The Cuttlefish
(Sepia officinalis):
A guide to its exploitation in UK waters

Seafish Report No.SR467

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The Sea Fish Industry Authority

Seafish Technology

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DATE: May 1996
AUTHORS: K Arkley
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Executive Summary

This report is concerned with a developing trap fishery for the cuttlefish *(Sepia officinalis)* off the south coast of England. It describes assistance given to fishermen in Hastings whose traditional trammel net sole fisheries were being jeopardised by the presence of large numbers of spider crab. Concurrently a new opportunity was being presented in the form of the increasing availability of cuttlefish in inshore waters. A development project was undertaken which was based at Hastings but the results are applicable to a much wider area. There were five main topics of investigation and each is detailed in the main report. They cover:-

- a fact finding mission to Brittany where a similar inshore trap fishery has developed;
- a review of available information on the biology, behaviour and exploitation of cuttlefish species in general;
- the design, manufacture and evaluation of a range of cuttlefish traps;
- post-harvest factors—handling and storage—which affect product quality; and
- a review of the existing patterns of trade in cuttlefish, recent trends and market potential.

The scope of the work therefore became very much wider than that which was originally envisaged—a simple gear development project. The report gives a coherent view of all aspects of trap fishing and sets that view in a much wider context. It contains practical information which should be of direct use to:

- fishermen;
- buyers and processors;
- exporters; and
- resource managers, particularly those concerned with the inshore zone.

The discussion sections cover a wide range of topics related to harvesting, commercialisation and resource protection. From these sections it is possible for individual operators to deduce a great deal about alternative fishing and marketing strategies.

The conclusions cover trap design and deployment, catch handling, market potential and stock protection. It is worth noting however that they are conclusions relevant to conditions obtaining at the time of writing. At some future date the same resource material in the report could also be used to arrive at quite different positions. In summary the main conclusions are:-

Trap design and deployment

- The most effective trap design, in terms of cost and simplicity, is the modern Brittany type. Parlour traps are also very effective when baited with a female cuttlefish.
- Optimum spacing of traps on the back line, soak times and other details of deployment should be guided by local conditions but 15–20 fathom [~35 m] spacing and 24 hour soak time are good guide values.
- Fleet length is strongly limited by vessel size because of the size of the traps. Fleets of 10 traps were ideal for the inshore vessels used for the fishing trials.

Catch handling

Torry fish quality scoring methods can be used to assess cuttlefish quality.

Rapid chilling, preferably with ice, is crucially important to retain quality and maximise shelf life. This imperative applies equally to day boats as to other classes of vessel.

Prompt gutting is not important but cuttlefish for the fresh chilled market should be gutted within a few days of landing.

Washing and icing cause practical problems because of the staining caused by ink-laden run off or melt-water.

Cuttlefish are delicate animals prone to mechanical damage from capture gear or poor handling. Damage levels should be minimised.

Market Potential

- Successful marketing of a quality product requires an efficient and dedicated infrastructure to store, collect, transport and process cuttlefish.
- The inshore trapping fleet is generally poorly served in terms of such infrastructure needs because it is involved in a new fishery.
- Given good infrastructure, the inshore trap fisheries could compete very effectively with other sources of supply in terms of intrinsic quality and product specification, but production would be seasonal.
- Demand is generally strong for the species and has been consistently so for several years. The nearest centres of demand are in some of the Mediterranean countries, the biggest markets are in the Far East.
- There is scope to develop a number of niche markets that could be supplied by producers of fish that meets fairly tight specifications.

Stock Protection

- The species has quite predictable seasonal distribution which makes it fairly easy to target but also vulnerable to over fishing.
- Females lay relatively few eggs—only a few hundred—and die shortly after laying these eggs.
- Trawling takes animals before they have mated and bred; trapping may take them pre-or post-egg laying.
- Traps are favoured by females as attachment points for eggs. Eggs layed on traps probably do not survive hauling and discarding, at best their survival chances are severely reduced.

- Other nations have introduced management measures for their inshore fisheries but these are most likely to result in a reduction of catch rates.

Overall the report opens a debate on a relatively new fishery that has substantial potential. It offers guidance in a number of important areas but leaves open ways and means of devising a coherent development strategy for the species.

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1. Introduction

Over recent years the static net fishermen on the Channel coast of England have been experiencing large by-catches of spider crabs *(Maia squinado)*. The crabs are caught in their gill and trammel net fisheries targeting round and flatfish species. In particular, the south-east coast trammel net fisheries for sole and plaice have been badly affected.

The spider crab numbers have reached such high levels that their presence has virtually stopped these fisheries altogether. What was once a seasonal influx of spider crabs onto the traditional inshore netting grounds has now developed into an almost year round presence. It is not unusual for fishermen to capture over 1000 individuals in a 400 yard (366 m) fleet of trammel nets. Consequently, excessive net clearing times, gear damage and losses of target catch quality are being experienced. This has resulted in the loss of valuable fishing time, high gear replacement costs and poor returns on catches of target species: altogether disastrous consequences for these fishermen.

During the late spring and early summer, fishermen on the south-east coast of England encounter another, this time more welcome, by-catch to the sole fishery. Considerable numbers of cuttlefish *(Sepia officinalis)*, migrating from overwintering grounds in the central western Channel, concentrate on the inshore fishing grounds in preparation for breeding.

Until recently this by-catch was being virtually ignored as being of no commercial value to fishermen in this area. In recent seasons however, demand from French and Spanish markets meant that prices for cuttlefish rose considerably. This provided a welcome catch bonus in an otherwise declining resource base. Prices as high as £9/stone (~£1.41/kilo)[1] were being paid by buyers on the Hastings fish market in 1995. This change in fortunes led to cuttlefish constituting a major part of catch revenue in recent seasons, but the presence of spider crabs in such large numbers meant that fishermen were being prevented from taking advantage of this 'bonus' fishery.

As a result of these problems, some fishermen representing the Hastings Fishermen's Protection Society (HFPS) contacted Seafish's Gear Technology section to ask for assistance in developing an alternative method that would allow them to continue catching cuttlefish despite the presence of spider crabs.

Any method suggested had to be compatible with their existing vessel designs and operational procedures. Hastings has the largest beach-launched fishing fleet in Britain consisting of around 40 vessels of less than 12 m in length. The mostly clinker-built vessels operate as gill/trammel netters and small scale trawlers in a very traditional fishery. With these constraints in mind Seafish staff set about addressing this problem.

Following some initial investigations into available options, it was decided to concentrate attention on the use of static traps to exploit this resource.

[1] Prices ranged from £7.10 to £9.10/stone (£1.12 to £1.43/kilo)

2. Approach

After consideration of a range of factors it was decided that the situation warranted more than an exercise in developing fishing gear and techniques. The opportunities available covered all sectors of the industry and, therefore, a fisheries development programme would be required. In order to make best use of the limited staff time and resources available to the project it was decided that the study should cover:

- **Trap design.**
  Optimising trap performance by looking at other fisheries and local conditions.

- **Biological aspect.**
  A review of available research on the species, its habits, distribution and behaviour where these are relevant to its exploitation.

- **Post-harvest care and quality.**
  Identifying best handling practices that would maximise the revenue available from any particular catch.

- **Market conditions and opportunities.**
  Reviewing the existing and potential outlets for the catch in order to describe the market structures and potential niche outlets.

- **Management regimes.**
  An overview of management practices in established fisheries and an assessment of some of the risks facing the European stock.

The initial research to find suitable alternative methods for catching cuttlefish identified a recently established trap fishery in Brittany in northern France. Following contacts with gear technologists from the French Fisheries Research Institute (IFREMER) in Lorient, some very valuable information on the French inshore fishery was obtained. This information suggested that there was good potential for a similar trap fishery on the English side of the Channel. The Hastings fishermen's representatives were confident that such a fishery could prove a viable seasonal alternative to the existing static net fishery, thus taking pressure off sole and plaice and re-directing effort onto a non-pressure stock species.

Following discussions between The Sea Fish Industry Authority (Seafish), the Hastings Fishermen's Protection Society (HFPS) and the National Federation of Fishermen's Organisations (NFFO); (which was enthusiastically supportive of the initiative), it was agreed that a visit to France should be undertaken to investigate the fishery first hand and to discuss operations with French fishermen.

A visit was arranged to the port of St. Malo in northern Brittany in August 1994. Two Seafish gear technologists were accompanied by three Hastings fishermen to meet French fisherman Monsieur Denis Ourselin. The meeting was arranged and attended by our contact from IFREMER.

Monsieur Ourselin was one of the first fishermen to develop a trap fishery for cuttlefish in northern Brittany. Over the last few seasons Monsieur Ourselin has developed a trap design that is proving very effective at catching cuttlefish in the shallow inshore waters around St.Malo.

During the two month season, which extends from April to May, he operates up to 200 traps set in strings of 10. At the height of the season it is not uncommon to catch up to 1 ton of cuttlefish for a 2 day soak period. With high prices received from French and Spanish outlets, this has proved to be a very lucrative fishery.

Sufficient information and advice were obtained from the visit to provide the Hastings fishermen with the confidence to pursue their interest further. Seafish were sufficiently impressed to assist in a transnational technology transfer and set up a project to develop a trap fishery on the English side of the Channel.

The other areas of work followed the pattern identified above. Trap variants based mainly on the French design were evaluated by extensive sea trials which included direct observation of cuttlefish behaviour around and within traps. A range of handling and storage regimes were used for the catch and relationships were established between temperature, handling, storage and product quality. Existing buyers were interviewed in a number of areas, the global market for cuttlefish was investigated, and potential new UK production was thus set in a commercial context. Literature searches and reviews were also carried out into a number of aspects of the species including their behaviour, biology, exploitation and management.

By these means a large mass of quantitative data and more general information was built up. That mass was filtered, sorted and organised and now forms the basis of this report.

3. Biological,Behavioural and Commercial Aspects of the Cuttlefish *(Sepia officinalis)*

The common cuttlefish *(Sepia officinals)* is one of the best known cephalopods of the old word. Despite being abundant in the eastern Atlantic and the Mediterranean Sea it is relatively under exploited in Europe. It is however, commonly exploited in the Far East. Recently there has been increased consumer demand leading to the development of new fisheries world wide. The consequence of this has been the introduction of the cuttlefish to new consumers. The common cuttlefish is currently targeted in the northeast Atlantic by France, Portugal and Spain.

The success or failure of fishing often depends on the level of the fishermen's understanding of the habits and natural conditions that control the life cycle and distribution of the animals targeted. This section aims to give a background to some of the natural factors that influence the fishery. Seasonal distribution patterns, temperature variations, annual migrations, reproduction, prey, predation and tidal influences represent some of the numerous variables to which fishermen must constantly adjust.

3.1 The Biology of the Cuttlefish

A number of aspects of the cuttlefish's biology are described in the following sections. Particular attention has been drawn to those biological factors that are thought to be pertinent to the capture process.

3.1.1 Anatomy

The common cuttlefish is classified as a mollusc. Molluscs are soft bodied animals generally protected by a shell and include oysters, whelks, cockles and mussels. The cuttlefish is a member of the group of molluscs known as cephalopods. This group is characterised by the presence of arms surrounding the mouth and an internal or reduced shell. Their behaviour and pattern of living makes them more akin to finfish than other molluscan shellfish. Other members of the cephalopod group are squid and octopus.

The cuttlefish is easily identified by its oval, flattened shape and long, narrow fins that form an undulatory margin along each side of the main body or mantle. The head is relatively large in proportion to the body and has a crown composed of eight arms, each equipped with suction cups on their internal face Figures 1 and 2 show the general external anatomy of the cuttlefish.

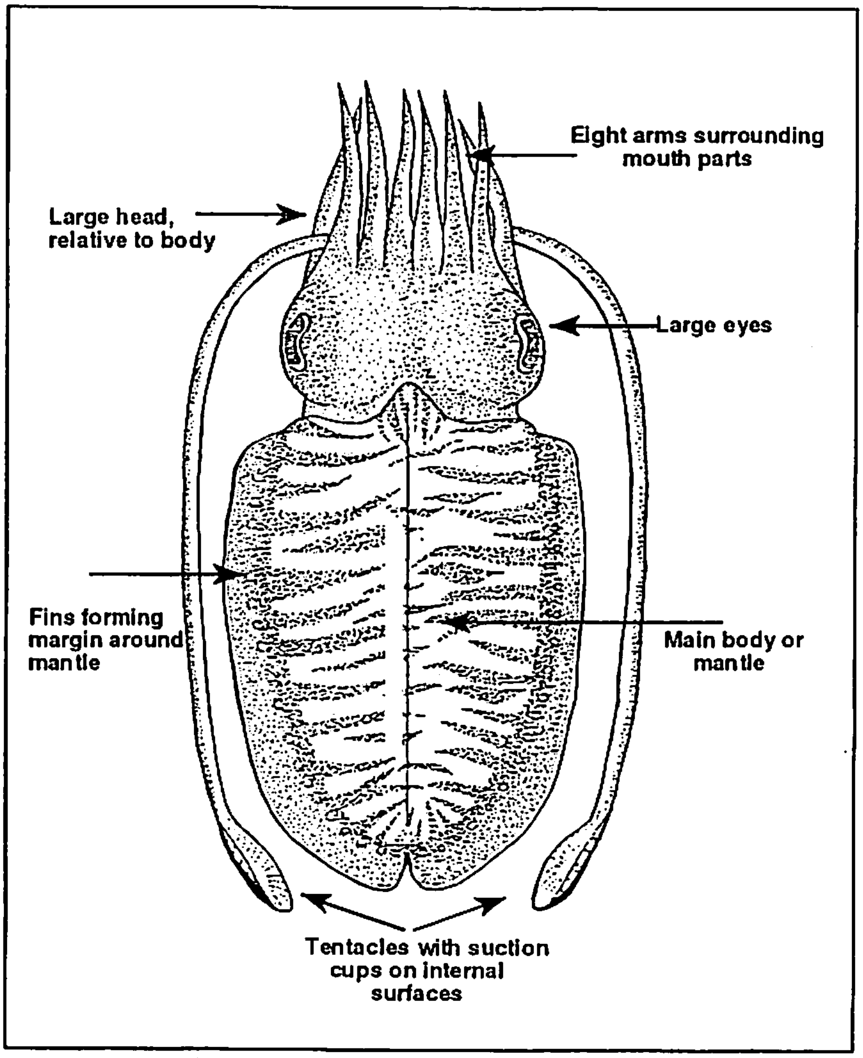


Figure 1 - External anatomy of the cuttlefish

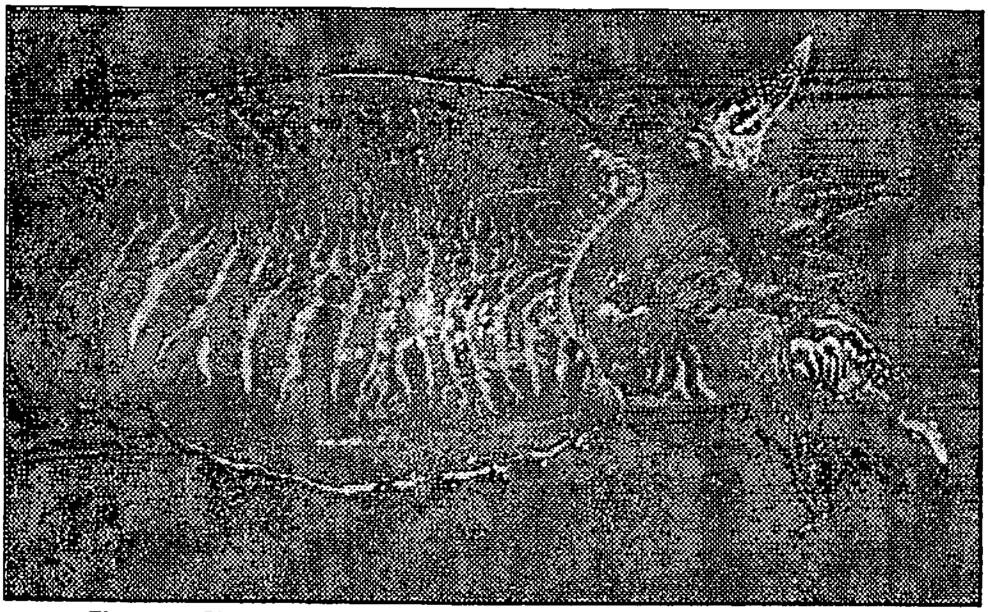


Figure 2 - Photograph showing external characteristics of the cuttlefish

The arms surround the mouth and also conceal two long tentacles normally contained in pouches. These tentacles are projected and used to seize prey items with the aid of suction cups on their flattened ends. The eyes are situated on the sides of the head and have 'W'-shaped pupils. The mantle is heavily pigmented, characterised by a broad, irregular 'zebra' striped pattern which is more prevalent in the male of the species. These animals have the ability to change their colouration. This is a process that they use to great effect in blending with their background as a means of camouflage and predator avoidance. Colouration is also a major part of their courtship displays during breeding. The colouration can also be used to distinguish males from females. The male is generally more striped and darker in colour. The outer arms are heavily striped. Other distinguishing features are that the female has a shorter, deeper mantle and the head is also shorter and broader in comparison to the male. The left ventral arm has no suction cap at the base. Figure 3 clearly shows the differences between the two sexes.

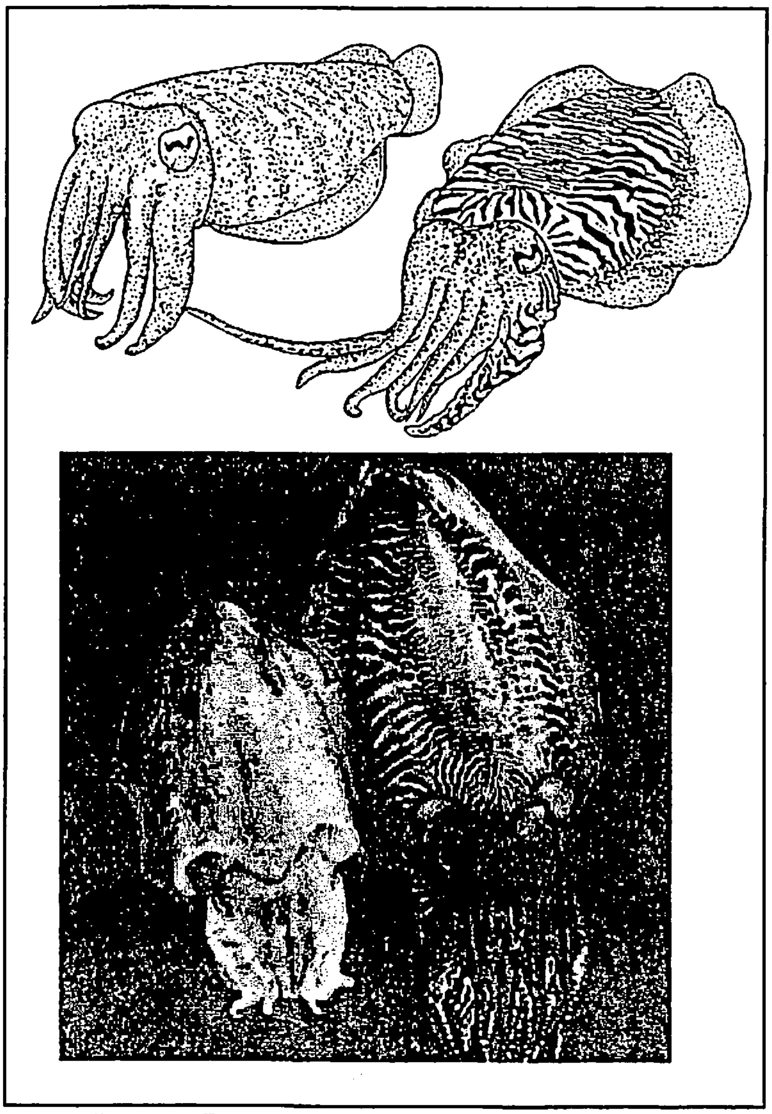


Figure 3 - Female ♀(left) and Male ♂(right) Cuttlefish

The mantle covers the hard bone or sepion which is in fact an internal shell. It is this part of the anatomy that most people generally associate with cuttlefish. The 'cuttle bone' is often found washed up on the tideline of beaches around the UK coastline. The 'cuttle bone' is composed of bony chambers filled with liquid and gas. The proportion of liquid and gas can be varied in order to alter the animal's buoyancy. It is this method that is used to regulate the animal's depth in the water column. This system makes the cuttlefish vulnerable to pressure changes. In depths much beyond 150 m the 'cuttle bone' could implode due to water pressure. This is a major factor in restricting cuttlefish to inshore and continental shelf waters. At the front the mantle covers a sac, the mantle cavity, which contains the respiratory organs, digestive and circulatory systems and reproductive organs. Water enters the mantle cavity via a slit in the mantle and exits via a funnel during normal respiratory activity.

The cuttlefish has one of the most highly developed nervous systems among invertebrates. A relatively large brain is housed within a hard cartilaginous skull. The part of the brain which connects to the eyes is particularly highly developed and complex. As a result, these animals have extremely good vision.

3.1.2 Locomotion

Cuttlefish are excellent swimmers, capable of travelling considerable distances as indicated by their seasonal migrations between shallow and deeper waters (see Section 3.2). Two modes of locomotion are used. The undulations of the fin, which borders almost the whole length of the mantle, enable the animal to move around at a slow speed. This form of movement makes the cuttlefish highly manoeuvrable, allowing it to move around in confined spaces. It is this ability that is being exploited to a certain degree by fishermen using traps. The second mode of locomotion used by the cuttlefish is more of a rapid 'reactive' movement, effected by jet propulsion. When danger arises, the animal has the ability to expel a jet of water from the funnel within the mantle cavity. This is done by the violent contraction of powerful muscles in the mantle. This movement is often combined with the ejection of a cloud of dark blue ink (secreted by an ink sac within the mantle) which the animal uses as a 'smoke screen' to escape danger.

When not active, cuttlefish have a tendency to bury themselves in soft sand or mud. This usually takes place during the daylight and is noticeable even in juvenile cuttlefish where this burrowing response is also triggered by light. Cuttlefish also have the ability to attach themselves firmly to hard substrates like rocks. By using their ventral surface, ventral arms, and the mantle fins they can produce a suction effect that anchors them to the surface. This allows them to remain stationary in strong tidal conditions. This behaviour is more commonly observed in juveniles.

3.1.3 Feeding

The cuttlefish is an active predator feeding almost exclusively on live prey. It is capable of capturing large and very mobile prey, including shrimps, fish, crabs and other cephalopods. The fish and crustaceans eaten by the cuttlefish are species which live on the sea bed and share the same habitats as the cuttlefish. Crustaceans form the major part of their diet, followed by fish. The proportion of fish generally increases with age and/or size of the cuttlefish.

Two strategies are employed in prey capture; one involves lying in wait to ambush prey using what is termed as 'jumping' strategy. With this method, the cuttlefish lies buried in the sand awaiting the passing of crabs or other crustaceans. The prey is captured by pouncing on the victim and smothering it with its arms. The other method known as the 'tentacle' strategy involves pursuit of the prey, in this case usually fish. The tentacles are ejected very rapidly and attach themselves to the victim by the suction cups. The prey is then pulled into its mouth where it is killed very rapidly by a venom[1] injected by the bite from the beak like mouth. The prey is then shredded, swallowed and digested. All inedible parts like shells are rejected.

Attacks on prey are visually triggered and are particularly effective because of the species' excellent vision. It is above all, the movement of the prey which seems to attract the cuttlefish. A system similar to the lateral line in finfish is used to detect vibrations and movements from prey in poor visual conditions. Cuttlefish often feed by preference at dusk and dawn. Anecdotal evidence from fishermen supports this assertion. It has been reported that cuttlefish catches in nets improve when slack tidal conditions coincide with dawn and dusk. This is presumably when these animals are more active and mobile and hence more vulnerable to capture by this method.

3.1.4 Reproduction and Life Cycle

Cuttlefish reproduce in Spring (March to June) gathering in shallow coastal waters, rarely greater than 30 or 40 m in depth. It is these concentrations of breeding adults that are targeted by fishermen. Mating takes place in the 'head to head' position. The males grasp the females by the head and the arms of the animals are intertwined. During this embrace, the male deposits sperm capsules into a sac below the female's mouth. Shortly after mating, fertilised eggs are laid. The eggs are soft and gelatinous and about 1.2–1.4 cms in diameter and approximately 2.5–3.0 cm long. They are stained black with ink which gives rise to their common name of 'sea grapes'. The females attach their eggs to any upright object on the sea bed using their arms. They prefer cylindrical objects such as weed stalks, worm tubes, submerged branches, cables and netting. The eggs are laid in clusters with animals often attaching eggs onto previously laid batches. Each female will lay several hundred eggs over a

[1] Cuttlefish venom is **not** toxic to humans

period of a few days, or sometimes weeks, dependant on conditions. The eggs are attached individually by means of a ring-shaped structure formed from protrusions extruded from the gelatinous egg case as it is laid. Using its arms, the cuttlefish winds these around the object to which they become securely attached. (Figure 4).

