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Crayfish culture

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1. INTRODUCTION

In recent years, crayfish farming has attracted attention in Great Britain. This leaflet summarises new and existing legislation governing the protection and exploitation of all crayfish populations in Britain and their habitats and provides a short account of the main aspects of production. It seeks to put into perspective the various claims that have been made regarding the ease and profitability of this activity. Profits can be made but, as with most activities, they involve hard work and dedication. Crayfish farming alone is unlikely to provide full-time occupation and should only be taken up after very careful consideration and evaluation. Account must be taken of the provisions of the Wildlife and Countryside Act, 1981*, and the consequent need to ensure that signal crayfish, the principal species farmed, and other non-native species – cannot escape into the wild.

2. BACKGROUND

2.1 Species

Crayfish are freshwater crustaceans and are highly valued as a food item in Europe and North America. There are about 500 different species, widely distributed from polar to tropical regions. Since the mid-nineteenth century several species have been introduced into Europe from North America and more recently from Australia. These introductions have been mainly for the purpose of cultivation or to replace native species affected by disease.

The only species native to Britain is the white-clawed crayfish *Austropotamobius pallipes,* which grows only slowly. Most farming is done with the quicker growing signal crayfish *Pacifastacus leniusculus* introduced from North America via Sweden.

2.2 Species present in England and Wales

The species of crayfish that may be found in England and Wales are as follows:

(i) The white-clawed or Atlantic stream crayfish, *Austropotamobius pallipes*, which is native to England and Wales and south-western Europe, and is relatively slow-growing. It is widespread and common in rivers and still waters in England and Wales, but susceptible to crayfish plague.

(ii) The signal crayfish, *Pacifastacus leniusculus*, which is native to western North America and was introduced into Europe as a crayfish plague-resistant species to replace noble crayfish populations and for farming. This crayfish grows rapidly. It now occurs in the wild in a number of places in southern Britain and has recently been found in Scotland.

(iii) The slender-clawed or Turkish crayfish, *Astacus leptodactylus*, which is native to southern and eastern Europe, and was formerly very common, but is highly susceptible to crayfish plague. It grows rapidly to a good size, although its claws contain little meat. It now occurs in the wild in a few areas of England, mainly in and around London and in Suffolk.

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* *The Acts of Parliament mentioned in this leaflet may be obtained from Her Majesty's Stationery Office, P O Box 276, London SW8 5DT*

2.3 Other notable species include:

(i) The noble crayfish, *Astacus astacus*, which is native to northern Europe, but not Great Britain, and was formerly common and widely distributed, but is highly susceptible to crayfish plague. It is thought to occur in a reservoir in Somerset.

(ii) The American red swamp crayfish, *Procambarus clarkii*, which is native to southern North America, grows rapidly and is farmed in extensive systems in Louisiana. It is resistant to plague, but has caused major environmental problems when introduced in some areas of Europe and Africa. This species is present in considerable numbers in a pond on Hampstead Heath.

(iii) The Australian marron, *Cherax tenuimanus*, the red claw, *C. quadricarinatus* and the yabby, *C. destructor*, grow rapidly and can reach a large size, but are crayfish plague-susceptible. Their suitability for farming outside Australia has been widely examined in, for example, Chile, Ecuador, Great Britain (indoor intensive culture), Malawi, New Zealand and south-eastern and central United States. As yet, no significant commercial production is reported.

2.4 Life cycle

The growth (Figure 1) of freshwater crayfish is slow, even in southern England. The native crayfish takes more than 5 years to reach a total length of 80-100 mm, whereas the signal crayfish grows more rapidly, reaches a larger final size and can sometimes reach a marketable size in 2 years. The Turkish crayfish, first found established at a couple of sites in England in the 1980s, but now established extensively in the wild (including the Grand Union Canal and the Serpentine in London), grows even faster.

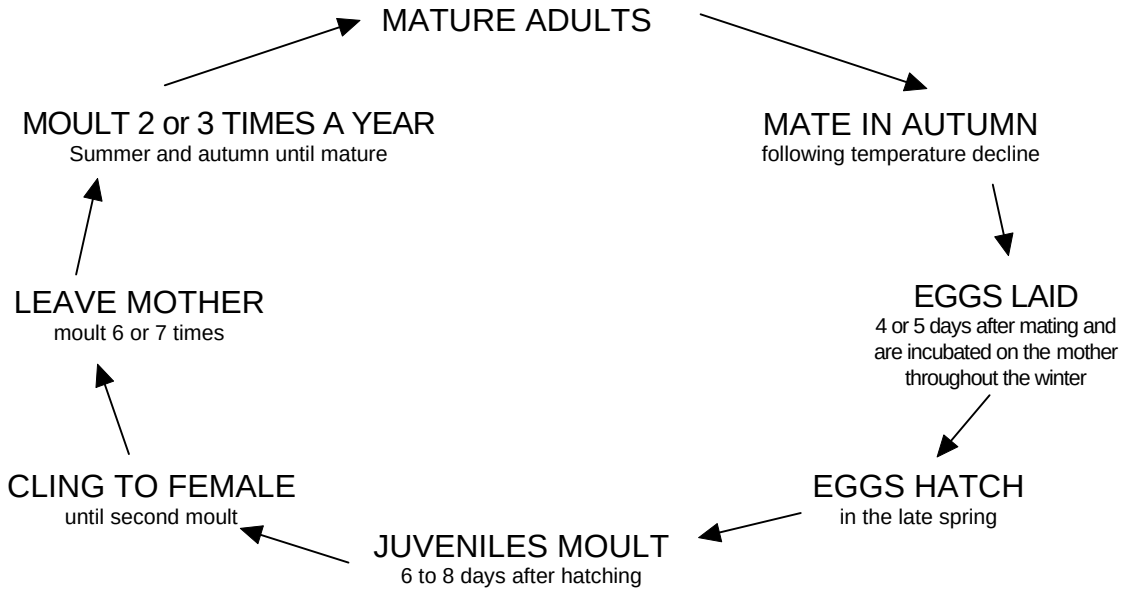


Figure 1. A generalised life cycle of crayfish in Great Britain

3. LEGISLATION TO PROTECT NATIVE CRAYFISH IN GREAT BRITAIN

3.1 Reasons why protection is necessary

Like other animals that have been brought into the country, such as the grey squirrel, exotic crayfish species, if they escape or are released into the wild, can endanger native species and damage the environment. Crayfish spread quickly, they are expert 'escape artists' and the signal and the Turkish crayfish are larger and faster growing than our native crayfish. Once in rivers, they can take over the habitats of our native species. The signal crayfish can carry crayfish plague (see Section 8) and infect native crayfish (entire populations of native crayfish have been wiped out in a few days). They can also alter aquatic ecosystems by destroying plant life, invertebrate communities and fish populations and by burrowing into and weakening river banks.

