CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE

SHELLFISH NEWS

NUMBER 12

NOVEMBER 2001

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

DEFRA
Department for **Environment, Food** & **Rural Affairs**

CEFAS is an Executive Agency of the Department for Environment, Food and Rural Affairs (DEFRA)

* ‘SHELLFISH NEWS’ is produced and edited by CEFAS on behalf of DEFRA, Fisheries II Division.

* It is published twice yearly (May and November) as a service to the British shellfish farming and harvesting industry.

* Copies are available free, on request to the editor.

* Articles, news and comment relating to shellfish farming and harvesting are welcomed and should be sent to the editor. The deadline for the next issue is Friday 5th April 2002.

* The views expressed in this issue are those of the contributors and are not necessarily the views of the editors, CEFAS or of DEFRA. The editors reserve the right to edit articles and other contributions.

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CONTENTS Page

ARTICLES

OYSTER PIONEER DIES

Clive Askew
The Shellfish Association of Great Britain, Fishmonger's Hall, London Bridge, London, EC4R 9EL

A Legacy of Native Oyster Revival

One of the leading personalities in the oyster farming business, Clarrie Devall, died on 30th August. Although he was one of the remaining few 'old timers' of the industry, Clarrie was also one of the most imaginative and forward thinking to the end. His company, the Essex Oyster and Seafood Company had established large scale Pacific oyster farming since its foundation in 1988. More recently it was the industry partner in the major LINK Funded study on native oyster physiological stress resistance to *Bonamia*, which was reported in last November's issue of Shellfish News.

Clarrie Devall (1922-2001)

It was Clarrie's conviction that some aspects of traditional oyster cultivation were less stressful to native oysters and this might be the key to survival in those areas where *Bonamia* is present. This provided the impetus to the study, which was carried out by a team at Southampton Oceanography Centre, headed by Dr. Lawrence Hawkins. It confirmed his view and provided a scientific understanding of the mechanisms reducing physiological stress. Until now, native oyster cultivation using hatchery-reared spat has rarely yielded survival rates that would be commercially acceptable. In this experiment, the oysters were laid directly on the bed in Goldhanger Creek in the Blackwater Estuary at densities of 10, 20 and 30 per square metre. A comparison was also made with similar oysters held in bag culture on racks just above low water spring tides, so they were just drying. As well as being laid at low density, minimising any disturbance to the oysters was the other key element to the methods used.

The oysters from the various trial lays were then subjected to experimental challenge by *Bonamia* and a number of methods were used as measures of susceptibility and health. Throughout the project there was no indication of infection by *Bonamia* among the oysters at the site. The first two years of growth were critical and growth during this time was inversely

Native oyster plots in the River Blackwater

proportional to stock density. After that the differences did not show much in terms of growth, but the various indices of 'immunocompetence', their ability to resist diseases, continued to show benefits from low stock density, and low tidal exposure. The oysters in bags showed much poorer resistance, which has been commercial experience. Although the hatcheries have been able to produce native oyster seed for some thirty years, mortality during the nursery and on-growing stages has, until now, defeated commercial success.

This study, which Clarrie Devall fought so hard to start and which he supported so fervently has provided a scientific basis for a future strategy for native oyster cultivation. Parallel work done by Seasalter Shellfish and Gary Wordsworth in Poole Harbour is taking a similar direction, with native oysters set at the hatchery on cockleshell, but again grown on as low density. The industry can now see a new way forward in farming Native Oysters, at last using hatchery seed, largely thanks to the vision of this pioneering Essex grower.

RESTORATION OF NATIVE OYSTER BEDS IN STRANGFORD LOUGH, NORTHERN IRELAND

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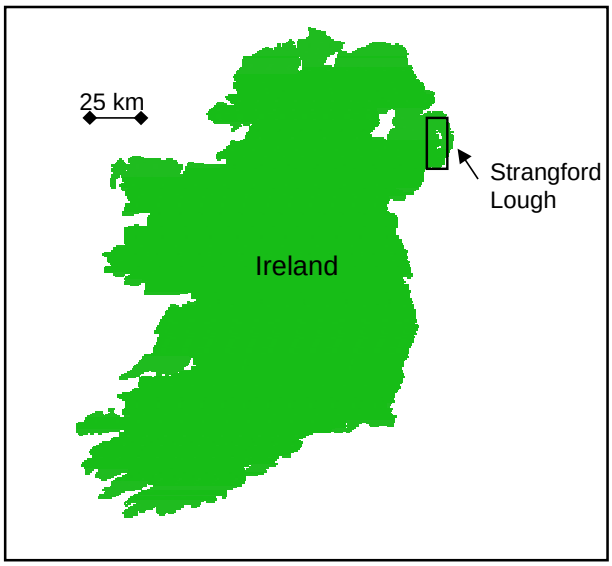
An historical perspective

Historically, Strangford Lough had a productive oyster fishery supporting up to 20 oyster dredging boats. This fishery, first documented in 1752, was already in a state of decline in1877, when fishermen complained of falling catches. By 1903, oyster fishing in Strangford Lough had effectively ceased. In more recent times live specimens of *Ostrea edulis* have been recorded both inter-tidally and sub-tidally at various locations around the Lough. Both native and Pacific oyster spat showed favourable growth in trials conducted in the Lough in the 1970s but since then commercial production has focused primarily on Pacific oysters. In addition, the Lough is fully saline which would afford a degree of protection against *Marteilia refringens*, which favours reduced salinity, and the area is considered free from *Bonamiae ostreae* because there have been no dense populations of *O. edulis* for over 100 years. These observations suggest that there is great potential for flat-oyster production in Strangford Lough.



The location of Strangford Lough in Ireland

Re-establishment of the beds

This promising potential did not go un-noticed and between 1997 and 1999 a local Co-operative embarked on an EU funded project aimed at re-establishing oyster beds to support a sustainable oyster fishery in the Lough. Oyster-bed re-establishment involved laying cultch and seed and re-laying native adults at selected sites. During the same period, a baseline survey was initiated to establish the status of *O.edulis*, and monitor larval production and spatfall patterns in the northern part of the Lough, as part of a Ph.D. project. Oyster and cultch densites were estimated using random 0.25 m^2 quadrats along 100 m transects at 16 sub-tidal and 11 inter-tidal sites. Plankton samples were taken in summer and autumn to monitor oyster larval densities at 8 sites, and subsequently spatfall was monitored on slate spat collectors at 11 sites. Cultch was deployed sequentially over the study period at 9 sites to monitor fouling levels.

Survey results

Field surveys revealed natural cultch cover at between 0 and 70% and extremely low densities of oysters (1-2 per 1000 square metres) in the areas surveyed. By contrast, densities of *O. edulis* on commercial oyster mats ranged between 66 and 100 individuals m^{-2}. In 1997 plankton surveys revealed larval densities from less than 1 m^{-3} to 17 m^{-3}. Densities peaked in August and September and were highest in the outflows from embayments where large commercial stocks of *O. edulis* (over 100,000 individuals) are over-summered by Cuan Sea Fisheries. Spatfall was evident at 6 of the 11 sampling sites in 1997 and is probably attributable to larval production by over-summered commercial oysters.

O. edulis on commercial oyster mats in Strangford Lough

Initial success

Has this restoration strategy worked? It seems so; this year the fishermen's co-operative has started to take the first harvest of native oysters from Strangford Lough for nearly 100 years. Further surveys are planned for next year to gauge the scale of oyster settlement and recruitment at selected sites in Strangford Lough in order to develop a model for optimal sustainable harvesting.

Newly settled oyster-spat on slate spat collectors deployed in Strangford Lough in late summer 1997

Acknowledgements

The authors would like to acknowledge the time, help and generous advice provided by Jasper Parsons, Cuan Sea Fisheries, and Malcolm Carter and David Clarke, Strangford Lough Shellfishermen's Co-operative

Further information

Kennedy, R. J. & Roberts, D. (1999) A survey of the current status of the flat oyster, *Ostrea edulis*, in Strangford Lough, Northern Ireland with a view to the restoration of its oyster beds. *Biology & Environment* [*Proceedings of the Royal Irish Academy*] Vol. 99B, pp 79-88.

ABALONES - NEW PROSPECTS FOR CULTIVATION?

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Introduction

Abalone were introduced to Ireland in the 1970s as a potential species for commercial aquaculture. Despite establishing hatcheries and cultivation techniques for two species (*Haliotis tuberculata* and *Haliotis discus-hannai*) the industry has been slow to develop. Low winter sea temperatures mean that grow-out times often exceed five years, exposing producers to losses from equipment failure and toxic algal blooms.

Trials in closed systems

In the summer of 2000, C-Mar established a small re-circulated seawater system at its base in Portaferry. The system was based on a commercially available Tropical Marine System 5000, which was modified to include heating and cooling units. The system was allowed to condition for two months before the introduction of abalone. The cultivation system was held at 17°C ± 2°C and salinity varied between 31ppt and 35ppt. Oxygen levels were always in excess of 85% saturation. Abalone juveniles (2,000 of each species) were purchased from Boet Mor Seafoods in Clifden, Co. Galway in October 2000. The juveniles had an average shell length of 6 mm.

Juvenile abalone were separated into cultivation baskets (28 cm x 28 cm x 17 cm) and held in flow trays with a mean water depth of 10 cm. Shelters consisting of two semicircular pieces of pipe were placed in each basket. Each basket contained 125 individuals of one species and was provided with one of four dietary regimes:

- Amos and Amos Pellet (Australia)
- Redmills Pellet (Ireland)
- Dulse (*Palmaria palmata*)
- Mixed diet of 1:1 dulse and Redmills pellet.

All diets were allocated on a dry weight basis and feeding rates were 3% of abalone biomass per day. Feed always appeared to be in excess. Uneaten food was removed every other day by siphon. Water removed by the cleaning process was replaced with 20 µm filtered seawater.

Haliotis tuberculata in the experimental system

System performance

The cultivation system requires 1 kw per hour to run the recirculation and tank feed pumps. In addition approximately 10 kw per day were required to maintain the water temperature during the period between November and April.

Water replacement after cleaning amounted to 4% of the system volume each day. Ammonia levels were monitored within the system periodically but never rose above 2 µmoles l^{-1}.

Abalone Survival and Growth

H. discus-hannai suffered high mortalities (30-60%) in the first two months of cultivation on all diets. Subsequent mortalities were lower and overall survival remains around 50% Growth rates were variable on all diets with a number of animals in each basket not reaching 10 mm after 7 months. Colour variation was evident, with *H. discus-hannai* fed on dulse and the mixed diets being red in colour and those fed on pellet diets being predominantly blue-green.

H. tuberculata suffered significantly lower mortalities than *H. discus-hannai*, with overall mortality less than 10%. Colour variation was evident, with *H. tuberculata* fed on dulse and the mixed diets being pink in colour and those fed on pellet diets being predominantly pale green. The highest growth rates were observed in animals reared on the Amos and Amos diet.

Current predictions for growth of both species suggest grow-out to market size (100 g) will be achieved in two and a half years.

Haliotis discus-hannai fed the Amos and Amos pellet diet

Conclusions

The pilot scale trials indicated that it is possible to cultivate *H. discus-hannai and H. tuberculata* in a closed system and achieve better growth rates than are possible in open sea culture in Ireland. The best growth rates were achieved by *H. tuberculata* reared on the Amos and Amos diet, but coloration on this diet may not be desirable for marketing.

THE WASH MUSSEL FISHERY: STEPS TO ITS RECOVERY

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Background

Stirling Aquaculture, a commercial arm of the Institute of Aquaculture at the University of Stirling, was commissioned by the Kings Lynn Fisheries Industry Co-operative Ltd to undertake a five month project as a preliminary scoping study on factors affecting the re-establishment of the mussel fishery of the Wash. Following considerable discussion and concerns about the future of the Wash mussel fishery, the Co-operative wanted data on how the natural stocks within the fishery were performing alongside the managed mussel lays. The study was therefore required to address the following points.

- Identify which are the most productive and least productive areas for adult mussel production and to determine how this relates to the current protected beds and what the implications are for the future re-establishment of the fishery.
- Determine larvae /settlement dispersion patterns and abundance, and the implications of these findings for future re-establishment of the fishery.
- Suggest potential management initiatives from these findings especially for maintaining a sustainable resource through husbandry measures, fishing strategies and adequate site selection for ongrowing and seed supply.

The survey

Five survey sites were set up and monitored each month in terms of reproductive health of the mussels (*Mytilus edulis*). In addition, work was carried out on water quality, larval dispersion and settlement to allow a comprehensive overview of the situation within the mussel ecosystem to be built up.

Ben Lowen sampling on the Gat sands (Photo courtesy of David Bryant)

The results showed that the most productive areas of the Wash, in terms of spawning behaviour, sex ratios, body condition and rate of recovery of body condition in the mussels were on the south-eastern side of the Wash. The least productive area was the Gat bed, the one remaining "natural" site. It was concluded that since this site is exposed for the longest period during low tide the mussels here have less feeding time, accounting for many of the observed differences. The mussels of the Gat beds and the Boston lays also had marked differences in sex ratios (see Figure 1) and gamete development, and also a very high incidence of pea crabs and shell worms compared to the stocks on the south-eastern side. Overall indications, however, were that the mussel stocks as a whole were not stressed and that environmental conditions had actually improved since 1996.

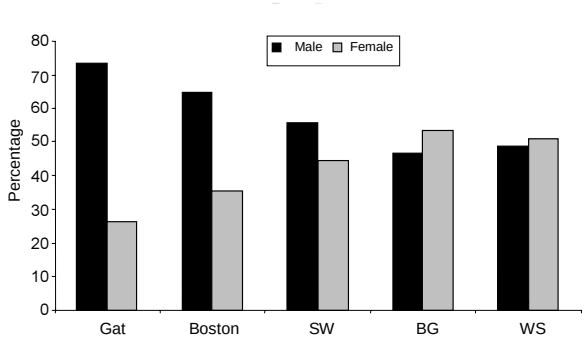

Figure 1. Sex ratios of Mytilus adults at the five surveyed sites, during May to August, 2000

Results from larval trawls showed considerable potential for re-establishment of mussel stocks in the south-eastern part of the Wash. Starfish predation and unauthorised collection of seed from the Gat beds were clearly indicated as working against the successful re-establishment here, but neither could be quantified during such a short study period. However, since this study some action on the latter has been reported in the paper 'Wash Shellfish Recovery' given by Chris Amos of the Eastern Sea Fisheries Committee at the Shellfish Association of Great Britain's Conference of 22nd -23rd May 2001 in Fishmongers' Hall, London.

The commissioned study report indicates that finding ways of preserving and enhancing spawning stocks are vital. It is also clearly important to determine in more detail where suitable sites for settlement and ongrowing might be; also of finding ways to help fishermen to utilise mussel seed within the water column effectively, and the general need for research on the impacts from predation.

The Wash is not only a huge area but also has a large number of stakeholders in the fishery and other uses of the area as a whole. Finding a way to fund further research through so much stakeholder interest will be difficult, with sponsoring a PhD research programme being one of the least expensive but most flexible options. To this end, it was hoped to continue the present work by obtaining funding for a research training scholarship for Ben Lowen who was employed by Stirling Aquaculture as project scientist to the original study. Unfortunately Ben has been asked to undertake a similar piece of work towards a PhD in Canada.