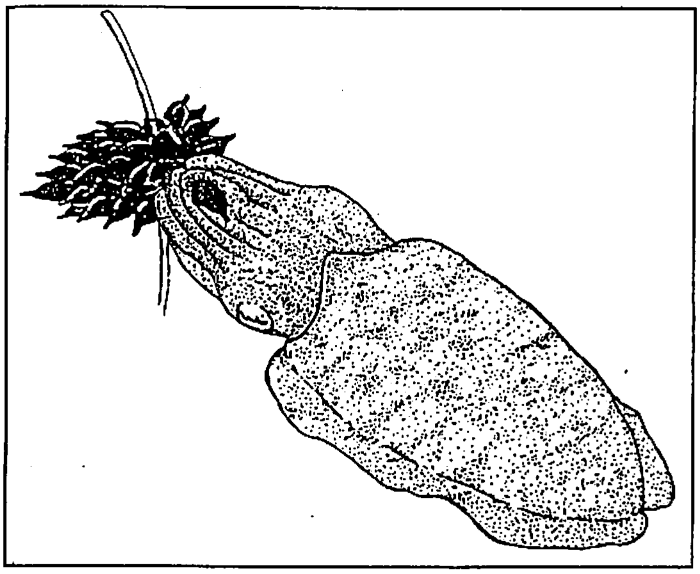


Figure 4 - Female cuttlefish attaching eggs to weed stalk

The cuttlefish appear to be attracted to objects already carrying eggs. Certain items of fishing gear, including traps have been found to be attractive to females laying eggs (Figures 5,6 and 7).

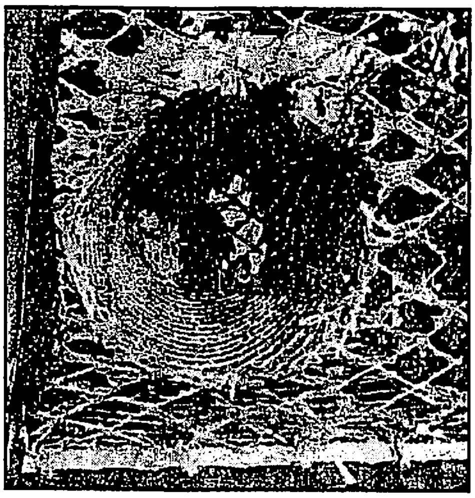


Figure 5 - Cuttlefish eggs laid in bunches around the trap entrance

Figure 6 - Cuttlefish eggs laid on netting covering trap

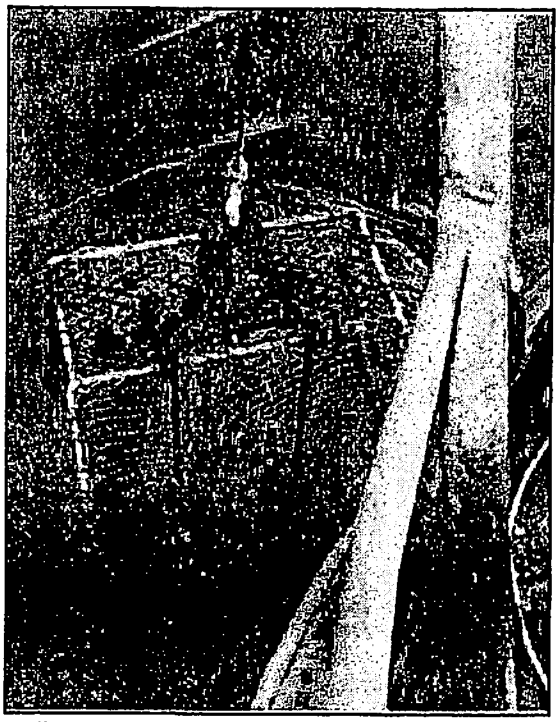


Figure 7 - Cuttlefish eggs attached to bridle arrangement of the trap

Following the egg laying process the females die, which obviously means that reproduction only occurs once in the life cycle.

Hatching takes place up to two months after the eggs are laid. The timing is dependent on water temperature. In good conditions cuttlefish can emerge as early as one month after laying. They emerge as miniature adults (6–9 mm) and spend this juvenile stage living on, or very near the sea bed. They feed themselves by capturing small crustaceans. This phase of their life-cycle is entirely devoted to growth which is very rapid. By autumn, the young cuttlefish have generally reached 'recruitment' size and are vulnerable to capture by trawls. The second phase of the life-cycle known as the sub-adult phase sees the animal maturing sexually. The females take longer to reach maturity. During the final adult phase the cuttlefish concentrates its efforts on reproduction. Adulthood is usually arrived at within 18–22 months, at which time they reach a size of 20–30 cm mantle length (ML) and can weigh approximately 1–2 kg. Cuttlefish may attain sexual maturity at very different sizes. Males can be mature at as small as 6–8 cm ML. Conversely males over 10 cm ML may still be immature. Similarly, females may mature at sizes ranging from 11–25 cm ML.

The length of time spent by cuttlefish under optimal growth conditions in the juvenile phase (inshore, summer conditions) determines the timing of sexual maturity. In good conditions they will mature during their first winter.

3.2 Cuttlefish Migration

The main migrations of cuttlefish are related to spawning and overwintering. The main documented migration patterns are shown in Figure 8.

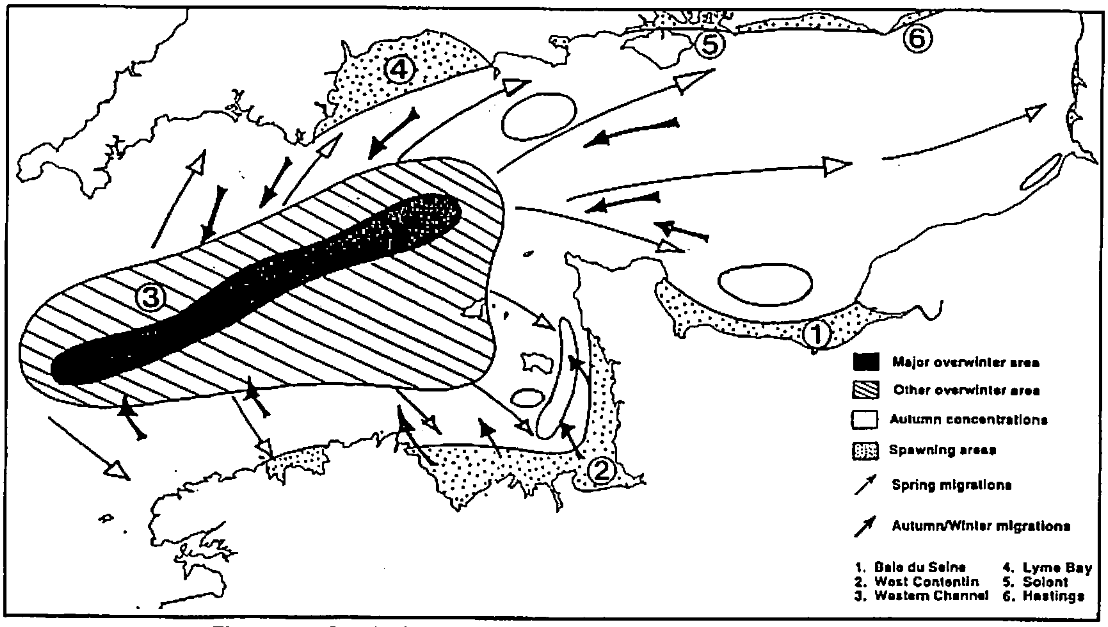


Figure 8 - Cuttlefish movements within the English Channel

There is a general tendency for cuttlefish to migrate inshore in spring and summer, seeking warmer water conditions suitable for spawning. Not all animals migrate at the same time. Mature males and large females are the first to enter the inshore spawning areas. These females are about 18 months old. These are followed by smaller females which spawn later on, in the late summer (14–16 months old); they are the offspring of the large animals that have spawned early in the previous year. The situation with male cuttlefish is not as clear. Males mature earlier than females and reproductive activity lasts longer. The larger males, up to 30 cm ML must be at least 2 years of age.

Major spawning areas on the Channel coast have been found in the Baie du Mont St.Michel and Lyme Bay. Cuttlefish also spawn in the Baie de Seine, Baie de St. Brieuc, Baie du Somme and the Solent.

Following the spring and summer breeding activity, the remaining animals move offshore in the autumn (October). This movement is triggered by falling water temperatures. The extent of these movements varies. In the Channel, the migrations cover a relatively long distance. The animals seek areas of suitable substrates at a depth (>70 m) and temperature (>9°C) that will allow them to overwinter comfortably. Some notable overwintering areas are in the western Channel and from November to February relatively large concentrations are found around the Hurd Deep. There is a similarly deep overwintering area in the Bay of Biscay, but juveniles from the Channel do not appear to migrate there. The animals concentrating around the Hurd deep move progressively westward to reach deep water south of the Lizard by March. Both juveniles and sub-adults from all regions of the French Channel coast mix during this migration.

Following the overwintering period, the return migration is rapid with animals moving from the central western Channel to Normandy coastal waters in less than two weeks. It is suggested that these animals use currents and tides to cover these distances so rapidly by travelling higher in the water column. The cuttlefish hatching in the Channel are unlikely to move to other regions during their life-cycle. However, it is not known whether the cuttlefish of the Channel are members of one distinct stock or whether there are separate breeding stocks, all of which migrate and mix in the same overwintering areas.

3.3 Availability for Exploitation

Considering biological and behavioural aspects of cuttlefish, there are a number of factors which influence their availability for exploitation. Among these are their geographical location and associated seasonality, their growth and reproduction and their behavioural responses to fishing gears.

Traditional trap fisheries are principally concerned with operations by relatively small inshore vessels with a limited operational range. The spring and summer migrations of cuttlefish onto the coastal spawning grounds bring these animals into exploitation range. At present, cuttlefish are mainly caught by towed gears, on both the inshore spawning grounds and the deeper offshore, overwintering areas.

The cuttlefish's preference for certain substrates and conditions during the spawning season makes the location of these animals at such times relatively easy. The very nature of some of the most prolific or preferred breeding grounds may exclude the operation of towed gears, for example in and around estuary mouths. In these areas static traps would be more effective. Differences in behaviour, and the timing of the seasonal movements of males and females means that effort may not be evenly applied to both sexes. Similarly, since it is the older larger animals that move inshore first, catch quality (in terms of individual size), can be predicted to a certain degree. The targeting of cuttlefish with demersal trawls (otter and beam) in overwintering grounds is less discriminating, taking sub-adult and mature animals. These gears also have the ability to capture non-active cuttlefish buried in the substrate.

Since cuttlefish migrations to inshore waters are linked to their breeding cycle, the development of a trap fishery aims to exploit aspects of the animals' reproductive behaviour. During the breeding season females actively seek out structures on the seabed for shelter and attachment of their eggs. They will investigate traps to determine their suitability. This close contact makes them vulnerable to capture. The use of the traps for egg-laying tends to attract additional females which prefer to lay on objects that have been previously used for this purpose.

Male cuttlefish actively seek out females and once located, breeding females are aggressively protected by the males. By using females as 'bait', the catching performance of traps during the breeding season is greatly enhanced. Males will enter traps in numbers to compete for females. At certain times of the year, therefore, traps can be more selective for males.

Examination of the stomach contents of cuttlefish caught during the spawning season has indicated that these animals reduce feeding during spawning periods. This, coupled with the animals' preference for live food, has indicated that the use of natural, dead bait in traps would be inappropriate. This has been supported by fishermen's experiences with traps baited with dead crab and fish.

The smaller sub-adult cuttlefish may be more likely to be 'baited' given selection of the right live prey food. Cuttlefish are intelligent and highly curious animals and these factors alone seem to make them vulnerable to capture in traps. French fishermen have long been advocates of using bright shiny objects such as mirrors, pieces of ceramic tile and white plastic as attractants in their traps.

During the overwintering, resting phase, the recently arrived adults mature and the juveniles slowly grow prior to the onshore migration in the following spring. These characteristics make the animals relatively unavailable to a trap fishery in the deeper water. These overwintering populations do however, support a seasonal trawl fishery lasting from September to February.

3.4 Current Exploitation

The annual UK landings of cuttlefish, approximately 2,700 tons, are taken from the English Channel. About 6,000 tons are taken annually by the French from both the Channel stock and that off the west coast of France. Assuming the French catch is taken equally from both stocks then approximately 5,700 tons are removed annually from the English Channel stock. Two UK fisheries prosecute the same Channel stock—each accounting for approximately half the UK landings.

The winter fishery occurs mainly from October to March in the mid English Channel where the Brixham beamer fleet and other trawlers from the southwest target the overwintering stock of sub-adults. The vessels operate mainly beyond 12 miles from the shoreline in the mid Channel area off Start Point and around the Channel Islands. Most cuttlefish landed are large, ranging from 0.4–0.7 kilograms (greater than 14 cm ML).

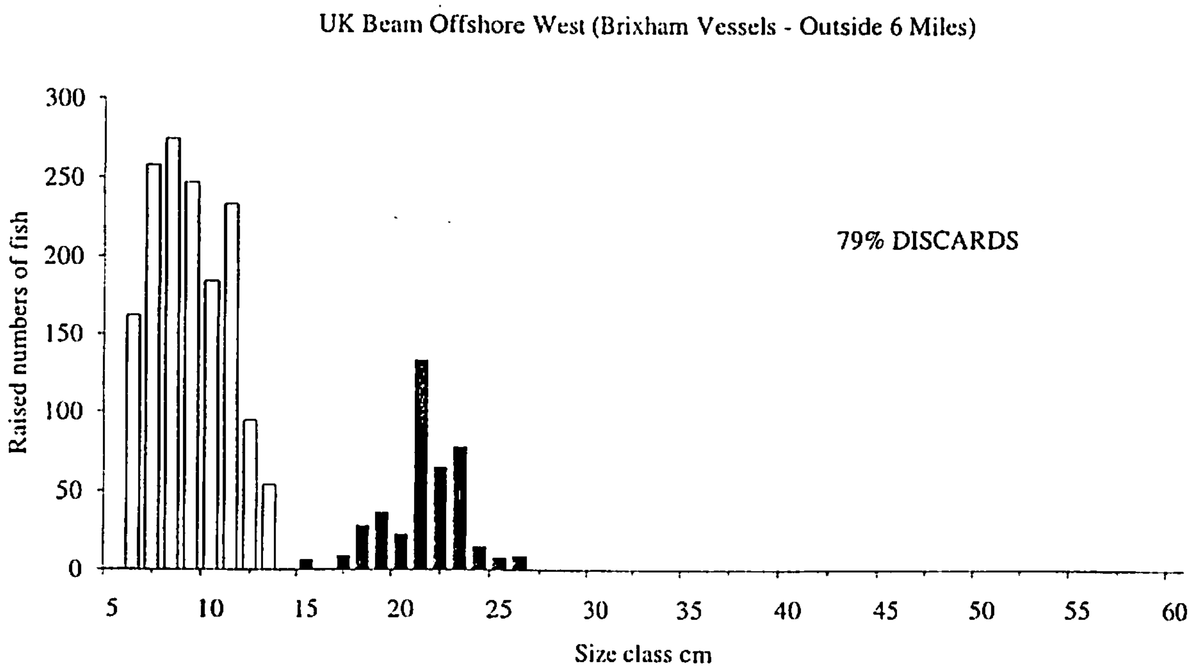
Information from a Seafish discard survey indicates that, from January to March (Figure 9) two size classes of cuttlefish are caught by the offshore fleet, prior to their onshore migration. During the April to June quarter (Figure 10a) no large animals were caught by offshore beamers supporting the theory that animals have left the area and migrated inshore. From October to December (Figures 12a and 12b) the animals caught are most likely from the overwintering population of sub-adults which left the inshore areas in autumn to mature in the deeper waters over the winter period.

The spring/summer fishery extends from March to August close inshore along the south coast. Otter trawls and static nets are used to target spawning adults on breeding grounds from March to July (Figure 10b), whereas growing juveniles, which occur further offshore, are caught up to August, mainly as a by-catch of the sole fishery (Figure 10c).

The inshore fishery at Lyme Bay and Start Bay starts in early March. Otter trawls target cuttlefish beyond six miles offshore, whereas small day boats can operate up to the shoreline. It is reported that most cuttlefish are caught 4–6 miles offshore by the day boats and are relatively small.

The seasonal fishery at Portsmouth commences later, extending from May to June. Otter trawls target large mature individuals migrating through the Solent to breed and spawn in Osbourne Bay.

Similarly, at Shoreham, Hastings and Newhaven there are directed fisheries for large adults (Figure 10b), from the end of April to May/June using trawls and gill nets. By mid July no large cuttlefish are caught. Smaller cuttlefish are caught later in the season up to August, mainly as a by-catch of the sole fishery (Figure 11a).



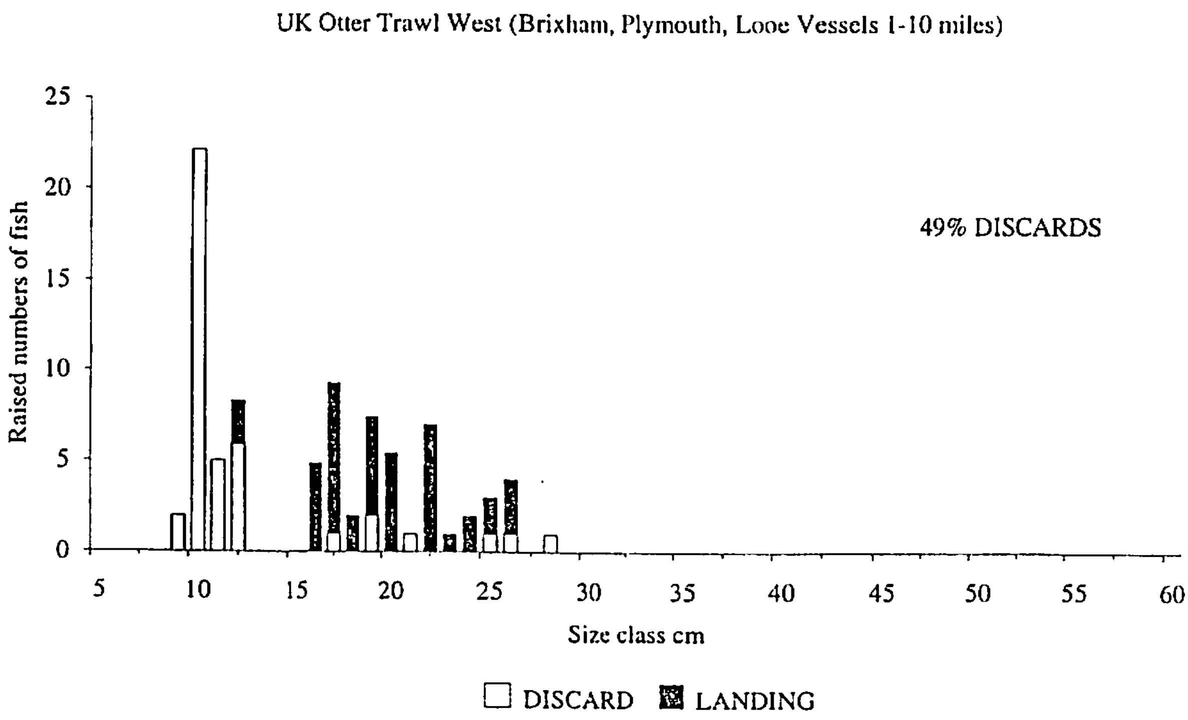


Figure 9 - Length/frequency distrubtions for Cuttlefish landings and discards. January-March 1995

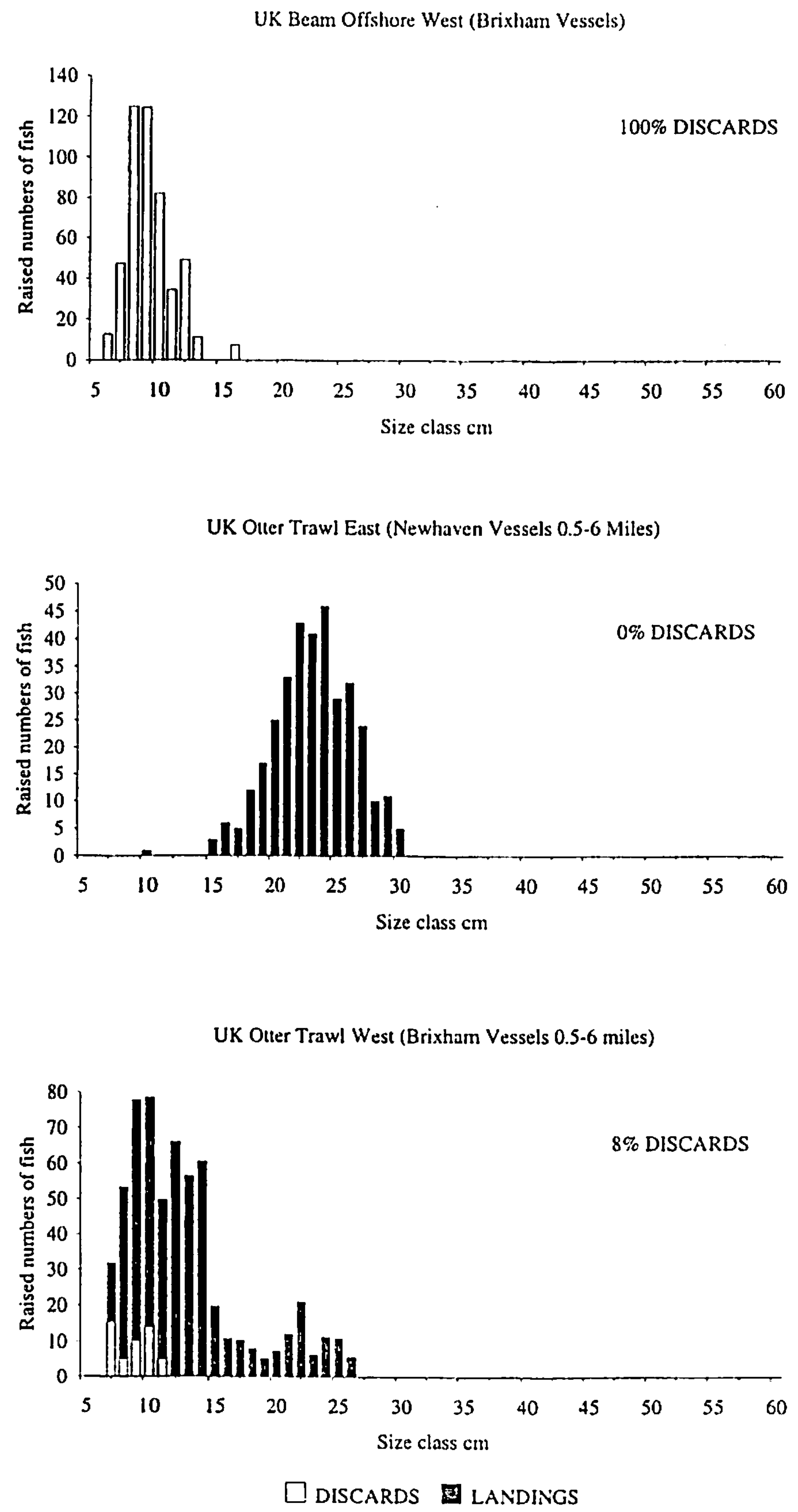
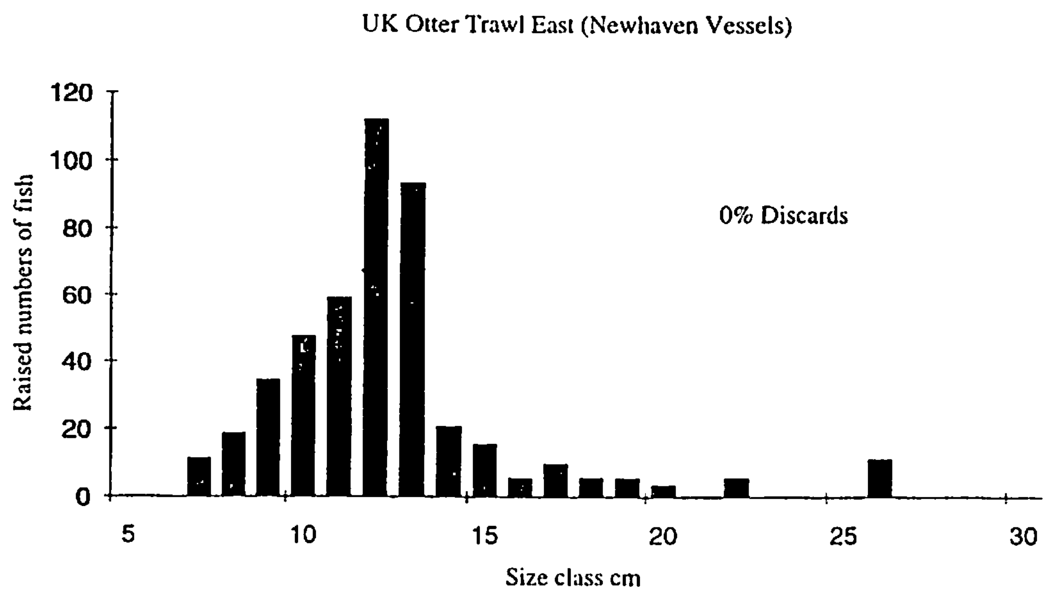