Since the beginning of the 1980s the population of native crayfish in Great Britain has declined rapidly to the extent that the species is listed as threatened in the Bern Convention (The Convention on the Conservation of European Wildlife and Natural Habitats) and in EC Directive 92/43/EEC (The Habitats and Species Directive), under which several Special Areas for Conservation (SACs) have been proposed for this crayfish. It is also protected under Schedule 5 of the Wildlife and Countryside Act, 1981 in respect of taking from the wild and sale. The same Act also makes it illegal to release non-native crayfish or to allow them to escape (see Section 3.2 below) except under licence.

Both government and conservation bodies are attempting to maintain the present distribution of native UK populations through commitments to the UK Biodiversity Action Plan (Department of the Environment, 1994), this country's response to the Rio Earth Summit. An action plan for the conservation of the native freshwater crayfish in the United Kingdom has also been proposed (Palmer, 1994; Wynne *et al*., 1995; HMSO, 1995). The new Prohibition of Keeping of Live Fish (Crayfish) Order, 1996 (England and Wales) and similar legislation in Scotland described below will aid these proposals.

Attempts to conserve native stocks are centred on limiting the spread of crayfish plague (a fatal disease carried by some imported North American crayfish), limiting the spread of non-native species, and maintaining appropriate habitat conditions. To these ends, three species of non-native crayfish are listed on Schedule 9 of the Wildlife and Countryside Act which, makes it an offence to release or allow them to escape into the wild.

3.2 Conservation Legislation

3.2.1 The Wildlife and Countryside Act, 1981

This Act makes it an offence to release or allow non-native crayfish to escape into the wild except under a licence issued under this Act. If you are thinking of setting up a crayfish farm, or of introducing crayfish to a pond or other water, you must consider whether this involves the release of crayfish. If you think that it does not involve a release itself, but that the crayfish might be able to escape from the site, you must also apply for a licence before any introduction is made. Persons farming crayfish need to make sure that they have taken all reasonable steps to make sure that stock cannot escape, and in particular cannot escape into ponds or adjoining river systems. As a rule of thumb, you will need to apply for a licence for any introduction of crayfish except for those introduced into enclosed tank systems which are crayfish proof. You should apply to the address (MAFF, SWIF A Division) given in Section 11.

Additionally, the native crayfish has been given protection under Schedule 5 of the Wildlife and Countryside Act, which prohibits the taking of any native crayfish for any purpose, except as licensed by the appropriate national nature conservation body (see Section 11).

3.2.2 The Prohibition of Keeping of Live Fish (Crayfish) Order, 1996

This Order makes it an offence to farm or keep any species of non-native crayfish in Great Britain except under licence. Its objective is to control the holding of non-native crayfish in areas of Great Britain in which there are still good stocks of native crayfish or, (as in Scotland) where there are no native crayfish present. Please note that that much of southern and central England is exempt from these requirements for the farming or keeping of the most common varieties of non-native crayfish (the signal crayfish). If you wish to start keeping signal crayfish, you must first check whether your site falls in one of the exempt areas. For a list of the exempt areas see Section 12. If your site is not in an exempt area, or if you wish to keep any other species of non-native crayfish, you must apply for a licence to keep them to the address given in Section 11 (MAFF, SWIF A Division) before you introduce any stock. You should also consider whether you need to apply for a licence under the Wildlife and Countryside Act. A licence under the Prohibition Order does not absolve you from the need to comply with the Wildlife and Countryside Act and vice versa.

3.2.3 Restaurants, fish wholesale markets etc.

Restaurants and wholesale fish markets holding crayfish for sale for direct human consumption need not apply for a licence to keep crayfish under the Prohibition Order, but should follow the Crayfish Code of Practice, a copy of which is included with this publication.

3.2.4 The Habitats Directive (EC)

Under this EC legislation the UK is required to propose special areas of conservation (SACs) for the protection of our native crayfish and to maintain its favourable conservation status. A number of sites in England, Wales and Northern Ireland are under consideration as possible SACs and some of these proposals have been submitted to the European Commission which makes the final decision about selection.

4. OTHER RELEVANT LEGISLATION

4.1 Farming Legislation

The following legislation may be of interest to you, but this is not an exhaustive list.

4.1.1 The Diseases of Fish Act, 1983,

which requires that all shellfish farming businesses register with the Ministry of Agriculture, Fisheries and Food (MAFF), the Scottish Office Agriculture Environment and Fisheries Department (SOAEFD), or the Welsh Office, Agriculture Department (WOAD) (see Section 11), and maintain records of stock for inspection by MAFF or SOAEFD for purposes of disease control.

4.1.2 The Town and Country Planning Act, 1971,

which requires that farms comply with Local Authority planning requirements, e.g. in regard to construction of living accommodation on site, etc.

4.2 Water Legislation

4.2.1 The Water Resources Act, 1963, (as amended by The Water Act, 1989),

which requires that a consent be obtained to impound (dam) a watercourse or to construct a borehole. An abstraction licence would also be required to remove water from a watercourse or borehole and such authorisation will depend on the impact on the environment and on downstream effects. Permission will not necessarily be granted as effects on other water users must be taken into account.

4.2.2 The Land Drainage Act, 1976,

which covers constructions on water courses, the impoundment (dam construction) of watercourses, etc.

4.2.3 The Reservoirs Act, 1975,

which imposes safety requirements on the construction and annual inspection of dams impounding volumes of 25 mega-litres and above.

4.2.4 The Water Act, 1989, (as consolidated by the Water Resources Act, 1991),

which controls the discharge of water from any site into any watercourse. Discharge consents prescribe water quality limits which may not be exceeded.