A conclusion from the commissioned study showed provision of more research is essential to help make the Wash, once again, the most productive shellfish producing area in the UK. What is now required is finding the best means to get the work done.

Further information

Information for this article is taken from the report: Lowen, B., Brown, J.H, Telfer, T.C. and Bostock, J.C. 2001 "The Mussel Fishery of the Wash: A scoping study of factors affecting its re-establishment." Report to the Kings Lynn Fishing Industry Co-operative Ltd. by Stirling Aquaculture, University of Stirling. April 2001. 68pp.

INITIAL COCKLE RELAYING TRIALS USING STANDARD HYDRAULIC COCKLE HARVESTING EQUIPMENT

Joss Wiggins
Kent and Essex Sea Fisheries Committee

Background

Annual cockle spat settlement in the Thames estuary is variable and inevitably more consistent on some grounds than others. In 1998 there was a strong settlement in a number of areas. It was decided, in collaboration with the local industry, to run initial trials to look at the possibility of using the existing commercial solids handling pump hydraulic cockle dredging equipment to relay cockles.

This initial assessment involved a fairly informal exploration of possible techniques in order to assess whether it would be worthwhile proceeding with development of the idea.

Trial relaying of cockles was undertaken during 1999 and again during 2000 and the two aims of the project were as follows:

1. To give an initial indication of the feasibility of relaying cockles. The idea would be to thin out stock in areas where growth is likely to be stunted, due to excessive population density, and to take advantage of enhanced growth by relaying in areas of low density stock, where growth rates can be expected to be above average.

2. To gain further information on the likely survival rate of undersized cockles normally rejected by the commercial harvesting operation.

First Relaying Trials

In June 1999 an area of the Maplin Sands was selected for the collection of juvenile cockles where 1998 year class cockles were present at exceptionally high density (between 2,000 - 3,500 cockles/m^2). At the time of removal the mean cockle size was 11.5 mm (*shell thickness*) and mean weigh 2.1grams.

For collection of the cockles the standard commercial harvesting equipment was modified so as to retain all cockles by covering the riddle with small gauge wire mesh. This resulted in the cockles being retained throughout the whole length of the rotating riddle before falling down a shute into 0.75 tonne bags in the hold.

Relaying cockles from bags in the first trial

The first catch of 10 tonnes was taken in 50 minutes and the vessel then steamed 14 miles to a slightly sheltered shallow bay within the East Barrow offshore sand bank. The cockles were released from the bags whilst steaming at 4 knots across a previously selected plot where virtually no cockles were present.

The cockle dredger returned to the Maplin Sands removal site on the next flood tide and took another 10 tonnes for relaying at an inshore site. These cockles were laid in a similar manner within an area one mile from shore, on the edge of the intertidal coastal foreshore at Southend. This second relaying took place at high water in approximately 12-15 feet of water and there was concern that the cockles would be carried away by the tide before they could bury into the ground.

Follow-up surveys of the East Barrow site showed low densities of relayed cockles remaining within the deposit site. Further surveys carried out during 2000 also showed low densities of relayed cockles remaining within the site. This exposed offshore site is difficult to survey and it is assumed that cockles may have been washed into surrounding areas. The small numbers of cockles recovered showed very good growth. Monitoring of cockles within the second, more sheltered site was less difficult due to access by foot from the shore on spring ebb tides. On returning to the site 19 days after deposit a trail of relayed cockles could be observed within the plot. The cockles had buried into the sand successfully within strips of approximately one metre in width.

The site was again visited after 33 days and a similar situation was observed. The mean density of cockles within the strips was 770 cockles/m^2 and the mean weight was 3.26 grams. An approximate estimate of observed stock was 4.6 tonnes. It was not possible to achieve an accurate assessment of stock but it appeared apparent that a significant quantity had survived.

The site was further monitored in June 2000. The strips of cockles could still be observed but the cockles had spread out to 2.5 metres in width at a mean density of 230 cockles/m^2. Mean size was 18 mm (*shell thickness*) and mean weight was 7.3 g. The approximate estimated biomass of relayed cockles remaining was 6.2 tonnes.

Second Relaying Trial

A further relaying trial was again carried out in May 2000

The methods used were similar to those used in the previous year. 56 tonnes of 1998 year class cockles were moved from an area off the Isle of Sheppey, where stock was at densities of 1,000 - 2,000/m^2 and mean cockle weight was 2.7 grams.

Relaying cockles by grab in the second trial

The cockles were taken using a similar system except that the cockles were carried loose in the hold and the cockles were released by grab whilst slowly steaming across the selected relaying plot off Southend.

Fishermen returned to the deposit plot on the following low water and reported observing good survival with most cockles buried in the sand. Some cockles that remained in heaps were raked out onto surrounding grounds and buried on the following tide.

This site was again visited after 19 weeks and the relayed cockles were observed to remain in significant numbers within the relay site. Mean weight of the cockles was 5.7 grams.

Conclusion

These initial trials appear to indicate that relaying of cockles using standard hydraulic dredge equipment could be successful on a commercial basis and that it would be worthwhile undertaking a fully monitored relaying project and further commercial trials.

The level of survival of these relayed cockles appears to indicate that there will be significant survival of undersized cockles rejected during the normal commercial fishing operation. It is assumed that undersized cockles rejected during normal fishing operations will show better survival, as retention time in the riddle will be much less and return to the sea is immediate. There is a need for further studies of this subject.

SOME NEW THOUGHTS ON THE SPAWNING OF EDIBLE CRABS IN THE NORTH SEA

by Derek Eaton, Shellfish Resources Group, CEFAS, Lowestoft.

Introduction

Pot fisheries for edible crab (*Cancer pagurus*) occur along almost the entire length of the British North Sea coastline, and traditionally these fisheries have been essentially inshore in nature. Many crab tagging studies have been carried out in the North Sea, dating back as far as 1900, the results of which were summarised by Eric Edwards (1979). Tagging showed that whilst males and immature females were relatively sedentary, there was a northerly migration of at least part of the adult female crab population along the east coast of England and Scotland. This movement of mature females was interpreted as part of an inherent behaviour pattern in which the mature females were moving north to spawn and the larvae were drifting back south in prevailing currents to areas suitable for their settlement and subsequent survival. Tagging also showed an offshore movement of females into deeper water in the autumn prior to spawning, followed by an inshore movement in the spring. However, the interpretation of tag/recapture data is constrained by the distribution of fishing effort which was essentially inshore at the time of the studies. However, since the late 1980s, offshore crab fisheries have developed east of the Humber estuary revealing the presence of large quantities of mature female crabs. This was unexpected in the light of the theory of crab spawning and recruitment along the North Sea coast. A crab larvae survey was undertaken in the North Sea in 1999 and the results of this and two previous CEFAS surveys have been re-examined in the light of new understanding of the hydrography of the area.

Crab larvae surveys

After hatching of the eggs (usually in late June to early July) the planktonic crab larvae pass through 5 stages before metamorphosing and settling out on the seabed, a process which takes, on average, 30 – 40 days. Three surveys have been carried out, all in early July, in 1976, 1993 and 1999, targeted at the earliest stage larvae to give an indication of the areas used by crabs for spawning and incubation of their eggs. The common feature of all three surveys, which covered an area extending from the Scottish border to the Norfolk coast and out to 3° East, was the low numbers of larvae north of Flamborough Head, confined to the coastal area and the northern edge of the Dogger Bank, and the existence of a dense patch of early (stage1) larvae approximately 70km south-east of Flamborough Head, around latitude 54°N, longitude 1°E (Figure 1). The distribution of later stage larvae suggested that there was indeed very little crab spawning occurring north of 54°N, with only a slow drift to the east away from the main hatching area and to the south-east parallel with the North Norfolk coast in areas further to the south.

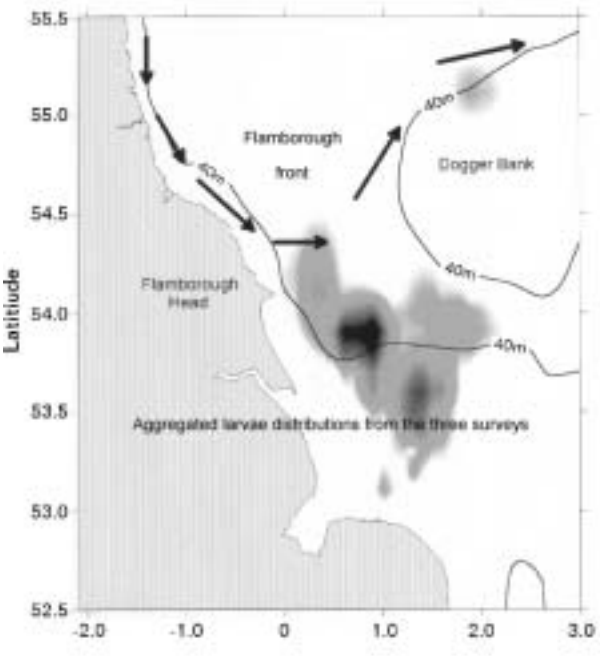

Figure 1. Aggregated larvae distributions from the three surveys

Hydrography of the English North Sea coast

During the months when crab larvae are present in the water column (generally June to October) the region is divided into two distinct hydrographic regimes. The deeper (>50 m) northern part of the central North Sea, north of the Dogger Bank, is strongly thermally stratified from late April until November. Here, a pool of cold bottom water is isolated beneath the thermocline and temperatures at the seabed seldom rise above 7°C. South of the Dogger Bank, and bordering the north-east coast of England, the combination of comparatively shallow water and strong tidal currents maintains a vertically mixed water column, where seabed temperatures typically exceed 10°C by early June. Between these two distinct regions is a zone of strong, horizontal, sea-water density gradients (known in the south as the Flamborough front.) Associated with these fronts is a strong and persistent density driven, seasonal jet-like circulation which extends south, along the English east coast as far as Flamborough Head, before moving offshore and along the northern edge of the Dogger Bank (Figure1).

Once the fronts are established there is very little interchange across them. Evidence for this comes from the trajectories of drogued satellite-tracked drifters deployed in the vicinity of the north-east coast and to the north of the Flamborough front. The drifters followed the boundary of the front passing southward parallel to the north-east coast and moving offshore to skirt the western and northern flanks of the Dogger Bank (Figure 2). An element of this work examined the incidence and possible origin of paralytic shellfish poisoning (PSP) on the east coast of the UK (*See Research News no. 20 on page 44*). There are sporadic outbreaks of PSP, caused by toxins produced by the dinoflagellate *Alexandrium tamarense*, in shellfisheries along the north-east coast of the UK. However, despite the presence of extensive shellfisheries south of Flamborough, there are no recorded instances of PSP in this area. This, together with supporting data on water masses, suggests that when established, the front acts as an effective barrier to the transport of water-borne materials in either direction across it.

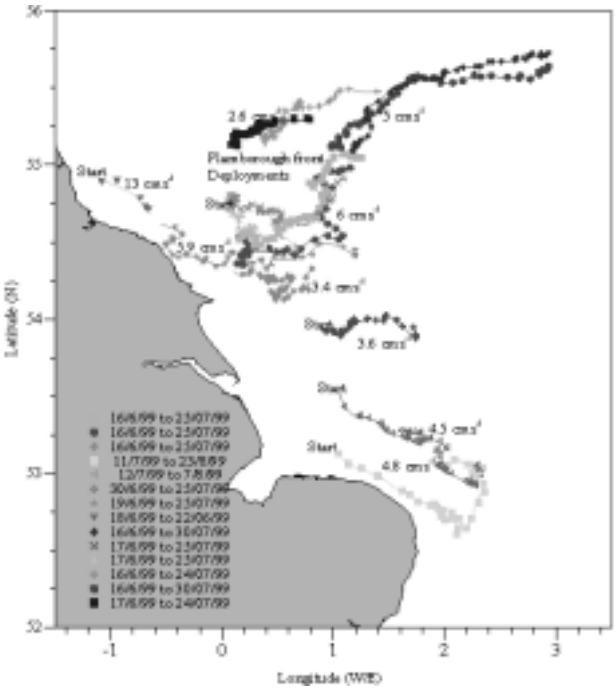

Figure 2. Filtered drifter trajectories June-August 1999

Drifter deployments to the south of the front indicate that in the main area of crab spawning there is a weak eastward advection of water. Further south the residual drift is still very weak, running parallel to the north Norfolk coast before either turning north-east towards the Dutch coast, or stagnating. There is no evidence of any significant penetration into the Southern Bight. There is some movement from the eastern English Channel into the Southern Bight, but except under conditions of prolonged easterly or southerly winds, the residual drift is north-easterly along the French and Belgian coasts and away from the English coast.

Discussion

Spawning and larval development in the edible crab are both dependent upon temperature and neither are triggered below 7 or 8°C. The observed spatial pattern of the crab fishery closely matches the observed distribution of stage 1 larvae and sea-bed temperatures above 7°C at the onset of hatching. If the distribution of stage 1 larvae is assumed to mirror the distribution of spawning females then it suggests that spawning female crabs are generally restricted to the shallow waters south of the Dogger Bank and to the warmer coastal waters to the north. The effective barrier provided by the Flamborough front ensures that larvae south of the front are retained in the hatching area and there is essentially no exchange with areas to the north. Similarly, crabs spawning to the north of the front would appear to occur in marginal areas of the cold water pool and the transport of larvae across the front is likely to be minimal. In addition there does not appear to be a transport mechanism whereby larvae from spawning in the eastern English Channel can contribute to significant recruitment in the North Sea.

In essence the main spawning area appears to be effectively isolated from the rest of the North Sea by hydrographic features, throughout the period from hatching of the eggs to settlement of the larvae on the seabed. This isolation challenges the accepted wisdom of a contra-natant movement by females providing recruitment to the fishery from spawning areas in the central and northern North Sea to the north. It also suggests that the crab population in the area of the main fishery is a separate, self-sustaining stock and may even provide recruitment of adult crabs to the northern areas through the gradual movement northwards of mature females throughout their life. This has implications for the management of both the inshore and offshore crab fisheries in the North Sea.

Further information

Edwards, E. (1979). The edible crab and its fishery in British Waters. Fishing News Books Ltd., Farnham, Surrey, England.

THE NORTHUMBERLAND SEA FISHERIES COMMITTEE LOBSTER 'V' NOTCHING SCHEME

Second year of success

The Northumberland Sea Fisheries Committee has just successfully completed the second year of a three-year programme involving the release of 'V' notched lobster back into the wild. In each of these years a thousand egg-carrying mature females have been notched and returned to local fishing grounds within the Committee's district with the intention of enhancing stocks. Lobsters released in 2000 were notched in the left side, inner tail flap (uropod) adjacent to the telson. To distinguish between these, the lobsters released this year (2001) have been notched on the right hand side tail flap.

The release programme, which runs from May through to the end of September, has proved to be more time-consuming than first envisaged. Although we tried to carry out releases during existing patrols, quite a number have, due mainly to the availability of lobsters from wholesalers, needed to be carried out independently, using either the RIB or Patrol Vessel.

Funding

As well as using its own funds, Northumberland Sea Fisheries has sought funding from other organisations, including

- One North East
- Northumberland County Council
- Leader II
- Various other organisations along the Northumberland coast.

