Preliminary investigation into the feasibility of laying artificial substrates as receptors for cuttlefish eggs.

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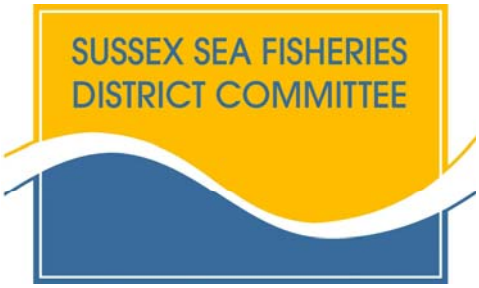

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1.0 Introduction

1.1 Overview

In the English Channel Cuttlefish (Sepia officinalis) migrate inshore into shallow waters where they are caught by a variety of fishing methods including nets, traps and trawls.

English Channel cuttlefish fisheries are not currently subject to management via quota and/or a total allowable catch. Reduced opportunities to target quota species have resulted in an increase in effort directed towards non-quota species. Since the mid 1980's there have been better marketing opportunities for cuttlefish, these combined factors have resulted in a rapid increase in the landing of cuttlefish by U.K. vessels operating in the English Channel. Sea Fisheries Committees are responsible for the management and conservation of fisheries and the wider inshore environment within their Districts. In the Sussex Sea Fisheries District traps are commonly deployed to catch cuttlefish.

Dunn (1998), in an overview of the exploitation of cuttlefish in the English Channel, concluded that 'no management measures have been introduced to maintain the channel stock(s) of cuttlefish under the increased levels of exploitation,' and commented that 'the use of cuttlefish traps has been encouraged…because traps only catch spawning cuttlefish'. Arkley et. al, 1996 notes that there may be high mortality amongst the eggs that remain attached to the traps.

In the absence of national management measures and aspects of sensitive life history within the jurisdiction of the Sea Fisheries Committees it is timely to investigate management measures that might be applied to mitigate aspects of exploitation; namely in this case to investigate novel techniques to offset egg mortality associated with the trap fishery targeting spawning cuttlefish.

1.2 Sea Fisheries Committees

There are twelve Sea Fisheries Committees (SFC's) around the coast of England and Wales. SFC's were established more than 100 years ago and are empowered to implement byelaws for the management and conservation of local sea fisheries out to 6 nm. Although their primary role is inshore fisheries management in 1995 their powers were widened to include the control of fisheries in their districts for environmental reasons. SFC's are now very much at the forefront of marine environmental protection in inshore waters. Committees are core-funded by local councils, although project-based income is becoming increasingly common as a way of implementing new fisheries management initiatives.

The Sea Fisheries Committees of England and Wales manage fisheries in the inshore zone to 6nm. by way of byelaw. The Sussex Sea Fisheries stated aims are:

"To regulate, protect and where appropriate develop sea fisheries within the Sussex District in order to ensure their sustainability both now and into the future, and to balance the needs of the fisheries in the context of a sustainable marine environment."

1.3 Management

There exists no directed cuttlefish management: no total allowable catch is allocated and no minimum legal size is applied. EC Technical Conservation Regulations allocate a mesh size requirement but this does not restrict pre-mature cuttlefish exploitation.

As quota restrictions on target species have increased, fishing effort directed to non-quota fish has increased and today cuttlefish are targeted both on their coastal spawning grounds and in their pre-adult stage. The fishery has an international dimension with the majority of the English Channel landings being made into France.

It is pertinent for the Sea Fisheries Committees to monitor and evaluate fisheries with important life history stages that occur within their competence and this principle is developed through international legislation. The management of member states inshore fisheries is consistent with certain principles of the EU Common Fisheries Policy and the 1973 treaty of Ascension Art. 100 which included a derogation authorising member states to restrict fishing in waters under their sovereignty or jurisdiction situated within a limit of six nautical miles….geographic coastal area. The derogation was reasserted in Council Regulation 170/83 establishing a Community System for the Conservation and Management of fishery resources and again confirmed in 3760/92.