In England and Wales, the above Acts are enforced by the Environment Agency (EA) (see Section 11.1), under the Water Act, 1989. The Environment Agency, established by the Environment Act, 1995, replaced the National Rivers Authority on 1 April 1996.

5. CULTIVATION

Two main approaches to crayfish farming have developed in Britain.

The first may be described as 'minimalist' farming in natural, or semi-natural enclosed waters such as irrigation ponds and gravel pits, and can produce yields of 60-200 kg per year per hectare of water surface.

The second type is in the form of intensive or semi-intensive culture in specially constructed 'canal-like' channels. These more intensive sites have been constructed with the expectation of producing much greater yields per hectare, but at the expense of increased construction and management costs.

In addition, it is worth mentioning that laboratory scale experiments have indicated the technical feasibility of indoor, controlled-environment culture of some Australian crayfish. Similar conclusions were obtained from studies with tropical prawns and with clawed lobsters. None of these trials, however, has resulted in

significant commercial activity mainly due to the high capital and labour costs involved. The lack of a commercially available, manufactured diet is a significant constraint since wet diets such as offal and fresh vegetable scraps are not suitable for use in intensive culture systems, particularly those employing water treatment and reuse. Such strictures also apply to the possibility of culture of signal or another crayfish species in enclosed tank systems.

5.1 Pond construction

The concept of pond design is based on the crevice dwelling and burrowing habit of the crayfish, together with the fact that crayfish emerge to forage on water weeds and the animals that live in them. In larger ponds and lakes, the addition of islands and stone outcrops will increase the number of potential hides available. Water depth should be between 1.5 and 5 metres to maximise production of natural foods for the stock. In many lakes, without modification, suitable habitat for crayfish may comprise less than 20% of the bottom area.

Semi-intensive farms are built in the form of parallel canals (Figure 2) to maximise the bank and crevice area available in any given area of land. Such canals are generally 1.5-2 metres deep with sloping sides to reduce the risk of bank collapse. Width may be from 2-10 metres and has an important effect on the foraging area available to crayfish living on opposite banks. Hides may be provided in the form of rough stone lining of ponds, or by the use of coarse hard-core at 10-metre intervals. Short lengths of weighted plastic pipe of various diameter can also provide valuable hides. Canal pond lengths can be from 50-150 metres depending on the size and shape of the site. The soil should not be unduly porous, but should be sufficiently fertile to support good plant growth. Weed growth (e.g. *Fontinalis, Glyceria maxima*) should be encouraged for shelter and to provide habitats for food organisms.

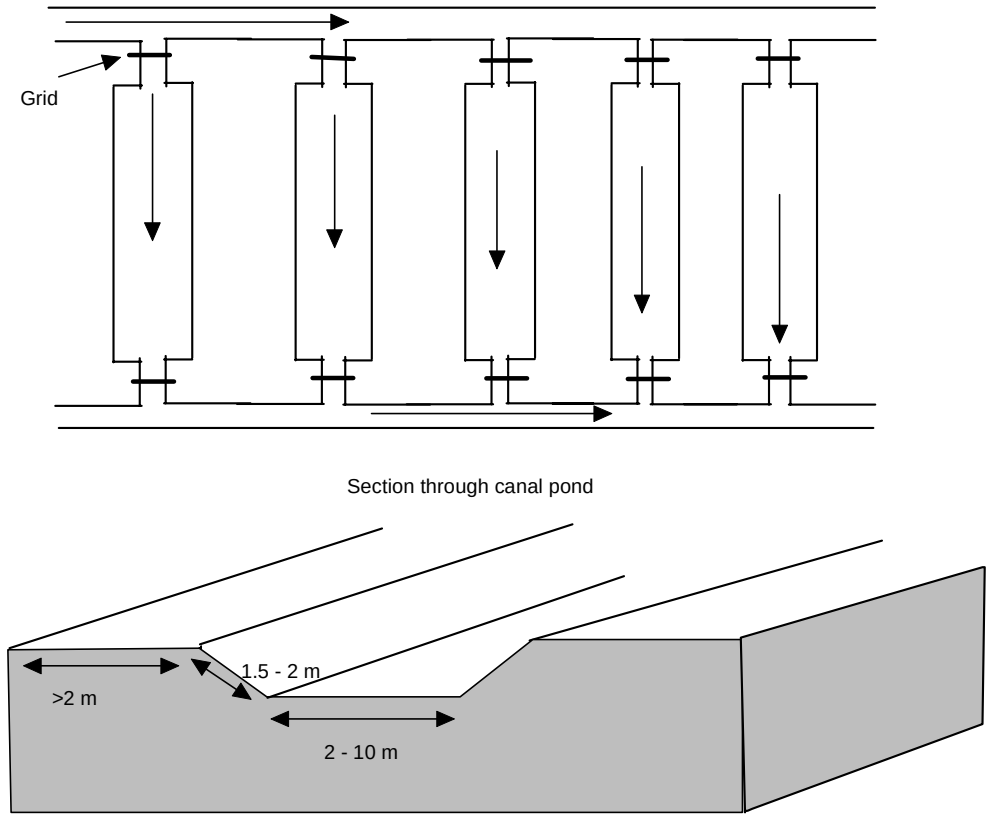


Figure 2. Canal-type crayfish ponds

5.2 Excavation costs

Construction and excavation costs are heavily dependent on the type of site being constructed, its location, accessibility, the type of soil and time of year. The time of year is important in that unimproved valley bottom sites with good springs which are likely to be selected for crayfish enterprises will be waterlogged and thus difficult to excavate for much of the year. Account must be taken of whether or not the work has to be done by an external contractor.

As a rough guide, a canal pond 100 metres long and 10 metres wide with a central depth of 1.5 metres will require the excavation of >750 cubic metres of soil at a current (1995) cost of £3000 to £4000. Some of this soil can be used to produce banking to prevent the escape of crayfish. Additional excavation costs will be incurred in constructing inlet and outlet channels (if any).

In calculating the number of ponds that can be fitted into any area, account must be taken of the need for banks between ponds. These must be at least 2-3 metres in width and, in some soils, 5 metres may be appropriate to ensure stability. Once excavated, hard-core and other material to consolidate banks and create hides for the crayfish must be obtained – transportation costs will be the main consideration here.