In addition to these organisations there has been a positive response from the majority of local fishermen in that they have made there own financial contributions to assist with the purchase of lobsters from local merchants. These merchants have also made a significant contribution to the scheme in that they have supplied the Committee with lobsters at near cost price.

Prices paid for lobsters during the 2001 release period varied between £8.25 and £12.10 per kilo, working out at an average price of £5.49 per animal. Total outlay for the 1,000 lobsters purchased throughout the release period was £5487.30.

Release areas

The majority of releases throughout the district have again been within 3 nautical miles off the shore. As in 2000, dispersal has also not been indiscriminate but has been based on past catches and fishing effort. However, instead of the 3 sub-divided sectors that were used during 2000, distribution of lobsters in 2001 has been within one of 6 sectors.

1. River Tyne to Blyth
2. Blyth to North of Cresswell
3. North of Cresswell to Alnmouth
4. Alnmouth to Newton
5. Newton to North of Farne Islands
6. North of Farne Islands to England/Scotland Border

The main reason for this change, as well as making recording easier, was to enable a record of releases carried out within the Special Area of Conservation (SAC) to be recorded. Transportation of lobsters has not proved to be a problem. During transfers to the RIB and/or the Patrol Vessel and during releases we only had one mortality.

Further information

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HYDRAULIC DREDGING FOR RAZOR CLAMS – PROGRESS TOWARDS BEST PRACTICE

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Alternative fishery

Current moves to reduce the fishing pressure on a number of fin-fish species within the North Atlantic and North Sea has led to a call for a diversification of fishing effort onto alternative fish and shellfish species. At the same time, recent difficulties experienced by scallop fisherman because of extensive closures caused by shellfish biotoxins such as ASP, has also led them to seek novel species to harvest.

Razor clams (*Ensis* spp.) represent one such alternative resource and today a large number of divers throughout Scotland collect clams by hand from depths of 2-5 m to supply markets in the Far East and Europe. As an alternative to the use of divers, there has been a growing interest in the use of mobile hydraulic dredges to collect these animals.

In the Republic of Ireland, hydraulic fishing for razor clams has already been practised for a number of years, although recently the fishery has experienced problems caused by over-fishing, poor recruitment and extensive winter mortality in some beds. In Scotland, fishermen have used hydraulic gear to harvest razor clams in the past, although its use is currently restricted in many areas. In Northern Ireland, hydraulic fishing is currently prohibited whilst the authorities maintain a watching brief on progress and developments elsewhere. The future expansion of this industry needs a revision of current management practices and the instigation of new legislation both to support and protect future development.

In light of this, the University Marine Biological Station Millport (UMBSM) is taking part in a two-year EC-funded programme to investigate hydraulic dredging, as part of a wider project involving partners at the Istituto di Ricerche sulla Pesca Marittima (IRPEM) in Ancona, Italy and at the Marine Laboratory in Aberdeen (MLA).

Methods

The aims of the current project are to assess the impact of the fishing gear on the seabed and also to investigate the population biology of razor clams, a species whose basic biology is little known. These aims are being addressed by a number of approaches:

1. An investigation has been made of the damage caused to razor clams (the target species) as well as to non-target species, or by-catch. This has been extended to include an assessment of the damage caused to the animals that remain on the seabed after the gear has passed by.

2. Studies have also been made of the effects of hydraulic dredging on the physical nature of the seabed. Divers have collected core samples and measured the shear strength of the sediment before and after dredging using an *in situ* shear vane developed with colleagues at the Sediment Ecology Research Group, University of St. Andrews. Shear strength reflects the degree of consolidation of the sediment, with stable sediments having high shear strength. In addition, shear strength tends to increase with depth in stable sediments that exhibit vertical stratification.

3. Experiments have been conducted to determine the reburial capacity of dislodged animals.

4. On-going fieldwork includes an assessment of the annual biomass production of different razor clam beds as well as an assessment of the increase in predator and scavenger activity associated with hydraulic fishing. Finally, studies will be made of the sub-lethal effects of the fishing process on the biochemical composition of the target species.

Equipment

The majority of this work has been carried out using a toothed dredge operated from RV Aora at UMBSM. Whilst it is accepted that this design of dredge is somewhat dated now, dredges of this type have been used until quite recently around the Western Isles and may initially be used in any future expansion of the industry, at least until more appropriate designs are identified. In addition this research has benefited greatly from the co-operation of Cliff Henderson, of Portling Fisheries, who has provided access to dredges of alternative designs and has given advice during the contract.

A toothed hydraulic dredge used to fish the razor clam Ensis spp.

Preliminary results

A series of preliminary observations have been made at this stage:

1. It has been shown that the toothed dredge tends to fish non-selectively, along a track approximately 45 cm wide in the case of the UMBSM gear. Large burrowing bivalves dominate the species retained by the dredge. These include the target razor clams *Ensis siliqua* and *E. arcuatus,* as well as *Lutraria lutraria,* and *Mya truncata.* The burrowing heart urchin *Echinocardium cordatum* is also abundant in the catch. Damage caused to these animals is primarily a function of the amount of water pumped down to the dredge as well as the towing speed. Damage is reduced with a reduction in towing speed and with an increase in water pressure. Damage rates to *Ensis* spp. have been recorded between 5 and 90% for fishing carried out in the Firth of Clyde. The main conclusion from this work however, is that

hydraulic dredging is most appropriate for fine 'coral sands' such as those found around the Western Isles. The sandy seabed in the Firth of Clyde is generally too compacted to support any widespread efficient hydraulic fishing.

2. The dredge leaves tracks of fluidised and unconsolidated sediment which can been seen at the surface as shallow furrows. The vertical structure of the sediment within the track is completely disrupted as material is brought to the surface from as deep as 50cm. With time, the physical structure of the sediment begins to return to the pre-dredged condition, although for areas with only weak tidal streams the recovery in shear strength takes in excess of 100 days (see Figure 1). Large bivalves, such as *L. lutraria* and *M. truncata*, as well as the razor clams begin to return to the dredged track within this 100-day period, mainly as a result of migration from un-dredged 'refuges' beyond the immediate area of impact. Some species however, such as the tubicolous polychaete *Lanice conchilega,* do not appear to re-colonise the dredged area even after six months. Re-colonisation rates are likely to differ seasonally according to when and how different species recruit to the seabed.

3. Field studies on the reburial capacity have shown that dislodged animals seem unaffected by the passage of the dredge with approximately 80% of intact razor clams successfully reburying within one hour of exposure and, in any event, often before they suffer harassment from scavengers or predators. Interestingly it has been shown that razor clams are able to bury significantly faster in the fluidised sand of a fresh dredge track than in consolidated sand.

4. There are two razor clam species commonly present within the Clyde Sea area, the pod razor *Ensis siliqua* and the curved razor *Ensis arcuatus*. Irrespective of the species, however, data suggest that between three and four year classes may be present in a bed at any one time and that recruitment of juveniles to an established bed is not guaranteed each year. Initial estimates suggest that the growth rates of both species may be as little as 2 cm in length per year for some cohorts.

Conclusions and recommendations

Although the research programme is still underway several initial recommendations can be made at this stage:

1. Any future hydraulic dredge fishery within UK waters will require comprehensive regulation and rigorous enforcement. The fishery could be managed through the establishment of a short fishing season, at least initially, and efforts should be made to leave fished beds 'fallow' to allow them to recover. The duration of any fallow period will be dependent on both the local seabed habitat as well as the hydrodynamic environment. Additionally the establishment of a minimum landing size of at least 15cm would be recommended, which is larger than the present EU designation of 10 cm.

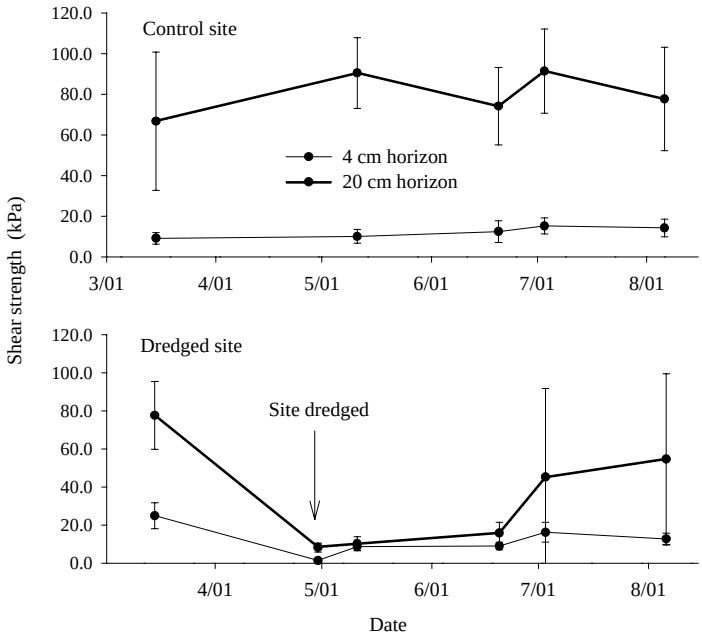

Figure 1. Changes in in situ shear strength in control (top graph) and dredged (bottom graph) sediment

2. Initially the capacity of water pumps and gear should be restricted until we have a better idea of an optimal, more selective, gear design. With the use of larger gear and higher water pressures, irrespective of the gear design, extensive damage can be wrought on the seabed within a very short period of time.

3. It would seem prudent that any initial fishery is small-scale, both in terms of the number of boats involved, and in the areas licensed for fishing. The slow growth of some year class cohorts combined with uncertainties relating to their reproductive activity needs to be fully explored before any expansion can be advocated.

4. Some habitats, such as pristine maerl grounds, should be protected from all dredging activity. These structurally complex and biologically diverse habitats, which provide inshore nursery grounds for a number of marine fish and shellfish (including *Ensis* spp.), would suffer irreversible damage should they be dredged.

5. Further work is required to optimise gear design and to explore impacts at a fishery scale. This would best be served as a collaborative venture between the scientific community and a small number of licensed vessels at the outset. Similar resources should be directed toward optimising post-catch handling to minimise sub-lethal stress to the animal and maximise the efficacy of depuration and prolong shelf life. Further studies on the biochemistry, physiology and immunology of *Ensis* would also prove beneficial to the cultivation and possible future ranching of this important shellfish species.

ASSESSMENT OF SEWAGE DISCHARGE CONSENT APPLICATIONS WITH RESPECT TO MICOBIOLOGICAL IMPACTS ON SHELLFISHERIES

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Background

Illness as a result of eating bivalve molluscan shellfish contaminated with bacterial and viral pathogens has been known for hundreds of years and is still a widely recognised problem. Bivalve molluscs are efficient filter feeders and as a result accumulate pathogens to high concentrations relative to the surrounding water column. In developed countries viral pathogens associated with sewage, such as small round structured viruses and Hepatitis A virus tend to predominate as the causes of shellfish related illness

In the European Community, controls intended to address the public health problems associated with bivalve mollusc consumption are exerted under the Shellfish Hygiene Directive 91/492/EEC. These controls include classification of shellfish harvesting areas according to the degree of faecal contamination determined by monitoring faecal indicator bacteria (faecal coliforms and/or *Escherichia coli*). The classification determines the type of processing to which shellfish from a particular area must be subjected.

Harvesting may be prohibited from areas subject to marked amounts of contamination while processing requirements for areas subject to moderate levels of contamination may make harvesting uneconomic. Reducing the amount of contamination at source both reduces the associated health risk and enhances the commercial potential of harvesting areas.

CEFAS Weymouth has a responsibility for providing comments to the Environment Agency on the consenting of point source discharges affecting tidal waters. This area of work is undertaken on behalf of DEFRA Marine Environment and Fisheries Divisions. The focus of this article is to provide an overview of the provision of advice regarding microbiological impacts of point source discharges affecting shellfisheries.

The discharge consenting process

Under the Water Resources Act 1991 as amended by the Environment Act 1995 the Environment Agency (EA) has responsibility for the regulation of discharges to controlled waters. This is achieved through the determination and issuing of discharge consents and subsequent monitoring for compliance assessment.

In the process of determining discharge consents by the EA is required to advertise the consent application in the both local press and in the London Gazette. The Agency also has a statutory duty to undertake consultation with

various other organisations, for tidal waters this includes CEFAS, Local Sea Fisheries Committees and English Nature or in Wales the Countryside Commission for Wales. It may also include where relevant the Harbour Authority, local authority or water undertaker and National Parks and Broads Authority. This provides for a range of interests and views to be taken into account and acts as a system of checks and balances in the overall process.

Other mechanisms under which consultation may take place relevant to discharge control and consents are the issuing of temporary consents, modifications to existing consents, revocation of consents or the issuing of enforcement notices in the case of action against illegal discharges.

CEFAS's role as a statutory consultee is provided for under the Control of Pollution (Applications, Appeals and Registers) Regulations 1996. This role is devolved from the Minister of Agriculture Fisheries & Food and undertaken on behalf of DEFRA Marine and Environment Division.

CEFAS Aims

For a number of years, CEFAS has identified the following aims with respect to the impact of sewage discharges on shellfisheries:

1 A medium term aim of class B and a long-term aim of class A as per the classification criteria for shellfish harvesting areas determined in England and Wales by the Food Standards Agency.
2 Improvement in the level of treatment of continuous discharges consistent with this
3 Limitation of spills from combined sewer overflows (CSOs) to 10 per annum for all areas apart from class A - this frequency is deemed sufficient to protect class B status;
4 No new CSOs to be directed into class A areas and reduction of spills for existing CSOs to a minimum;
5 Annual spill summaries for CSOs to be provided to food authorities to enable the impact on the microbiological status of shellfisheries to be assessed;
6 No new emergency overflows (EOs) to be directed into class A areas and the removal of existing ones where possible
7 Notification of the operation of emergency overflows to food authorities as soon as possible after the start of the event in order that appropriate action can be taken to protect public health.

The objectives in item 1 above are being advanced through improvements to discharges programmed in the current 2000-2005 (AMP3) investment period. A number of these aims (items 3, 5 and 7 above) have now been incorporated into the recently issued EA Policy 'Standards for consenting discharges to achieve the requirements of the Shellfish Waters Directive (microbiological quality)'.

CEFAS assessment and advice

CEFAS assessment of discharge consent applications will take account of the physical, chemical and microbiological character of the proposed discharge, its likely impact on receiving water quality and the quality of fisheries. Advice from within CEFAS is coordinated from the Burnham-on-Crouch Laboratory following referral to one or more specialist groups within the organisation.

CEFAS Weymouth undertake technical assessment of sewage discharge consent applications with respect to their microbiological impact on shellfisheries. The focus of these assessments is the evaluation of possible effects of discharges on shellfisheries, both from the view of the protection of public health and the utilisation of harvesting areas by the shellfish industry.

Typically an assessment will include the following components: assessment of microbiological load in relation to current and proposed levels of treatment; consideration of the discharge regime; location of the discharge in relation to the proximity of shellfishery interests and assessment of the discharge impact on the nearest shellfish harvesting areas or areas of potential commercial interest. The combined effects of the proposed discharge with those of other discharges affecting or potentially affecting the same shellfishery are also considered.

Sources of information used for making an assessment include that information given in the application, information on other relevant discharges in the vicinity, classification status, monitoring data and other supporting information such as environmental, hydrographic and engineering reports.