1.4 Project Aims

The aim of the project was to:
Document the cuttlefish fishery off the Sussex coast and describe the fishery
Describe the biology of cuttlefish caught off the Sussex Coast
Describe the effectiveness of the current management techniques for cuttlefish management
To evaluate the effectiveness of techniques to mitigate egg mortality associated with fishing practices (with reference to designing media with post consumer waste).

2.0 Biology

The bulk of the English channel cuttlefish population has a 2 year life cycle (Boucaud-Camou et. al., 1991). The species spawns in spring on both north (English) and south (French) Channel coasts (Boucaud-Camou and Biosmery, 1991; Dunn 1999). The main period for recruitment to the fishery is October to November, when young of the year migrate offshore to wintering grounds. A second group of recruits is observed in March-April when the stock migrates to inshore areas. These recruits are considered to be animals born late in the hatching season, which experience slower juvenile growth than the first group (Medhiob, 1986; Royer, 2002). The stock is thus composed of two overlapping annual cohorts (including 2 subgroups of recruits in each cohort) (Royer et. al 2006). From March to September Cuttlefish (*Sepia officinalis* L.) congregate inshore off the Sussex coast to lay eggs.

Growth is rapid and seasonal, growth rates suggest that early hatched individuals grow faster than animals hatched later in the summer (Challier et. al., 2002).

2.1 Spawning

Eggs are laid on suitable biogenic substrate that includes the tubes of polycheata, Zostera sp. and algae. Cuttlefish eggs are also laid on artificial substrates, including the fishing gears that are deployed to catch them. The number of eggs laid will vary, but their total volume will be about half of the females' body size.

2.2 Recruitment

Recruitment variability is a complex phenomenon. It can either be related to abiotic factors affecting juvenile growth (and thus age-at-recruitment) or to density-dependent factors. Temperature used as a proxy of environmental conditions showed significant effect on recruitment success in *Illex illecebrosus* (Dawe and Warren, 1993; Dawe et al., 2000) and in Loliginid squid (Robin and Denis, 1999). On the other hand, density-dependent survival seemed to play a more significant role in recruitment in *Loligo gahi* (Agnew et al., 2000). In this stock and at high biomass levels, a negative trend is observed between spawning biomass and subsequent recruitment. All of the factors must be taken into consideration in order to understand recruitment variations. Stock assessment based on recruitment predictions will only use a subset of predictable variables.

Table 2.1 Cuttlefish Life History Schematic

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<tr><td colspan="2">Egg</td><td colspan="10">Juvenile, growth</td><td colspan="3">Sexual maturation</td><td colspan="6">Adult</td><td colspan="3">Adult Reproduction</td></tr>
<tr><td colspan="2"></td><td colspan="10">Juvenile, growth</td><td colspan="6">Sexual maturation</td><td colspan="3">Adult Reproduction</td></tr>
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2.3 The Cuttlefish Fishery

In March inshore boats based from Sussex ports target cuttlefish through a variety of methods including static gear; nets and pots, and trawls. Typically the inshore fishery involves vessels less than 10m in length targeting cuttlefish in traps, whereas an offshore trawl fishery exists predominantly in the Western English Channel using stern and beam trawls. Traps are baited with either a reflective/white media or more commonly a live female cuttlefish. Both male and female cuttlefish are trapped. The fishery is significant in economic terms and represents an increasingly important part of the inshore fleet's catch.