5.3 Containment and protection of stock

Crayfish farming in England and Wales has developed around the signal crayfish, which is a 'non-native' species. A major consideration is, therefore, the need to take reasonable steps to prevent its escape into the wild. This has added significance because, as carriers of crayfish plague, signal crayfish can, and have, spread disease among native stocks. It has also to be remembered that signal crayfish are highly mobile and unless checked can move considerable distances over land.

To prevent escape of stock, several enclosure techniques have been suggested. Earth banking up to 1 metre high on site borders adjacent to other ponds and streams may assist the prevention of escape and, of course, this can be a useful means of disposal of excavated soil from ponds. Corrugated plastic sheeting or other smooth rigid material (old conveyor belting has been suggested) sunk into the ground to provide a 25 cm high smooth barrier around the site has also been proposed. Such fencing can only be effective if grass is mown and vegetation kept down around the fencing, otherwise the crayfish will use this vegetation to climb out of the enclosure. Inevitably, such fencing can be easily damaged by people tripping over it. Outlets (and inlets, if water supply is from origins other than spring sources) must be suitably trapped to prevent escape, plastic or wire mesh with an inwardly-directed overlap at the top being the most usual means of prevention. Care must be taken to ensure that these do not become blocked or site flooding and stock escape will result.

Even these precautions may not be sufficient to prevent the escape of very small juveniles. It must also be remembered that crayfish disease agents (e.g. the crayfish plague fungus) are very small in size and can be transmitted by any direct water contact, both between farmed stocks and even more importantly by water discharged from a farm.

As indicated in Section 4.2.4 you will require both abstraction and discharge consents if you take water from a river, spring or borehole and/or if you discharge it. The Environment Agency which issues such consents can include a range of requirements, including a requirement that no crayfish pathogens are discharged from your site. This would mean that your stock source would have to be demonstrably disease free, which is far from easy.

In areas where mink are present, anti-mink fencing of the site would be advisable. Eels in crayfish ponds will destroy stock, so inlet and outlet traps must be designed to prevent their entry. In areas where poaching is a possibility, the major risk will be to stocks in breeding ponds and to stocks trapped and held before delivery to market. Animals in traps in the main ponds may also be at risk at night. Investment in security measures would be advisable in such localities.

6. HUSBANDRY

6.1 Stocking

Before considering sources of crayfish for stocking, make sure that you have a Wildlife and Countryside Act licence and a Licence to Keep (as appropriate) BEFORE you introduce any stock, and a Wildlife and Countryside Act licence for each subsequent introduction.

Stocking with juvenile (spring) or summerling (late summer/autumn) crayfish should be carried out a the rate of approximately 3 animals per metre of canal or pond bank or 200-1000 per hectare of lake every year for at least 3 and up to a maximum of 5 years. Extensive lake stocking should be carried out by introducing the juveniles in groups of 50 at intervals along the banks. Ponds may also be stocked with berried (egg-bearing) females, but such females are less suited for introduction into intensive systems. Once populations have become established with a good mix of ages in the form of an established self-producing population, then no further introductions will be necessary or advisable in view of the risk of introducing disease.

Prospective crayfish farmers must pay particular attention to the units used when calculating the number of crayfish to buy for stocking purposes and when estimating yields and returns. This can be difficult because writers in the fish farming and scientific press often use different baselines for expressing crayfish densities. For example, terms such as weight of crayfish per square-metre of water surface, pond bottom, or submerged bank, or crayfish per running metre of bank are all used.

Translation between these different definitions of production is not always simple and confusion, for example between submerged bank and bottom area, can easily arise leading potential crayfish farmers to expect much higher yields than are, in fact, practicable. It must be remembered that both in extensive and in semi-intensive culture systems the farmer is depending on his crayfish converting the natural productivity of the water into growth. Crayfish can only convert what the water produces and, if there are too many crayfish competing for a limiting amount of natural food, they will not grow well. The result of competition in an overcrowded environment will be damaged animals with claws and legs missing. Such animals will, of course, be of reduced value. Supplementary feeding can increase the production of crayfish in any pond, but the economic benefit of such supplementation remains to be demonstrated.

Once stocked, little idea of total stock numbers can be obtained from draining the ponds, because many crayfish will remain in their burrows which can extend one metre below the pond bottom or into the banks. Capture, marking and release techniques have been developed for scientific investigation of crayfish populations and these could be adapted for stock controls of ponds.

6.2 Diet

Young crayfish feed avidly on the small crustaceans that abound in the weeds of calcium-rich streams, but adults derive up to 70% of their diet from vegetable matter. Most farms rely heavily on natural production

within the ponds and canals to sustain their crayfish populations. Under laboratory conditions, crayfish have been found to feed well on potato and carrot. Although artificial diets have been experimented with (including trout pellets), the effects of supplemental feeding on crop yields and water management requirements in British waters have yet to be determined.

6.3 Water flow

Little information is yet available on optimum flow rates in canal culture systems. However, the main criterion to be considered is that the exchange rate should be sufficient to prevent fouling and subsequent reduction in oxygen levels. Obviously, higher flow rates will be necessary if supplemental feed is added. Crayfish canals in England have been designed with water flows giving 50% exchange in periods between 54 and 150 hours. These rates correspond roughly to between 1 and 6 cubic metres (1000-6000 litres) of water per hour through a 'V-bottomed' canal 1.5 metres deep by 4-10 metres wide.

In the wild, native crayfish survive both in streams with high flow rates and in static ponds. Crayfish culture is therefore possible in static ponds, but risks of fouling and eutrophication from any added feed may be great.

6.4 Water quality requirements

The water quality requirements for good growth and survival of crayfish are given in Table 1. For natural breeding, the water temperature should remain above 16°C for at least 3 months of the year and fall below 14°C in the autumn to stimulate mating and spawning. If ponds are spring-fed with water at 10°C, then flow rates must be slow enough to allow the pond water to warm sufficiently to produce these temperatures.