The application itself will contain details of the proposed discharge in terms of volume, flow, discharge regime and effluent quality. Information on other relevant current, proposed or historic discharges held on the CEFAS database will be referred to and can be visualised via a Geographical Information System, GIS.

Monitoring data made available from local food authority hygiene sampling and EA shellfish waters monitoring programmes together with data arising from other monitoring programmes, investigation work or applied research whenever this is available, will be used in the assessment.

Other information may be provided for consideration at the time of consultation, requested during the course of it, or as a result of the assessment. This includes reports on effluent treatment process studies, environmental studies, hydrographic data, mathematical modelling outputs, engineering calculations and design specifications.

At the end of the assessment advice is given to the EA which may include recommendations for changes in the discharge regime, reduction in microbiological load or refusal of the application. Other advice may recommend changes in operational practices at an effluent treatment plant or of sewerage system to mitigate the effects of emergency or extreme events.

Where no resolution of technical differences is achieved then DEFRA policy divisions will be notified.

Consent determination

The regulatory process of consenting discharges as with many other regulatory processes is always open to legal challenge. Appeals against decisions in connection with sewage discharge consenting in England and Wales are made to and determined by the relevant Secretaries of State. This may result in the appeal being quashed, upheld or the ordering of a public enquiry.

RE-INSPECTION OF SHELLFISH PURIFICATION CENTRES

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The need for depuration

Depuration is a process of self-purification in tanks of clean seawater whereby shellfish continue to filter feed and eliminate sewage contaminants. All shellfish from harvesting areas classified as category B as defined by EU directive 91/492 require treatment before placing on the market. Given the scarcity of clean coastal waters for relaying and the unsuitability of approved heat treatment processes for shellfish other than cockles, depuration is the commonly preferred treatment option. Given this and the fact that over 70% of harvesting areas in England and Wales are classified as category B, it is apparent that depuration is a major control point in the production of market-ready shellfish.

Approval of systems

To ensure requirements for successful depuration are met, the design and operation of purification systems are carefully controlled. Legal requirements for the approval and control of depuration centres are set out in The Food Safety (Fisheries Products and Live Shellfish) (Hygiene) Regulations 1998. Officers at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Weymouth, together with the local Environmental Health Officer (EHO), inspect all new purification systems before they are 'approved' for commercial use. Conditions of Approval (CoA) are then issued by CEFAS on behalf of the Food Standards Agency. These conditions set out the operating criteria that, assuming the system has been correctly designed (assessed during the initial inspection), will enable the various legal and technical requirements for successful depuration to be met. Final approval of the plant is given by the local food authority on condition of continued adherence to the CoAs.

Traditionally, unless problems were encountered such as end product failures or association with food poisoning outbreaks, no further technical inspections were carried out by a central body. On occasions where inspections have been made in such circumstances systems have often changed markedly from their original operating specifications and these changes could have a detrimental effect on the depuration process.
Given these problems a periodic technical re-inspection of shellfish purification centres was implemented to ensure that purification centres throughout the country were operating to consistent acceptable standards.

Re-Inspection Programme

A three-year programme of purification plant re-inspections initially funded by the Joint Food Standards and Safety Group of MAFF, and then by the Food Standards Agency, commenced in April 1998 and was completed in March of this year. A total of 36 purification centres with 85 systems of various types were inspected under the programme.

Re-inspections were arranged through the Local EHO and the following steps undertaken for each centre.

- A review of existing information for each centre
- Liaison with EHO regarding site visit.
- EHO arranged site visit and confirmed arrangements with operator.
- CEFAS and EHO carried out a joint inspection to check compliance with Regulations and CoAs.
- CEFAS sent report of the inspection to EHO and FSA
- EHO provided feedback to operator
- CEFAS liaised with local EHO regarding any improvements, which might need to be made, and the need for any further inspection.

Re-inspection procedures were similar to those used for initial approval inspections and are outlined below.

- Inspect system whilst operating and loaded to the usual operational capacity.
- Check general running of the system and record system specifications e.g. tank dimensions, water capacity, UV system details, pump details, trays used, water storage facility details (if present), source of seawater and method of filling the system with seawater.
- Measure and record water temperature, turbidity dissolved oxygen, flow rates and salinity.
- Confirm operational procedures with the operator.
- Examine operator's records.

During each inspection particular attention was given to ensuring both the operator and the EHO were aware of any problems and the acceptable options available to rectify them. Further effort was made to ensure that both were aware of the detrimental effect on the depuration process that may be caused by the problem. Any problems were also highlighted in subsequent correspondence with the EHO.

Result of the programme

Problems were identified at the majority of plants inspected during the programme, with all but 6 non-compliant with either the requirements of their CoAs or the legislation. Problems ranged from relatively minor administrative non-compliance through to major technical problems seriously affecting the efficiency of the depuration process. Some of the most frequently occurring problems are discussed below.

Batch operation. It is a fundamental and critical requirement of the depuration process that each purification cycle is performed as a batch operation. Once the tank has been appropriately loaded and the cycle has commenced, no additional shellfish should be added or removed until the full cycle (42 hours) has been completed and the tank drained down. Failure to follow this practice may allow recontamination, either from the introduction of contaminants through the addition of new shellfish or by re-ingestion of re-suspended shellfish faecal material caused by the addition or removal of trays. Correct procedures for operating a batch system were not in place at 5 of the purification centres inspected.

Draining Down. At the end of each purification cycle, water should be drained from the system in a controlled manner, avoiding the re-suspension of sedimented shellfish faecal material. This is normally achieved by draining through the suction bar, which allows the same flow rate and direction to be maintained. Once the level of the water has fallen below the lowermost shellfish, they can be removed and the remaining water in the tank, containing the sedimented shellfish faecal material, discarded. Inadequate procedures for controlling the drain down process were present at 5 purification centres.

Ultra-violet (UV) system. UV irradiation is used in purification to ensure that the quality of both intake and recirculating water is controlled. It is a requirement that all seawater should be treated by UV either passing through the operational UV prior to entering the system or by recirculating within the system for 12 hours prior to the addition of shellfish. This ensures that any seawater used in the system will be of an acceptable microbiological quality when used in the system. This requirement was not met in 6 of the centres.

Cascades. Cascades from spray bars must not fall directly on shellfish in the system, which may cause them to close and stop filtering. They should not cause re-suspension of shellfish faecal material. Cascades at 4 centres fell directly onto shellfish or caused re-suspension of sediment.

Record keeping. It is a requirement of the legislation that records are kept of purification times and the quantities of shellfish purified, including the retention of movement documents so that the origin of shellfish can be established. Details of microbiological testing of shellfish must also be kept. CoAs also stipulate that detail of UV usage and any extended re-use of seawater must be recorded. In addition, it is recommended for good practice and due diligence purposes that records of salinity, temperature and flow rates are also maintained. Record keeping fell significantly short of these requirements at 6 of the plants inspected.

Settlement of sediment prior to use of seawater in purification systems. Excessive turbidity of the seawater used in a system can have both a detrimental effect on shellfish activity and the efficiency of the UV system. Where excessive turbidity is likely in the source seawater, settlement of sediment is required to ensure the seawater meets an acceptable standard prior to use. Five centres where previous recommendations to settle sediment prior to purification had been made were not carrying this out this correctly.

Conditions of Approval. These needed to be written or amended at 5 of the centres inspected. Most often this was because they were out of date and CEFAS had not been informed of changes. These included a change of address for two centres, change of ownership for one, new systems at two and CoAs not reflecting current practice at one. CoAs were not displayed at three of the centre. This highlights the need for CEFAS to be informed of changes at purification centres in a timely manner.

Shellfish Loading. Overloading of shellfish in trays may prevent adequate filter-feeding activity by shellfish in the lower layer. Limits of shellfish loading are stipulated in

the CoAs to ensure overloading does not occur. These limits were exceeded at 5 of the centres inspected.

Other problems. Some other problems, with the number of centres affected in brackets, were: the waste water was discarded to shellfish holding areas (3); UV units not working (5); cleaning of tanks inadequate (2); salinity too high (2); purification of non approved species (3); non approved systems present (3).

Conclusions

In general re-inspections were welcomed by both plant operators and the local EHO, who saw it as opportunity to improve procedures or to reassure themselves regarding operation. It was apparent that systems and operational procedures often changed over time and that such changes could have a detrimental effect on the depuration process. This, combined with the variable levels of compliance found at purification centres demonstrated the need for regular technical inspections of shellfish purification systems and their operation by a central body. The re-inspection programme will therefore continue into the future with purification centres undergoing technical inspections by a central body every 2 to 4 years depending on the size and type of operation.

CEFAS undertake technical inspection of shellfish purification centres on behalf of the Food Standards Agency who are the competent authority for shellfish hygiene issues. Further details regarding technical requirements for shellfish purification systems can be obtained from Bill Doré at the CEFAS Weymouth Laboratory.

RECENT STUDIES IN KING SCALLOP CULTIVATION

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The 13th International Pectinid Workshop was held in Chile earlier this year. Scallop biologists from all over the world gathered to exchange notes and ideas. Some of the presentations were relevant to UK interests in king scallop cultivation. A summary of these is given below.

Hatcheries

The Norwegians are continuing their studies on hatchery and nursery cultivation of king scallops. There has been a trend towards investigating extensive rearing systems, using low densities of animals and seawater replacement by partial through-flow in re-circulation systems. All this work is designed to eliminate the need for antibiotics (e.g. chloramphenicol) to control bacterial problems. Posters on cultivation of other species suggest that these are otherwise essential in intensive systems. Larval concentrations of 1 per ml in an up-welling system gave the best growth, survival and percentage yield at metamorphosis, although total yields (but also bacterial loads) were higher at greater (up to 9 per ml) larval concentrations. This was with 100% daily water replacement. Post larval experiments with water replacement rates of 8-33% (per hour) gave variable but similar results in systems supplemented with cultured algae. A pilot nursery system using raceways fed by waste heated water from a gas plant showed potential, until the parent plant was closed for economic reasons. Another low-technology approach was using mesocosm bags (170 µm mesh size) in Mulroy Bay for larval rearing and spat setting. This has also shown some potential, but the results are variable

Suspended culture

Results presented at the previous (1999) workshop, which showed that scallops in suspended cultures have thinner, more easily broken shells and that these juveniles are more liable to be predated by crabs when put onto the bottom, compared with wild scallops, have been further developed in a wider study. These differences become increasingly apparent with increasing size of animals, once larger than 20mm shell height. Comparisons of bottom and suspended culture with the tropical scallop indicated that smaller juveniles are able to perform well in suspended culture but that wave action, and thus movement in the nets, can be a major stress factor as the scallops grow. Both positive and negative effects of net fouling on growth were described in separate papers. The paper by Katherine Ross on positive effects was summarised in the previous (May 2001) issue of Shellfish News.

Suspended culture to assess growth of scallops in LINK-funded trials in Portland Harbour

Other work

Various indicators of stress, including biochemical markers, righting, recessing and escape behaviour were evaluated in studies on the effects of fishing and of predators.

French studies are currently mainly concerned with examination of daily growth rings in relation to environmental perturbations, showing reductions in growth during, for example, toxic bloom events. These studies otherwise showed a strong correlation between growth rate and temperature, supporting the findings from the LINK-funded CEFAS work on site selection. A final report on this work will appear in a future issue of Shellfish News.

Several papers dealt with stock assessments from wild fisheries, and modelling. The most impressive of these were the studies on the Georges Bank grounds in the western Atlantic, which have recently been partially re-opened. Satellite tracking and logging has produced much detailed data on fishing effort.

SOFT CRABS, HARD ANSWERS

- the search for production methods to promote moulting in the Green Crab

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Introduction

The Shore or Green Crab (*Carcinus maenas*) is, perhaps, one of the most familiar animals on the UK seashore. It occurs throughout European seas and in the Mediterranean. It has also been introduced into waters elsewhere in the world, either accidentally or deliberately, where it is universally regarded as a 'pest' species. Traditionally, Green Crabs have never been seen as either a useful or valuable food species, but in the early 1990s a small-scale fishery began in Scotland to supply hard-shelled animals for an export market. These animals were used in the preparation of stocks and other fish-based commodities. However, within the UK, there was one group, sport sea anglers, who historically valued the newly-moulted or 'peeler' crabs as bait – particularly when fishing for species such as cod. Elsewhere in Europe, in particular in parts of Portugal, Spain and Italy, soft, newly-moulted crabs are served as regional food delicacies, in a manner similar to the well known US speciality of soft Blue Crab.

The Green Crab (Carcinus maenas)

The supply of 'soft' Green crabs for either the angling or the gourmet market is highly seasonal and dependent upon artisanal gathering from the shore. This restricts supply and, as a result, both markets value the product

highly, paying a considerable premium over the prices paid for hard-shelled individuals. In an attempt to meet market demand and introduce stability of supply for consumers, a consortium of partners from Portugal, Spain, Ireland and the UK took part in a project (SOCRATE) to examine all aspects of 'soft' Green Crab collection, storage and supply. The prospects for developing a commercially viable production process were also looked at. The work was funded by DG XIV (DG FISH) of the EU, under the FAIR initiative, in partnership with the commercial companies involved. Consequently, the intellectual property rights reside with the commercial partners.

Research Programme and Results

The programme began by characterising the wild populations in Portugal, Scotland and Ireland, paying particular attention to the moult phase status of the animals captured from the littoral or sub-littoral zones or taken by different fishing methods.

The most relevant findings may be summarised as follows:

- Crabs captured sub-littorally, by trap or trawl, are generally larger and heavier than those collected from the shore.
- Crabs caught sub-littorally are generally in either inter- or pre-moult phases (hard shell) of the moult cycle.
- Crabs in the post-moult (soft) phases were only gathered from the shore (littoral zone).
- Post-moult crabs were collected between April and August.
- Crabs in the pre-moult phases can be collected year-round.
- No easily distinguished external mark or feature was identified to allow animals just about to moult to be distinguished from those in the inter-, early pre- or late post-moult phases (i.e. 'hard' shelled).

Moult inducing hormone (ecdysteriod) concentrations in the haemolymph were measured using enzyme immunoassay (EIA) techniques. Sub-samples of Portuguese-caught crabs, which were in each phase within the moult cycle, were examined. Those in the late post-moult phase (B) recorded the lowest levels (7 ng ml^{-1}), whilst those in the immediate pre-moult phases (D_2, D_3) had the highest levels (210 – 306 ng ml^{-1}). Unfortunately, this technique could not be adopted for commercial purposes at this time due to its complexity and expense. However, it may be possible to develop cost-effective sampling 'kits' in the future, should funding be available and the commercial imperative exist.

Previous data on moult induction in Green Crab and other Crustacea were reviewed and several of the most promising techniques selected for evaluation. Unfortunately, none of the physical stressors, such as aerial exposure and reduced oxygen partial pressure, hormonal (20-hydroxy-ecdysone [20-OHE]), or chemical (*p*-chlorophenylalanine [PCPA], cyproheptadine [CPH], dimethyl-β-propriothetin [DMPT], dimethylacetothetin [DMT], fenoxicarb) agents assessed produced significant levels of moult promotion. In some cases, reduced levels of survival were encountered as a result of the treatments. However, it was established that February and March were the months when it was easiest to artificially induce moulting under controlled conditions. Therefore, it was concluded that, at present, there is no method that could be used as part of a commercial production process for inducing pre-moult animals to moult.