Figure 10 - Length/frequency distrubtions for Cuttlefish landings and discards. April-June 1995



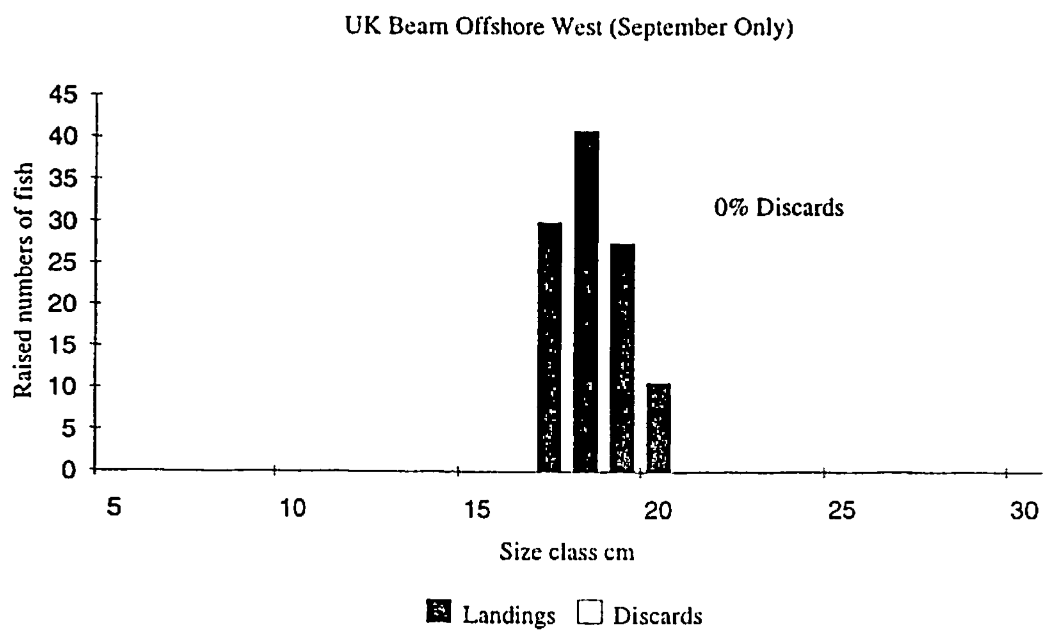
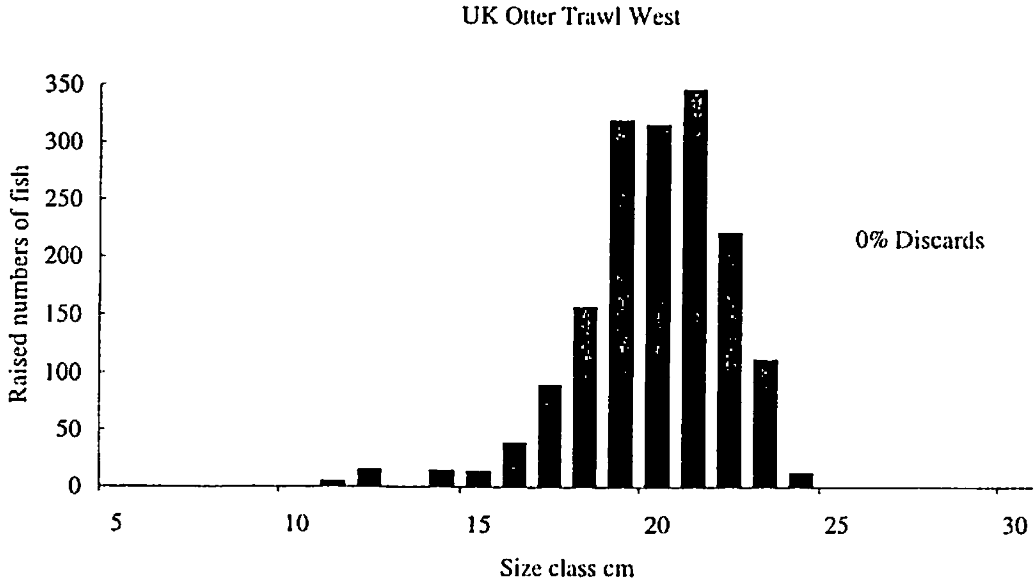


Figure 11 - Length/frequency distrubtions for Cuttlefish landings and discards. July-September 1995



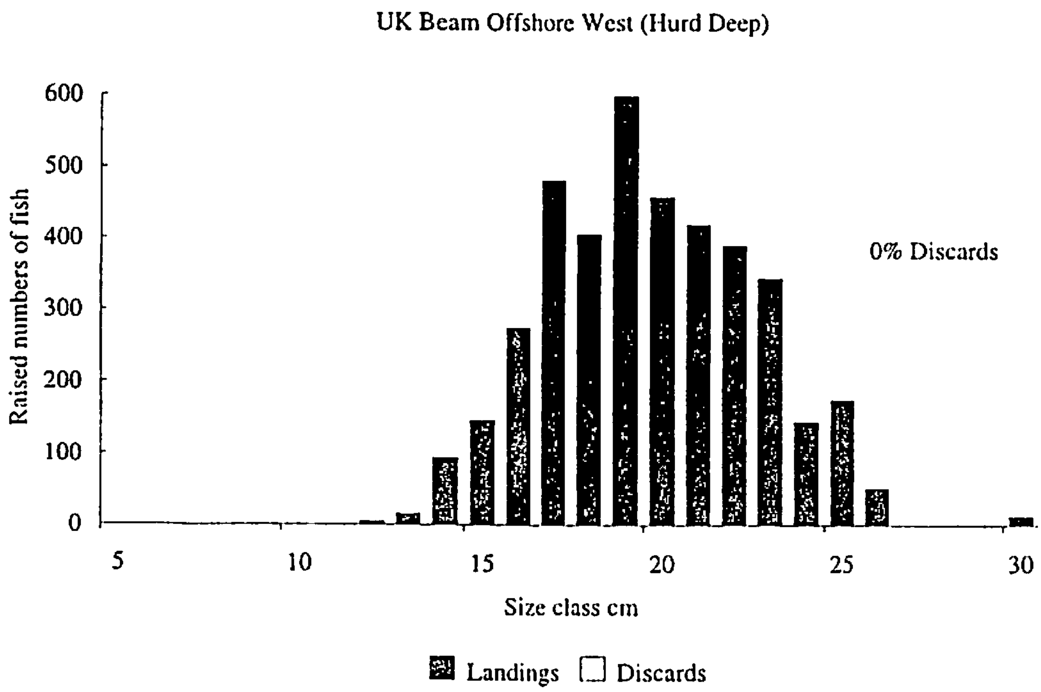


Figure 12 - Length/frequency distrubtions for Cuttlefish landings and discards. October-December 1995

3.5 Future Exploitation - Rational Management and Risks

The Channel cuttlefish stock is fished by both UK and French fishermen. Historically, catches have been relatively constant but cuttlefish could be fished harder in the future as it is an increasingly valuable alternative to quota species, being a high value, non-pressure stock. Recent estimates indicate that cuttlefish contribute a third to a half of a Brixham beamer's grossings. Also, trap fishing could become more attractive because:-

- market demand is for large animals which generally command higher prices;
- traps are selective for large animals;
- trapped animals do not contain sand and grit as do trawled animals resulting in a loss of quality and value;
- traps are more environmentally benign than towed gears;
- traps catch cuttlefish when the presence of spider crabs prevents use of static nets.

Opportunities for trap fishing would exploit behavioural and biological characteristics of cuttlefish. Traps could be used most profitably from March to June on breeding grounds (Figure 8) to catch large adult animals which congregate in dense shoals to breed. These grounds should be relatively more accessible to smaller vessels due to their proximity to the coastline and protection from adverse weather.

There may be scope in catching growing sub-adult cuttlefish on feeding grounds, attracting the animals with traps baited with food. Considering the characteristics of vessels that would, most likely, be employed to catch the fish it would be necessary to employ more suitable catch handling practices (icing fish) to ensure minimum loss of quality.

Consideration of a rational management approach poses considerable problems. Measures developed for finfish cannot be applied due to particular characteristics of population dynamics. It is practically impossible to age cuttlefish as the growth rings on the cuttle bone result from feeding and not age, and the crystals in the 'ear bones' (statoliths) are too large to be interpreted. Furthermore it is difficult to define discreet populations due to extensive migrations and mixing of stocks. Also, the short life cycle, which is generally less than two years, gives rise to large and often unpredictable fluctuations in stocks. This would limit the effectiveness of potential management measures and suggest that cuttlefish should be caught when available.

Finally, compared to other finfish species, spawning females lay relatively few eggs (0–500) in a few discreet locations when they congregate inshore to breed.

Considering the above, fisheries biologists agree that suitable protection measures should include protecting eggs, either through egg collection or establishing protected areas, and protecting juveniles by restricting mesh size of trawls and nets, and/or seasonal or geographical restrictions.

Currently the French permit the use of traps only during the spawning season in waters less than 30 m depth, whereas the Japanese have implemented an egg collection programme in an attempt to increase juvenile populations.

In considering the development of a trap fishery in the English Channel, it would be wise to evaluate potential risks in the context of risks associated with other fisheries targeting the same stock. Existing trawl fisheries target both mature breeding animals and maturing sub-adults at different times of the year and in different locations.

This potentially reduces the number of eggs laid during the summer and decreases the number of sub-adults surviving the winter to breed. Widespread trap fishing would further reduce the numbers of eggs laid by catching mainly breeding adults prior to them spawning. Eggs that were spawned inside traps would most likely not survive due to drying out and being damaged during hauling and shooting of the gear. Eggs attached to the outside of the trap would suffer the same fate, possibly resulting in greater egg loss as spawning females target the outside of traps to lay their eggs on.

Thus, the use of traps poses a dilemma; they are effective at catching adults and collecting eggs. This latter point means that commercial use could result in considerable egg loss, possibly proportional to trap usage. Since egg loss could be a major effect of trap fishing, and is one of the two factors that proposed management measures are designed to prevent, it is worthwhile considering other possible options.

Restricting the use of trawls on breeding grounds could allow a greater number of animals to spawn. This could potentially increase the number of eggs laid and the total number of mature animals available to a developing trap fishery. The additional animals available as a result of any trawl fishery restrictions would help to offset the potential losses due to egg damage from traps. However, this would have implications for the inshore trawl fishery, potentially compromising their viability as they rely increasingly on revenue from cuttlefish. Restrictions could take the form of increased minimum mesh sizes to protect juvenile cuttlefish or closed areas to protect spawning sites.

Deploying egg collectors on spawning sites could minimise egg loss but this might reduce trap catch returns by diverting cuttlefish attention away from traps.

These issues should be considered in the development of a trap fishery. The additional impact of egg loss could compromise the viability of the resource considering the level of effort already sustained by both the spawning and sub-adult populations, and the requirement to protect eggs as perceived by the scientific community. Neither of the situations given as examples is ideal. Both would be impractical to introduce in such a simplistic form. It is almost inevitable that if any measure is to be introduced, it will be a compromise. However, it is worth considering a range of options available at the development stage, in order that sensible compromises can be reached which will benefit both the stock and those exploiting it.

4. Fishing Gear — Selection of Trap Design

The Hastings fishermen had collected considerable anecdotal information about the cuttlefish catching ability of various pot and trap designs currently in use by local fishermen aimed at catching crabs and lobsters. This information suggested that the cuttlefish encountered on these coasts were not averse to entering traps. However, it was decided to examine the use of tried and tested French designs before considering alternative ideas.

The initial research into the French fishery uncovered a number of designs of trap which are basically variations on a relatively simple design. One type is of circular shape, about 1.0 m diameter, standing approximately 0.5 m high. (Figure 13). With frames constructed of round steel bar (~ 10 mm diameter) the traps are covered in either 25 cm wire mesh (chicken wire), or white nylon netting and weighted with a heavier grade steel (14 mm) 'skid' arrangement to protect the base of the trap from damage on the sea bed and to improve trap stability. Two opposing entrances are provided in the form of cones constructed from chicken wire with an external diameter of 15 cm and an internal one of 10 cm.

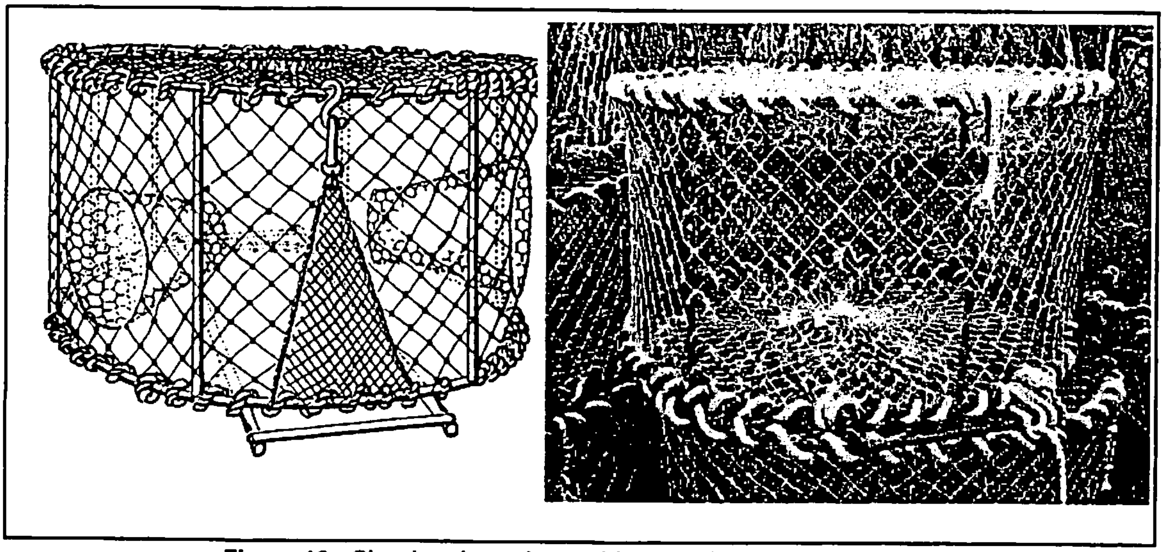


Figure 13 - Circular shaped trap. Line drawing and photograph

The traps are baited and emptied via a door in one side with a netting cover retained by a hook attached to an elastic band.

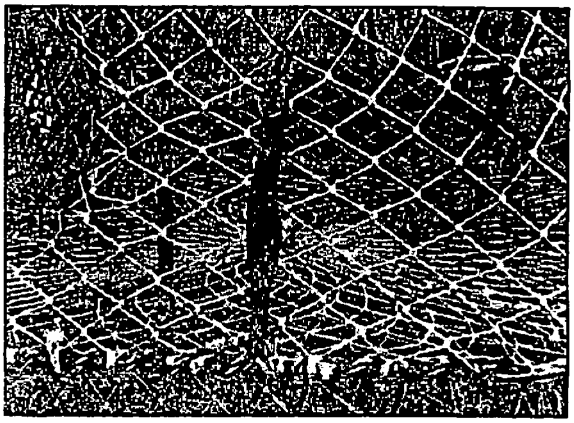


Figure 14 - Photograph showing door arrangement

A rectangular based version of the previously described trap is also commonly used (Figure 15).

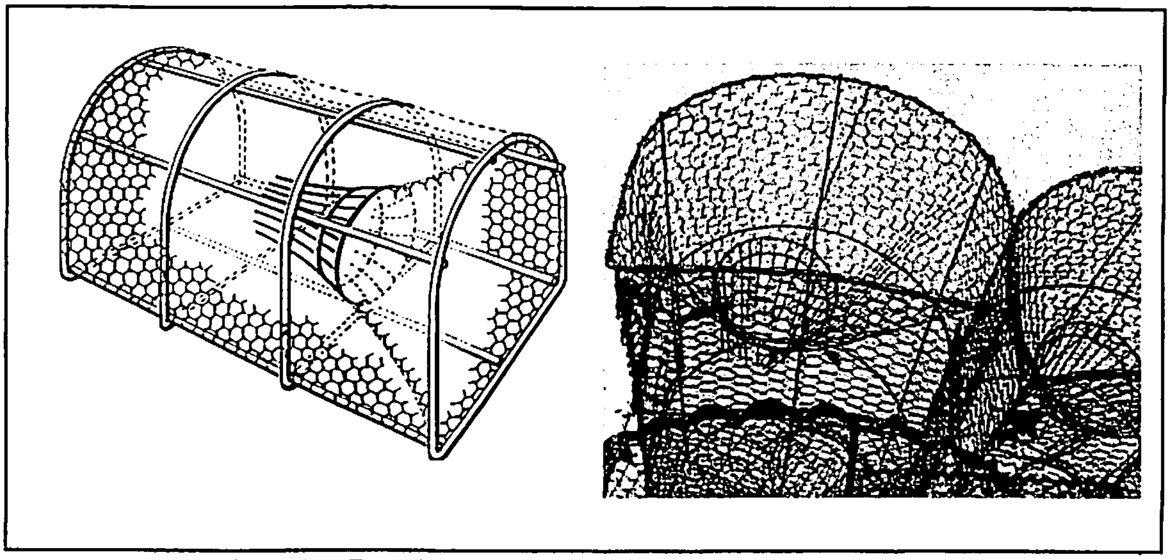


Figure 15 - French creel style trap, line drawing and photograph

This trap has base dimensions of 1.0 m x 0.5 m with a 'D' shaped cross-section formed by ≈ 10 mm diameter round steel bar. As with the previous design, the trap can be covered with galvanised chicken wire or nylon netting. The base is often strengthened with heavier steel giving the trap an overall weight of between 8 and 10 kg. The trap can be rigged with one or two entrances, either in the ends or at the sides. These are nearly always conical in shape and formed from wire mesh or, occasionally, netting. Access to the trap is provided by a conveniently placed 'door' covered by a netting cover, secured in the same way as for the previous design. These designs can be seen in use in northern France.

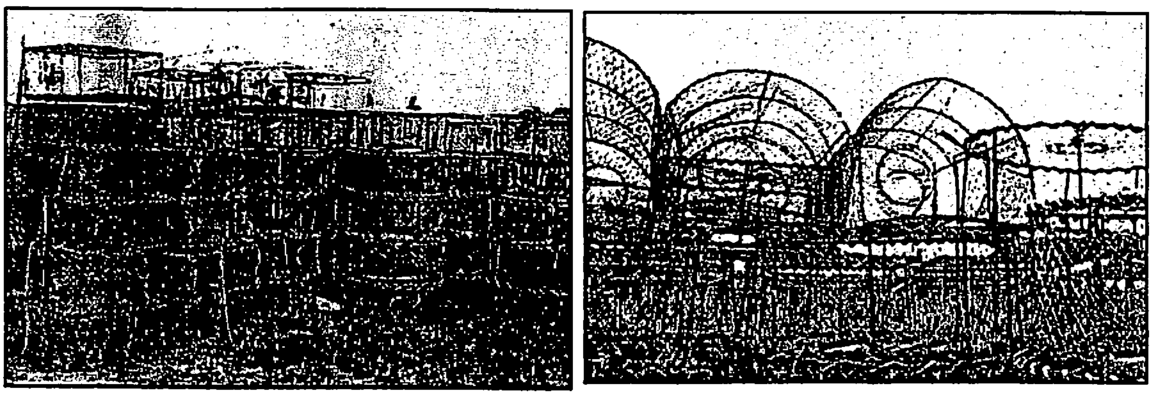


Figure 16 - Photographs showing a mixture of trap designs as used from the French port of St.Malo

The more modern design of trap, as developed by Monsieur Ourselin is based on a more square design (See Figures 17 and 20, for full specification and details).

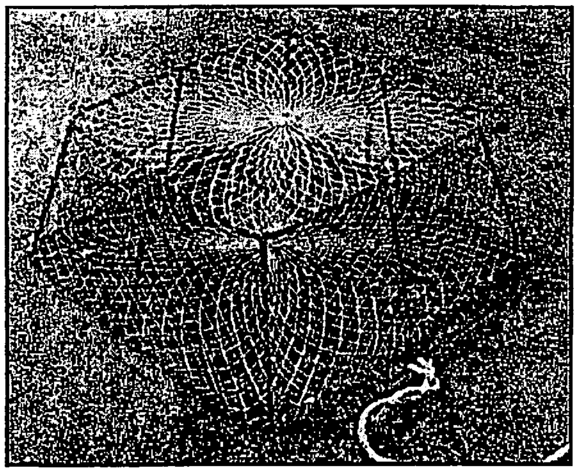


Figure 17 - Photograph showing French style trap used in Seafish trials.

The overall shape is that of a truncated pyramid based on a square frame. The base frame being larger than the top frame is supported by four corner bars and four intermediate supports inclined at approximately 15° from the vertical. The trap is constructed from 12 mm galvanised round steel bar.

A heavier 20 mm diameter bar is used to construct the protection bars which give the trap added weight and together with the overall shape of the trap provide more stability on the sea bed (Figure 18).

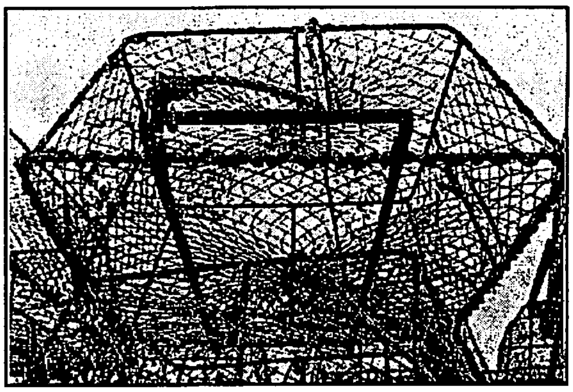


Figure 18 - Photograph showing the base protection bars and point of attachment for the traps

The protection bars also provide the point of attachment for the bridle connecting the trap to the main ground line.

Two conical shaped wire mesh entrances are fitted on opposite sides of the trap at right-angles to the axis of the protection bars. This reduces the chance of cuttlefish falling out of the trap entrances during the hauling process. The external entrance to the cone is approximately 270 mm in diameter, tapering to an inside diameter of 125 mm over a length of around 280 mm. This entrance shape has been arrived at after considerable experimentation by French fishermen. They however, would be the first to admit that it is not perfect. Cuttlefish have the ability to 'retrace their steps' and find their way out, given time. It is important that the cone entrances are constructed of a sufficiently heavy grade of chicken wire to prevent collapse through the force of water as the traps are being thrown overboard during the shooting process. The inside end of the cone is usually supported by twine tied to the frame, maintaining the entrance above the base of the trap.