Table 1. Water quality requirements for crayfish culture

Temperature for growth		14 - 22°C
Temperature for breeding		6 - 13°C
pH	(minimum 6.0)	7.0 - 8.5
Total hardness	(minimum 40 mg/l)	50 - 200 mg/l
Calcium	(minimum 4 mg/l)	> 8 mg/l
Oxygen	(minimum 6 mg/l)	> 6 mg/l
Un-ionised ammonia nitrogen		< 0.1 mg/l

6.5 Harvesting your stocks

Harvesting can commence 2-3 years after the first stocking. If simple funnel traps are used, these should be set at roughly 5-metre intervals in canal systems or at 25-50 traps per hectare in ponds. They should be set at dusk and collected in the early morning. An example of the effort likely to be involved when trapping three modest lakes in southern England is 2 hours per day, 5 days per week for 20 weeks from the end of May to mid October.

In the early years of trapping, males should be culled for the market in preference to females, since a ratio of one male to up to a maximum of 5 females is acceptable. Figure 3 shows the morphological details needed to differentiate between crayfish sexes.

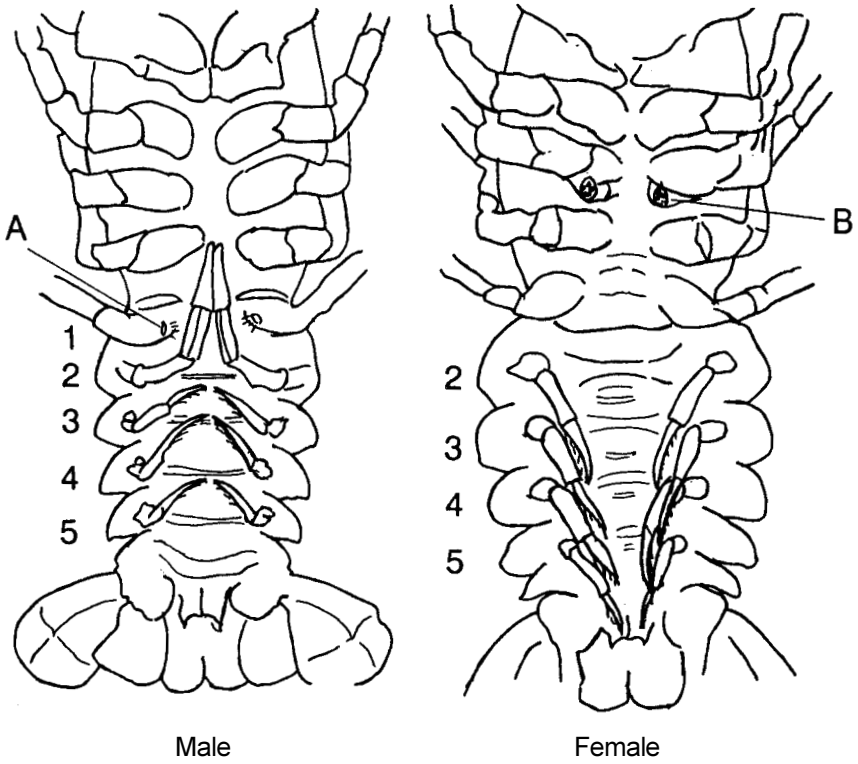


Figure 3. Sexing crayfish

The principal means of harvesting crayfish stocks is trapping, which depends on crayfish being attracted to and entering baited funnel traps. As an alternative, fyke nets may also be used. Seine netting and trawling may be possible on some sites, whilst crayfish in drainable ponds can be collected by hand. All forms of trap and farm equipment including boots and waterproof gear can carry disease. Equipment should not be moved between ponds and certainly not between sites and never into natural waters without thorough disinfection. Advice on disinfection may be obtained from MAFF Fish Diseases Laboratory, Weymouth.

Traps are baited before they are set. Various baits have been tried, including kippers, chopped bones, smoked fish skins and chicken bones, depending on availability. The most important point is that the bait must be fresh – the idea that stale fish or rotten meat will attract scavenging crayfish is mistaken.

Once harvested, stocks of crayfish for sale may be built up on site in shallow holding tanks fitted with hides made of plastic pipe to prevent damage. Moored holding cages or keep nets may also be employed. Care should be taken to ensure that these animals are not subjected to sudden temperature shocks.

Animals in holding tanks are the most susceptible to theft. Poaching is unlikely on extensive sites, although interference with traps may be a problem in some areas. Obviously, traps should be kept under lock and key when not in use. Crayfish traps may be purchased traps (1995 price approx. £15.00 - £25.00 each, see Section 11.2) or hand-made (about £3.00 for materials, plus 2-3 hours work). Additionally, fyke nets may be used in some areas, prices for these start at £45.00. However, fyke nets may be regarded as 'fixed engines' by the Environment Agency fisheries departments and their use therefore prohibited. Where they are allowed, their use is regulated by EA bylaws and a licence may be required. Details can be obtained from your local EA office.

7. HATCHERIES

Farmers may wish to produce their own juvenile crayfish for on-growing at other registered farm sites. For this purpose, a covered broodstock pond or tank needs to be established in late August to hold mated, egg-bearing females over winter. Hides must be provided to reduce the risk of fighting and cannibalism. Each egg-bearing female can carry 50-300 eggs, depending on her size.

In April, when hatching is due, females are placed in individual mesh boxes (40 x 20 x 10 cm, with 1 cm mesh) in shallow (30 cm) nursery tanks. An excessive number of hides such as air bricks or short pieces of plastic pipe are placed in these nursery tanks. Water exchange should be set at once per 24 hours. Newly-hatched juveniles remain with the mother for 2-3 weeks until their second moult. Once the juveniles become independent, the females can be removed from the cages and returned to their ponds. Female crayfish in their third and fourth years are the most productive.

In the nursery tank, the juveniles are thinned to a maximum of 100 per square metre and fed (for 3-4 months) on small crustaceans which can be collected in streams and ponds. When they are 3-4 cm in length, they can be used to stock new ponds or for supplementary stocking of existing ponds. Note that the recipient of your stock will need a licence under the Wildlife and Countryside Act for each introduction of stock.

8. DISEASE

As with most aquacultural enterprises, disease is one of the major hazards to success.