Figure 2.2 A cuttlefish trapping boat

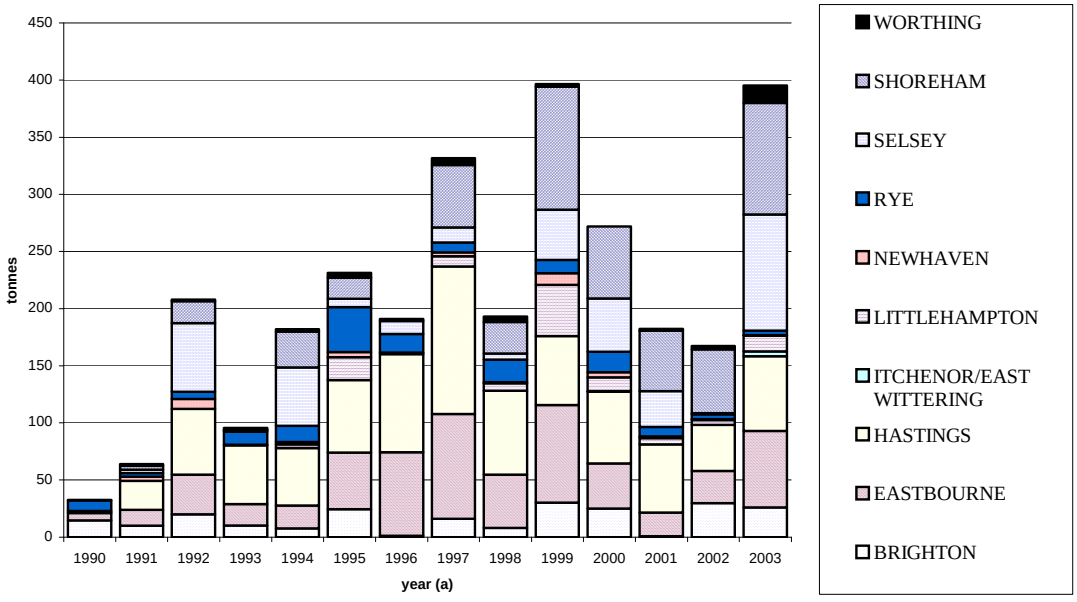

Figure 2.3 Chart showing the landings of cuttlefish into the Sussex District 1990 – 2003
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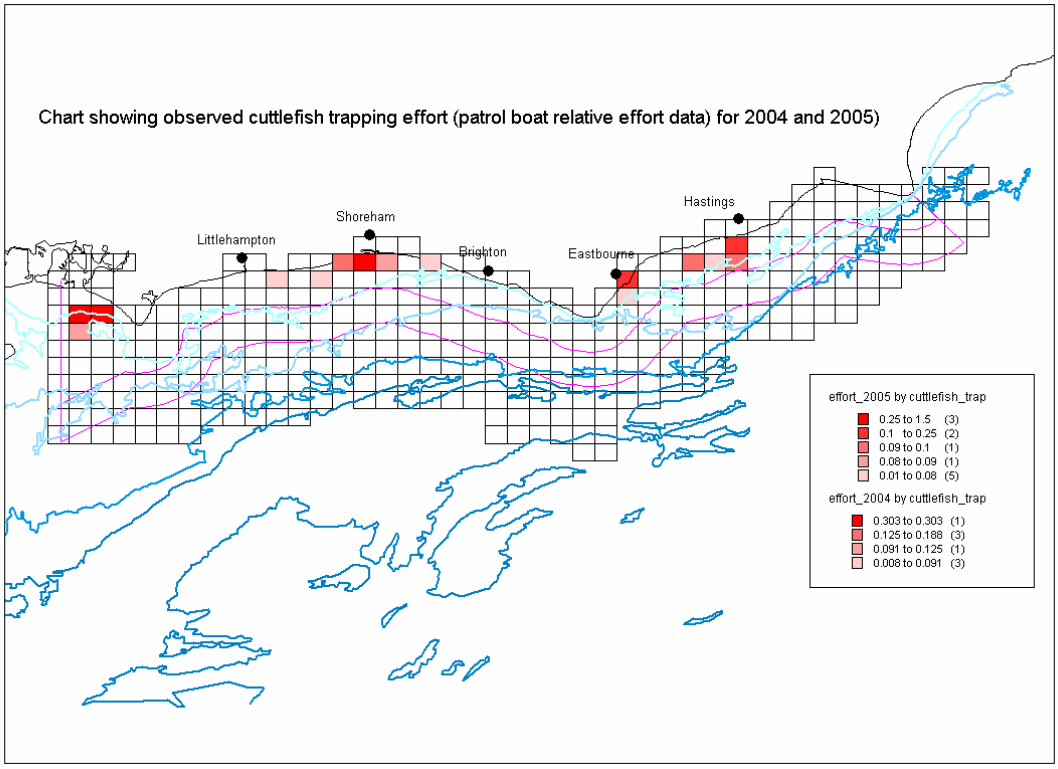