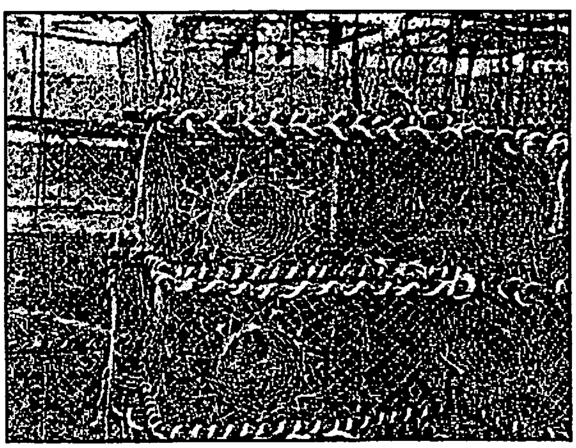


Figure 19 - Traps fitted with conical shaped chicken wire entrances

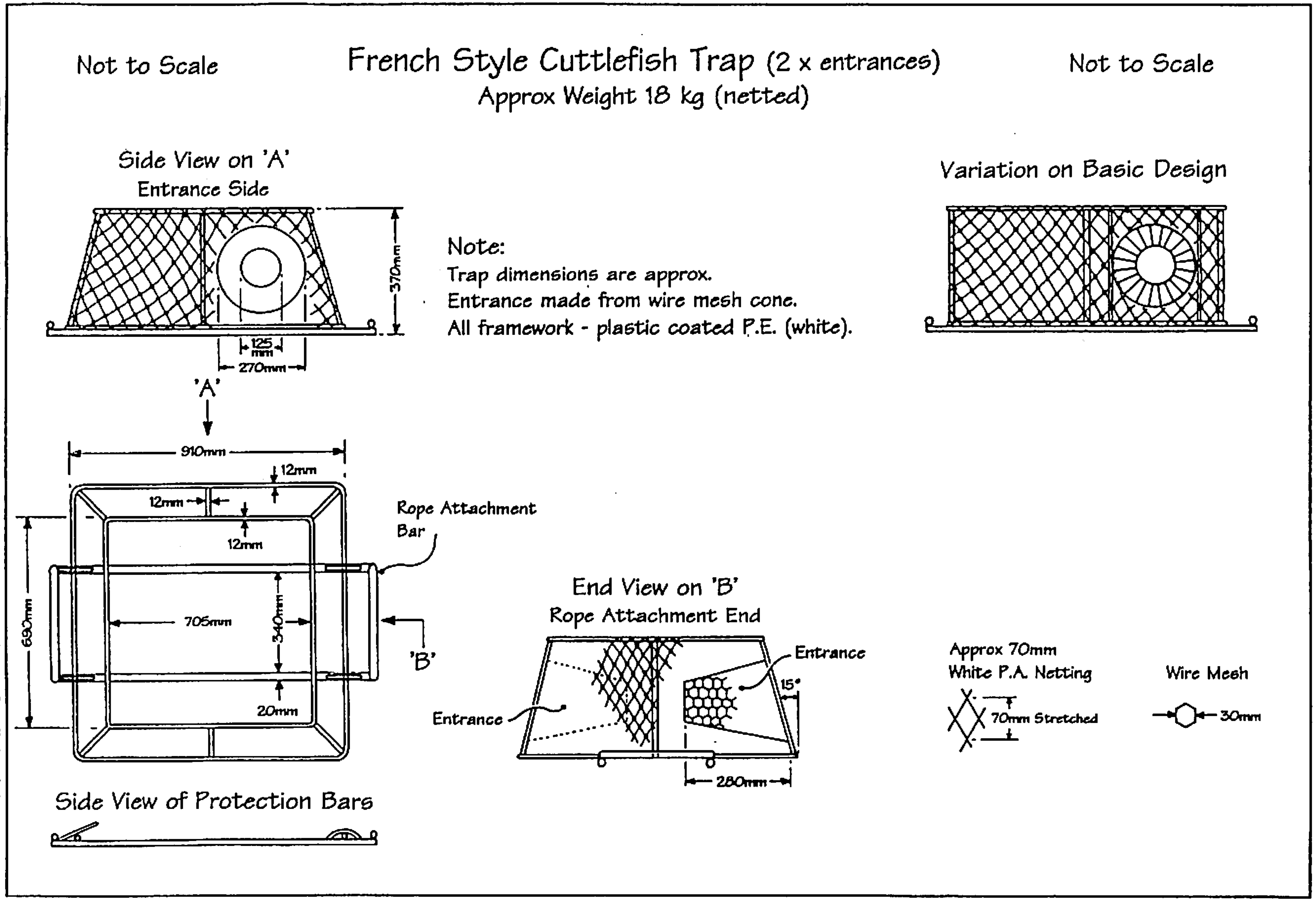


Figure 20 - Detailed specification of French style trap as used inthe Seafish trials

The whole trap is covered in relatively light white Polyamide (PA) netting with a mesh size of around 70 mm (stretched, full mesh). French fishermen have come to the conclusion that the colour of the netting on the trap is very important and that white netting is the preferred colour. It appears that white materials are more attractive to cuttlefish. The mesh size is not too critical to the catching performance of the trap, however factors that must be borne in mind when choosing the netting are;

- **seabed debris** - if very small mesh sizes (particularly of heavy twines) are used the meshes can become clogged with weed and algal growth. This masks the white colour of the trap and obscures any visual attractants used inside the trap. In the extreme, heavy build-ups, (which are possible in certain areas in the summer months), produce more resistance to water flow and can make the trap less stable on the sea-bed

- **selectivity** - using very large mesh sizes may allow the escape of juvenile cuttlefish, making the trap more size selective. On the other hand it may also allow entry of unwanted species such as shellfish or predatory fish species capable of catching or causing damage to the cuttlefish, i.e. making the trap less species selective. In some instances these by-catches may be of value and could be encouraged.

- **construction** - smaller mesh sizes generally mean more material is required for covering the trap and often entails more time consuming work. More material often incurs additional expense.

From this it can be seen that the selection of mesh size is a compromise and can be influenced by the nature of the fishery to a greater or lesser degree.

While on the subject of netting, another important point that was emphasised by the French fishermen was that when netting a trap, it must be ensured that the netting is tightly stretched across the frame. Traps covered with slack netting do not appear to fish as well as tightly netted ones. The reasons for this are unclear, but it is suggested that the movement of slack netting in the water flow caused by tides etc., causes vibrations and 'noise' which is off-putting to cuttlefish. When constructing these traps, the final process is to provide additional protection to the netting that is stretched over the framework. This is done by 'roping' the frame in old rope or rubber strips. This gives the frame protection whilst on the sea bed and also during stowage and handling on deck. This process also allows the netting to be tightened further by taking-up any additional slack that may have appeared due to inherent stretch in the nylon (PA) netting. A trap is finished by cutting a 'doorway' which is used for baiting and emptying the trap. The door can either be laced closed or covered with a flap of netting secured similarly to the other trap designs. A completed trap of this type will weigh approximately 18–20 kg. A trap of this size and weight can be managed quite easily by a single fisherman. The traps are relatively easy to stow on deck and can be stacked on their bases. It was this trap design that Seafish decided to evaluate in the English fishery.

4.1 Manufacture of Traps

Having decided on the initial design of trap for evaluation, the next stage was manufacture of the traps. Following some publicity concerning the fact-finding visit of Seafish staff and Hastings fishermen to France, a small engineering company in Dorset contacted Seafish with an interest in the project. This company was already producing bases for 'inkwell' and other shellfish pots and suggested that their production system could easily be adapted to produce a hot dipped galvanised frame very similar to the French design. Further investigations brought to light a Yorkshire based manufacturer that was producing crab and lobster pots with polyethylene (PE) coated frames. This process has the same effect as galvanising i.e. protection of the metal work against corrosion. The plastic coating process is carried out 'in-house' by the manufacturer and is cheaper than galvanising. It has the additional benefit that the coating can be produced in white making the trap more attractive to cuttlefish. It was decided to order a number of each of the two trap types for comparison of performance. Unfortunately, due to manufacturing problems, the Dorset company was unable to fulfil the original order, apart from a few sample traps. The full order was then transferred to the Yorkshire supplier[1]. This had repercussions on the timing of the trials. The additional workload placed on the remaining company meant that the full complement of traps was not ready for the proposed start date in May 1995.

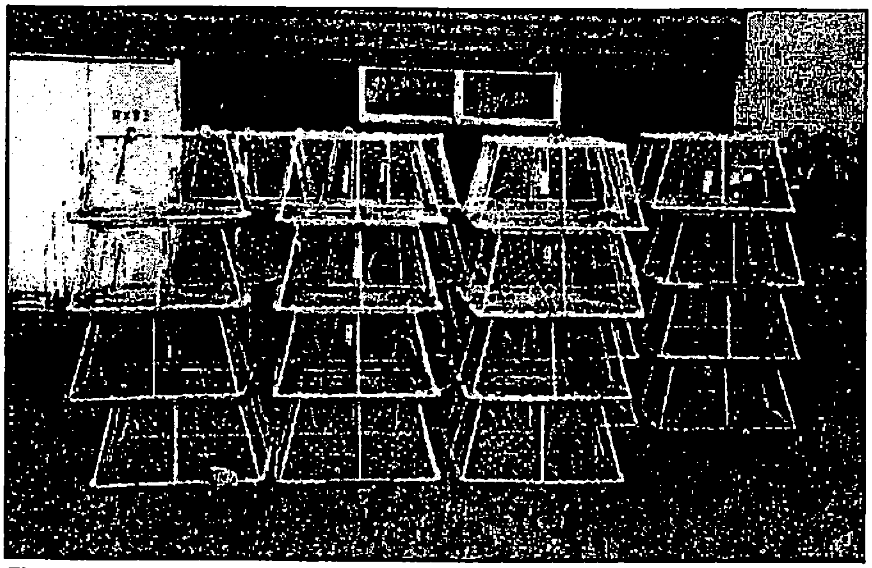


Figure 21 - Photograph showing some of the completed traps ready for the trials

During the manufacturing process, the engineering company was asked to identify any areas where production costs could be reduced or improvements to the trap design could be made. Throughout the duration of the project, Andy Skow of the Yorkshire Crab Pot Company (YCPC) gave Seafish the benefit of his experience in pot manufacture by suggesting a number of design changes.

[1] The Yorkshire Crab Pot Company

One particular area of interest to Seafish was the design of the trap entrance. Seafish's aim was to produce an effective design of trap entrance that would lend itself to speedy manufacture and fitting into the overall trap design. The experience of the French fishermen had been that the chicken wire cone shape was the most productive, despite a number of drawbacks. Early in the manufacturing process, the YCPC identified this component as one causing particular manufacturing problems. Firstly, it was difficult to obtain heavy grade mesh at a reasonable price, and secondly the operation to construct these entrances was labour intensive and time consuming.

The first suggestion was to make the trap entrances from narrow closely spaced bars (~35 mm) rather than mesh (Figure 22). This design was used to replace a number of 'chicken wire' cones in the original French design for comparison. At a later stage, this entrance design was incorporated into the framework at the manufacturing stage of a slightly modified design. This next modification was designed to simplify and speed up the overall construction process and consisted of altering the trap shape.

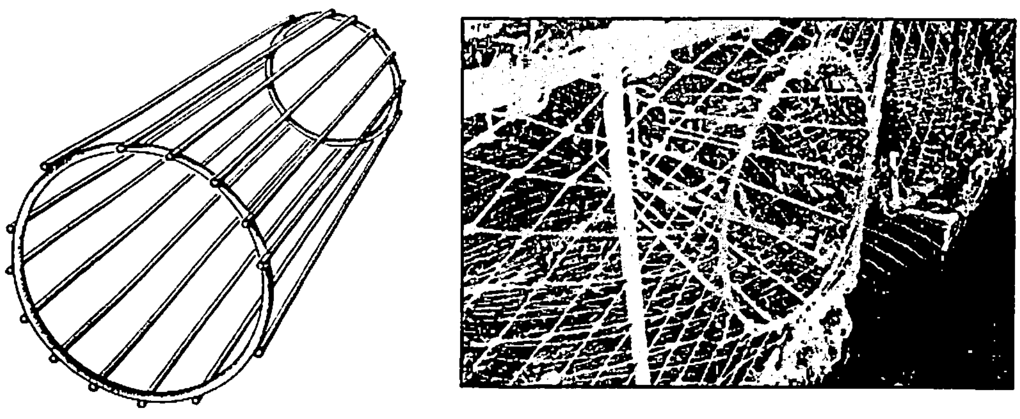


Figure 22 - Entrance constructed from round bars. Line drawing and photograph

The top frame size was increased to that of the base frame thus removing the sloping sides, resulting in a box-shaped trap. The overall size and volume of the trap was increased. This made the trap easier to stow but the increased volume meant that a greater area of deck space was taken-up. This trap type was designated large square.

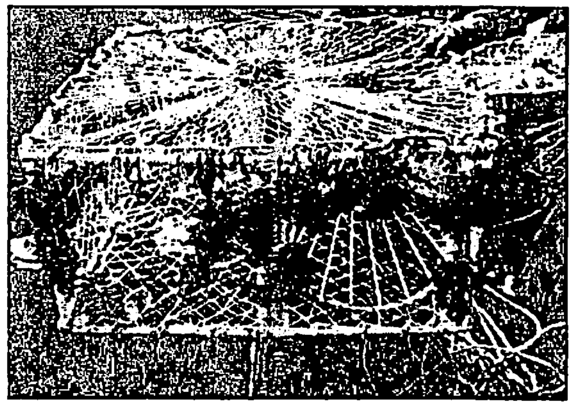


Figure 23 - Photograph showing the modified box-shaped trap design.

These two basic trap types, incorporating two different entrance designs were available for the start of evaluation trials in May 1995. As the project progressed a number of other design changes were made to both the overall trap shape, and the entrance.These changes will be discussed later in the report. Having arrived at some basic designs for testing, a programme of sea trials was put together in order to evaluate their performance under commercial fishing conditions.

4.2 Rigging of Traps

The completed traps were rigged to ground lines or back lines made from 12 mm polypropylene (PP) rope with a leaded core. This additional weight helped to stabilise the strings of traps in strong tidal conditions. The traps were rigged in fleets or strings of 10 and anchored at both ends and marked with dhan markers at the surface. The spacing between traps was set at approximately 20 fathoms (36.6 m) to be compatible with the net fleets to which they were being compared (see 5.4.1 Gear Arrangements, Sequences and Operations). Each vessel evaluated one string of traps at 10 fathom (18.3 m) spacings to compare catch rates with the 20 fathom spacings (Figure 24).

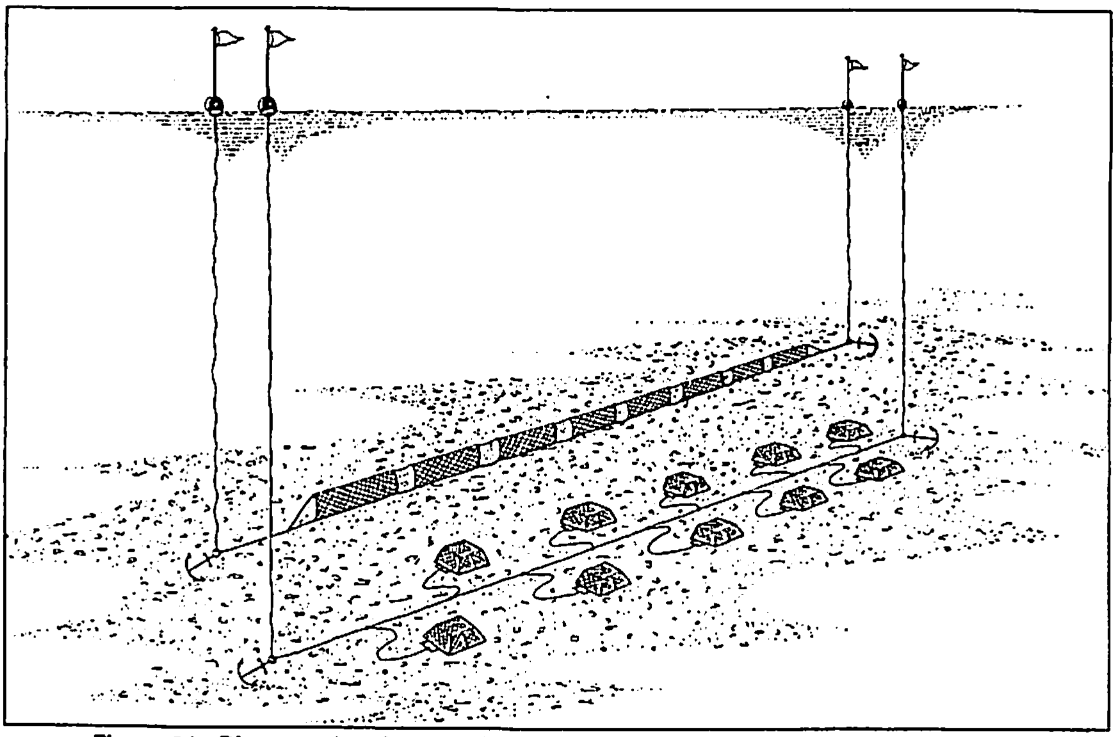


Figure 24 - Diagram showing trap fleet arrangements in comparison to static nets

In order to make the changing of trap sequences easier, a quick-release system of attachment of the traps to the back-line was designed (Figure 25). This entailed splicing approximately 1.0 m lengths of leaded rope (A) into the back line (B) at the pre-determined spacings. An eye splice was formed in the free end of this 'dropper'. Each trap was then rigged with its own bridle arrangement consisting of two components. The first was approximately 2.0 m of 12 mm PP rope onto which was threaded a nylon pot spinner (C) (through the larger of the two holes). This bridle was then secured to the bar of the protection skid attached to the base of the trap. The second component, made of 1.0 m of the same rope (D) had another pot spinner incorporated into another eye splice (E) using both holes of the spinner. The other end was connected to the pot spinner (C) in the bridle by passing it through the small hole and securing with a 'figure-of-eight' stop knot. By matching the size of the eye splice in (A) with the widest section of the pot spinner (E), the trap was connected to the dropper (A) by passing the eye splice over the pot spinner in the same manner as a button and button hole arrangement. To release the trap, the spinner was simply eased out of the eye splice.

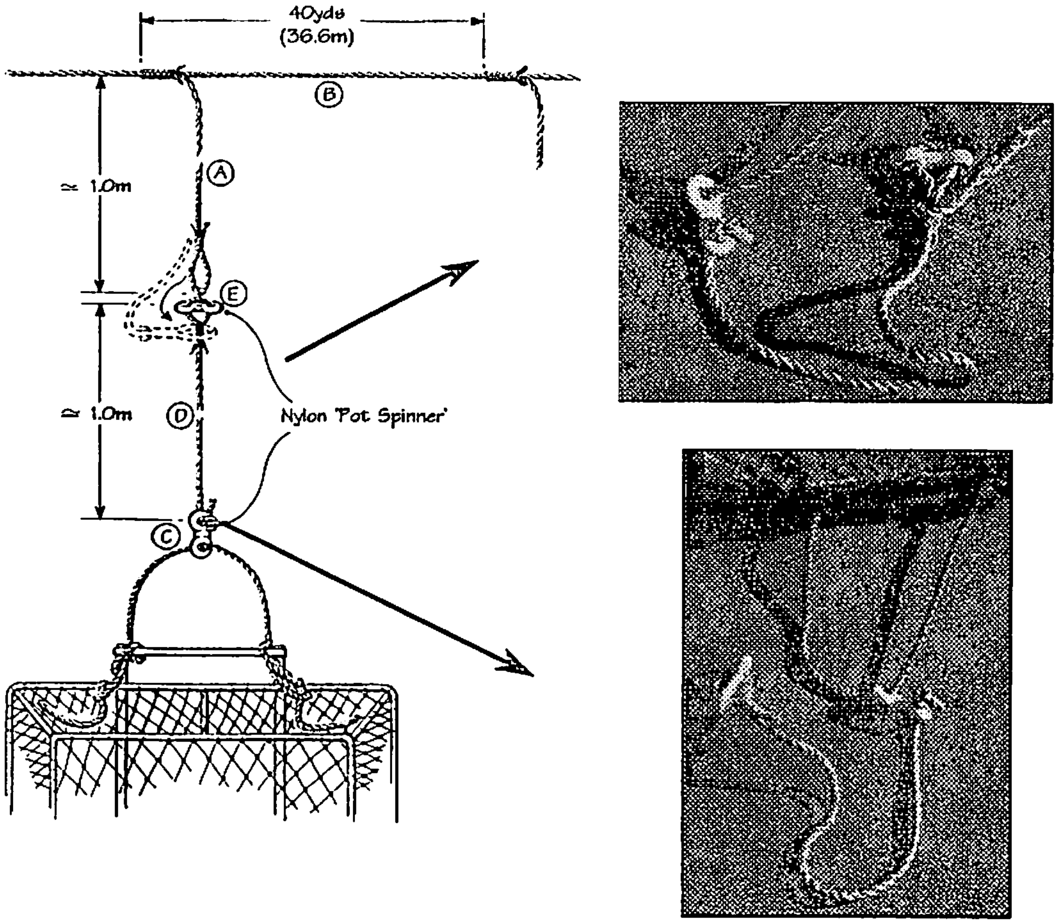


Figure 25 - Trap rigging arrangement and connection to groundline. Line drawing and photographs

Once the weight of the trap is on the eye splice the connection is made secure.This enabled traps to be changed and/or replaced without the need for releasing knots, hitches or splices.

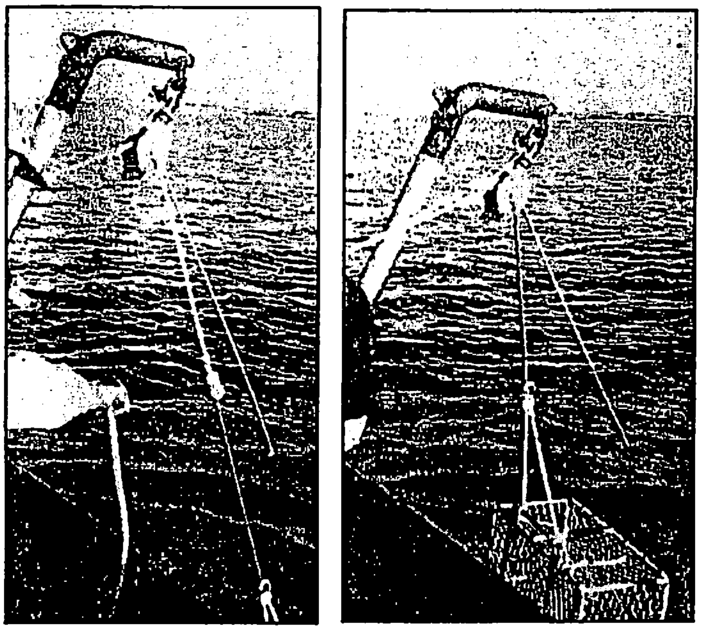


Figure 26 - Photographs showing the trap rigging arrangement in operation

When attaching the bridle arrangement to the individual traps it must be ensured that the door on the trap is positioned on the side providing easiest access for emptying during the hauling process.

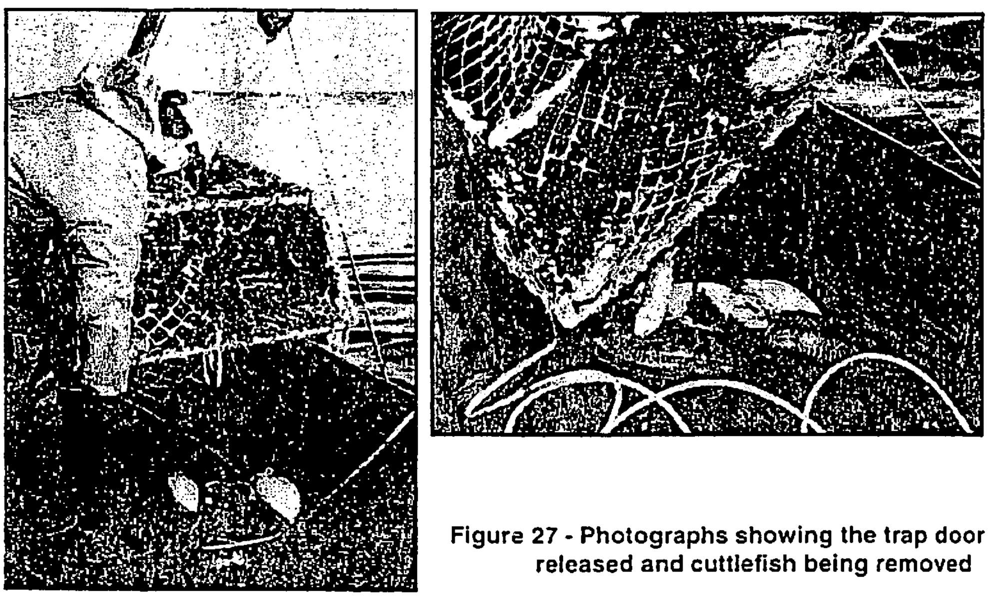


Figure 27 - Photographs showing the trap door being released and cuttlefish being removed

All the traps supplied for these trials were 'baited' with pieces of white uPVC as an attractant for cuttlefish. These were suspended centrally in the traps as recommended by French fishermen.