8.1 Crayfish plague

All crayfish species, other than those of North American origin, are extremely susceptible to crayfish plague. This disease, which is caused by an aquatic fungus, is one of the most virulent of all animal diseases. Amongst susceptible animals, survivors are rarely, if ever, found. There is no treatment for crayfish plague.

North American signal crayfish are normally resistant to the disease, but under conditions of overcrowding and stress become susceptible. Infected signal crayfish can take many months to die and once infected can act as disease carriers and transmit plague to new parts of the country and to native crayfish. The gross signs of crayfish plague on susceptible crayfish are complex and variable, but with signal crayfish, animals showing any dark-brown spots or patches on the exoskeleton should be regarded as potentially infected. Farmers should take care to obtain disease-free stock.

8.2 Porcelain disease

This is a disease caused by a minute protozoan which invades and destroys the muscles of affected animals. It gives the muscle a porcelain-white appearance, evident even through the thickness of the claw. Infected animals may take months to die. Infection is believed to spread by cannibalism; thus any infected animals detected should be removed and destroyed immediately. All species of crayfish are susceptible to porcelain disease.

8.3 Bacterial disease

When a crayfish is wounded, the exoskeleton in the region of the wound is liable to become infected by opportunistic bacteria resulting in extensive brown exoskeletal spotting (which can be confused with plague). Animals from overstocked ponds will be particularly susceptible to such damage which, whilst rarely lethal, will reduce the value of affected animals.

8.4 Other fungal diseases

Fungal infections other than crayfish plague, occur. These may affect the exoskeleton or the gills. As with trout eggs, *Saprolegnia* infections of crayfish eggs may occur, particularly under adverse cultural conditions.

9. PRODUCTION TARGETS, COSTS AND PROFITABILITY

Little information is available about production levels that have been attained under British conditions. In canal-type ponds, the target for production appears to be 6 market-sized animals per running metre of pond bank per annum. This target has probably not yet been attained in Great Britain and is probably impossible without supplementary feeding. Indeed, the limit of natural production attainable without feed supplement is probably in the region of 3 animals per running metre of pond bank per annum. It should be emphasised that unless canal ponds are wider than 9 metres only one bank should be counted as productive, at least in preparing initial estimates of potential production from any site. This is because the number of crayfish that any length of pond bank can support with good growth is limited by the productivity of the water in the pond. A wider pond has much more productive surface for plant growth and can, therefore, support more crayfish along its banks.

Thus, in a 100 metre long by 10 metre wide by 1.5 metre deep canal pond with a production of 3 market-sized animals per running metre of bank, a production of 600 crayfish per annum might be expected. Alternative design features such as 'W' shaped canal bottoms and artificial reefs placed in lakes can increase crayfish habitat and hence yields, provided temperatures and the natural production of food remains high.

The 1995 market price for such prime grade crayfish was about £11.00 per kg delivered. Three year old signal crayfish may weigh about 65 g, whilst in 4 years, 100 g might be reached. If crayfish are sold at 70 g, the 100 metre pond would give a yield of £470 per annum, whilst with 100 g animals the yield would be £660. Ten such ponds should, therefore, yield between £5,000 and £6,000 per annum (gross). Increases in the catch of 'wild' crayfish, or of foreign imports, could depress prices.

During the initial phase of crayfish production in Britain a number of producers having stocked their own available water with juvenile crayfish were able to gain an income from selling either further imported juveniles or juveniles derived from their own waters. This is inevitably a short term income since once all possible sites have been stocked, there is no need for further stocking crayfish since crayfish populations are self sustaining once established. The only long term market for crayfish is therefore the table market, whether in the form of supply to local restaurants, to wholesale fish markets or even exported.

10. PURGING, PACKING, TRANSPORTATION

Prior to shipment or cooking, crayfish are best held in clean, running water for 48 hours to purge the gut. This may improve the flavour and can increase their value. Crayfish are frequently transported in lightweight boxes (e.g. expanded polystyrene), in layers up to four deep. The layers are separated by damp foam, moist cloths, newspaper or algae to maintain high humidity. The crayfish should be kept the right way up throughout the journey when survival can be 100% over 48 hours. Boxes may cost around £1 each, collected (Section 11.2). It is worth noting that in France the transportation of live, non-native crayfish is prohibited.

Read the Code of Practice for restaurants and markets entitled "Keep the Lid on Crayfish" enclosed with this publication. You should also be aware that the provisions of the Welfare of Animals in Transit Order will apply to movements of crayfish.

11. USEFUL ADDRESSES, CONTACTS AND FURTHER READING

11.1 Addresses for registration information and licensing

Ministry of Agriculture, Fisheries and Food,
SWIF A Division,
Nobel House,
17 Smith Square,
London SW1P 3JR

Scottish Office Agriculture Environment and
Fisheries Department,
Pentland House,
Edinburgh EH14 1TW

Welsh Office, Agriculture Department,
Division B,
Crown Buildings,
Cathays Park,
Cardiff CF1 3NQ

Environment Agency,
Waterside Drive,
Aztec West,
Almondsbury,
Bristol, BS12 4UD
(or contact the local EA office)

(The Environment Agency took over the responsibilities of the National Rivers Authority from 1 April 1996)

English Nature,
Northminster House,
Peterborough, PE1 1UA

Scottish Natural Heritage,
2/5 Anderson Place,
Edinburgh, EH6 5NP

Countryside Council for Wales,
Plas Penrhos,
Penrhos Road,
Bangor,
Gwynedd, LL57 2LQ

Joint Nature Conservation Committee,
Monkstone House,
City Road,
Peterborough PE1 1JY

Ministry of Agriculture, Fisheries and Food,
Fish Diseases Laboratory,
The Nothe,
Weymouth,
Dorset, DT4 8UB

11.2 Sources of traps and boxes

The following can supply crayfish traps:

Mr J H E Colton
Kingcombe Aquacare,
St Francis Farm,
Hooke,
Near Beaminster,
Dorset

Mike and Julia Thomas
Stoke Manor,
Stoke on Tern,
Market Drayton,
Shropshire,
TF9 2DU

Boxes (18 x 12 x 6 inches holding 10 lb. of crayfish) can be obtained from:

J.B. Packaging
Unit 6, Metherell Avenue Industrial Estate,
Castor Road, Brixham, TQ5 9QB

11.3 Further reading

Wynne, G., Avery, M., Campbell, L., Gubbay, S., Hawkswell, S., Juniper, T., King, M., Newbery, P., Smart, J., Steel, C., Stones, T., Stubbs, A., Taylor, J., Tydeman, C. and Wynde, R., 1995. Biodiversity Challenge (2nd edition), RSPB, Sandy, UK. 285pp.