Figure 2.4 Chart showing observed cuttlefish trapping effort (patrol boat data) for 2004 & 2005

2.4 Fisheries induced egg mortality

Habitat degradation due to anthropogenic influence increases egg mortality. The direct removal of cuttlefish eggs that are laid onto traps limits egg survivorship. Egg mortality is a function of the traps being worked once eggs have been laid on them. It appears that damage associated with this activity is a function of physical removal and destruction as opposed to the pressure changes the hauling of the gear subjects the egg too. Whilst egg mortality is experienced at the trap during fishing, the major factors limiting survivorship are the removal and cleaning of traps with eggs laid upon them.

This impact may be significant as anecdotal evidence suggests that divers in Pevensey Bay do not commonly observe eggs on natural substrates/ biota. This may indicate an absence of suitable laying media. However it may be simply that cuttlefish are more attracted to traps. Cuttlefish have highly developed vision and are predisposed to entering a trap as this represents a confined area (or so various studies have demonstrated). The result is large numbers of eggs are laid on traps. In the Gulf of Moribihan it has been estimated that an average of 28 million eggs are laid every three years on traps.

Figure 2.5 A cuttlefish trap with eggs

3.0 Materials and Methods

To establish the opportunities to offset the impact of cuttlefish trap egg induced mortality an experimental deployment of egg receptors was undertaken. Two artificial egg receptors were deployed off the Sussex Coast in an area identified as being associated with the presence of gravid female cuttlefish. These areas were established with consultation with the project partner, a cuttlefish fisherman operating from Sovereign Harbour, Eastbourne.

Figure 3.1 Sampling aboard M.F.V. Halycon

The cuttlefish egg receptors were designed and manufactured by the project partner using a primary rope (a backline), weighted at each end with anchors and with floating rope attachments (suspended in the water with floats). At each end a Buff and tide-breaker was attached to facilitate location and lifting of the gear. The egg receptor was deployed during the cuttlefish egg laying season and checked at regular intervals to monitor utilisation of the techniques.