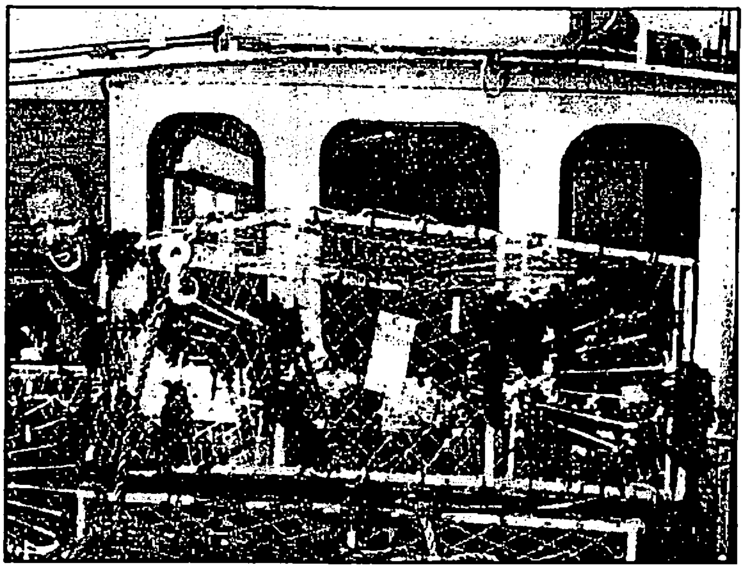


Figure 28 - Trap showing piece of white uPVC suspended within the trap acting as a visual attractant for cuttlefish.

5. Fishing Trials

The fishermen who initiated this work offered to supply their vessels and time free of charge to conduct a programme of evaluation aimed ultimately at developing a viable trap fishery for cuttlefish. As part of this commitment, the skippers agreed to make any modifications required to deck layout, including installation of gear handling equipment at their own expense.

Seafish supplied all the fishing gear for evaluation and reserved the right to conduct comparative fishing trials on three vessels at named times throughout the cuttlefish season, with complete control over operations. A total of 50 traps per vessel were allocated to be used in conjunction with their own static nets (gill and trammel) for catch comparison and location of cuttlefish. The vessels were free to continue operations outside the Seafish monitored periods on the understanding that catch data would be recorded.

Operations took place on the local fishing grounds normally fished using static nets. For these trials fishing was conducted with 2 miles of the coast stretching between Rye and the East, and Bexhill to the West, in waters of less than 10 fathoms (18.3 m).

5.1 Aims

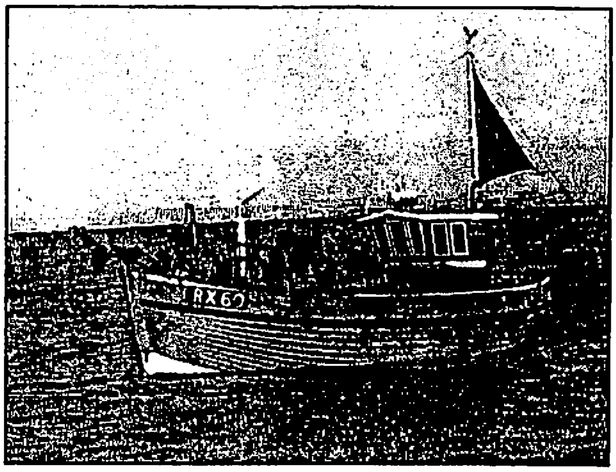
The main aims of the fishing trials were:

- To evaluate the existing French trap design and its performance in UK waters.
- To modify/improve the existing design to satisfy any specific requirements of the UK fishery and the conditions and operationalprocedures of the UK vessels, as required.
- To examine trap entrance designs and improve performance, where necessary.
- To gather as much information as possible on cuttlefish behaviour, particularly in relation to the fishing gears under evaluation by use of direct observations of captive and wild cuttlefish using underwater camersas *in-situ* on the fishing gear.
- To develop operational procedures, gear handling arrangements etc., compatible with existing vessel design and layout.
- To consider the economic implications of changing over to a trap fishery or supplementing existing methods.
- To compare the performance of the traps against static nets aimed at catching cuttlefish.

5.2 Vessels

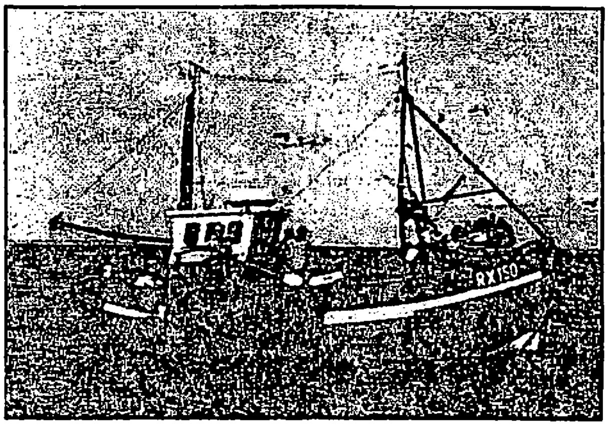
The three vessels who volunteered their services were all of typical Hastings beach boat design and were all under 12 m in length.

MFV "ST. RICHARD" (RX60)
Skipper - Graham Coglan
Operated by the skipper and two crew members.



MFV "SANDRA" (RX83)
Skipper - Paul Joy
Operates with a skipper and one crew member.

MFV "GRACE GEORGINA"(RX150)
Skipper - Roy Coglan
Operated by the skipper and two crew members.



5.3 Vessel Modifications

The three vessels used in this project were all rigged originally to operate as static netters and small scale otter trawlers, and as such were rigged with net haulers, trawl winches, gallows and running-gear for these respective methods. For this project two of the three vessels had their trawl gear removed to provide additional deck space for carrying cuttlefish traps. Additionally, all three vessels had slave pot haulers fitted. These operate with line sizes between 8 and 14 mm, through davit mounted, open sided potting blocks. MFV "SANDRA" was fitted with a North Sea Winches 1.5 ton slave hauler and the two other vessels with Icelander™ 0.74 ton haulers (Figure 29).

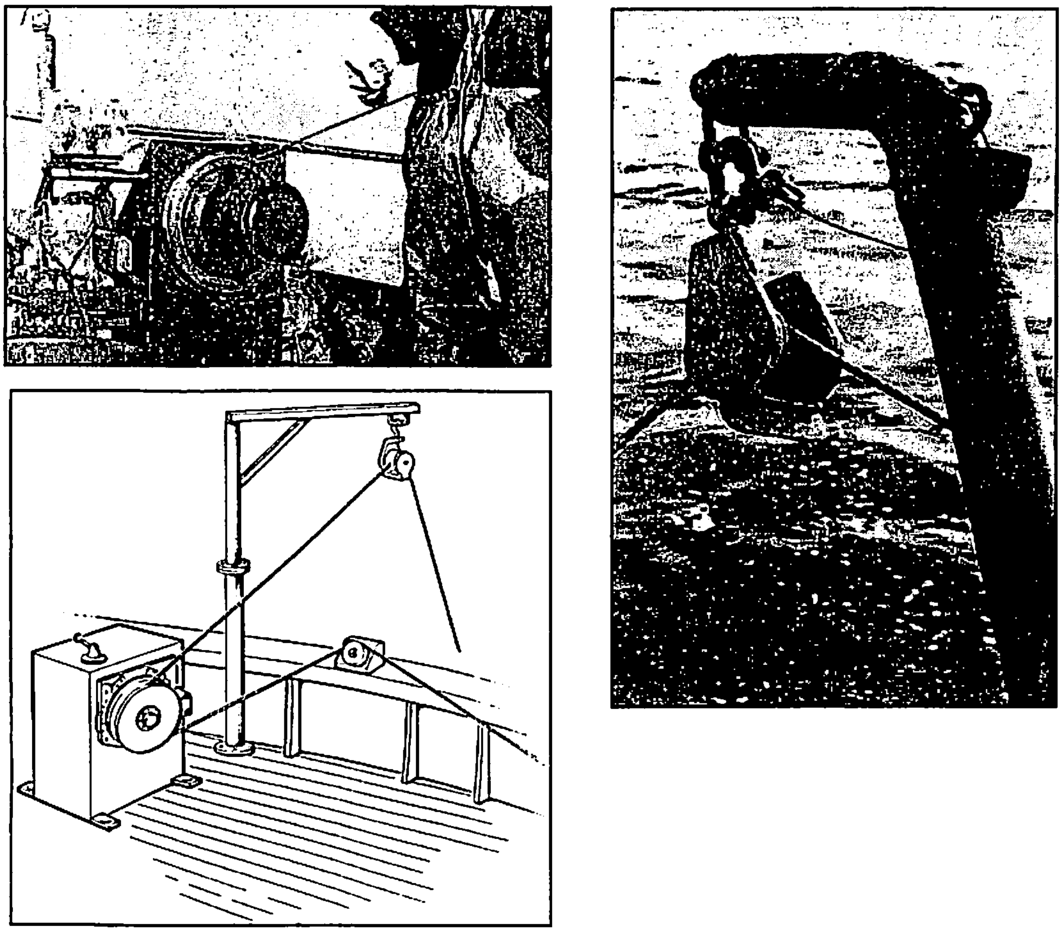


Figure 29 - Photographs and line drawing showing slave haulers and davit mounted potting block

Despite the removal of trawl winches and the clearing of deck space, these vessels can only comfortably carry two fleets of ten rigged cuttlefish traps at any one time. The stacking of traps more than three high is not recommended in anything other than perfect, flat-calm sea conditions. This factor automatically restricts the total number of traps that this class of vessel can sensibly operate. (Figure 30).

Figure 30 - Photograph showing space limitations when carrying traps

5.4 Methodology

The original intention was to supply the three volunteer vessels with a total of 50 traps each for evaluation over the full cuttlefish season, starting in May and ending in July. It was obviously impossible to have Seafish staff monitoring these vessels for the full duration of the season. It was decided that the most satisfactory approach would be to have Seafish staff onboard all three vessels at selected times, at intervals covering the start, middle and end of the season. A full week of fishing trials was programmed for each month—May, June and July. At all times between these periods the skippers were instructed to record all necessary catch data and make observations on the performance of the gear. In this way a comprehensive evaluation of the trap fishery could be undertaken for the whole season.

By having the vessels operate in different areas at the beginning of the season, it was hoped that cuttlefish concentrations could be located more easily and their movements monitored more effectively.

The early problems encountered with the manufacture of traps by the Dorset based company meant that insufficient traps were available to commence the project early in May using all three vessels. Rather than delay the trials, the decision was made to start using only two boats, MFV "SANDRA" and MFV "ST.RICHARD". The third vessel, MFV "GRACE GEORGINA" was to come on line later in June. The monitoring period was also cut short with the July trials being cancelled due to an earlier than expected end to the cuttlefish season.

Prior to the full complement of traps being ready and the monitoring exercise starting proper, some traps were delivered to the fishermen as they were completed. This enabled the fishermen to familiarize themselves with the gear, set-up the handling arrangements and test the new hauling equipment. In this way most of the teething problems were dealt with prior to Seafish commencing their trials. This testing period, conducted at the end of April with MFV "SANDRA" and MFV "ST.RICHARD", using 2 strings of 10 traps each proved valuable in indicating a start time for the main monitoring exercise. At the end of April these vessels using 5 inch mesh, multi-mono trammel nets were seeing signs of cuttlefish coming onto the local grounds. Even at this stage the sample strings of traps were catching more cuttlefish than similar lengths of nets.

By the middle of May 1995 100 traps were completed and delivered to Hastings. These consisted of 50 of the original French design and 50 of the square design, all coated in white PE plastic.

5.4.1 Gear Arrangements, Sequences and Operations

In order to compare the performance of the different trap designs, each vessel was given 25 of each trap type. Since it was also intended to compare catch returns from the traps with those from nets, the trap sequences were rigged to be comparable with net fleet lengths.

Gill and trammel nets operated by this class of vessel are commonly rigged in fleets of 8-10 nets, each 50 yards (45.7 m) in length. It was decided to compare a 400 yard (366 m) fleet of 8 nets with a similar length or string of 10 cuttlefish traps rigged at approximately 20 fathom (36.6 m) spacings. (See figure 24, Section 4.2). In addition, one string from each vessel was rigged with traps spaced at 10 fathom (18.3 m) intervals. It was expected that if the cuttlefish were spread openly over the ground, then wider spacing of the traps would be more effective. Conversely, if it was found that cuttlefish were concentrated in small areas, then a closer interval would be more productive. It was hoped that this arrangement would give some indication of this.

Of the first 100 traps supplied, all those of the French design were rigged with traditional chicken wire cone entrances. The alternative square designs were fitted with the metal bar type entrances, apart from 3 traps which had entrances of the same shape as the French design but which were constructed in white plastic mesh. These were to be tested as an alternative to the galvanised chicken wire.

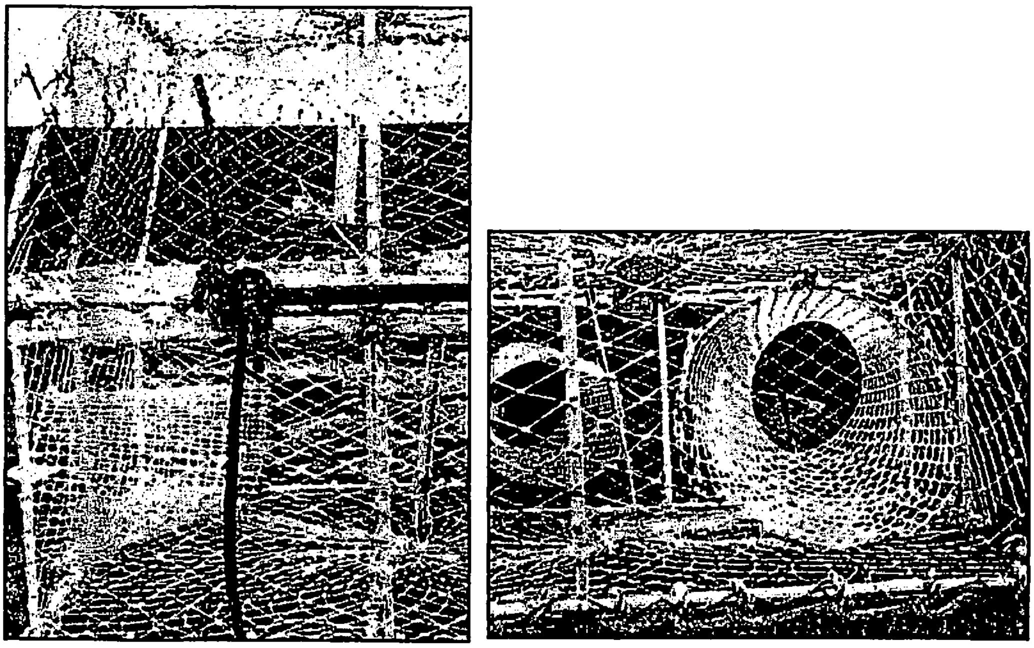


Figure 31 - Traps fitted with plastic cone-shaped entrances

The fishing trials commenced in the middle of May 1995 with MFV "SANDRA" and MFV "ST. RICHARD" each operating 5 strings of 10 traps. Each string consisted of the French design and the alternative square type traps, alternated in sequence for comparison. Of the 5 fleets operated by each vessel, one was rigged with traps at 10 fathom (18.3 m) intervals, the rest at 20 fathoms (36.6 m) (Figure 32). All traps were numbered for ease of identification and data recording.

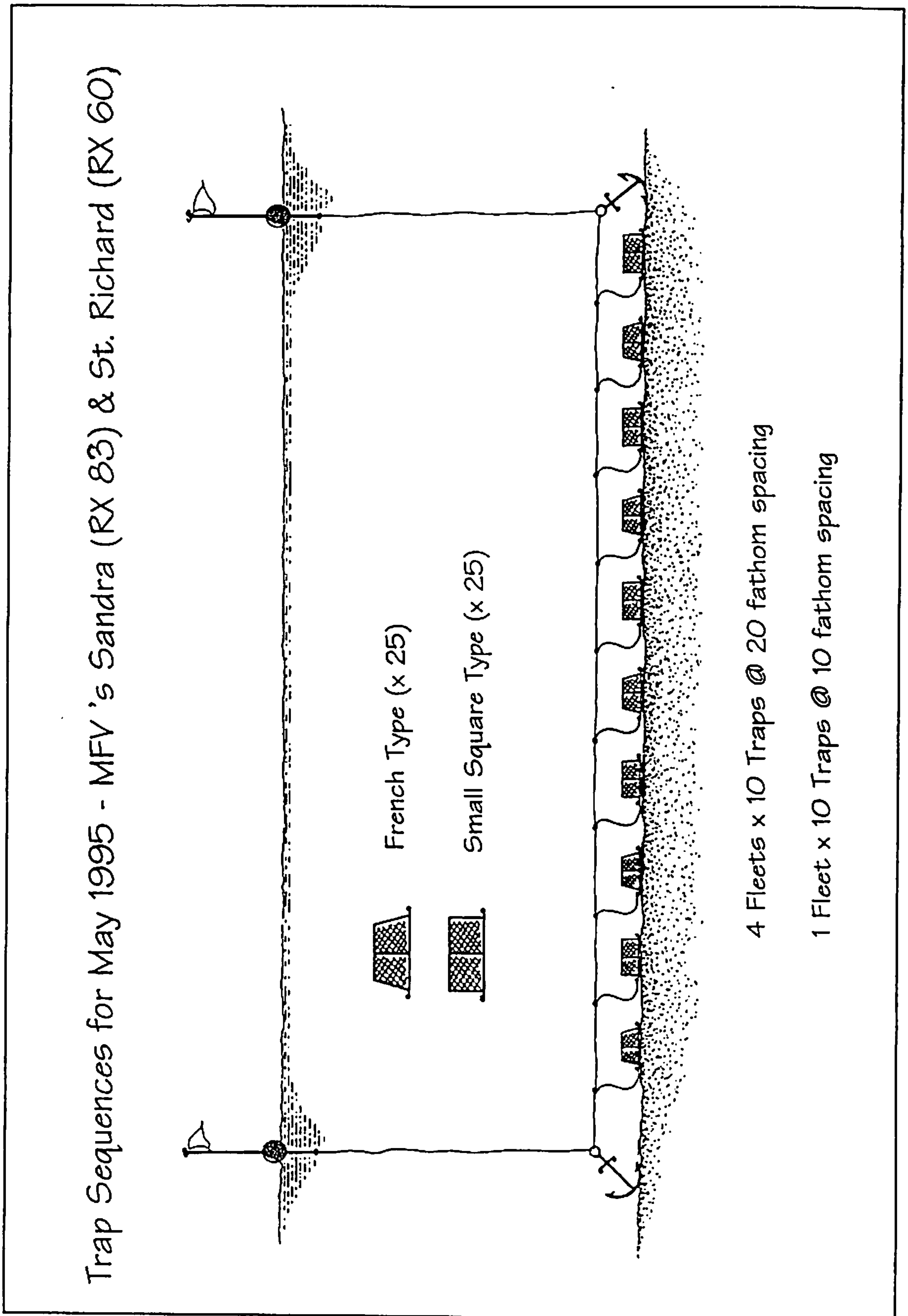


Figure 32 - Trap sequences for May 1995 - MFVs "SANDRA (RX33) and "ST.RICHARD" (RX60)

Apart from on one or two occasions, the only attractant to be used during the first monitoring period was the white uPVC lure fitted to the traps. Female cuttlefish were used as bait on the other occasions when the crew were confident that they could correctly distinguish males from females. More information concerning the external appearances of cuttlefish, including features used for distinguishing males from females is contained in section 3.1.1.

During the first week of operations Seafish staff were onboard both vessels to record catch data and generally monitor operations. Once operational procedures had been established and skippers and crews briefed on catch data collection, they were left to conduct fishing operations under their normal working conditions.

The original intention had been to shoot comparable lengths of trammel nets alongside the strings of traps to compare catch rates between the two gear types. Unfortunately, by the end of the second week in May spider crab numbers had reached such a high level that they put an end to any viable commercial operation of trammel nets. However, both skippers agreed to work short lengths of net (100 m in the vicinity of the traps to give some indication of their performance and also to highlight the extent of the spider crab problem. These were shot on a daily basis along with the traps. When areas were found with reduced spider crab presence a more representative length of net was set.

Operations were based on 24 hour 'soak times' in the initial stages of the trial, except where adverse weather conditions forced longer periods. In any event, soak times were never greater than 48 hours.

Two different methods of operating the strings of traps were established in the early stages of the trials. MFV "ST. RICHARD"operated a standard 'haul and shoot' system which involved retrieving a full fleet of traps and stowing them onboard before re-shooting. The other method, preferred by the skipper of the MFV "SANDRA" was to 'under-run' the traps. This involved hauling a trap, emptying, baiting and shooting it before the next one in the sequence was reached. The latter method can only be safely operated in good weather and tidal conditions, hauling with the tides, (especially with a two man crew).

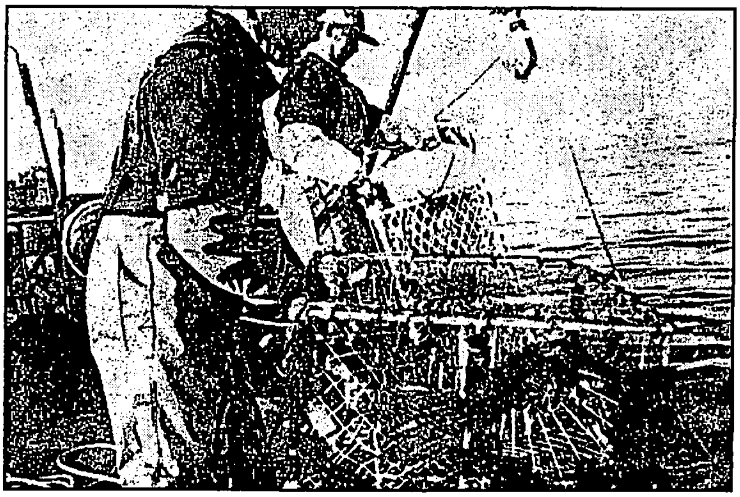


Figure 33 - Photograph showing the two-man 'under-running' method in operation

This operation was more easily managed with the traps at 20 fathom spacings. The closer spaced string puts more pressure on the crew leaving very little time for error or dealing with any problems that may arise. If this method of operation is preferred, trap spacings should be no less than 15 fathoms to allow for safe working. It is a speedier operation but it commits the vessel to deploying the fleet on the same ground. This is advantageous if good catches are made but can work against the operator if poor returns indicate a change of ground is necessary. The method chosen by MFV "ST.RICHARD" was more time consuming by comparison but gave the skipper more flexibility with regard to the choice of area of operation based on catch returns. By having to recover a full fleet of traps all at once, deck space and hence working areas became restricted. With limited deck stowage space the traps have to be stacked very carefully. It was noticed that the French traps with the sloping sides did not stack as well as the square type. Additionally, the larger square traps tended to be awkward and unwieldy to handle by one man.

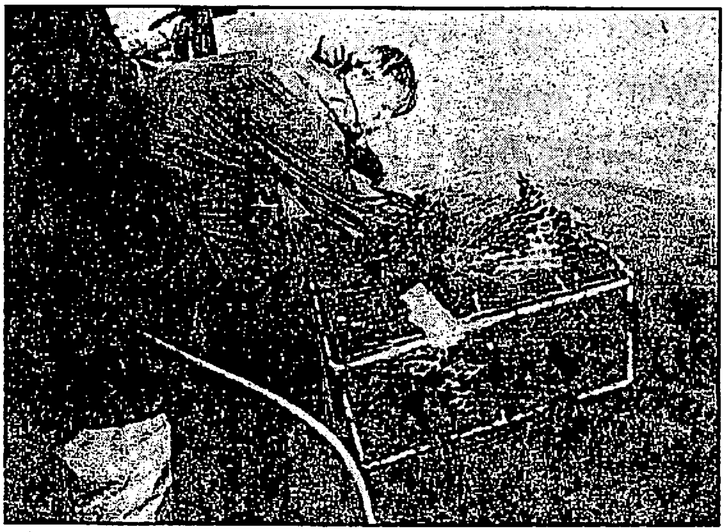


Figure 34 - Photograph showing potential handling problems with very large traps

The 'under-running' method also has a drawback if it is intended to bait traps with female cuttlefish. A supply of live animals is required to ensure enough are available for each trap. If sufficient females are not caught as the traps are hauled, then there is a problem of having to shoot unbaited traps. For the first string recovered there must be at least one female caught in each trap to continue the baiting process.

The strings of traps were deployed in the same manner as fleets of nets and marked in the same way. To all intents and purposes they could be treated as any other static gear requiring the same respect from other vessels, fishing or otherwise. In other words, for vessels changing over to this method there is no more danger of conflict with other channel users than already exists.