Methods for processing, packaging and storing both pre- and post-moult (soft) crabs were also investigated. A regime suitable for handling the live crabs required by certain markets was produced, as were very low temperature preservation protocols. An attractive range of point-of-sale packaging and display containers was also developed.

The established European markets were evaluated, together with potential new opportunities, both within Europe and in more distant regions, such as Asia. There appeared to be excellent market potential in some areas.

Conclusions

- Post-moult (soft) crabs can be collected from the shore, together with animals in all other moult stages.
- Crabs caught sub-littorally are generally in either inter- or pre-moult stages (hard-shelled).
- Animals caught sub-littorally are generally larger and heavier than those collected from the shore.
- Animals in the pre-moult phases can be caught year-round.
- For animals with a hard shell, there is no easily discernible external characteristic that can be used to distinguish crabs that are about to moult (late pre-moult) from those in the other moult phases (inter- and early pre-moult).
- The levels of moult inducing hormones within the haemolymph can accurately distinguish between animals in the different moult phases, but this method is not readily available for use commercially.
- No physical, hormonal or chemical stimulus was found which significantly promoted moulting.
- Protocols for handling, processing, packing and storing the crabs were developed, together with point-of-sale material.
- Good market opportunities were identified.
- No commercially viable method for the production of 'soft' Green Crabs was identified.

Partners

Commercial Companies: Con-Aqua (lead partner), Controle e Producao de Produtos Aquaticos Lda (Portugal); Bateamar SL, Ultracongelados Cocedero de Molluscos (Spain); Materaqua, Criacao e Comercializacao de Peixes Lda (Portugal); Ocean West Ltd (Ireland).

Research providers: Instituto de Ciencias Biomedicas de Abel Salazar, University of Oporto (Portugal); Sea Fish Industry Authority (UK).

Further information

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WHEN IS A BROWN CRAB NOT A BROWN CRAB?

It is good to know that there are still some eagle-eyed crustacean experts out there.

Some of you spotted that the photograph labelled 'Brown Crab' used to accompany the article on crustacean transport by Craig Burton in the last (May 2001) issue of Shellfish News was not the species (*Cancer pagurus*) that was the subject of the article. It was in fact a photograph of *Cancer bellianus* (Johnson, 1861). This species is found off western British coasts from Shetland to as far south as Portugal, in waters of 37 - 620 metres in depth. It has a 147 mm wide pale brown spotted red carapace. The marginal lobes are toothed, with a rougher surface then *C. pagurus*. There are also some differences in claw morphology. It would not seem to be a very abundant species, and is not fished commercially.

SEA URCHIN AQUACULTURE – THE ROAD FROM RESEARCH TO INDUSTRY

Maeve S. Kelly
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Sea Urchin Aquaculture in Scotland …

In the past, the sea urchin fishery in Scotland did not amount to much more than anecdotal tales of Orkney Islanders using urchin roe as a butter substitute at the turn of century. Since those times the fishery has consisted of the opportunistic export of small quantities of *Echinus esculentus*, for its roe or for its test, for the curio trade. However Scotland's second species of edible echinoid, *Psammechinus miliaris,* is similar in size to the species (*Paracentrotus lividus*) commonly eaten in Europe, and when fed a nutritious diet has a high roe content. For these reasons it has attracted considerable research effort which has highlighted its potential as an aquaculture species.

Many aspects of the lifecycle of the larval, post-larval, juvenile and adult stages have been investigated at the Scottish Association for Marine Science (SAMS) and the relative benefits of different diets, stocking densities and culture systems defined. The research scale hatchery at SAMS produces several thousand juvenile urchins a year. We have shown the larvae are robust, and relatively easy to handle compared with some other species. They are routinely raised with no contamination or disease problems and no pro-biotics are used in the larval culture water. The survivorship of the hatchery-reared stock is high in both tank and sea based culture systems. Currently there are several strategies evolving for the grow-out phase. Much of this research is carried out in conjunction with industrial partners who were interested in the economic potential of the species from the onset. Shellfish growers, some of whom have a high natural settlement of *P. miliaris* spat onto their long lines are investigating ways of using natural fouling or mussel production waste to feed the sea urchins. An alternative

The sea urchin, Strongylocentrotus droebachiensis, now grown commercially

approach, that of maintaining the sea urchins alongside the Atlantic salmon, alleviates the requirement for a special urchin diet as the sea urchins can trap and feed from any feed pellets the fish have missed.

Research continues at SAMS to add to our understanding of the biology and ecology of the sea urchin, as we study the foraging behaviour of urchins from shallow or intertidal communities and the factors that control the partitioning of energy between somatic (test) and gonad growth. We are also continuing research to improve the formulation of artificial feeds, incorporating natural carotenoid sources to enhance roe colour.

… and around the world

In other countries, where the need to cultivate has arisen from the demise of once lucrative fisheries, echinoculture is now shifting from the research phase to commercial development.

In Japan, the largest consumer market for sea urchin roe, sea urchins have been produced in hatcheries for many years, the juveniles being re-seeded to inshore areas, managed as fishermens co-operatives. Once market size they are fished for the domestic market.

In North America, we have seen the red sea urchin fishery of the Pacific coast boom and bust. On the east coast, however there is still a valuable fishery for the green sea urchin (*Strongylocentrotus droebachiensis*). In New Brunswick some 1400 metric tonnes of sea urchins were landed in 2000, worth $4 million (CAN). The fishery is currently managed through a Conservation Harvesting Plan, developed in consultation with the fishermen. Participants must hold a personal fisher's registration, a minimum landing size of 50mm horizontal test diameter has been imposed and the fishing season is limited to the winter months.

Throughout Newfoundland, New Brunswick and Maine sea urchins are collected using a drag, known as the Green trawl, modified from scallop dredge gear, but there are also dive fisheries. As the best sea urchin stocks are identified and depleted, urchins with poorer roe content are landed, and the industry becomes less profitable. Researchers from the University of Maine have teamed up with the local fishermen to investigate the economics of transferring urchins of low roe yield to better feeding grounds. After a period of conditioning it was their intention to re-harvest the urchins which would then fetch a premium price. This however, was not successful. Researcher Mick Devin found that fewer than 25% of the urchins collected by dragging survive once re-laid. Preliminary projections for the costs of collecting and relocating diver-collected urchins, which would have a much greater chance of survival, indicate the costs incurred collecting sufficient numbers may make it hard to show a profit.

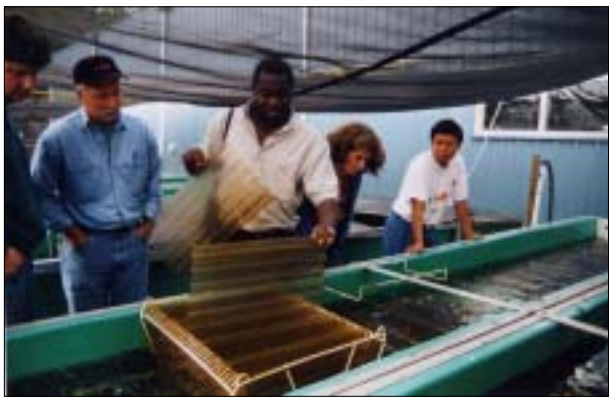
In Newfoundland, the company Green Seafoods Ltd, has taken a different approach to overcoming the problem of poor or variable roe content in fished urchins. The company currently processes a staggering 4 metric tonnes of roe a day during the fishing season. The shucked roe is then chilled and air-freighted to the Japanese markets where it fetches in the region of 1000 Japanese Yen (£5.70) per 100 g tray. However more time is spent processing poor as opposed to good quality roe. In addition, as the fishery is a winter one, there are days when the fishermen cannot operate which means a temporary laying off for the 40 processing staff. The company's initiative, led by Carl Parsons, has been to design a holding facility, where urchins can be kept for roe conditioning. The urchins will spend 8 weeks in the conditioning tanks and feed on a specially prepared diet. Particular emphasis has been put on tank design, and a series of tanks, with several innovative features, each designed to hold 500kg of urchins are currently being tested.

Ross Island Salmon Ltd., New Brunswick, another company committed to R&D, are currently contemplating a £1 million investment into a sea urchin holding and conditioning facility. Detailed financial analyses make the economics of this venture look attractive. The team, led by Dr Chris Pearce, believes they have hit upon an artificial diet formulation, containing no animal protein, which improves gonad yield and colour without detriment to the flavour. The aim is to condition diver-collected urchins for an 8 week period, the roe yield being boosted from around 8% on collection, to a minimum of 20%, and to re-coup a correspondingly higher price for the roe, perhaps as much as 4000 Japanese Yen (£23) per 100g tray.

Across on the west coast of Canada, Island Scallops Ltd have expanded the hatchery production of juvenile urchins to an impressive scale and have added the green sea urchin to the lengthy list of species they produce, becoming the first large scale commercial sea urchin hatchery outside of Japan. The sea urchin larvae are

Conference delegates view the sea urchin rearing facilities at Island Scallops Ltd. Vancouver

cultivated in vast 40,000 litre tanks, and settled by the million onto the traditional diatom covered wave-plates in raceway style tanks. The company is hoping spat sales will increase, however the growers seem hamstrung by the authorities controlling aquaculture development. One would-be grower reported that they would have to deal with 14 different government agencies in an attempt to secure a leased area of seafloor. Such is the power of the anti-sea farming lobby that growers cannot even avail of the urchin spat that settles naturally onto their existing oyster beds. It is hard to believe that something as environmentally innocuous as shellfish farming is beleaguered by that amount of red tape.



Sea urchin settlement plates in raceways at Island Scallops Ltd. Vancouver

A future UK industry?

We wait to see to what extent the UK aquaculture industry will pursue the research leads. The largest and most lucrative markets are for processed (shucked, chilled or frozen) roe in the far east but an under-supplied market for a whole live product also exists, closer to home, in France. In Scotland, the basic requirements are in place for an industry to develop which has no impact on vulnerable wild stocks, which has a low environmental impact and can produce a high value product for a niche market. Having been abreast of the leaders in developing culture technology, it remains to be seen whether Scotland will keep pace with the move to the industrial sector.

Further information

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SHELLFISH FARMING IN NEW ZEALAND

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A growth industry

Shellfish aquaculture is the fastest growing rural industry in New Zealand. In the past two decades shellfish production has gone from a few small-scale domestic operations to an extensive industry worth in excess of NZ$200 million.

Although New Zealand is only a small group of islands it has one of the largest coastal zones in the world, extending over 1.2 million square nautical miles. The convoluted coastline with excellent water quality and high phytoplankton productivity make it very well suited for shellfish aquaculture.

Mussels the main crop

The basis of the phenomenal growth in shellfish aquaculture in this small country is the endemic Greenshell™ mussel. The industry was first established in the late 1970s following the collapse of local dredge fisheries for mussels. In 1977 total production of

mussels was a mere 300 tonnes and by 2000 this had jumped to more than 75,000 tonnes. The majority of this NZ$200 million crop was exported mostly to North America and parts of Asia, but also to more than 60 other countries throughout the world. Effective marketing combined with highly efficient and mechanised farming methods has been critical to the commercial success of this industry.

Longline cultivation

The principle farming method is a modified Japanese longline culture technique where a continuous line of mussels forms looped 'droppers' hung from parallel surface ropes suspended by large floats. The culture lines are seeded with wild spat caught on fibrous ropes or, more commonly, collected from drift seaweed that washes up on beaches in large quantities in northern New Zealand. The spat are transferred onto growing lines inside cotton stocking which allows the mussels to become established on the grow out lines before rotting away. Later the juvenile mussels (10-20 mm) are re-seeded onto lines at densities of 200-300 per metre. The mussels reach harvestable size of 80 mm in about 18 months, producing on average around 30 tonnes of mussels per hectare. The harvested mussels are mostly frozen in the half-shell for export, but live, frozen whole, and shucked mussels are also produced.

Search for space

The industry is currently using around 3,000 hectares of water space mostly in the Marlborough Sounds in the north of the South Island. With the rapid growth in this industry applications for new growing areas around the country that would more than triple the total available growing space have caused considerable concern amongst the public and regulatory agencies. A number of these proposed sites are in offshore coastal waters where growing techniques are yet to be developed. However, the indication is that the industry looks set to continue its rapid growth with a doubling of production of all species predicted within the next five to ten years.

Oysters

Pacific oysters are the second most important shellfish aquaculture industry in New Zealand valued at around NZ$20 million, with in excess of $6 million in export receipts, from an annual production of about 4,000 tonnes. The main export markets for Pacific oysters are Australia, United States, Singapore, Taiwan, Japan, Hong Kong, and French Polynesia.

Oysters are produced on around 1,100 hectares of farms, mostly intertidal farms in sheltered harbours in the north of the North Island. A variety of farming methods are used including rack, basket, bag, and tray culture systems. Spat is mostly collected from natural settlement, although there is increasing use of spat produced from hatcheries. Harvest usually occurs between one and two years from spat collection. The growth in the Pacific oyster industry has been slower than the mussel industry, and this industry is facing increased international competition from growing production capacity in Australia and Asia.

Abalone

Abalone is the third most important shellfish aquaculture industry in New Zealand, although it is only in its infancy with production at around NZ$1 million in 2000. This production came from both meat and abalone pearls, which rely on the unique iridescent blue-green and purple shell coloration of the endemic abalone species. Significant increases in commercial production are expected as the abalone farming techniques become well established in a number of locations around the country. Most abalone farming is being conducted in land-based operations, although novel methods for culturing abalone in barrels moored in the sea have also been developed.

Crustaceans

The Malaysian prawn is cultured on a small scale in one location in the North Island using natural geothermal water as a low cost source of water heating. Production from this single site is around 12 tonnes a year with most of it being sold through a tourist restaurant on site.

Spiny lobsters are a new addition to the shellfish aquaculture industry in New Zealand. Techniques for catching large numbers of seed lobsters from the wild have been developed in the past few years and used to stock pilot scale aquaculture ventures. The initial focus of this development was on land-based farming systems, however, recent results from sea cage farming methods have been very promising. This method can be easily combined with mussel farming operations where waste mussels can be used as feed for the lobster farming operation.

Current Issues

The shellfish aquaculture industry in New Zealand has grown rapidly despite an almost complete lack of government support for this important emerging industry. Unlike many other countries, direct encouragement of growth or investment in the aquaculture industry by the government is minimal because it strongly advocates a free market approach to economic development. Unfortunately, the regulatory regime for both land-based and sea-based farming have encouraged poorly planned development and promoted conflict between regulatory agencies, resource users and marine farmers. In addition, key issues for the industry such as diversification and product value adding have been stifled because of the cumbersome regulatory regime and the unresponsive administrative agencies. These are now struggling to cope with the continuing rapid growth of the mussel farming industry and this has prompted the Minister of Fisheries to initiate a review of the legal framework for aquaculture. Unfortunately, early indications are that this review will not be extensive and far-sighted enough to meet the needs of this growing shellfish industry.