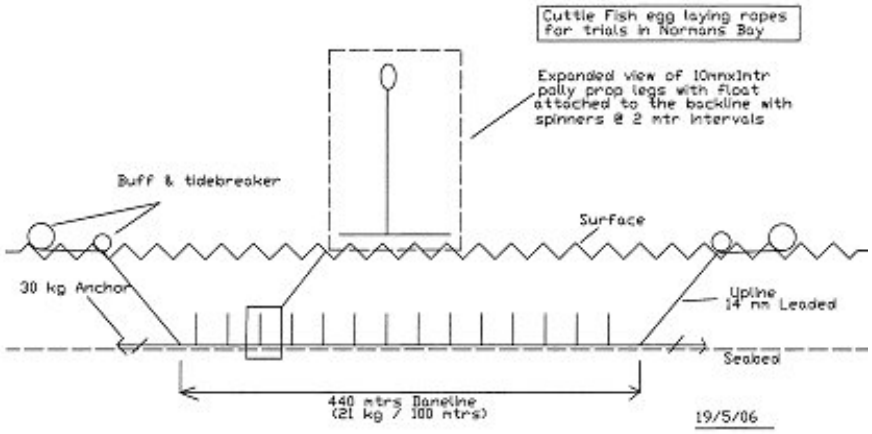

Figure 3.2 Schematic representation of cuttlefish egg laying ropes

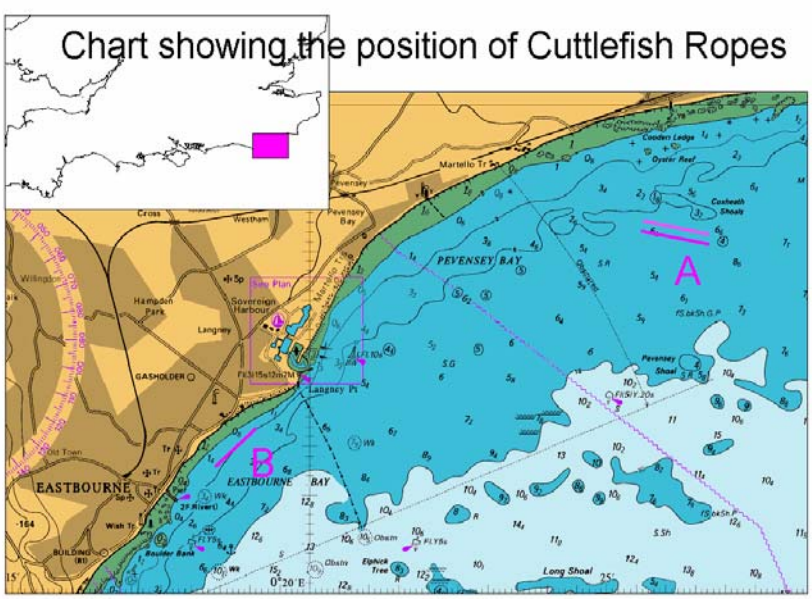

Figure 3.2 Chart showing position of cuttlefish ropes

3.1 Sussex SeaSearch

In conjunction with the deployment of the cuttlefish egg receptor a preliminary investigation was made of the local seabed. This was undertaken using divers and a remotely operated vehicle. The purpose of this investigation was to qualify the utilisation of seabed flora and fauna as egg receptors. The diver part of the survey was conducted in conjunction with the Sussex SeaSearch organisation.

SeaSearch is a volunteer diving project that aims to increase knowledge of the marine environment around the UK and contribute towards its conservation through participation of SCUBA divers, whose objectives are to gather information on UK seabed habitats and associated wildlife through participation of SCUBA divers. SeaSearch provides standardised training to enable SCUBA divers to participate in marine surveys. They ensure the quality of data gathered and make available the data collected through SeaSearch to raise awareness of the diversity of UK marine life and its environment.

3.2 Project diary

16th	June	Cuttlefish receptor deployment
25th	June	Cuttlefish receptor preliminary assessment
6th	July	assessment
16th	July	seabed survey and assessment
30th	July	redeployment of ropes
3rd	October	recovery of ropes and redeployment in sheltered water

4.0 Findings

Initial cuttlefish egg receptor deployment took place on the 16th of June 2006 into an area marked on the chart as 'A'. This area was in the immediate vicinity of cuttlefish traps. After the successful deployment of the ropes an assessment of their use by cuttlefish was made using a Remotely Operated Vehicle (ROV) travelling along the egg receptor line. Unfortunately the 2006 recruitment to the fishery was below average (based on anecdotal data) and due to time delays the initial deployment did not attract significant cuttlefish egg laying. A decline in the capture of cuttlefish in the nearby traps indicated that the abundance of catchable cuttlefish had declined.

By monitoring which traps were coming up with new eggs attached to them it was possible to locate areas where spawning cuttlefish were still congregating. An assessment of catch per unit effort revealed that the area of the initial deployment was no longer the optimum deployment site. A decision was taken to move one of the receptors further to the west (between Eastbourne and Sovereign Harbour) where traps were more frequently still fishing (and having eggs laid upon them) this area is marked on the chart as 'B'.

Soon after the redeployment of the ropes eggs began to be laid. Soon after rope redeployment a survey revealed that of the 40 uprights on the string, c. 50% had cuttlefish eggs laid upon.

Eggs were laid on average 300mm off the ground rope and the legs (uprights), which were located closer to the ends of the strings were colonised more frequently than those in the centres of the strings. The ends of the strings were closer to the anchor points and it is therefore likely that those locations were preferred due to possible (though limited) movement due to tide in the centre of the strings.

On the third investigation of the receptors further egg laying had taken place and also hatching. During the period the receptors were in place some poor weather was experienced but previously utilised upright legs did not lose their eggs, once more however attachment was more frequent at the ends of the strings.

The final survey of the receptors was achieved by lifting the eggs to the surface. At this time a reduction in eggs was noticed due to hatching. As cuttlefish were no longer being caught in the vicinity the receptors were retrieved and the uprights from the strings carefully removed, then placed in an aerated tank and taken the short distance back to Sovereign Harbour, Eastbourne. The egg-encrusted ropes were then placed in netting and put in sheltered water. Hatching of the eggs was observed using an underwater camera. Hatching from the ropes occurred from week one to week six when the experiment was concluded. Hatching was successful with high levels of hatch survival (over 90%).