Following the first week of Seafish monitoring, the two vessels were left to continue fishing and recording catch data. The second monitoring phase involving Seafish staff took place approximately one month later, around the middle of June. The experiences of the two skippers up to this point in time had highlighted a number of areas for possible improvements to the system as a whole, and in particular to the trap designs. The deck stowage and handling problems noted onboard MFV "ST.RICHARD" with the large square type traps prompted a design change. Prior to the supply of the final 50 traps required to bring the third vessel, MFV "GRACE GEORGINA", into the programme, the trap manufacturer was consulted on modifications to the existing designs. It was decided to experiment with a smaller trap, to investigate whether a simple reduction in trap size would affect catching performance. This reduction in size would alleviate deck stowage and handling problems. The new traps were of the same shape as the previous square design but with a base area equivalent to that of the top frame of the French design (≈700 x 750 mm). These were designated small square traps for comparison with the large square and French types. The bar type entrances were fitted to the latest batch and were constructed as an integral part of the trap.

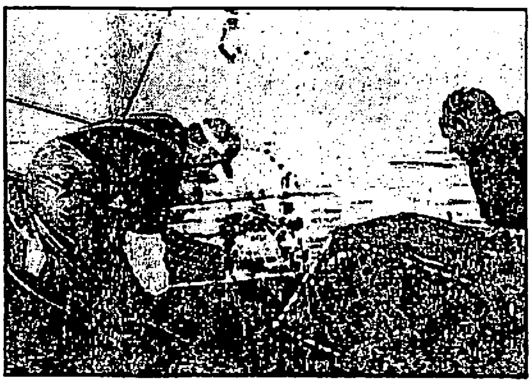


Figure 35 - Photographs showing the large square design compared to the French type (left) and the small square design (right)

On completion of the small square traps, all traps were brought ashore and the fleets were rigged to incorporate the new design. Each of the three vessels was now supplied with 5 fleets x 10 traps, consisting of the three types alternated in sequence, as shown in figures 36, 37 and 38. The addition of the third vessel to the programme allowed more flexibility to the operations and increased the search area in the hunt for cuttlefish concentrations.

By this stage of the trials most of the operational problems had been ironed out. Skippers Paul Joy and Graham Coglan had settled into a smooth working routine. Skipper Roy Coglan of MFV "GRACE GEORGINA" was given the benefit of the knowledge and experience already gained by the other two skippers enabling him to adapt to this new gear and techniques quite easily.

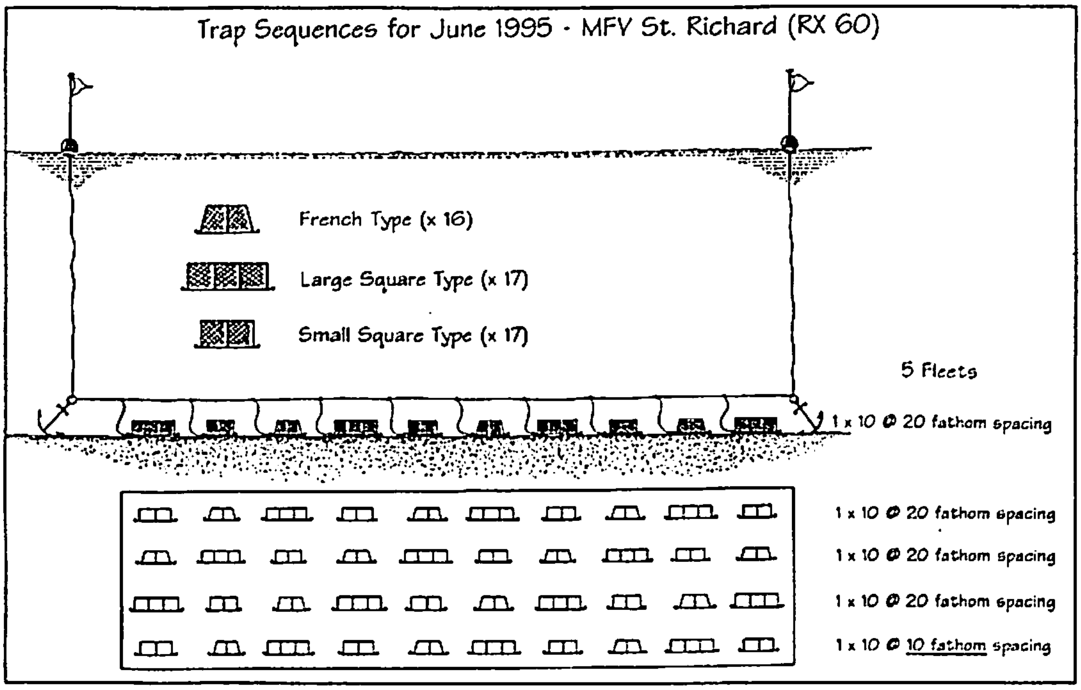


Figure 36 - Trap sequences for June 1995 - MFV "ST.RICHARD" (RX60)

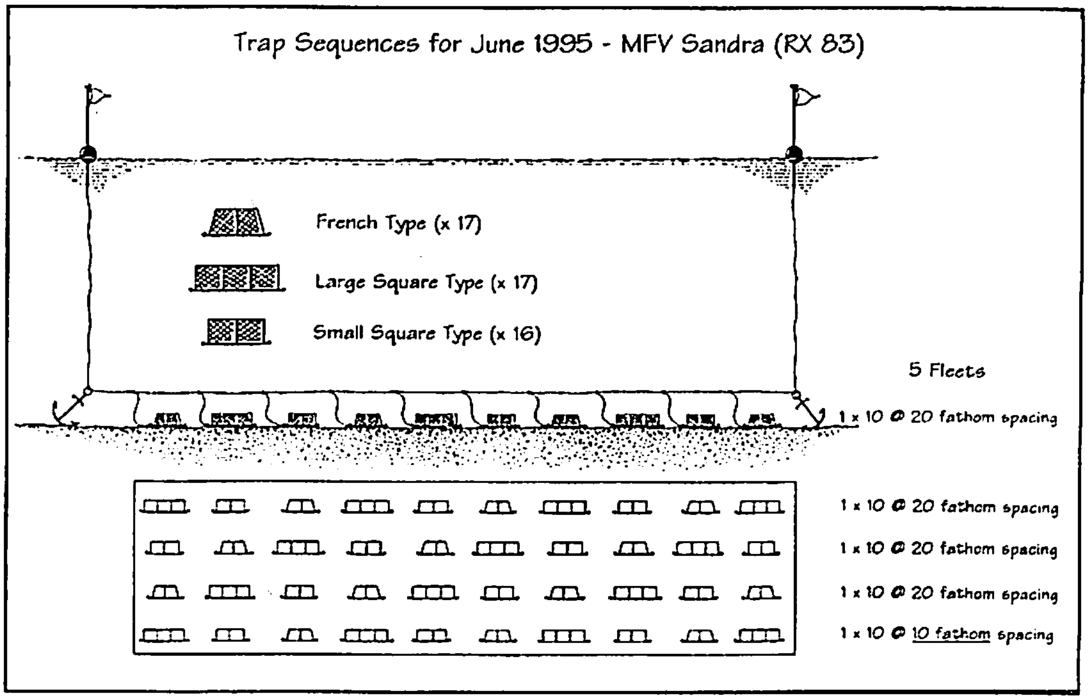


Figure 37 - Trap sequences for June 1995 - MFV "SANDRA" (RX83)

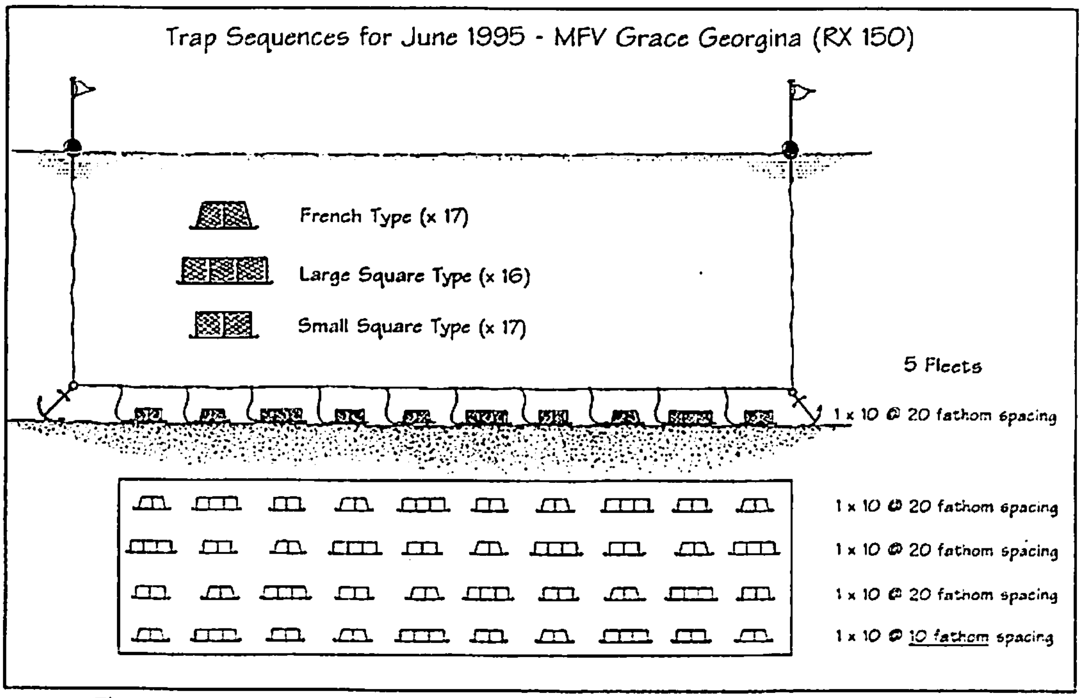


Figure 38 - Trap sequences for June 1995 - MFV "GRACE GEORGINA" (RX150)


Figure 39 - Photograph showing a French trap being hauled single-handed

No problems were experienced with the pot hauler/davit arrangements used for handling the traps. The rigging arrangements (length of droppers etc) used on the traps were compatible with the davit heights and positioning. In conjunction with the open-sided potting blocks being used, these arrangements allowed the hauling operation to be conducted by one man.

As the fishery developed and catch rates improved, all three skippers realised the benefits of baiting their traps with females, as and when sufficient numbers were caught. However, it was noted that the cuttlefish had the ability to escape from these traps. On a number of occasions previously baited traps were recovered with no females remaining. To try and combat this, some of the trap entrances were fitted with 'flappers'. Small pieces of nylon netting were suspended over the inside end of the cone entrances. Alternatively, nylon 'tie wraps' were used to cover the entrances (Figure 40). This acted as a type of non-return valve, allowing cuttlefish to enter the trap but at the same time preventing exit. Their presence did seem to retain bait females but there remained some questions over their effect on the entry of additional cuttlefish. It was clear that they did not totally prevent cuttlefish entry but they may have deterred cuttlefish to some degree.

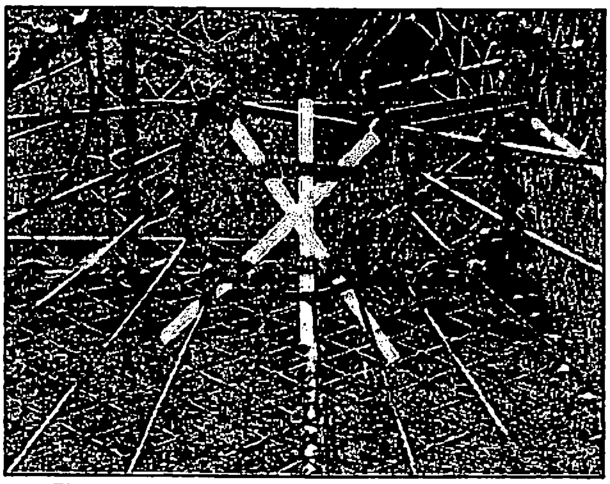


Figure 40 - Nylon 'tie wraps' used to prevent cuttlefish escapes

Bearing in mind the concern about the possible deterrent effect of the 'flapper' on the trap entrances, attention was applied to alternative ideas for preventing bait females from escaping. Andy Skow of the Yorkshire Crab Pot Company suggested that a parlour pot arrangement might be a possible solution. This arrangement, as used in some crab and lobster pot designs involves the creation of a second chamber or parlour within the trap. This parlour was accessed by the same type of entrance as fitted to the external surface of the trap. The bait (in this case the female cuttlefish), is retained inside the parlour. Any cuttlefish entering the trap have to enter the second chamber to get at the bait. To escape from this arrangement involves negotiating two sets of entrances which becomes more difficult, hopefully resulting in more retained bait females and additional animals attracted into the trap.

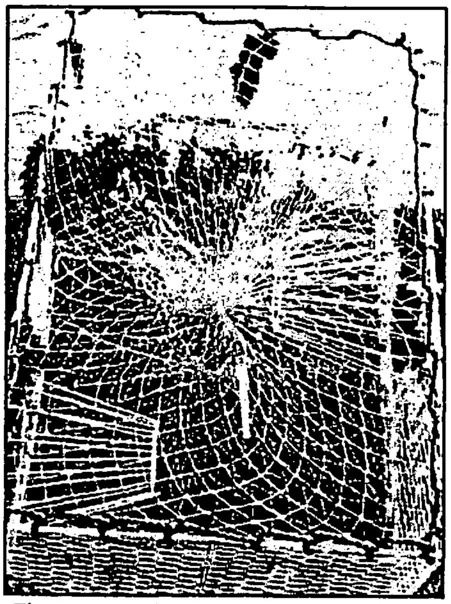



Figure 41 - Photographs showing the larger parlour traps

As a result, a number of parlour traps were manufactured, based on the square design. (Figures 41 and 42). This involved the addition of another section incorporating a third entrance. The trap was approximately 50% larger than the original square design. This made the trap more awkward to handle but this was offset by its apparent improved performance. This design was introduced late in the trials but the initial results prompted the skippers to make modifications to some of their other large square traps to convert them to parlour arrangements.

All three skippers continued operating the cuttlefish traps for the rest of June, following Seafish's monitoring period. The next monitoring exercise planned for July had to be cancelled when the number of cuttlefish dropped off dramatically early in the month. It was not considered worthwhile to continue the programme any further. Each of the three skippers put their trap gear ashore in stages as the catch rates deteriorated.

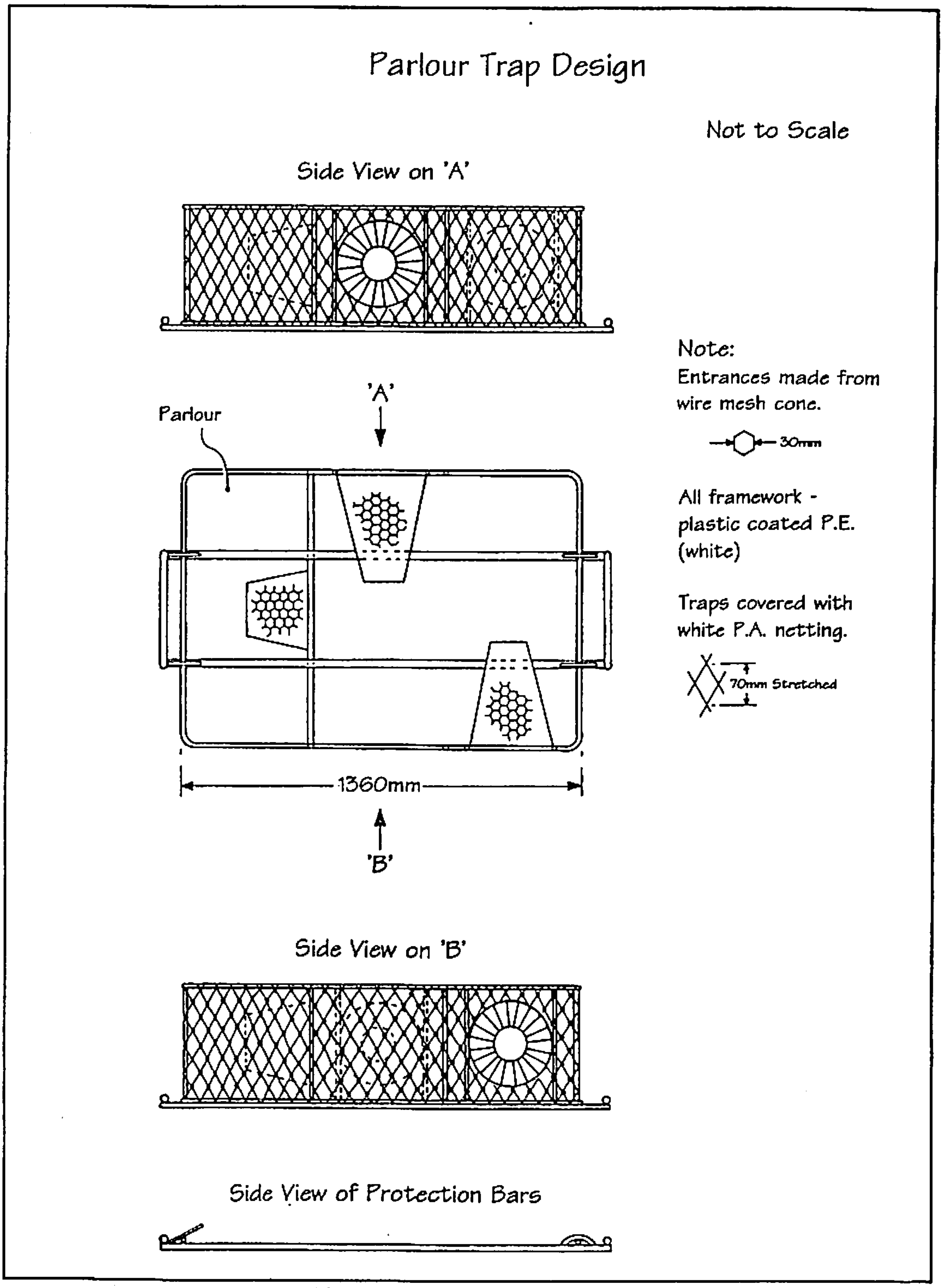


Figure 42 - Parlour Trap Design

5.4.2 Underwater Observations

One of the aims of this project was to gather information about the behaviour of cuttlefish in response to the fishing gear. One of the approaches taken was to utilise direct underwater observations using video cameras. This work took two forms; one using an underwater video camera mounted *in-situ* on the fishing gear under actual fishing conditions; the other using a video camera set-up outside an aquarium to observe cuttlefish in captivity.

The aquarium set-up was carried out courtesy of the Sea Life Centre in Hastings. A number of cuttlefish (males and females) were collected at sea during the trials and supplied to the Sea Life Centre for housing in one of their display aquaria. After a 'settling-in' period, a trap was introduced to the tank containing the cuttlefish. Video observations were made of the cuttlefish's behaviour in response to the trap including reactions of male animals to females baited in the trap. The video camera was set-up to run for a period of three hours overnight when the centre was closed. Although this exercise was limited, it did produce some interesting observations and gave an insight into how cuttlefish may react in the wild.

Male cuttlefish were observed following females around the trap from the outside. They were very inquisitive in this respect, trying to maintain contact with the female through the netting and often settling on the trap. Once inside the trap, the males targeted the female trying to 'take possession' of her and aggressively fending off any other males attempting to make contact. Males would often fight with each other within the confines of the trap. Once one male had entered the trap, additional males seemed hesitant to enter, remaining in the entrance. The cuttlefish did not appear to show any fear of the trap, more of a curious interest and pre-occupation with the females inside. The trap used for this experiment was fitted with the bar type entrances. The cuttlefish had no difficulty in negotiating this type of entrance and were seen to swim through them quite easily. In fact, these observations, and later ones made of the trap in a fishing situation, both highlighted a potential drawback of this entrance design. Cuttlefish were seen on a number of occasions, both entering and exiting the trap by passing between the bars of the entrance rather than passing through the inner ring. This suggested that this design may be more prone to loosing baited females and/or subsequent catches.

For the filming of the traps under fishing conditions, one of the large square designs was modified to carry an underwater camera and video recording unit.

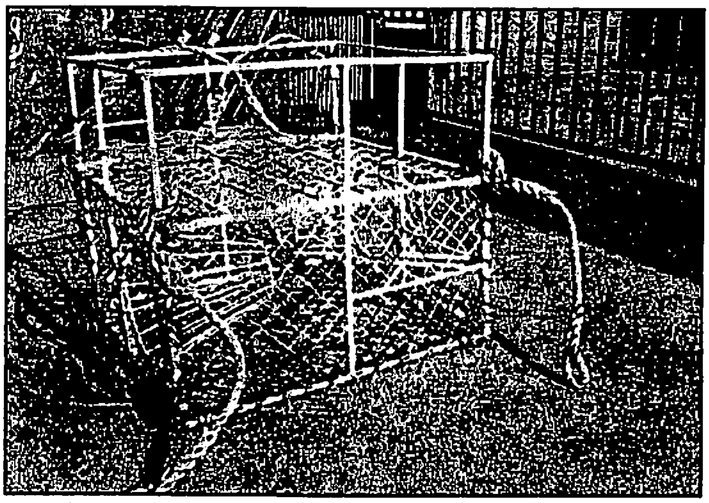


Figure 43 - Square trap modified to carry underwater observation equipment

The camera head was mounted inside the trap in a position to monitor the trap entrance. Filming time was restricted to 3 hours, a constraint of the system (maximum of 3 hours of video tape). To try and optimise this time the camera trap was deployed to operate over the high water slack tidal period. This was thought to be the best time for cuttlefish activity. The trap was baited with one or two female cuttlefish to improve the chances of catching more cuttles and to observe the behaviour of the females in the trap.

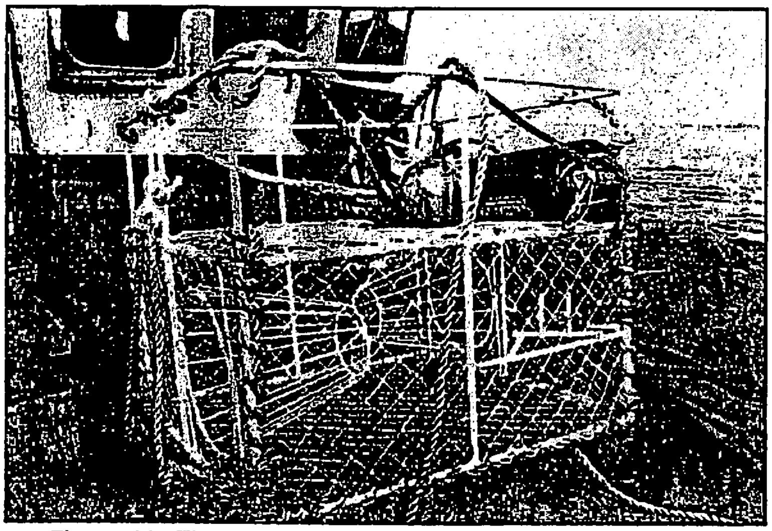


Figure 44 - The camera trap with the camera and recording systems fitted

On two of the three occasions that the camera trap was deployed cuttlefish were attracted to, and caught in the trap. This allowed some unique observations to be made of cuttlefish entering the trap and their subsequent behaviour. At one stage a female was actually observed attaching eggs to the outside of the trap. The females inside the trap showed very little activity until joined by males which actively pursued them. As previously mentioned, cuttlefish were observed squeezing, (with very little effort) between the bars of the entrance funnel to gain entry to the trap. It appears that even large individuals can alter their body shape to manoeuvre through and around confined spaces. This is a factor that must be borne in mind when designing traps in general and entrances in particular. Where entrances were fitted with flapper arrangements, the cuttles did not appear to be deterred by their presence. By using their tentacles they were able to 'feel' their way through without any difficulty.

Once again, these *in-situ*, camera observations were limited but proved very valuable in adding to our knowledge of cuttlefish behaviour and providing confidence in the observation techniques.

5.5. Results and Observations

The figures displayed in the catch results tables 1–8, are based predominantly on the results from the Seafish monitored periods. Although considerably more data were gathered between these periods by the skippers filling in catch logs, much of it is not shown. This is due to the fact that it is not directly comparable with the other data. A number of difficulties were encountered by the skippers and crews trying to collect and record data consistently while conducting normal fishing operations. However, all the information and data have been analysed and considered in the formulation of the results for this report. The data shown are representative of the total data collected.

The type of data collected can be seen from the example log sheets shown in Appendix I. Form (1) shows the range of information collected during the Seafish monitoring periods and Form (2) the less detailed records taken by the skippers between Seafish monitoring periods.

5.5.1 Catch Results and Observations Prior to Monitoring Period

Based on previous experiences and catches taken from nets in past seasons, the fishermen were expecting to see signs of cuttlefish in April. This year followed the same pattern with fishermen reporting numbers of cuttlefish showing in their 5 inch mesh, multi-mono trammel nets. At this stage MFV "SANDRA" and MFV "ST.RICHARD" were familiarizing themselves with the new gear by operating small strings (2 x 5) of sample traps. Early in May catch rates were promising with the short strings catching more than similar lengths of netting. The traps were spaced at 20 fathom intervals. On some tides, following a 24 hour 'soak time' catch returns were as high as 15 individuals per trap. This, however was the exception rather than the rule with the fishing being mostly very variable. Table 1 shows some cuttlefish catches, by weight, for RX60 for the month of April. These returns are from nets and show the variability experienced.