Department of the Environment, 1994. Biodiversity: The UK Action Plan. HMSO London, 188pp.

HMSO, 1995. Biodiversity : the UK Steering Group Report. ISBN 0-11-75321-5

Palmer, M., 1994. Action plan for the conservation of the native freshwater crayfish *Austropotamobius pallipes* in the United Kingdom. JNCC Report No 193, ISSN 0963-8091.

There are few books which are of help to prospective crayfish farmers. Publications in English include:

Wickins, J.F. (1982) Opportunities for farming crustaceans in western temperate regions. *In*: Muir, J.F. and Roberts, R.J. (eds.) Recent Advances in Aquaculture. Croom Helm, London. pp 87-177.

Holdich, D.M. and Lowery, R.S. (1988) Freshwater Crayfish, Biology, Management and Exploitation. Croom Helm, London, 498pp.

Lee, D.O'C. and Wickins, J.F. (1992) Crustacean Farming. Blackwell Scientific Publications, Oxford, U.K. 392 pp.

Huner, J.V. (1993) Freshwater crayfish aquaculture in North America, Europe and Australia. Food Products Press, New York, USA 312pp.

In French:

Arrignon, J. (1981) L'ecrevisse et son Elevage. Gauthiers-Villars, Paris, 178pp.

Masse, J. (1981) Elevage de l'ecrevisse *Austropotamobius pallipes* en France. Bull. Fr. Piscic., ***281***: 162-168.

In German:

Hoffman, I. (1980) Die Flusskrebse. Verlag Paul Parey, Hamburg and Berlin, 100pp.

In Italian:

Mancini, A. (1986) Astacicoltura Allevamento e Pesca dei Gambari d'Aqua Dolce. Edizione Calderini, Bologna, 180pp.

12. AREAS IN WHICH EXOTIC CRAYFISH MAY BE HELD WITHOUT A LICENCE UNDER THE "PROHIBITION OF KEEPING OF LIVE FISH (CRAYFISH) ORDER, 1996 (ENGLAND AND WALES)"

The information below is taken from a draft of the Order. The boundaries on the accompanying map are approximate and provided for information, and they are not to be construed as legally accurate or binding. For the definitive text see "The Prohibition of Keeping of Live Fish (Crayfish) Order, 1996 (England and Wales)", obtainable from Her Majesty's Stationery Office.

The fact that exotic crayfish may be held without a licence under the above Order does not grant exemption from the requirements of the Wildlife and Countryside Act (1981) in regard to release to the wild and in regard to taking due precaution to prevent escape of stocks to the wild.

Exotic crayfish may be held without licence in these Postcode Areas of England and Wales

Postcode Areas	Centred on	In all Postcode Districts in the Area code
AL	St Albans	All
BA	Bath	All
BN	Brighton	All
BR	Bromley	All
BS	Bristol	All
CB	Cambridge	All
CM	Chelmsford	All
CO	Colchester	All
CR	Croydon	All
DA	Dartford	All
DT	Dorchester	All
DY	Dudley	All
E	London E	All
EC	London EC	All
EN	Enfield	All
GU	Guildford	All
HA	Harrow	All
HP	Hemel Hempstead	All
IG	Ilford	All
KT	Kingston	All
LU	Luton	All
ME	Maidstone	All
MK	Milton Keynes	All
N	London N	All
NN	Northampton	All
NW	London NW	All
OX	Oxford	All
PL	Plymouth	All
PO	Portsmouth and Isle of Wight	All
RG	Reading	All
RH	Redhill	All
RM	Romford	All
SE	London SE	All
SG	Stevenage	All
SL	Slough	All
SM	Sutton	All

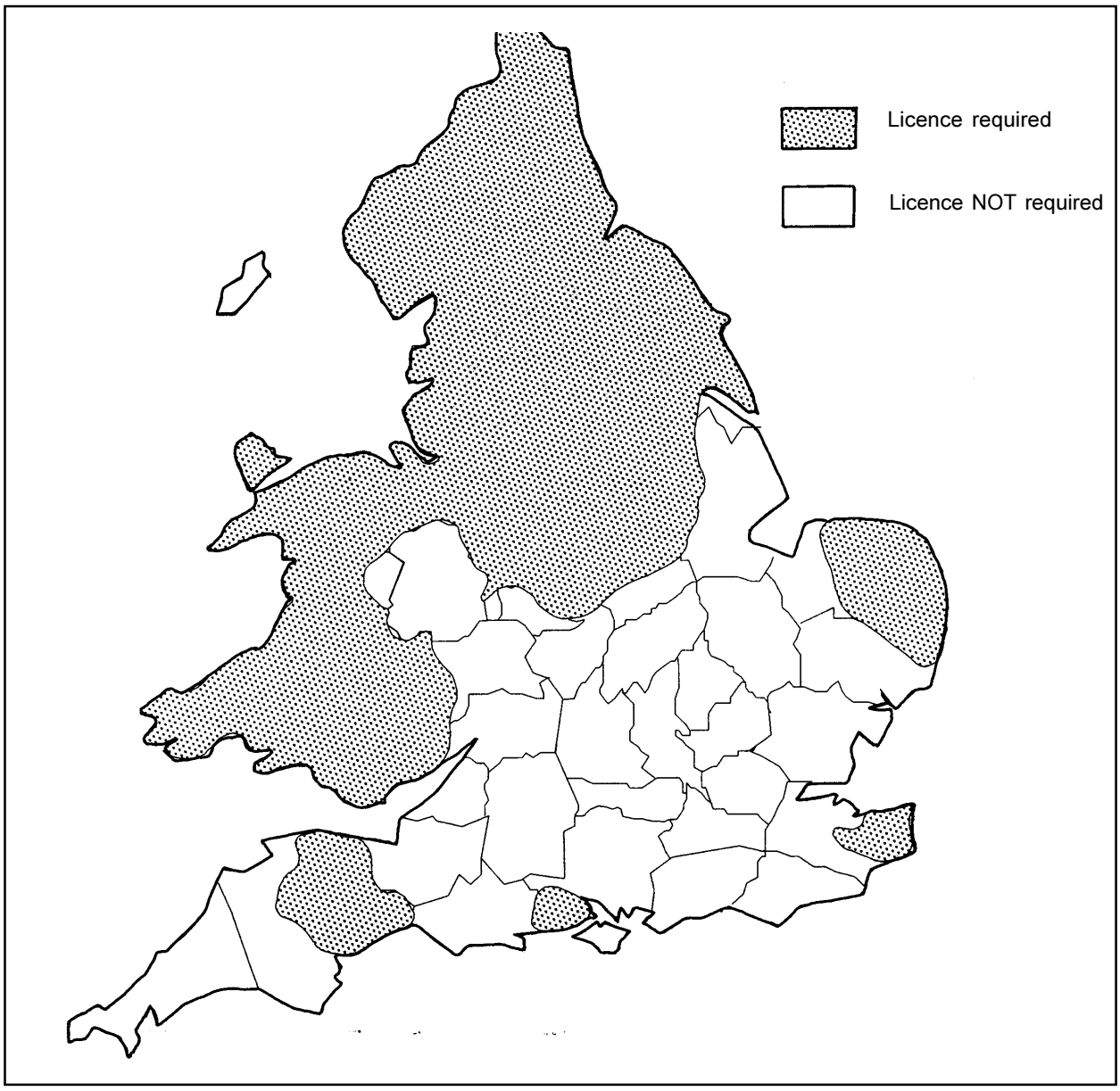
Postcode Areas	Centred on	In all Postcode Districts in the Area code
SN	Swindon	All
SP	Salisbury	All
SS	Southend	All
SW	London SW	All
TF	Telford	All
TQ	Torquay	All
TR	Truro	All
TW	Twickenham	All
UB	Uxbridge	All
W	London W	All
WC	London WC	All
WD	Watford	All
WR	Worcester	All