THE ENVIRONMENTAL COST OF TROPICAL FRESHWATER PRAWNS

By Dr. Nesar Ahmed, Assistant Professor, Department of Fisheries Management,
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Introduction

In Bangladesh, there are about 450 species of snails. However, only the freshwater snail *Pila globosa* is traditionally and commercially used as prawn (*Macrobrachium rosenbergii*) feed. This snail is widely distributed in ponds, lakes and rivers. The snail is a valuable aquatic resource and low-lying marshland is their best habitat. They feed mainly on leaves of aquatic plants.

Snail collection

The snails are collected using a triangular concave mesh attached to a short pole, used to scoop the snails off the surface. Hundreds of small boats (typical size 2 to 3 m length and 1 to 1.5 m width) move through the weeds and waters for snail harvesting. A single harvester operates each boat. Collected snails are stored in the boats; when a boat is full it heads towards assembly centres, of which there are 5 or 6 on the flood-plain.

Local brokers then carry snails to prawn farming areas using trawlers, trucks or boats and sell them to snail traders. A snail collector harvests an average 22.3 kg of snails daily during the season, earning an average TK 40 (US$ 0.8). Earnings have decreased recently, due to declining availability of snails.

Environmental impact

The snail population has become extinct in most parts of the prawn farming areas in Southwestern Bangladesh due to excessive harvesting during the monsoon when the peak season of their reproduction. As a result, snails are now harvested from river areas in neighbouring districts. Removal of the snail tends to result in an increase in the growth of at least some species of aquatic macrophytes. This can reduce light penetration as well as photosynthesis and lead to eutrophication of water bodies and a decreased diversity of wild flora and fauna. Some canals have become blocked with snail waste and shells due to the use of snail meat as prawn feed. The canals have become neglected (i.e. not used for fishing or other purposes) as a result of the dumping of snail shells. The smell of rotting snails permeates the air, and the open waterways have become polluted

Future prospects?

It will be essential in future to culture snail in ponds, lakes and also rice fields to maintain the ecological balance and to provide food to sustain prawn production, which earns a considerable amount of foreign currency.

ANNOUNCEMENTS

GOODBYE MAFF, HELLO DEFRA

It should not have escaped your notice that we have a new name on the front cover of Shellfish News. DEFRA - the Department for Environment, Food and Rural Affairs - came into being in June. The new Department brings together all the functions of the former MAFF, the Environmental Protection Group and the Wildlife and Countryside Directorate from the former DETR, and responsibility for certain animal welfare issues and hunting with hounds from the Home Office. It also has responsibility for a number of Executive Agencies (including CEFAS) and Executive Non-Departmental Public Bodies, e.g. the Environment Agency.

The creation of DEFRA will bring an integrated approach to sustainable development, rural affairs, food and environment policy. It means that most (if not all) of the key issues affecting shellfisheries will, for the purpose of policy formulation and delivery, fall within the area of responsibility of one Government Department. More information about DEFRA including details of its aims and objectives can be obtained from the DEFRA website [http://www.defra.gov.uk].

THE FISH HEALTH INSPECTORATE & YOU

STANDARDS OF SERVICE – CITIZEN'S CHARTER PERFORMANCE RESULTS

by Debbie Murphy, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB

Introduction

The Fish Health Inspectorate (FHI) aims to provide an efficient, quality service. Our standards of service have always been high and we are constantly looking for ways to improve them. Under the terms of the Citizen's Charter we are required to publish an annual summary of the results of our performance against the standards set. The results are reported in the DEFRA publications 'Trout News' and 'Shellfish News', which are sent free to all registered fish and shellfish farmers. A copy of the results is sent separately to all fish and shellfish import licence holders and can be found on our web site www.efishbusiness.com . Additional copies of our new Charter can be obtained from the FHI or on the CEFAS web site www.cefas.co.uk .

The FHI has agreed to answer all calls to the administrative team (01305 206673/4) promptly. Since the publication of our new charter document we have accepted the DEFRA standard within 10 rings (20 second period). This is monitored regularly by logging all calls received on a chosen day. We fully met this standard.

Over the spring the FHI launched a web site dedicated to the movement and keeping of fish - www.efishbusiness.com. In parallel with this a new and improved section devoted to the work and responsibilities of the Fish Health Inspectorate (FHI) was added to the CEFAS Internet site (http://www.cefas.co.uk). The FHI pages are located in the **Info Centre** part of the CEFAS site, under the '**Aquaculture and Fish Health**' heading (http://www.cefas.co.uk/fhi). Information on the FHI pages is designed to help both shellfish and fish farmers, and is divided into six areas: Farm Registration; Movements, Imports and Exports; Disease Monitoring and Investigation; Controls and Enforcement; Advice and Legislation; Publications.

The following report shows the performance achieved against our target of 100%, for the period 1st April 2000 to 31st March 2001.

	Achieved in 2000-01
Correspondence	
The Inspectorate's target is to reply to all letters, e-mails, faxes and complaints, within 10 working days of receipt.	**93.8%**
Import licence applications	
The Inspectorate has undertaken to issue import licences within 10 working days of receipt.	**99.7%**
Deposit licence applications	
The FHI issue crayfish, lobster and mollusc deposit licences, these are <u>not</u> currently covered by our Citizen's Charter Statement, but it is currently our aim to issue them within 10 working days'.	**100%**
Movement document applications	
The Inspectorate has agreed to respond to all requests for movement documents, provided 5 working days' notice is given.	**100%**

Fish and shellfish farm registrations

Registration visits

The Inspectorate has undertaken to visit all potential farmers Within 20 working days of receipt of their application.	**70.6%**

Registration administration

The Inspectorate aim to complete the administrative action within a further 10 days from the date of the visit.	**93.1%**

Notifiable diseases

Respond immediately to a notification of suspicion of infectious salmon anaemia (ISA), infectious haematopoietic necrosis (IHN), viral haemorrhagic septicaemia (VHS), gyrodactylosis caused by G. salaris, bonamiosis, marteiliosis, haplosporidiosis, iridovirosis, mikrocytosis and perkinsosis.	**100%**
Respond to other notifiable diseases within 2 working days.	**100%**

Reporting of test results and visit summaries

The FHI must report all negative test results within 5 working days of the full results becoming available and give a verbal report within 1 working day where a notifiable disease is found. We have agreed to provide a follow up letter within 10 working days to advise the farmers in writing of any points raised during the visit.	**78.2%**

Overall results

The overall compliance rate with our set targets.	**89.9%**

The total correspondence received and recorded by the Inspectorate was 2022. Our performance fully met or approached our targets in most areas. We will continue to strive to achieve all our standards in 2001/ 2002.

Customer care helpline

The purpose of our work is to prevent the introduction and spread of disease into and within England and Wales. This involves implementing European Union Fish Health Directives and administering and enforcing national legislation. In carrying out this work our main aim is to ensure that you receive a high quality, cost effective service so that your compliance costs are kept to a minimum. The best way for us to measure our performance is to receive feedback from people who require our service. To help us achieve this we have set up a Customer Care Helpline on 01305 206673/4 where all complaints will be recorded and, thoroughly and impartially investigated. Our helpline staff can assist the customer to formulate the complaint and will explain in full our complaints procedure. They will also aim to send a reply within 10 working days and to ascertain whether the customer is satisfied with the outcome.

SEAFISH AQUACULTURE ECONOMIC MODELS AND HYBERBOOKS

Seafish launched its series of computer-based economic models at the Shellfish Association of Great Britain Annual Conference in May. The models, which can be used to guide investors when putting together a financial plan for a new or expanding shellfish business, have been developed for dredged and rope-grown mussels, oysters, king scallops, Manila clams and native clams. (Additional information can be found in Shellfish News Number 11, on the Seafish website – www.seafish.co.uk or by contacting any of the Aquaculture Development Team – for details see below).

Since the launch in May, 150 copies of the models, which are available on CD-Rom with an accompanying set of guidance notes, have been sent out in the UK to industry, trade associations, government bodies, agencies and other individuals. There has also been considerable interest from abroad.

The Aquaculture Development Team have organised and attended a number of seminars and workshops to demonstrate the capabilities of the models. These have included the Wales Agri-Food Partnership Fisheries Sub-Group, the Teign Fishermen and Watermen's Association, the C-Mar Workshop in Portaferry and seminars held in Shetland and in the Western Isles, together with the Enterprise Networks in the Highlands and Islands. If you are aware of other groups and organisations that might also be interested, then contact the Seafish Aquaculture Development Team.

The models will be continually up-dated as more information is gathered. To this end, Seafish bid for and was successful in winning an FIFG grant under the 'Innovative Fisheries Measures Scheme (Scotland)'. Part of this will be used to develop further the computer-based interactive models into Hyperbooks. These will include not only economic data but also the most up-to-date information on technical aspects of shellfish culture with 'web-browser' style hyperlinks to additional information on equipment, markets, operating procedures, and environmental issues.

Further information and assistance

Contact the Seafish Aquaculture Development Team:

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ELECTRONIC MAPS OF AQUACULTURE SITES IN EUROPE

La Tene Maps, the Ireland and Scotland-based aquaculture map producer, have announced the availability of electronic versions of all its aquaculture maps. According to a spokesman, these electronic maps were seen for the first time at AquaNor in Norway last month where they were well received. Initially the electronic versions of the aquaculture maps are essentially *.pdf files of the existing maps, with some modifications. The maps are the same size as the printed versions, but do not carry advertisements. In many cases the electronic versions are more up to date than the printed versions, which are only published every two years. In some cases the electronic version is the only version currently available.

Aquaculture maps show the disposition of aquaculture, finfish farming, or shellfish farming in the country or area covered by the map. A unique set of symbols is used to show what species is farmed with site type (marine ongrowing unit, onshore hatchery, etc). The name of the farm operator is included beside the symbol. By this system a user can tell who is farming what and where.

Further information

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NEW MUSSEL FARMING ROPE

Advanced technology

United Kingdom, Norwegian and Irish aquaculturists have pooled their skills with the world of fibre extrusion to produce a revolutionary production advancement for the mussel industry. MYTI • ROPE® has been developed for this rapidly expanding industry to replace conventional ropes. It attracts and holds the byssal threads of the swimming mussel larvae onto its fibrous surface in greater numbers. The secret lies in the unique fibres contained within the MYTI • ROPE®. The unique AUTOCRIMP® fibres mimic the growth of wool on a sheep's back, their formation at the point of molten extrusion being helical or spiral with alternating changes from clockwise to counter clockwise and by regular degrees.

Greater settlement

These tiny alternating spirals create voids or pockets which allow the mussel larvae to become easily attached and in much greater volume than before. The Norwegian and Irish proving grounds report dynamic improvements in yield over conventional mussel lines from the earliest tests, due primarily to both increased adherence and a larger diameter of rope.

Dimensions

MYTI • ROPE® is manufactured exclusively under patent in the United Kingdom in continuous 35 mm (1½") diameter rope form for cutting to drop length on site. Each rope contains over 8000 minute continuous fibres with a surface area in excess of that of normal ropes with no increase in weight. It stretches up to 60% during larval growth permitting subsequent byssal thread attachments as the rope increases in length, for example: a 6.25 m initial drop length will increase to 10m during this process. Available in charcoal grey, which has proved the highest yielding colour, MYTI • ROPE® promises to revolutionise this industry and can be purchased in 1,000 m bales which weigh 25 kilos per bale.

Further information

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NEWS FROM THE TRADE ASSOCIATIONS

SHELLFISH ASSOCIATION OF GREAT BRITAIN (SAGB)

Classification of harvesting waters

In the last issue of Shellfish News, the Shellfish Association presented its views on the shortcomings it sees in the way harvesting waters are classified in the UK, when compared with Holland and France (See Shellfish News No 11 p32).

Whilst the Association continues to make this case over UK implementation of the current Directive, it is increasingly giving thought to trying to ensure that the failings that were inherently built into the Shellfish Hygiene Directive are ironed out when it is replaced by new Regulations. The Association believes that the small number of Class A Harvesting Waters in Britain does not reflect a worse pollution situation here than on the continent or in Ireland; it is merely a result of near-impossible criteria being applied in the UK, whereas other countries have found pragmatic and effective ways of interpreting the Directive.

The great hope is that the new regulations will provide an opportunity for such differences in interpretation to be ironed out. Certainly many changes will be made, and there may be some flexibility built in for modifications to be made as new techniques or fresh evidence of food risks become known.

The industry's great hope is that a standardised and workable classification system is developed. The essential need is for shellfish to be safe. The industry can only survive if the public have the confidence to eat fresh shellfish regularly.

Further information

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ASSOCIATION OF SCOTTISH SHELLFISH GROWERS (ASSG)

The summer season of 'Consultation Documents' has thankfully drawn to a close, after the drafting of an unusually large number of responses.

ASP in scallops

Notable amongst these exercises has been the Food Standards Agency Scotland consultation on the *'Proposal for a Tiered System for the Harvesting and Marketing of ...King Scallops... Affected by ASP'.* What was particularly notable about this document, seeking to introduce a three tiered system (for sales of, respectively, whole animal, shucked roe-on and roe-off/ adductor muscle alone) was the contrast with the introduction of a two tiered system in April 2001. This earlier change to the marketing regime consisted of a two sentence instruction. The expansion to a three tiered system apparently required ten pages describing a proposed regime of surveillance, testing and tracing of byzantine complexity! It also introduced what is essentially a new Action Level, named a 'Trigger Value', of such a low level that it would almost guarantee the extinction of the fresh roe-on market.

The extension to a third tier should have been be no more complex than that for the two tier regime, with the instruction that King Scallops from a third group of specified areas must be taken to an approved plant for 'full shucking' (removal of hepatopancreas, mantle, gills and gonad). This should be supported by a requirement for the creation of an effective traceability system for each approved plant, which need not be more complex than differentiation through variously coloured sacks and identification tags.

My personal feeling is that the driving force behind some of these 'Over The Top' controls may well be found in Brussels, in DG SANCO, the ASP Expert Working Group and some national representatives on the Standing Veterinary Committee, rather than in St Magnus House, Aberdeen. But if this is so it makes the discriminatory nature of these proposals even more difficult to accept - the import of Pectinid roe-off meats from Third Countries remains free from constraints, because it has been previously acknowledged that these products do not pose a threat to public health.

Aquaculture Regulations

A second major 'consultation response' of the season has been to SEERAD over the proposed amendment of aquaculture Regulations. While the majority of the Regulations apply to our finfish colleagues, the shellfish sector naturally has an interest in ensuring that the reins of governance are not slackened off too much on 'nutrient enhancing aquaculture' (NEA). I strongly believe that there is a role in the food chain for responsible NEA, however, the 'precautionary principle', prudence and caution must surely be the watchwords when regulating these restricted waters, with the concepts of 'sustainability' and 'ecological footprints' constant in our thoughts.

There is a clear need to improve, expand and enhance the tools and information that policy-makers have to hand. This holds whether they are based in Pentland House, St Magnus House or Erskine Court - or indeed in the Planning Departments of the Local Authorities or the legislators in Rue de la Loi, Brussels.

Carrying capacity

The priority contender for allocation of intensive research and analysis resources to effectively support a long term sustainable and diverse aquaculture industry, covering the range of NEA and nutrient extractive aquaculture (NXA), such as shellfish and seaweeds, is an evaluation of the biological carrying capacity of our inshore hydrographic systems. This would enable a scientifically robust assessment of the optimal portfolio of species, from salmon and marine finfish through a variety of shellfish to seaweeds, balancing and utilising the range of potentially available nutrients.