Table 1
RX 60 Cuttlefish catches from 8 fleets of nets for April 1995

Date April 1995	Cuttlefish Catch (kg)
5	6.4
12	7.3
13	13.2
14	167.0
15	72.3
17	108.6
18	127.0
19	22.3
21	90.0
22	98.0
24	38.2
25	84.0
26	47.3
27	71.0
28	106.4
29	79.1

From early May nets and traps were showing signs of cuttlefish spawning activity with eggs being laid everywhere. By the middle of May eggs were being laid on any vertical component of the fishing gear and many traps were 'heavy' with masses of black eggs, particularly around the entrances. This egg laying activity was used as an indicator and confirmed cuttlefish presence on the grounds and around the gear. It also produced a number of problems. In extreme cases the build up of eggs blocked the meshes of the netting and restricted the entrances. It was suspected that this may affect the entrance of cuttlefish to the traps. The additional weight of the eggs made trap handling more difficult. The eggs were scraped from the traps when it was felt that their build up was affecting the gear's performance. This created a further problem with the presence of the very slippery eggs on deck making for a more difficult, (and messy) working environment.

It is part of the cuttlefish's natural behaviour to lay its eggs on vertical objects on the sea bed. This would normally consist of sea bed vegetation, rock outcrops etc. It appears that it also finds artificial objects attractive for this purpose, hence its affinity to certain fishing gears. This association with fishing gear has raised some concern by certain elements of the French fishing industry. They are worried that trapping operations may have a detrimental affect on the cuttlefish's breeding activity by destroying the large numbers of eggs which are being laid on traps and associated fishing gear.

5.5.2 Catch Results - May

During May, in which the Seafish monitoring periods started, only two vessels were operating, MFV "SANDRA" (RX83) and the MFV "ST.RICHARD" (RX60). Two trap types were being evaluated, namely the French design and the large square type. The vessels were operating in an area off Bexhill in less than 10 fathoms of water and concentrating effort on patches of hard ground and rock ledges. At the time of the monitoring exercise tides were increasing towards springs. It was thought that the cuttlefish were using these areas to shelter from the strong tidal conditions. These tidal conditions, coupled with very coloured water as a result of heavy algal suspensions (locally known as 'gulley water'), were blamed for poor catches of cuttlefish at this time. The catch rates suggested that those traps that had been fished the longest were more successful than newly introduced traps. Those with evidence of cuttlefish activity i.e. eggs laid on or in the traps, regularly caught more than the new ones. Most traps were catching ones and twos but occasionally some traps were producing larger quantities with as many as 14 individuals being taken from one French trap.

At this stage of the project, crews were still not 100% confident in distinguishing male from female cuttlefish, and consequently it was difficult to establish the ratio of males:females that were caught. It also made the baiting of traps with females a 'hit or miss' exercise. However, on a number of occasions some traps were baited with females and on most of these occasions the baited traps caught more than those which only had the plastic lures attached. The main problem was catching and identifying sufficient females to maintain a consistent baiting regime. It became apparent at this stage that the cuttlefish were capable of escaping from the traps as indicated by the number previously baited traps being recovered empty.

Where 48 hour soak times were imposed by adverse weather conditions, some of those traps that had been baited were recovered with dead females. Often the live bait females showed signs of damage due to the activities of aggressive males. The presence of dead females in the traps was often associated with poor catches. This emphasised the importance of baiting with strong, live females. There were some indications that 48 hour or extended soak times may be beneficial to improving catch rates. The suggestion was that cuttlefish need time to get used to the traps. However, there was no firm evidence of this.

The catch results for the May period for the two vessels RX60 and RX83 are shown in Table 2. When considering the cuttlefish numbers caught per trap, it is the French design with the wire entrances that comes out on top. The difference is more noticeable for RX83. The closer spacing of traps shows a slight benefit for RX60. On the whole, however, the differences are barely significant.

Table 2
Catch Results - May
Traps Baited with Plastic Lure Only

	Large Square	French	Large Square	French	Large square
	Bar Entrance	Wire Entrance	Plastic Entrance	Wire Entrance	Bar entrance
	20 Fathom Spacing			10 fathom spacing	
RX60					
Catch Total	332	413	92	110	39
Total/Trap	19.5	20.6	18.4	22.0	13.0
RX83					
Catch Total	191	427	80	86	48
Total/Trap	15.9	35.6	20.0	28.7	16.0

Note: The catch totals shown in the results tables are those recorded for the Seafish monitored periods, plus some additional data from the Fishermen's logs. Only directly comparable data have been used. The numbers caught per trap are the average numbers for each trap type compared during the monitored periods.

When considering catch returns for the whole of May the indications were that the French design of traps were catching more than the square design and that the closer spacing (10 fathoms) was more effective. It was also generally accepted that traps baited with females caught more than unbaited ones. The small sample of square traps fitted with the alternative plastic mesh cone entrance performed less well compared to the other designs.

Table 3
RX60 - Cuttlefish catches, by weight, from 50 traps fished in May 1995

Date May 1995	Cuttlefish Catch (kg)
15	40.0
17	32.7
18	40.0
20	40.4
22	34.5
23	183.6
24	116.8
25	141.0
26	127.3
29	149.1
30	143.2

Table 3 shows the catches by weight for May for RX60 using 50 traps. It can be seen that despite being relatively small quantities these results compare favourably with returns from nets during April. It is also noticeable how variable the catches were.

5.5.3 Catch Results - June

The June survey period covered all three vessels, MFV "ST.RICHARD" (RX60), MFV "SANDRA" (RX83) and MFV "GRACE GEORGINA" (RX150). Three trap designs were operated by all three vessels. The small version of the square trap had been introduced as a consequence of problems experienced with the handling and stowage of the large square design. The area of operation of the three vessels ranged from Hastings to Pevensea.

Unfortunately, the timing of the second monitoring period again coincided with strong tidal conditions. Coloured water also remained a problem. Many pots were collecting the dead brown algal growth on the netting which was offsetting any benefit of the white coloured nylon netting. Whenever possible this material was brushed off in an attempt to restore the traps to their original colour.

Whenever catch rates allowed, all traps were baited with female cuttlefish. It became very difficult to carry out consistent comparisons of performance of baited and unbaited traps because of the irregular supply of females. However, by this stage of the project it was readily accepted that the addition of females as bait improved catches. To try and combat the loss of bait females, almost all trap entrances were fitted with flapper arrangements. Table 4, shows some results for traps baited with females compared to those with only plastic lures. These results for RX60 were typical of those observed during the June period with numbers/trap more than doubling for some of the trap designs baited with female cuttlefish. Generally catch rates were down for this period, this was attributed to the prevailing weather and sea conditions. Strong 'day breezes' had added more 'colour' to the water by stirring-up the sea bed.

Table 4
Catch Results - June. Comparison of Traps baited with plastic lure and female cuttlefish

	Large Square		Small Square		French		Large Square		Small Square		French		Large Square	
	Bar entrance				Wire entrance		Bar entrance				Wire entrance		Plastic entrance	
	20 fathom spacing						10 fathom spacing						20 fathom spacing	
	♀	lure	♀	lure	♀	lure	♀	lure	♀	lure	♀	lure	♀	lure
RX60 Catch Total	77	60	170	107	278	184	28	20	28	23	94	37	6	6
Total/ Trap	6.4	5.0	14.2	8.9	19.8	13.1	7.0	5.0	9.3	7.7	31.3	12.3	2.0	1.7

Lure - Baited with Plastic lure only
♀ - Baited with Plastic lure and female cuttlefish

The traps were still showing signs that the cuttlefish were still spawning. Fresh eggs were noticed on traps on most days.

The results in Table 5, again show that the French design was more effective than the square (for two out of the three vessels). The catch numbers/trap for RX150 were very similar for the three types ranging between 16 and 22 compared to 21-40 and 34-81 for RX60 and RX83 respectively. The sample sizes for RX150 were markedly smaller than for the other two vessels. This may have been as a result of the area of operation. MFV "GRACE GEORGINA" (RX150) tended to be the westernmost boat of the three vessels operating.

Of the two square designs the small size performed better than the large version. This, coupled with its easier handling and stowage, make it a better choice particularly for small boat operations.

The difference in performance of the traps set at different intervals was not as consistent. No significant benefits with regard to catch rates could be attributed to the shorter spacings for this exercise. It would appear that the cuttlefish spread themselves over relatively large areas and spend a considerable amount of time foraging for food or in pursuit of breeding partners. It is envisaged that if tight concentrations of cuttlefish can be located then the closer spacings may be more beneficial. Considering the experiences gained from these trials, the selection of 20 fathom intervals for traps provides an acceptable working arrangement. To cut down on fleet lengths and gear costs, 15 fathom intervals would be a suggested compromise.

With regard to the differences in performance between the two sizes of the square design, it is difficult to offer any explanations based on the results or observations so far obtained. Since the two trap types were identical in all other respects, including entrances, it is difficult to even speculate as to the reasons for these differences.

Table 5 - Catch Results June

	Large Square	Small Square	French	Large Square	Small Square	French	Large Square
	Bar entrance		Wire entrance	Bar entrance		Wire entrance	Plastic entrance
	20 fathom spacing			10 fathom spacing			20 fathom spacing
RX60 Catch Total	257	409	557	96	92	94	31
Total/Trap	21.4	34.0	39.8	24.0	30.7	31.3	10.3
RX83 Catch Total	383	512	1019	101	122	322	114
Total/Trap	38.3	42.7	67.9	33.7	40.7	80.5	38.
RX150 Catch Total	244	359	234	49	87	58	-
Total/Trap	20.3	16.2	19.5	16.3	21.7	19.3	-

An indication of the overall performance of the traps for June is given in Table 6, which gives the cuttlefish catches (by weight) taken by RX60. This table can be compared with Tables 3 and Table 8. The catch rates for June were generally higher than for May. The daily variability of catches was not as marked as observed in May.

Table 6 - RX60 - Cuttlefish catches from 50 traps for June 1995

Date June 95	Cuttlefish Catch (kg)
1	215.0
6	185.9
9	200.9
10	251.4
12	431.4
13	221.8
14	162.3
16	161.8
17	141.8
19	77.7
20	90.0
21	126.4
22	192.3
23	110.4
26	96.4
27	129.5
28	64.1
29	7.3

Parlour Traps

As previously mentioned, in an attempt to reduce the loss of bait females, some trap design changes were suggested. One such suggestion was the use of 'parlours' to retain the female cuttlefish. The manufacturers that supplied the traps modified the large square design by adding an extra chamber or 'parlour', accessed by its own entrance. The trap was increased in length by almost half as much again to accommodate the parlour and entrance.

One of the vessels, RX83 was supplied with a prototype of this design for testing during the June monitoring period. The 'parlour' trap was incorporated into an existing string and produced some very interesting results. The results for RX83 for six consecutive hauls for 1 parlour trap are shown in table 7. The trap was baited with one female cuttlefish in the parlour and hauled each day along with the rest of the traps. The catches far exceeded those from traps within the same string and in general from all three vessels. The maximum number of cuttlefish taken in any other individual trap, over the same period was seven. The repetitive success of this trap design was not considered coincidental.

Table 7
Catches from prototype parlour trap - RX83

Haul	Catch				
	Males ♂	Females ♀	Total	Main chamber	Parlour
1	6	7	13	9	4
2	5	7	12	7	5
3	6	7	13	5	8
4	2	6	8	-	8
5	4	3	7	-	7
6	5	6	11	-	11

It appeared that the problem of losing females had been further limited by this design. It had been suspected that the cuttlefish had the ability to move relatively freely in and out of the traps during their time on the sea bed, with some entrance designs being more prone to loss than others. The presence of the additional chamber and entrance appeared to have restricted the cuttlefish's movements in and out of the trap during the soak period.

As a result of these improved catches a number of the large square traps were converted to parlour traps by sectioning off one corner of the trap using plastic netting rigged with an entrance made from the same material. (Figure 45).

These traps were fished alongside the original ones for the rest of the trial and generally showed improvements on their original performance. However, by late June catch rates in general were dropping off as cuttlefish became harder to find. The converted traps did not perform as well as the prototype parlour trap, possibly due to the restricted size of the parlour and the less efficient, improvised entrance designs used. The parlour traps did have the disadvantage of being more expensive to produce and were more difficult to handle and stow. The experiences to date do however indicate that the use of parlour traps in this fishery warrants further investigation.

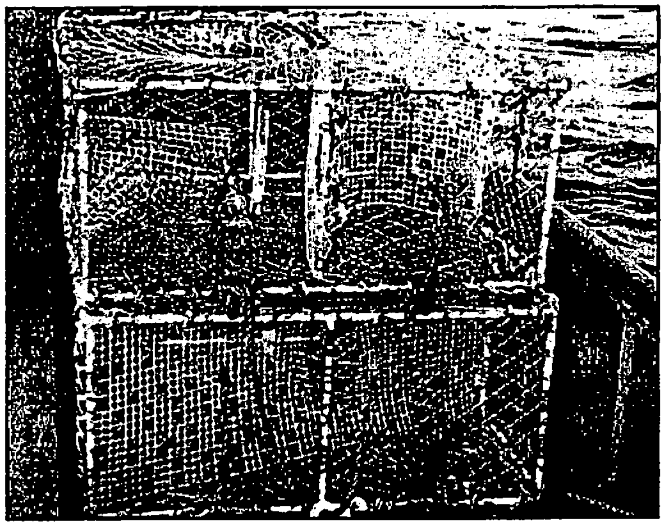


Figure 45 - Photograph showing large square traps converted to parlour arrangement

With the fall off in catch returns in late June/early July, as indicated in Table 8, the trap fishery became uneconomic. The proposed monitoring period for July was cancelled and the three vessels reverted to their normal netting operations.

Table 8
RX60 - Cuttlefish catches from 50 traps for July 1995

Date July 1995	Cuttlefish Catches (kg)
	81.8
1	40.9
3	52.7
4	32.7
5	47.7
6	66.8
7	10.9
8	6.6
10	2.0
11	8.2
12	3.2
13	

5.5.4 Catch Results from Nets

As previously mentioned in the earlier section (5.4.1) the intention had been to compare catches from traps with those from similar lengths of nets. This idea had to be abandoned early in the project due to the presence of vast quantities of spider crabs on the grounds. Their presence made net comparisons totally impractical. However, each vessel did shoot a short length of net (up to 100 m) in the vicinity of the trap fleets. The aim was to give some indication of cuttlefish catches and to highlight the damage caused by the spider crabs.

During the May monitoring period very few cuttlefish were caught in the sample nets, mostly single figures were encountered. Even those short lengths were catching relatively large numbers of spider crabs (up to 30 individuals per 100 m length) which were causing a lot of damage to the inner meshes of the trammel nets. (Figure 46). Some vessels that were still persevering with full complements of nets were reporting anything between 200 and 800 spiders per fleet of trammels.

Figure 46 - Photograph showing the results of spider crabs being caught in trammel nets. Note the damage to the inner wall of the netting.

The spider crab problem persisted throughout June, by which time the sample nets had almost been destroyed by crab activity. The combination of direct crab damage and additional damage caused in removing the crabs from the nets meant that new net inners were required by the end of the project. Cuttlefish numbers taken in the short net lengths remained low for June. Again, these could not be used for any valid comparison due to the short lengths used. Reports from other vessels operating nets indicated catch rates well below those obtained from the vessels using traps.

5.5.5 By-catches from Cuttlefish Traps

During the two month period that the traps were used, the by-catches that were experienced were negligible. By-catches consisted of both shellfish and finfish. Certain shellfish species had been expected to enter these trap designs, however, the numbers observed were very small.

On a number of occasions the fishermen experimented with different natural baits in an attempt to attract more cuttlefish. These proved ineffective for cuttlefish but did result in other species being caught. The use of dead spider crabs and dead fish (pouting) attracted some small edible crabs, shore crabs, swimming crabs and the inevitable spider crabs. Most of these were able to enter and escape through the meshes of the trap, only the larger spider crabs were actually retained with any regularity. On one or two occasions the added bonus of a lobster was a result of baiting with fish.

The finfish by-catch consisted of the occasional small pouting, whiting and codling. The fishermen also reported a Dover sole, small plaice and one or two dabs, all of a size which precluded them from entering through the meshes covering the traps. The largest fish caught was a conger eel (≈ 4 kg) which presumably entered in pursuit of a captive meal. These observations indicate that the traps are very species selective when 'tuned' to optimise cuttlefish catches.

Most of the cuttlefish captured during the trials were large adults, very few were under 20 cm mantle length. There was no evidence of small, juvenile cuttlefish being retained in the traps. It may have been the case that smaller animals had been entering the traps but because of their size had escaped more readily. It is more likely that differences in the behaviour of the juveniles mean they are less likely to come into contact with these traps. Even if small cuttlefish were to be encountered in this type of gear, there is enough scope to increase the mesh size to release juveniles without losing the larger more marketable animals. This makes these traps size selective for the target species.

5.6 Conclusions and Recommendations

A number of conclusions and recommendations were drawn from these fishing trials:

- The French design of cuttlefish trap (as currently being used by Brittany fishermen) proved the most effective for catching cuttlefish during these trials.

- When targeting cuttlefish with traps during the breeding season the best results are obtained from traps 'baited' with female cuttlefish. If using females as 'bait' it is recommended that they are retained in 'parlour' type traps.

- The most effective and practical trap spacing was found to be 20 fathoms (36.6 m). Trap spacing is dictated to a certain degree by water depth, however, it is recommended that a minimum of 15 fathoms (27.4 m) spacings are used for small boat, inshore shallow water, operations.

- 'Soak times' of approximately 24 hours were found to be the most effective. Extended soak times (>48 hours) tend to produce poorer quality catches caused by trap damage and/or aggressive cuttlefish behaviour. This sometimes results in the death of cuttlefish, 'bait' females in particular.

- It is recommended that only small, manageable fleet sizes be operated on small vessels. The physical size and shape of cuttlefish traps make them awkward to stow and handle. Fleets of 10 traps were found to be ideal for the class of vessel and associated working arrangements used during these trials.

- The catch results from the designs selected for evaluation during these trials demonstrated that this method of capture is both size and species selective for cuttlefish.

6. Post Harvest Factors Affecting Cuttlefish Quality

Within the scope of this project, it was decided to investigate current cuttlefish catch handling practices in an attempt to identify areas where improvements could be made. The aim was to optimise returns through improved catch quality.

In May and June 1995, Seafish's Fish Technology department conducted some cuttlefish quality and handling trials. These trials were run in conjunction with the fishing gear trials previously described in Sections 5 and 6. The investigations concentrated on examining the effects of both icing and gutting delay upon cuttlefish quality.

6.1 Methodology

A number of catch monitoring exercises were conducted as part of the cuttlefish capture trials. Observations were made of the capture and handling procedures to identify if changes in at-sea handling practices were necessary and/or practical.

Cuttlefish were being caught by both gill/trammel nets and traps as part of the fishing trial. Normal handling practice involves immediate removal of cuttlefish from traps as they are hauled. A similar procedure is used for nets, except when catches are extremely high or when the nets are 'heavy' with weed or other debris. In this instance, the nets would be hauled and catches removed as the nets are 'pulled-over' and cleaned (Figure 47). In any event, the time to removal of the animals from the nets is not more than 30 minutes.

Figure 47 - Cuttlefish being removed from a trammel net

Figure 48 - Cuttlefish boxed on deck, at sea

Figure 49 - Cuttlefish iced in boxes on the market

On removal from the nets or traps the cuttlefish are placed, ungutted in plastic fish boxes (Figure 48). The boxes are stowed on the open deck. No ice or protection is added to the boxes. Occasionally water is added to prevent drying out. Other than this, the catch is open to the elements. Ice is only added to the catch when it is landed and placed on the market some 6–8 hours later (Figure 49).

As a result of these initial observations it was decided to run two parallel series of trials One to establish the effects of delays in icing and the other, delays in gutting.

Ice was taken to sea for the trials. Cuttlefish samples were taken and some were immediately iced, others were stored at ambient temperatures, 12–18 °C, for various time periods of 6–36 hours. Some cuttlefish that were immediately iced after capture were gutted after various delays of 1–12 days to determine what impact this had upon their quality. All the samples were brought back to the Seafish Fish Technology laboratory in Hull, where they were stored on ice for up to 16 days after capture, during which time a taste panel carried out standard Torry cooked fish quality assessments at regular time intervals.

6.2 Results

The results of these trials showed a deterioration in fish quality (as measured by Torry Score) as time delay before icing increased. Most striking was the difference between the directly iced, and the six hour delay samples. Here a one Torry point difference was evident, even 1 day after capture. This difference was maintained right through to 16 days after capture. This equates to a 3–4 day shelf-life reduction being caused by only a six hour delay in icing.

The gutting delay trials showed that quality loss did not occur up to nine days. However, quality losses due to gutting delay were evident after 12 days.

Some physical damage to cuttlefish was observed as a result of both fishing methods examined. Cuttlefish taken from gill and trammel nets showed signs of surface abrasion, and removal of the outer pigmented skin. This was caused more by the removal process than by the actual capture method. This damage is superficial and should not affect the quality of the end product. Those cuttlefish captured in traps also showed some similar signs of damage. As a result of underwater observations, this was discovered to be caused by animals using their 'reactive' form of locomotion. In response to trap movement during hauling, the cuttlefish were seen to collide with the netting walls of the trap during rapid jet propulsive movements. The result of this was some superficial skin damage to the posterior end of the body. More severe damage, including removal of pieces of the mantle was observed when male cuttlefish were fighting for 'possession' of females within the traps (Figure 50). These wounds were caused by the animals' very sharp beak-like mouth parts. This type of damage may have implications on quality.

Figure 50 - Signs of damage caused by aggressive cuttlefish

A more detailed description of the results obtained from these trials is contained in Seafish Report No.465, Cuttlefish Quality and Handling Trials.

6.3 Conclusions and Recommendations

This work is based on the findings of a small-scale series of trials. These were carried out over a short time scale and under a limited range of ambient conditions. Although the major findings seem clear, this should be be borne in mind when considering the weight which can be attached to them. Ideally further trials should be carried out to provide a more comprehensive picture, particularly of the outcome under a wider range of conditions.

The conclusions and recommendations derived from these trials are:-

1. Cuttlefish should be chilled as soon as possible after bringing onboard as they spoil rapidly if not immediately chilled.

2. During the trials, ungutted cuttlefish rapidly chilled after bringing onboard had a useful storage life of about 16 days, this reduced to 13 days with only a 6 hour delay in chilling after bringing onboard.

3. Washing and icing may cause practical problems due to ink running off from the cuttlefish.

4. Gutting at sea is not considered necessary or practical but to minimise quality loss, chilled cuttlefish should be gutted within 9 days of capture.

5. The Torry fish quality scoring scheme for cooked squid was considered to be applicable to cuttlefish.

6. The capture methods, particularly potting, result in some damage to the cuttlefish but further work is required to determine the extent of this.

7. The Market for Cuttlefish

Although cuttlefish have been caught in the English Channel for many years it is only more recently that the species has become targeted to any significant degree. The driving force behind this move has been the ever more restrictive imposition of quotas on the staple species caught by the fleets in that area. This has resulted in the catching sector looking to spread its efforts on to other profitable species. One of these has proved to be cuttlefish, and a growth in landings has been experienced. One of the most significant factors permitting such growth has been the ready market found for the product most of which has been exported. The following sections will attempt to illuminate the situation somewhat.

7.1. The International Situation

Cuttlefish, including *Sepiid* and *Sepiolid* species are part of the expanding cephalopod fishery whose landings reached 2.3 million tonnes world-wide in 1993 (FAO). Cuttlefish make up 10% of this total having averaged 230,000 tonnes over each of the past 10 years. When compared with the other major groups of cephalopods, the cuttlefish catch has been reasonably consistent from year to year.

The main cuttlefish catching nations in 1993 were Thailand, which supplied about 30% of the total and Vietnam, whose catch has been expanding over the past five years to reach 15%. Other countries catching significant volumes include France, Japan, Italy, Taiwan, Morocco and Spain.

Cephalopods form a group of species in which significant international trade occurs. In 1993 the volume (as totalled imports) measured in excess of 850,000 tonnes. None of the species is particularly robust as fresh product so trade in this format accounted for only 4% of the total, with frozen making up 93% and dried/salted 3%. The main consuming areas/nations are Japan (45%); other Asian countries, particularly Korea (32%); and the Mediterranean countries (15%).

