. Within the channel, large stones (>20 cm) are preferable to small ones. They should be loosely scattered rather than bedded in.

If installing hard bank reinforcement such as concrete or sheet piling consider adding features such as:

- holes through into the bank;
- facing with un-mortared stones, engineering brick or breeze blocks;
- incorporating short lengths of pipe into or through the structure in a range of sizes, (e.g. 15 mm to 150mm), either individually or bundles. (The larger sizes can also give water voles access to banks or existing burrows.)
- forming concrete with added battens in the shuttering to create ridges or indentations or cavities suitable for refuges

Provided there are white-clawed cray fish within a few hundred metres of the working area and the channel still provides suitable habitat afterwards the cray fish will gradually move back into the vacated area without assistance.

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