Yet 'Carrying Capacity of Coastal Waters' was dismissed by the consultation document with two casual paragraphs of pejorative comment. This was in stark contrast to the forthright statement from SEERAD Minister Rhona Brankin : "we must examine the carrying capacity of Scottish coastal waters" (Q&A session before the Transport & Environment Committee of The Scottish Parliament, 26 June 2001).
The global industry is on the side of the Minister. It is widely acknowledged in aquaculture circles world-wide that the future of the industry will depend upon the implementation of balanced and integrated ecosystem approaches. Even the European Commission Green Paper on 'The future of the CFP' repeatedly mentions the need for ecosystem management for fisheries as well as aquaculture. Balancing the aggregate nutrient budget through the complementary natures, needs and contributions of different species, both NEA and NXA, with the introduction of innovative polyculture systems, is widely expected to significantly increase overall productivity in comparison to traditional monoculture systems.

Strategy

For a number of years we have been calling for the preparation of an over-arching strategy for aquaculture, going beyond the Crown Estate's 'guidance' documentation. It was therefore a positive development when Rhona Brankin announced in late June that the

Scottish Executive 'will consult with all interested parties with a view to developing a long term strategy for aquaculture', seeking 'to strike the right balance between environmental considerations and socio-economic benefits'. We must hope that the 'strategy' truly addresses the needs of the full spectrum of the aquaculture community, not simply the salmonid sector.

Finfish culture review

The ASSG passed a Reolution at the March AGM in favour of a moratorium on the further expansion of seacage finfish aquaculture. This reflected a sense of unease at the recent rapid expansion in sites and scale of operations at individual sites. It was also a 'wake up call' for a more general 'pause for reflection', to enable a review of the current status of coastal zone activities in the round and aquaculture in particular.

Coastal Zone Management

The hope of the ASSG was that such a review would put this into context within a broader, more comprehensive policy objective. What is needed is a holistic approach, consisting of, firstly, the development of an aquaculture strategy, and secondly, to accelerate progress towards a debate on the implementation of effective Integrated Coastal Zone Management (ICZM) in Scotland's inshore waters. So although the Scottish Executive's response to our Resolution was dismissive, the net result in practical terms may yet turn out to be positive and constructive.

Further information

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SHELLFISH PRODUCTION

SHELLFISH PRODUCTION IN THE UK IN 2000

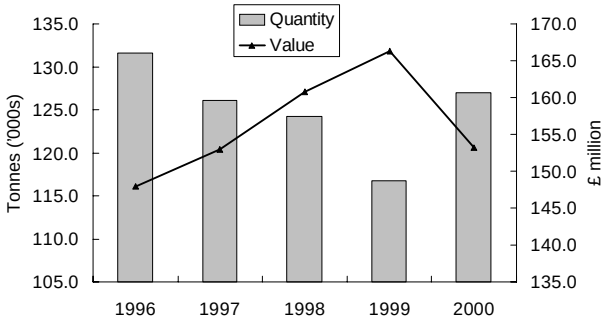
The figures available are presented in three categories. Readers should be aware that there is some overlap in the statistics. For example, figures for farmed production of some species may or may not also be included in the Fishery Order figures. This is indicated where information is available. The data are nevertheless valuable for giving an overall impression of activity within and value of the industry, and for comparisons between years. More detailed analyses of the figures may be obtained from the sources quoted.

1. Shellfish landings

Source: M.A.F.F., UK Sea Fisheries Statistics 2000, HMSO, London.

About 127,000 tonnes of shellfish were landed in the UK in 2000, which represents a 9% increase compared with the previous year, and reverses the declining trend of the previous 3 years. The catch was worth over £153 million, which is lower than the previous two years and represents a return to the value in 1997. Weight and value of shellfish landings in the UK over the last 5 years are shown on the figure.

The increase in weight of total catch in 2000 was due mainly to an increase of over 6,000 tonnes of cockles landed, which was over 40% more than in 1999, and is a return to the landings obtained in 1996 and 1997. The fall in total value of £13.1 million can be accounted for by a drop in the value of the Nephrops catch, which fell



Weight and value of shellfish landings in the UK (1996 – 2000)

from £74.3 million in 1999 to £60.8 million in 2000. This was due to a 9% drop in the landings together with a 10% drop in the price per tonne, compared with the previous year.

In 2000, about three-quarters of the total catch was made up of just four species. These were Nephrops (22%), Crabs (20%), Cockles (16%) and Scallops (15.5%). Almost 80% of the total value was made up from just 3 species. Nephrops were the most valuable, contributing 40% of the total, followed by scallops (20%) and crabs (18%). Lobsters were the most valuable species on a per weight basis, with the price per tonne above £10,000 for the first time. They contributed 8% to the total value of the catch. Despite the large quantities of cockles landed their low unit price, which fell by 20%

from the previous year, meant that they contributed less than 2% of the total value. The majority of the mussel landings are from cultivated fisheries, which also appear in the farmed shellfish production figures.

The 'Other Shellfish' category in the table includes oysters and clams, as well as some high value species, for example, Crawfish, English Prawns, Razor Fish and Squat Lobsters, for which there is no separate information available for 2000.

Total Shellfish landings in the UK in 2000

Type	Tonnes	Value (£s)	Unit Value (£ per tonne)
Cockles	20,309	2,952,599	146
Crabs	25,677	28,036,497	1,091
Lobsters	1,242	12,457,505	10,029
Mussels	7,468	1,441,938	193
Nephrops	28,305	60,778,144	2,148
Periwinkles	1,142	1,089,385	954
Queen Scallops	5,342	2,291,809	429
Scallops	19,729	30,741,150	1,558
Shrimps	1,590	2,062,283	1,297
Squid	1,425	2,716,006	1,906
Other Shellfish	14,795	8,680,084	
Total Shellfish	**127,023**	**153,250,000**	

2. Farmed Shellfish Production

A. England and Wales

P. Dunn and I. Laing, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB

The shellfish production statistics are collected by the Inspectorate during their disease inspection visits to shellfish farms in England and Wales. The recent Foot and Mouth Disease restrictions on farm access has meant that the visiting programme has been considerably disrupted this year, and it has not therefore been possible to complete the production statistics for 2000 in time to include a summary in this edition of Shellfish News. They will now appear in the May 2002 edition.

Overall, the indications are that farmed shellfish (table) production in 2000 was broadly similar to that in 1999. The figures for that year were native oysters (93 tonnes), pacific oysters (386 tonnes), manila clams (17 tonnes), palourdes (12 tonnes), and cockles (43 tonnes). There will have been an increase in mussel production, in line with that reported from the Fishery Orders and shown in the Table in Section 3 (10,691 tonnes). Farmed mussel production in 1999 was 8,009 tonnes. Total value of farmed production in 1999 was estimated at £3.7 million.

B. Scotland

Source: 'Scottish Shellfish Farms, Annual Production Survey, 2000' (ISBN : 1363-5867), available from Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen, AB9 8DB (Editors D.J. Pendrey & D.I. Fraser).

Introduction

This report is based on an annual survey questionnaire of all registered Scottish shellfish farming companies. The co-operation of the shellfish farming industry is gratefully acknowledged.

Movement and production forms were sent to 189 companies registered as active before the survey. One hundred and eighty eight (99%) returns were received; the remaining company, which could not be contacted, made no contribution to production in 2000. Production returns were recorded from 176 companies. Thirteen companies had ceased trading, and one 'wild' mussel fishery, registered as a shellfish farm has been excluded from this report.

The survey shows that 85 companies (48%) produced shellfish for sale, both for the table and for on-growing. The remaining 91 continued to operate, but had no sales during 2000. The number of active companies has decreased from a peak of 229 in 1990 to 176 in 2000. These companies farmed 247 active sites, of which 132 (56%) placed shellfish on the market.

Activity

The industry employed 138 full-time and 225 part-time workers during 2000, an increase of 18% over the previous year.

The number of companies registered as active increased by 25 during 2000 and the number of active sites decreased by 4%. This trend reflects the closure of inefficient sites. Many unproductive sites held stock not yet ready for market, others were fallow, and some were positioned in remote areas where the cost-effective production and marketing of shellfish proved difficult.

Many companies cultivate more than one species on site, a practice made possible by similar cultivation techniques. For example, scallops are grown together with queens, Pacific oysters with native oysters and mussels with Pacific oysters.

Production

Total production was dominated by mussels (2,003 tonnes) and Pacific oysters (247 tonnes). Small volumes of queens (58 tonnes), scallops (39 tonnes) and native oysters (4 tonnes) were also produced.

Pacific oyster production increased by 7% as markets were maintained and demand remained high. Native

oyster production decreased by 64% as the one major producer had an unforeseen marketing problem. Accounting for a small percentage of total oyster production, native oysters continued to supply a strong market. Mussel production increased by 43% as markets developed and prices remained high. Queen production decreased by 27%. Production of farmed scallops increased with the development of Several Order fisheries. Nine Several Orders have now been granted for scallop fisheries, seven for commercial companies, and two for companies involved in research and development. This increase in scallop production is likely to continue over the next few years. Following consultation with growers and the Scottish Shellfish Marketing Group, it was revealed that markets were maintained and demand remained high.

Prices of farmed shellfish fluctuated throughout the year, however, the value at first sale of the species cultivated was estimated. The price of Pacific oysters varied between 15 and 25 pence per shell; native oysters 50 pence per shell; scallops and queens 50-60 and five pence per shell respectively; and mussels between £800-£1,300 per tonne. The total value of the 2000 farmed production is estimated at £3 million.

Environmental and Health Influences on the Industry

Approved Zone status for the notifiable diseases Bonamia and Marteilia was maintained in 2000 (under EC Directive 91/67) after testing confirmed the absence of these diseases in Scottish waters. Samples were taken from 10 sites holding native oysters, a species known to be susceptible to these shellfish diseases. Approved Zone status continued to offer benefits to both wild and farmed native oyster stocks in Scottish waters. EC Council Directive 95:70 maintains that minimum community measures for the control of certain diseases affecting bivalve molluscs are in place. A third of all shellfish sites are visited annually by the FRS Fish Health Inspectorate under this Directive. Facilities, stocks, registration details, movement and mortality records will be inspected on these visits. It is the resposibility of farmers to inform FRS of any abnormal, unexplained mortalities on their sites. Statutory marine biotoxin monitoring in Scotland continued during 2000. Examination of more than 3,675 shellfish flesh, and 646 phytoplankton samples from 38 sites revealed the presence of paralytic shellfish poisons (PSP), diarrhetic shellfish poisons (DSP) and amnesic shellfish poisons (ASP) in most of the important shellfish growing regions. Voluntary Closure Agreements (VCAs) were agreed, and Food and Environment Protection Act 1985 (FEPA) closure orders were imposed in scallop aquaculture and important scallop fishing grounds. The ASP problem continued to the end of the year. Classification of bivalve mollusc production areas continued during 2000 under The Food Safety (Live Bivalve Molluscs and Other Shellfish) Regulations 1992, and areas were classified either A, A/B Seasonal, B, or C respectively. There are currently some 20 approved depuration systems: seven small scale oyster purification plants; six bulk bin systems for mussels; and seven medium-sized plants for the depuration of mussels or oysters. In an attempt to meet the End Product Standard at all times, the main buyers demand that all marketed stocks be depurated, including those classified as A (where purification is not essential).

Summary

The 2000 survey has shown:

- Mussels and Pacific oysters are the main species produced in terms of value and tonnage
- A small reduction in the number of producing sites
- That only 53% of active sites produced shellfish for table sales
- That manpower increased with an increased production
- An increase in production of Pacific oysters
- A substantial increase in the production of mussels
- A substantial increase in the production of scallops although scale of prodution remained low
- A decrease in the production of queens and native oysters
- That approved zone status for the diseases Bonamia and Marteilia was maintained during the year
- That the industry is still dominated by small producers, although a few large companies contribute significantly to the annual production of all species.

The market for all species appeared to be buoyant and prices remained stable throughout the year. It is predicted that production will continue to increase steadily over the next few years.

C. Northern Ireland

Mrs Cathy Moore
DARDNI, Fisheries Division, Annexe 5, Castle Grounds, Stormont Estate, Belfast, BT4 3PW.

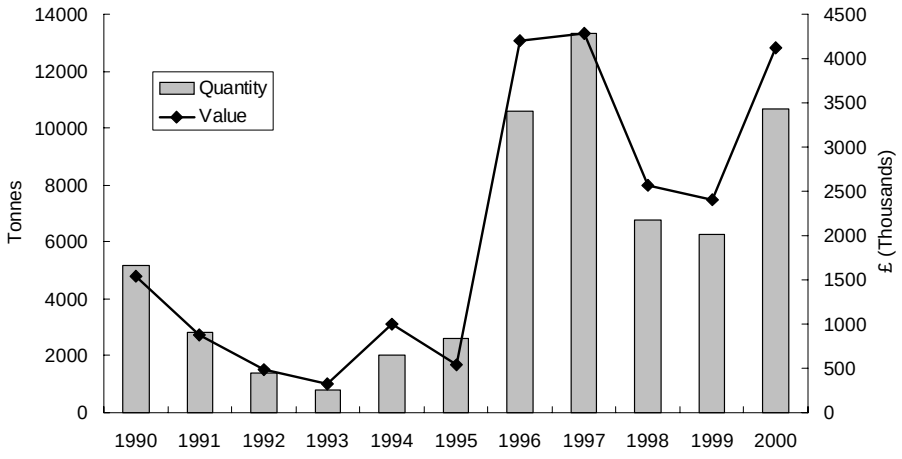
Shellfish production statistics for Northern Ireland in 2000 were not available at the time of going to press and these, as with the data for England and Wales, will be reported in the May 2002 edition of Shellfish News.

3. Shellfish Production from Several and Regulated Fisheries

Source: Annual Returns

There are currently 18 Several Fisheries, 7 Regulated Fisheries and 2 Hybrid Order Fisheries in England and Wales. Hybrid Orders are Regulating Orders where the grantee has the power to assign Several plots within the fishery.

Information was available for all the sites, and is included in the table. There was shellfish production at 13 of the 18 Several Fishery sites. Some of the other



Mussel production from Fishery Orders (1990-2000)

sites are still being developed; another is still affected by adverse hygiene classification, which effectively prevents harvesting of the shellfish on the beds. One site is no longer active and may be determined. There was also production at six of the Regulated Fisheries and both of the Hybrid Order Fisheries. The other Regulated Fishery is operated for supplying seed mussels. Various levels of other cultivation activity took place at many of the productive sites, for example relaying of cultch and or stock.

The Table (below) shows an estimated total value of production from the Fishery Orders in 2000 of just under £8.4 million. This is an increase of almost 30% over the 1999 value, mainly due to increased production of mussels, which contributed nearly half of the total value. Welsh Fisheries make up about half of this total. The value of production in 2000 saw a return to that achieved in 1996 and 1997 (see Figure above).

Production/Landings (tonnes) of shellfish from Fishery Orders in England and Wales in 2000

Type	Several	Regulated	Hybrid	Total	Estimated Value (£,000s)
Pacific oyster	15	17	21	53	81
Native (flat) oyster	166	736	38	940	1,074
Clams	-	5	176	181	273
Mussels	4,945	357	5,389	10,691	4,124
Cockles	-	14,388	6,788	21,176	2,831

The production of cockles also increased, to a record level (21,176 tonnes). The previous best year was in 1995, when just over 20,000 tonnes were fished. The unit value decreased by around 20%, but the increased production ensured that the total value also increased to a record level. Some farming of cockles takes place within Fishery Order areas. However, this accounts for less than half of one percent of total cockle production.