Cuttlefish fits into this market profile and more detailed information for the European area is given below. In the same way that finfish species such as cod are traded in a variety of forms and presentations, so are cuttlefish.

7.2 Europe

The countries within Europe which exhibit a strong demand for cuttlefish are those which, historically, have been major catchers of the species and where cuttlefish have entered the nation's cuisine. The markets in Spain, Italy, Greece, Portugal and Southern France are such that their home-based fleets are unable to meet demand and significant volumes are imported. The situation in the more important of these countries is explored below. It should be noted that the market for cuttlefish cannot sensibly be considered in isolation. The consumption in any one country will be a function of the price of competing foodstuffs (especially other cephalopods), which in turn will be affected by the relative strengths of currencies and market demand elsewhere.

The data which follow are far from complete but do give an indication of the relative importance of cuttlefish in the various countries.

7.2.1 Italy

The Italian catch of cuttlefish is around 15,000 tonnes/annum, caught both in the Mediterranean and in north west African fisheries. The main suppliers of imported product in 1993 were:-

Thailand	9000 tonnes
France	6000 tonnes
Mauritania	4000 tonnes

Italian exports of cuttlefish are not discernable from statistics, being summed with squid. Trade contacts state that Italy is a significant exporter to other Mediterranean countries and also to Japan. Such exports include some secondary processed items. Italian manufacturers provide cuttlefish processing machinery. It is likely that Italy is the second largest consumer of cuttlefish in the EU.

Table 9 - Italian Market for Cuttlefish 1984-1992

	Catch ('000 tonnes)	Imports ('000 tonnes)	Exports ('000 tonnes)	Apparent Consumption ('000 tonnes)
1984	13	9.3	Not known	<
1985	15	10.9	Not known	26
1986	15	11.1	Not known	26
1987	14	11.5	Not known	26
1988	16	23.2	Not known	29
1989	11	26.6	Not known	28
1990	10	32.1	Not known	42
1991	15	26.9	Not known	42
1992	11	25.2	Not known	36

7.2.2 Spain

Spain catches about one quarter of its domestic needs for cuttlefish, the other three quarters being imported. The main sources of imported product in 1993 were:-

India	10000	tonnes
France	7000	tonnes
Morocco	4000	tonnes

Spanish exports are relatively small (though larger than the UK catch). Much of the product is sold whole, though some is cleaned and the tentacles stuffed in the tube. Export markets include Portugal and Italy.

Table 10 - Spanish Market for Cuttlefish 1984-1996

	Catch ('000 tonnes)	Imports ('000 tonnes)	Exports ('000 tonnes)	Apparent Consumption ('000 tonnes)
1984	9			
1985	11			
1986	11			
1987	13			
1988	10	25		
1989	13	31		
1990	7	29		
1991	10	28	3	35
1992	18	32	3	39
1993		34		

7.2.3 France

French catches of cuttlefish average around 13000 tonnes/annum with the source being the Channel fishery which it shares with the UK and the Mediterranean. Imports have averaged 5000 tonnes/annum over the last six years. In 1993 the main suppliers were :-

Thailand	1700	tonnes
India	500	tonnes
UK	400	tonnes
Senegal	400	tonnes

Much of the total supply is destined for the French consumer. Between one half and two thirds is exported—6000 tonnes to Italy and 7000 tonnes to Spain in 1993. (Table 11).

From the forgoing it is apparent that the main domestic markets within Europe are to be found in Italy and Spain. These two countries trade product whilst Italy also exports to Greece and other eastern Mediterranean countries. France is catching, importing and re-exporting. The UK is exporting small amounts of both fresh and blast frozen material to France, Italy and Spain.

Table 11 - French Market for Cuttlefish 1984-1993

	Catch ('000 tonnes)	Imports ('000 tonnes)	Exports ('000 tonnes)	Apparent Consumption ('000 tonnes)
1984	8			
1985	8			
1986	7			
1987	5			
1988	11	5.4		
1989	13	5.6		
1990	22	6.5		
1991	13	4.8	12.9	5
1992	13	4.3	9.6	7.7
1993		3.6		

It is acknowledged that the information above is limited. An investigation in depth is required of the Spanish and Italian markets, plus others, to ascertain what further opportunities are available to the UK.

7.2.4 United Kingdom

Two sources of data are available for the UK. Firstly, the published statistics as produced by the Ministry of Agriculture, Fisheries and Food (MAFF), and H M Customs; the second being the results of an industry survey carried out as part of this exercise.

The official picture of the cuttlefish trade is set out in the table below (Table 12). The catch statistics (probably understated) show a catch peaking in 1990, then falling back only to stabilise at about 2000 tonnes for the last two years. Imports are not significant (averaging 50 tonnes/annum) and consist mainly of frozen material. Some is cleaned, whole fish, blast frozen in blocks. Some is in a processed format –with average values in the £5000/tonnes–£6000/tonnes level. Various species are imported including the lesser cuttlefish *(Sepiola rondeleti)*, other *Sepiola* species, *Rossia* species and *Sepia*. Some of this frozen material is for home use, and some for re-export trading. Over the last five years the average quantity of fresh imports has been 8 tonnes (Table 13). Statistical records show UK exports tracking UK landings, though seasonality and product type result in timing differences i.e. landings in one year may be exported the next if frozen. Over the last five years (1990–1994) a weight equivalent to 97% of the cuttlefish landed was exported. The development of UK added value is illustrated by the proportion of cuttlefish exported frozen rather than fresh, which has grown from about 40% in 1990 to 70% in 1994. Within the export total, approximately 500 tonnes was fresh. Imports at 73 tonnes were not significant.

Table 12 - UK Market for Cuttlefish 1985-1996

	Catch ('000 tonnes)	Import ('000 tonnes)	Export ('000 tonnes)
1990	3552	45.6	2923
1991	728	75	1460
1992	1097	31	1214
1993	2116	119	1982
1994	2026	73	1691

Source: Landings - MAFF
Import/Export - Customs & Excise (C & E)

The company survey has identified the following scenario:-

In 1994 the industry reported handling just over 2300 tonnes of cuttlefish. Of this 2150 tonnes was exported; 400 tonnes fresh, the remainder frozen.

(NB The majority of industry responders do not keep detailed records thus the figures they supplied are best estimates.)

Integrating these two sets of figures would give a catch of 2100–2200 tonnes with associated exports lagging into 1995.

Table 13 - UK Imports and Exports of Cuttlefish (tonnes), 1990–1994

	1990			1991			1992			1993			1994		
	Quantity	Value (£)	Value Average	Quantity	Value (£)	Value Average	Quantity	Value (£)	Value Average	Quantity	Value (£)	Value Average	Quantity	Value (£)	Value Average
Imports - Cuttlefish															
Live fresh etc	16.3	9095	556	1.0	2178	2202	0	0	0	4.5	13751	3034	17.3	50214	2897
Frozen *Sepiola Spp*	5.9	7767	1305	0	0	0	0	0	0	1.6	3141	1953	6.1	21284	3489
Frozen Other	13.5	37500	2775	61.3	60970	994	20.1	27050	1347	17.4	43016	2467	33.4	70806	2119
Other	9.8	60039	6116	12.6	70160	5552	10.9	69229	6342	95.5	172323	1803	16.6	83088	5004
Total	45.6	114401	2507	75.0	133309	1778	31	96279	3106	119.1	232231	1949	73.4	225392	3069
Exports - Cuttlefish															
Live fresh etc	1812.2	1770218.90	976	761.2	676715	889	820.7	545865	665	564.6	738287	1307.7	492.1	917489	1864
Frozen *Sepiola Spp.*	390.7	415235	1062	68.3	50105	733	113.5	137001	1206	497.0	746883	1502.9	464.6	499600	1075
Frozen Other	700.4	750035	1070	628.6	648104	1031	279.4	288249	1031	912.8	1383441	1515.9	711.0	1205892	1695
Other	20.4	28392	1392	1.4	2606	1873	0.0	0	0	7.9	22251	2816.6	23.5	52324	2231
Total	2923.7	2963880	1013	1459.5	1377530	943	1213.6	971115	800	1982.0	2890862	1458.5	1691.1	2675304	1582

UK Markets

UK consumption of fresh cuttlefish is small. The major outlet is Billingsgate market, where a few of the South coast fish merchants have business interests and others are represented. Most of the remainder of UK fresh sales take place through other wholesalers, some market based, some independent. Their customers are specialist retailers and restaurants, particularly Chinese and Italian. Supplies are predominantly from UK sources but small quantities of fresh may be imported when none is available from these sources. Wholesalers have indicated that during the warmest periods cuttlefish may have an extremely short shelf-life, when they receive it. Some wholesalers admit to freezing down cuttlefish when available, for later thawing in times of 'famine'—unfortunately often in their small cold stores. Some have attempted to sell prepared fresh cuttlefish but with little success.

Cuttlefish are also imported in blast frozen form. A large number of size ranges are available with the larger fish fetching a better price. The material is sold to the catering trade or destined for incorporation into such products as mixed seafood cocktails and salads.

UK Catches

Cuttlefish can be caught year round, however, the life-cycle and associated migrations of the species result in a seasonal effect at any one locality. This impacts on the size of cuttlefish available at any one landing point, the volume caught and the time of year when it is caught e.g. about 60% of the total UK supply is landed into Brixham in a seasonal fishery which lasts from September, through the winter into February. The majority is taken by beam trawlers fishing cuttlefish in deeper waters and landing larger fish (500 g plus). The small inshore trawlers tend to land smaller fish. The largest cuttlefish show up on breeding grounds in the spring in areas such as off Hastings or the Isle of Wight. These fish are caught in trawls, nets and pots. Maturing cuttlefish are caught at various times on inshore grounds all along the Channel Coast (and on both sides of it), their size being dependant on the point reached in the life cycle i.e. juveniles, sub-adults or mature fish.

Anecdotal comments suggest that the fishery is being extended further east along the English Channel as time passes. Whether due to changes in the distribution of the species, or simply the result of increased fishing effort, it is difficult to say.

Freshness

Cuttlefish are generally landed dead although the static fishermen may take cuttlefish onboard still alive. The general consensus of opinion amongst the fish traders is that the beamers land cuttlefish in the best condition. This is presumably due to storage in ice in chilled fish rooms. Next best are inshore trawlers storing the catch in ice. Worst are the day boats (generally no ice) whether static gear fishing or not. We thus have the paradox of the three day old fish from beamers being preferred over some day boat fish.

Marketing
Cuttlefish are landed all along the English Channel, at ports both large and small. A relatively small number of merchants have an interest in the species thus there has to be a mechanism to concentrate the material in the appropriate places. The first step is the primary point of sale. This takes place through the auctions at places such as Brixham, Hastings and Newlyn whilst at the smaller ports the local agent/merchant will arrange a sale. The system from that point is dependant on the sale/purchase and delivery of the cuttlefish from merchant to merchant. The system is not sophisticated but it does function to move relatively small volumes of cuttlefish and other species from landing point to where it is required. If larger volumes are available at any one point then dedicated transport is made available.

Fishermen report cuttlefish as being 'aggressive' whilst merchants report cuttlefish doing damage to each other and other species—thus reducing value. Merchants also report that trawled cuttlefish tend to contain more sand, thus require more washing. The general consensus is that cuttlefish are more delicate than squid and every attempt is made to transport them as quickly as possible.

With Brixham being the point of greatest landing, several merchants/processors in the area have become heavily involved with the species. In addition to local supplies, they source product from all along the south coast with material coming from Cornwall as well as Kent, Sussex and Dorset. The bulk of the product they handle is blast frozen in large, waxed card boxes (14 kg) after washing and grading. When their own freezing facilities are inadequate they make use of public facilities in the locality or elsewhere, sometimes outside the UK.

At the smaller ports the merchants are more likely to export cuttlefish in fresh form. If freezing is carried out by these merchants then the facilities used are often inadequate. The product may be exported or sometimes held for later thawing and placing on the UK market when fresh is not available.

None of the merchants trading in cuttlefish do so to the exclusion of all else. Cuttlefish are handled alongside several other species, although the animal's ink does cause problems, especially for public cold stores freezing the product. Merchants have been slow to invest as they are aware that the species has a short life-cycle and that little is known of the stability of the stock. They have also been aware that the species has historically been taken as a by-catch and only more recently in a directed fishery. Their response has been to treat the species as a windfall for trading when available. Freezing in cold stores and even insulated trailers from articulated lorries has occurred. As a result, the quality of some of the UK frozen product has been unacceptable and some traders have been penalised financially by their foreign customers.

Only relatively recently have merchants considered investing to handle the species. Those merchants exporting cuttlefish have strong trading relationships with their customers abroad. Product specifications and production targets and prices may be agreed in advance but there is little evidence of written contracts at present. This may change, if say, the Italians' customers try to tie them down to written contracts.

Prices

Cuttlefish are no different from other fish in that the key to achieving optimum prices is to provide top quality material, of the required size, on a continuous basis at volumes which merchants/processors find appropriate.

During the course of this work significant price differentials were noted, between £4.50 and £9.80/stone. The poorest prices were made for unsorted cuttlefish from day boats landing at small ports. This is for a variety of reasons. The volumes available meant only the smaller merchants would be interested, and even they might find the economics of freezing adversely impacting, thus long journeys with associated high transport costs might result. Quality would be questionable and the unsorted catch might have a high proportion of small animals. In comparison the autumn/winter catch from beam trawlers reaps a significantly higher price. The catch is well looked after, it tends to be all of one size (and large at that), and it is available in significant quantities regularly. This allows the larger merchants/processors with their economies of scale to get involved, resulting in a better return to the fisherman. There is little that the inshore fisherman can do about the size of his catch, where it is landed or the total available. He can however ensure that his catch is handled as well as possible, and the question of grading should be discussed with his customers.

Increasing Catch Value

It is apparent that the demand from our fellow EU members for cuttlefish is such that the UK has a ready market for all the material that it is likely to catch, provided that the price remains competitive. To do this the UK could simply carry on doing what it is doing now i.e. exporting whole cuttlefish in bulk, some fresh, some frozen. The attractions are the low level of risk and the low level of capital expenditure.

The simplest way to improve on this situation would be to ensure that all the material destined for bulk freezing is frozen in the UK. Some capital expenditure would be required and any freezing capacity would need to be designed for flexibility so that other species could be handled.

To go further, i.e. into true primary and secondary processing of cuttlefish, would be to engage in a field in which the present merchants have no experience. Such a move would entail considerable risk thus would need careful evaluation.

Viewed globally, Japan should also offer opportunities for secondary processed product. Products and distribution would have to be well researched and the cheaper labour to be found in the south east Asian countries may make the UK uncompetitive.

7.3 Conclusions

7.3.1 Overview

The preceding sections describe the global patterns of trade in cephalopods and then focus on cuttlefish. The Far East dominates this sector, the Mediterranean nations have a long tradition but are short on supply, and Northern Europe is a late entrant. In these circumstances those more northern nations are acting as feeders of fresh or frozen material to the Mediterranean areas. The UK and France are both exporting fresh and blast frozen whole cuttlefish to Spain and Italy whilst Holland acts as both a trader in the species and supplies freezing capacity. Once in these southerly markets the product may be consumed locally as imported, or be further processed. Italy in particular is believed to have significant exports, to adjacent countries and to Japan.

The preceding sections contained a number of observations relating to harvesting methods, handling and transport. When these are put in the broader international context of world trade further elements of time and logistics are introduced. These factors suggested that conclusions can be drawn in a number of discrete but related areas corresponding to the main industry sections involved.

7.3.2 Harvesting Methods

- Each of the harvesting methods currently used–offshore beam trawling in winter, inshore otter trawling, inshore netting and trapping–produces a distinct catch profile in terms of the size range of fish, level of production, intrinsic quality and the seasonality of the catch.

- There is scope for most harvesting sectors to improve the handling and grading of their catches where catch levels are high enough to justify this.

- The production levels of each sector–their scales of operation–have so far determined the level of dedicated and appropriate infrastructure that buyers are prepared to provide.

- The inshore trapping sector can produce cuttlefish of the highest possible quality focussing on large size grades.

7.3.3 Infrastructure

- Improved infrastructure provision will be crucial to building a successful inshore trap fishery.

- The main area of inadequacy is in temperature control and freezing: small vessels need to be able to carry ice and freezing capacity needs to be increased.

- The seasonal nature of the trap fishery and uncertainty as to stock stability introduces elements of risk to investment in infrastructure.

7.3.4 Product Value

- The UK is constrained in its ability to add value at the simplest level by a lack of freezing capacity capable of turning out a high quality product. Contract freezing abroad is a waste of potential added value.

- UK consumption is minimal and almost certain to remain so. Any strategy aimed at adding value needs therefore to look at export demand.

- Any useful specification of possible products would require a proper investigation of market requirements. Further comment could only be speculative.

8. Discussion

This project has demonstrated that trapping is a viable capture method for cuttlefish in certain UK waters. Whether its success or viability can be transferred to all inshore areas of the Channel remains to be seen. A directed trap fishery is far preferable to taking a by-catch from set nets. Traps are much more size selective, have almost no by-catch and produce a very good quality product. If the fishery continues to develop it will allow inshore Channel fishermen to diversify their activities and divert effort from existing pressure stock fisheries.

Considering the financial implications of trapping for a vessel already engaged in netting reveals some interesting points. At the time of the trials, the vessels involved in the survey would have been using, on average, 8 fleets of trammel nets consisting of 8 nets per fleet. At current prices the total cost of this gear would be around £6,000. Buying in 10 fleets of traps as described here will probably cost around £3000 as competitive pressure affect the price of traps. A new hauler and block arrangement may also be required. All this equipment has a relatively long life however–probably five years for traps and 10 years for deck gear. Trammel nets in the Hastings area have a working life of only one year.

At the catch rates found and average prices obtained, traps should be earning a minimum of five times their initial cost for each season that they are operated. Given the relative working lives noted above then investment in traps must compare very favourably to netting.

The interest in this fishery came about as a result of problems caused by the presence of spider crabs. If, in some years, spider crab numbers are low enough not to cause these problems, then trapping for cuttlefish could be another method to be operated alongside the normal netting operations. In other words, supplementary to the gill and trammel net fisheries, rather than a replacement for them.

Where fishermen have the choice of fisheries, then the influence of market price comes to bear. If cuttlefish prices can be maintained at the relatively high levels experienced over recent seasons, then even moderate catch rates could provide acceptable returns. This would enable trapping to compete well with finfish fisheries.

For vessels such as those in the Hastings fleet, effort is naturally restricted by the vessel design and the nature of their beach launched operations. The design of the traps limits the numbers that can be operated per vessel to relatively low levels. This gives some degree of control to a developing fishery.

This project has been formed around a basic technology transfer. A fishing method/operation that has been successfully prosecuted on the French side of the Channel has been shown to work on the English side. From the gear technology point of view, this technology transfer has been progressed to produce beneficial refinements to the gear. For example, the introduction of the 'parlour' trap arrangement towards the end of the trials produced very encouraging results. It is envisaged that developments will continue as more fishermen turn to this operation.

This project has again highlighted the benefits of direct underwater observations of fish behaviour in relation to fishing gears. Observations made during these trials influenced a lot of gear design changes in the process of improving overall trap design. Changes to entrance designs have been made as a direct result of observing cuttlefish escaping between the bars of some of the entrances used. The ability to observe fishing gears in operation, *in-situ*, can provide immediate answers to questions raised during the gear development process.

The consideration of the biological and behavioural aspects of the target species has proved very beneficial to this work. Certain elements of this knowledge have been useful in offering explanations for the results and observations obtained during this project. Biological aspects have also highlighted some potential problems for a developing fishery. The consequences of the cuttlefish's affinity for fishing gear as an egg-laying site have already raised concern in the French fishery. The cuttlefish's short life span has given rise to large, often unpredictable fluctuations in catches. This tendency could prove to be a major headache for any fisheries scientists trying to manage a fishery. This unpredictability also means that fishermen may not be able to rely on the cuttlefish's presence on local grounds from one year to the next.

The work conducted on the post-harvesting aspects of the fishery highlighted a number of areas for improvements in catch handling. Cuttlefish are evidently prone to rapid spoilage if not kept chilled after capture. To maintain a good quality product they should therefore be rapidly chilled. The use of ice introduces its own problems however because the melt water will inevitably be stained with cuttlefish ink. The use of dedicated boxes may be necessary but some staining is bound to occur to woodwork or paintwork. Objections might be raised over the discharge of ink-coloured bilge water in port. On large vessels with refrigerated fishholds, storage of cuttlefish without ice in the fish hold may be acceptable, but cannot be considered as a direct substitute for ice. To maintain cuttlefish quality on smaller vessels there is no alternative but to use ice. However, at Hastings and possibly other small ports or landing areas, there is a difficulty in taking ice onboard vessel due to the lack of a quayside. If required, boxes of ice have to be carried over the beach and then hand hauled up onto the vessels prior to sailing.

Besides icing the cuttlefish, it was evident from the sea trips and these trials that other handling operations onboard vessel were neither feasible nor necessary. The gutting delay trials have shown that the gut membrane of the cuttlefish is very strong and for cuttlefish stored from capture at chilled temperatures it takes approximately 9–10 days before this membrane weakens, ruptures and effects the cuttlefish's quality. Gutting cuttlefish is not a simple operation. The process is essentially filleting with the gut removed at the same time. This processing is not suited to a fishing vessel environment. Cuttlefish washing is also not advisable as this just causes ink to be removed from the cuttlefish.

It was evident from the sea trips that some damage to cuttlefish is being caused by the capture methods used, especially the pots. Further assessment of the effects of fishing gear upon cuttlefish quality is necessary to fully assess the extent of the problem.

Investigations carried out as part of the marketing review revealed a consensus of opinion within the UK market that, at present, offshore beam trawl caught cuttlefish are preferred. This is due to the consistent use of ice, volume of supply and size of individual animals caught. Most inshore supplies to date have come from otter trawlers and netters. These take a mixture of sizes, supply is intermittent and quality has often been questionable. The trap fishery has the potential to produce consistently very large individual cuttlefish of top quality provided handling, storage and transport practices can be improved.

The chemical composition of cuttlefish meat, its nutritive value and high yield make it comparable with commercial species of finfish or crustaceans. Traditional users of cuttlefish have prepared this type of seafood in many different ways; cut into rings or small pieces and then cooked, using numerous methods. Flavours are enhanced by adding distinct ingredients, using sauces or stuffing. Prolonging shelf-life by drying, smoking, canning or marinading and fermenting adds to the versatility of the product.

Time constraints prevented a detailed look at the market for cuttlefish in the Mediterranean countries although there is a series of reports produced by the Seafish Market Development department covering general entry requirements with particular reference to multiples. There is significant support from those in the UK cuttlefish business for an in-depth analysis of the market for cuttlefish in these countries. These UK businesses are interested in investigating the possibilities of producing secondary processed products. They are looking for information on product types and presentation, packaging, pricing, distribution, manufacturing (including mechanisation) etc.

Considerable promotion campaigns in countries where cuttlefish (or cephalopods in general), were never regarded as food, except by Far Eastern or Latin ethnic groups, have been carried out. The establishment of new markets, including consumers with traditional negative attitude towards this seafood, is determined by a number of factors. The influence of those promotion campaigns and of modern developments such as tourism, international experience, advertising etc., the presentation of new processed products and the excellent natural, healthy properties of the raw material make a promising future.

9. Recommendations

These follow naturally from the observations made in a number of the preceding sections.

Further work on capture methods is required, incorporating the use of underwater observations, in order to optimise trap design.

Care of the catch on board vessels needs to be examined carefully by each skipper in order that any quality loss is minimised.

A review of market opportunities is required and, following from that, a review of the implications for infrastructure provision.

Management options need to be examined carefully at a local level–by Sea Fisheries Committees–nationally, and internationally.

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Appendix I

Form 1

Cuttlefish Survey

Vessel (No) | Date

Trap No.	Float	Trap Type (PCF / GF / PCS)	Trap Spacing Fathoms	Entrance Type	Bait/Attractant	Float Position (Relative to Nets) and Soak Time	Depth	Sea Temperature	Tide: Strength	Tide: Direction relative to float	Catch – Trap: ♂	Catch – Trap: ♀	Catch – Trap: Total	Catch – Trap: Est Weight in Stones	Catch – Equiv. comp. Net Length: ♂	Catch – Equiv. comp. Net Length: ♀	Catch – Equiv. comp. Net Length: Total	Catch – Equiv. comp. Net Length: Est Weight in Stones	By-Catch	Comments: WX	Comments: Catch (Quality, Market Price)	Comments: General

Form 2

Cuttlefish Survey

Vessel (No)	Date

Trap No	Entrance Type	Bait/Attractant	Fleet Position (Relative to Nets) and Soak Time	Catch		By-Catch	Comments
				Trap Total	Net Total		