Figure 4.1 Retrieval of cuttlefish ropes

Figure 4.2 Cuttlefish eggs on cuttlefish ropes

Figure 4.3 Cuttlefish eggs transferred to nursery for hatching assessment

4.1 Dive/ROV results

The ROV monitoring technique proved useful but only at times of slack water and in settled conditions. The commissioning of a diver-based survey was beyond the scope of this project due to the cost and safety implications.

By utilising the data collected by the independent dives conducted by Sussex SeaSearch a useful preliminary investigation of the vicinity was achieved. In addition to the SeaSearch survey protocol divers were trained and set about specifically looking for cuttlefish eggs on the seabed. Dive returns consistently reported limited or no cuttlefish eggs on the seabed. The results were surprising and corroborated evidence from other local divers from the area. Whilst this result is interesting a more thorough survey would be required to evaluate the relative abundance of cuttlefish eggs based on a more robust survey design.

5.0 Conclusions

The study demonstrated that a high level of egg mortality occurs as a result of the inshore cuttlefish trap fishery, the literature however demonstrates that this type of fishery is potentially the most sustainable fishery on this resource. Furthermore the techniques that are deployed to target cuttlefish on their inshore spawning congregations are very selective and are associated with little or no bycatch. During this survey no bycatch was associated with trapping.

The deployment of cuttlefish egg receptors proved that it is possible to set artificial media to attract the placing of cuttlefish eggs, and that the use of such media can be done in such a way as to release cuttlefish once spawned.

The project showed that cuttlefish eggs were far more common on cuttlefish traps than on the surrounding natural features.

The project did not show that the placement of artificial media near to cuttlefish traps offset the mortality of eggs on traps.

6.0 Recommendations

Having demonstrated that cuttlefish will lay their eggs on artificial media not associated with cuttlefish traps techniques could be developed to mitigate the impact of cuttlefish trapping that are associated with the trapping process itself. In future work should concentrate on the placing of removable receptors on the traps which, once covered in eggs can be removed and returned to the sea. This would provide a medium for eggs to be laid on by the cuttlefish that are trapped in the traps, and those that surround the trap when it is in the water, whilst facilitating the normal working of the trap and the removal of the eggs upon the completion of fishing.

6.1 Opportunities for post consumer waste utilisation

Replacement of fishing nets is an ongoing process for commercial fishermen. The ropes and attachments used in fixed gear could be redeployed as part of cuttlefish receptors. This has multiple benefits;

1) it reduces the cost of deploying cuttlefish receptors
2) it reduces the cost of disposal
3) it means that materials for the manufacture of egg receptors are readily available.

6.2 Marketing Opportunities – advice from Marine Conservation Society

Increasing consumer awareness of conservation issues is translating into purchase decisions. Organisations such as the Marine Stewardship Council are awarding accreditation for sustainably managed fisheries and the Marine Conservation Society are providing advice on

which fish are sustainably exploited. The Marine Conservation Society advice for cuttlefish is ‘Taking cuttlefish in traps is generally a more selective fishing method and less damaging than trawl fishing. However, cuttlefish are caught in traps when they come into inshore waters to lay their eggs and when eggs are laid on the traps they are destroyed during harvest. Where available look for cuttlefish taken in fisheries where measures have been adopted to protect cuttlefish eggs, e.g. Brittany. These measures include leaving egg encrusted cuttlefish traps in sheltered areas of the sea to allow the eggs to hatch and providing a removable surface on the outside of the traps on which cuttlefish can lay their eggs’.
It is likely therefore that projects which increase the sustainability of stocks may increase the value at market of fish as levels of consumer awareness increase.

6.3 Benefits of the Project

Defining areas for fisheries developments
Confidence in investment for improved fisheries
Support for UK industry supply businesses
Support for long-standing fishing industry members
Communication between fishermen and other stakeholder organisations
Improved understanding of cuttlefish egg laying habits

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