Additionally, exotic crayfish may be held without licence in these Postcode Districts of England and Wales

Postcode Area	Centred on		In these Postcode Districts only and not in any other with the same Area codes
B	Birmingham	Part	B1, B2, B3, B4, B5, B6, B7, B10, B12, B13, B14, B15, B16, B17, B18, B19, B20, B21, B25, B27, B28, B29, B30, B31, B32 B38, B45, B47, B48, B49, B50, B60, B61, B62, B63, B64, B65, B66, B67, B68, B69, B70, B71, B80, B94, B95, B96, B97, B98
BH	Bournemouth	Part	BH1, BH2, BH3, BH4, BH5, BH6, BH7, BH8, BH9, BH10, BH11, BH12, BH13, BH14, BH15, BH16, BH17, BH18, BH19, BH20, BH21, BH22, BH31
CT	Canterbury	Part	CT5, CT19, CT20, CT21
CV	Coventry	Part	CV1, CV2, CV3, CV4, CV5, CV6, CV8, CV21, CV22, CV23, CV31, CV32, CV33, CV34, CV35, CV36, CV37
EX	Exeter	Part	EX19, EX20,EX21, EX22, EX23, EX31, EX32, EX33, EX34, EX35, EX35, EX36, EX37, EX38, EX39
GL	Gloucester	Part	GL1, GL2, GL3, GL4, GL5, GL6, GL7, GL8, GL9, GL10, GL11, GL12, GL13, GL14, GL18, GL19, GL20, GL51, GL52, GL53, GL54, GL55, GL56
IP	Ipswich	Part	IP1, IP2, IP3, IP4, IP5, IP6, IP7, IP8, IP9, IP10, IP11, IP24, IP26, IP27, IP28, IP29, IP30, IP31
LD	Llandrindod Wells	Part	LD7, LD8
LE	Leicester	Part	LE16
NG	Nottingham	Part	NG33
NR	Norwich	Part	NR17
PE	Peterborough	Part	PE1, PE2, PE3, PE4, PE5, PE6, PE7, PE8, PE9, PE10, PE11, PE12, PE14, PE15, PE16, PE17, PE18, PE19, PE20, PE30, PE31, PE32, PE33, PE34, PE37, PE38
SO	Southampton	Part	SO14, SO15, SO16, SO19, SO20, SO21, SO22, SO31, SO51, SO52
SY	Shrewsbury	Part	SY1, SY2, SY3, SY4, SY5, SY6, SY7, SY8, SY9, SY10, SY11, SY15, SY16, SY17, SY21, SY22
TA	Taunton	Part	TA1, TA2, TA5, TA6, TA7, TA8, TA9, TA10, TA11, TA12, TA13, TA14, TA15, TA16, TA17,TA18,TA19
TN	Tunbridge Wells	Part	TN1, TN2, TN3, TN4, TN5, TN6, TN7, TN8, TN9, TN10, TN11, TN12, TN13, TN14, TN15, TN16, TN17, TN18, TN19, TN20, TN21, TN22, TN28, TN29, TN30, TN31, TN32, TN33, TN34, TN35, TN36, TN37, TN38, TN39, TN40
WS	Walsall	Part	WS1, WS2, WS3, WS4, WS5, WS6, WS8, WS9, WS10
WV	Wolverhampton	Part	WV1, WV2, WV3, WV4, WV5, WV6, WV7, W12, WV13, WV14, WV15, WV16

12.1 Rough map of areas in the "Prohibition of Keeping of Live Fish (Crayfish) Order, 1996 (England and Wales)"

The boundaries on the accompanying map are approximate and provided for information, they are not to be construed as legally accurate or binding. For the definitive text see "The Prohibition of Keeping of Live Fish (Crayfish) Order, 1996 (England and Wales)", obtainable from Her Majesty's Stationery Office.



Note : the areas indicated roughly on this map refer to "Keeping Licences" under the Prohibition of Keeping of Live Fish (Crayfish) Order, 1996 and NOT to licences required under the Wildlife and Countryside Act, 1981. A "Keeping Licence" does NOT absolve you from the requirements of the Wildlife and Countryside Act.

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