Production and value of clams from Fishery Orders increased by around 34% compared to 1999, also reaching a record level (181 tonnes), the previous best being in 1997 (157 tonnes). As with cockles, all clam-farming sites are situated within Fishery Orders.

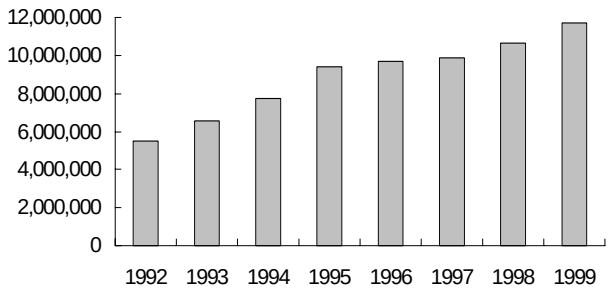
There was a slight (5%) increase in production of flat oysters compared with 1999, maintaining the high level of production of the previous year. However, the estimated total value of these oysters decreased slightly, due to the continuing fall in market price. Only around 2% of the production of flat oysters in Fishery Orders is recorded as being from farming. The industry are initiating a native oyster recovery programme, in line with the aims of the Biodiversity Action Plan, as reported in Shellfish News Issue 11 (May 2001). This will hopefully improve the prospects for the cultivation of this species in future years.

The level of production of Pacific oysters from Fishery Orders in 2000 was similar to the previous year. The reported estimated value increased considerably, compared with 1999, indicating a recovery of price levels to those in the early 1990s. While all Pacific oyster production in England and Wales is from registered shellfish farms, only 10-15% of the total production of this species takes place in Fishery Orders.

WORLD SHELLFISH PRODUCTION

Each year, the Food and Agriculture Organisation of the United Nations (FAO) publishes data on the status of global fisheries and aquaculture. The figures for 1999 were released recently.

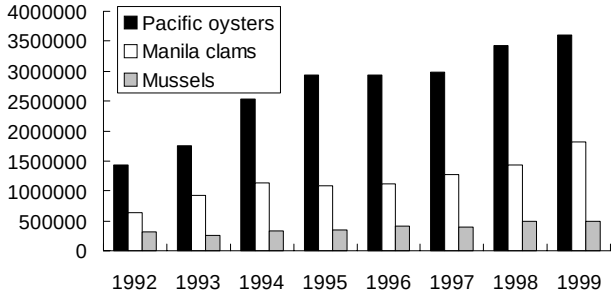
While production from capture fisheries has been more or less static during the 1990s aquaculture production has steadily increased. The figure shows shellfish aquaculture production, in metric tonnes, since 1992. There was an annual increase in total shellfish production of about 10% in 1999, the biggest jump since 1995. There was also a significant (6.6%) increase in the total value, from 16.8 billion US dollars in 1998 to 17.9 billion US dollars in 1999. Shellfish account for about 27% of total world aquaculture, which includes marine and fresh water fish as well as aquatic plants.



World Aquaculture - shellfish production (metric tonnes)

For the shellfish, molluscs are more important that crustaceans in terms of weight, making up 86% of the total, but the value of mollusc and crustacean aquaculture is about the same.

The Pacific oyster (*Crassostrea gigas*) is by far the most important individual species, making up over a third of the production and value of the molluscs. Production of this species has increased three-fold over the last ten years, with a doubling in the total value over the same period. Manila clams are also important, making up 18% and 24% of the total mollusc weight and value, respectively. Only 5% of world mollusc production is of mussels.



World aquaculture production of selected mollusc species in metric tonnes

RESEARCH NEWS

Research News includes abstracts of recent work that may be of interest to the shellfish industries. These abstracts are taken both from papers published in international scientific journals and from project work undertaken by students at Universities and Research Laboratories. Results from the latter are usually not widely available and ***supervisors of student projects are encouraged to submit abstracts to Shellfish News as a means of publishing this information***.

1. Upwelling systems best for bivalve hatcheries

This comparative evaluation of a fluidised-flow system for seed clam culture in land-based nurseries shows that it is a better alternative to raceway, down-welling, or traditional forced-flow culture methods.

A number of approaches have been used for growing bivalve hatchery seed (1 mm) to a size suitable for field planting (> 8 mm) but few have been directly compared, This study evaluated the growth and survival of northern quahog seed in three different culture systems and two different stocking densities. The three systems were 1) a stacked-tray unit with downward water flow; 2) traditional upweller culture units with water flowing upward without seed bed expansion; and 3) upweller culture units with water flowing upward at fluidization velocities to provide seedbed expansion. The two stocking densities were 1.0 and 3.0 g whole wet weight clams per square centimetre. During each trial period the seed clams were fed a 1% daily ration (% dry weight

algae per wet weight clam per day) of the cultured diatom *Chaetoceros muelleri*. Seed clams exhibited better growth and a greater final shell length under fluidized-flow condition at both stocking densities.

Reference

Pfeiffer, T.J., Rusch, K.A., 2001. Comparison of three culture methods for the intensive culture of northern quahog seed, *Mercenaria mercenaria*. Journal of the World Aquaculture Society Vol 32, pp 11-20.

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2. Oyster fattening in ponds in France

Oyster farming in France is a traditional activity. Each year, 60,000 tons of pacific oysters are fattened before being sold. Present-day fattening techniques for improving oyster taste and colour and increasing the meat weight are not particularly reliable. To optimise the fattening process, blooms of phytoplankton were induced in large ponds, then distributed into the oyster-fattening ponds. Despite the variability of the autumn weather conditions, diatoms, especially *Skeletonema costatum*, can be successfully cultured in this way. During neap tides (when no seawater replenishes the water in the oyster beds), between mid-October and mid-December, the fattening index (the weight of the meat) was constant or increased by 10-15% when a supplement of algae of 380,000 cells/oyster/day was added to the ponds. The algal supplement was clearly responsible for the fattening improvement. The addition of 110,000 cells/oyster/day, a significantly lower quantity, was not sufficient to prevent weight loss. A significant reduction in weight (up to 20%) was observed in oysters grown in ponds that did not receive additional algae.

Reference

Soletchnik, P (Patrick.Soletchnik@Ifremer.fr), Le Moine, O., Goulletquer, P., Geairon, P., Razet, D., Faury, N., Fouche, D., Robert, S., 2001. Optimisation of the traditional Pacific cupped oyster (*Crassostrea gigas* Thunberg) culture on the French Atlantic coastline: autumnal fattening in semi-closed ponds. Aquaculture Vol 199, pp 73-91.

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3. Barnacles prefer living mussels

There is very little suitable attachment substrate for sessile organisms on the unstable sedimentary tidal flats of the Wadden Sea. Mussel beds (*Mytilus edulis* L.) provide the only sites available for the barnacle (*Semibalanus balanoides* L) to settle. Field investigations showed that barnacles were more likely to settle near the siphons of living mussels. They rarely grew on dead mussels or shell fragments. Growth of barnacles was also significantly higher upon living mussels than on empty mussel shells. Moreover, individual barnacles on living mussels had a higher reproductive output. They produced twice as many nauplii larvae than barnacles attached to empty shells.

Reference

Buschbaum, C (cbuschbaum@awi-bremerhaven.de), 2001. Selective settlement of the barnacle *Semibalanus balanoides* (L.) facilitates its growth and reproduction on mussel beds in the Wadden Sea. Helgoland Marine Research Vol 55, pp 128-134.

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4. Mussel growth and barnacles

Growth in mussels (*M. edulis*), which is governed by tidal exposure, may also be modified by the extent of shell colonisation by barnacles.

The effects of tidal emergence and barnacles on the shells on growth of mussels in the Wadden Sea were investigated by field experiments and surveys. The results showed that mussel cohort lengths were lowest in the mid-intertidal zone (25-35 mm shell length), intermediate in the low intertidal (30-45 mm) and greatest in the subtidal zone (up to 60 mm). In the low intertidal zone *M. edulis* were heavily overgrown by barnacles compared with mussels grown subtidally and in the mid-intertidal zone. Cross-transplantation experiments of clean mussels (25-35 mm length) showed that from July to September growth was about 3 mm in the intertidal zone and significantly increased to about 10 mm subtidally. Mussel origin had no influence upon growth. Further field experiments showed significantly lower growth in mussels with barnacles than without. Living and experimentally sealed barnacles did not differ in their effect, indicating that food competition was not responsible.

Reference

Buschbaum, C. (cbuschbaum@awi-bremerhaven.de), Saier, B. (bsaier@awi-bremerhaven.de), 2001. Growth of the mussel *Mytilus edulis* L. in the Wadden Sea affected by tidal emergence and barnacle epibionts. Journal of Sea Research Vol 45, pp 27-36.

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5. Mussels, barnacles and periwinkles

It is suggested that periwinkle density may be a key factor in the population dynamics of barnacles on intertidal mussel beds in the Wadden Sea.

On the extensive tidal flats of the Wadden Sea, beds of the blue mussel *Mytilus edulis* represent the only major hard substratum and attachment surface for sessile organisms. The barnacle *Semibalanus balanoides* is the most frequent of these. The extent of barnacle overgrowth is not constant and differs widely between years. In summer 1998 it occurred on over 90% of the large mussels (>45 mm shell length) and the dry weight of barnacles reached 65% of mussel dry weight.

Periwinkles (*Littorina littorea*) may reach densities greater than 2000 per square metre on intertidal mussel beds. Field experiments were conducted to test the effect

of periwinkle grazing on barnacle density. An experimental reduction of grazing and bulldozing pressure by periwinkles resulted in increased recruitment of barnacles, while barnacle numbers decreased with increasing snail density. The highest numbers of barnacles survived in the absence of periwinkles. However, a lack of periwinkle grazing activity also facilitated settlement of ephemeral algae later in the year. Field experiments showed that the growth rate of barnacles decreased in the presence of these ephemeral algae. Thus, periwinkles may reduce initial barnacle settlement, but later may indirectly increase barnacle growth rate by reducing ephemeral algae.

Reference

Buschbaum, C. (cbuschbaum@awi-bremerhaven.de), 2000. Direct and indirect effects of *Littorina littorea* (L.) on barnacles growing on mussel beds in the Wadden Sea. Hydrobiologia Vol 440, pp 119-128.

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6. *Bonamia*-resistant oysters in Ireland

The parasite *Bonamia ostreae* has caused significant mortalities in the flat oyster *Ostrea edulis*. To date, methods of control and eradication have proved largely unsuccessful. Research is now concentrating on development of a population of oysters that has increased resistance to bonamiasis. Development of a strain showing some resistance to *B. ostreae* would allow oysters to be grown to market size before significant mortalities occurred, and would also allow restocking of areas that have been decimated by the disease.

The study looked at the relative resistance of three Irish strains of flat oysters to this disease. Two were naive strains, that had not previously been exposed to the parasite, and the other one had been exposed to *B. ostreae* since the 1980s, and has been selectively bred from survivors. In field and laboratory trials, oysters from the selected strain showed lower prevalence of infection, intensity of infection and mortalities compared to the two naive strains.

Reference

Culloty, S.C. (s.culloty@ucc.ie), Cronin, M.A., Mulcahy, M.F., 2001. An investigation into the relative resistance of Irish flat oysters *Ostrea edulis* L. to the parasite *Bonamia ostreae* (Pichot et al., 1980). Aquaculture Vol 199, pp 229-244.

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7. Lower mortality of flat oysters in a fully saline environment

Juvenile *O. edulis* were deployed among replicate floating trays at one estuarine (Little Point) and one marine site (Lowes Cove) in the Damariscotta River estuary, Maine, USA. Growth, mortality, and *Bonamia ostreae* prevalence were compared. Growth was faster at Little Point though oysters at both locations reached market size in less than three full growing seasons. Mortality was similar between locations except following a June rain event that decreased salinity more drastically at Little Point. Cumulative mortality was greater at Little Point (45.8%) than Lowes Cove (26.7%). Surprisingly, *B. ostreae* was observed in only a single oyster, from Little Point.

These data indicate that flat oysters may grow well across a wide range of environments, yet demonstrate better survival at marine sites where salinity fluctuations are less extreme. While *B. ostreae* is likely still a threat, selection of sites where rapid growth to market size is possible may reduce its impact.

Reference

Carnegie, R.B. (Pacific Biological Station, 3190 Hammond Bay Rd, Nanaimo,BC V9R 5K6, Canada), Barber, B.J., 2001. Growth and mortality of *Ostrea edulis* at two sites on the Damariscotta River estuary, Maine, USA. Journal of The World Aquaculture Society. Vol 32, pp 221-227

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8. Marteilia - different species in oysters and mussels?

Marteilia refringens is one of the most significant pathogens of flat oysters (*Ostrea edulis*) in Europe. A type of *Marteilia* is found in both flat oysters and mussels (*Mytilus edulis* and *Mytilus galloprovinciallis*). Previous comparisons from sequencing of the small sub-unit ribosomal RNA gene of *Marteilia* isolates derived from infected mussels and oysters had not revealed any genetic differences, despite indications from epizootiological data that different types may exist. However, investigation of the internal transcribed spacer region of the ribosomal RNA gene sequences showed clear differences. The distribution of the two genetic types, named 'O' and 'M', appeared to be linked to the host species, oysters and mussels, respectively. This would support the recognition of two species of *Marteilia* in Europe and it is proposed that the 'O' type corresponds to *M. refringens* and the 'M' type to *M. maurini*.

Reference

Le Roux, F. (fleroux@ifremer.fr), Lorenzo, G., Peyret, P., Audemard, C., Figueras, A., Vivares, C., Gouy, M., Berthe, F., 2001. Molecular evidence for the existence of two species of *Marteilia* in Europe. Journal of Eukaryotic Microbiology Vol 48, pp 449-454.

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9. Marteilia - a complex life cycle?

The life cycle of the flat oyster parasite *Marteilia refringens* is unknown and may be complex, involving several hosts. Recent developments in the DNA-based diagnosis of *M. refringens* make it possible to detect the

parasite in other hosts. However, the large number of other species living in the vicinity of oyster beds hampers any screening programme.

Semi-enclosed oyster ponds (so called 'claire' in Marennes-Oleron Bay) are being used as a study model for the life-cycle of *M. refringens*. Claires are located in an area endemic for *M. refringens* and transmission of the disease to healthy oysters has been achieved during the course of this study. The environmental characteristics of the claires limits the number of species, compared with intertidal areas and oyster beds. Consequently, extensive sampling of a limited number of species cohabiting with oysters is possible. These have been preserved for future screening of *M. refringens*. The experimental model should bring new insights to the life-cycle of *M. refringens*.

Reference

Audemard, C., Barnaud, A., Collins, C.M., Le Roux, F., Sauriau, P.G., Coustau, C., Blachier, P., Berthe, F.C.J. (fberthe@ifremer.fr), 2001. Claire ponds as an experimental model for *Marteilia refringens* life-cycle studies: new perspectives. Journal of Experimental Marine Biology and Ecology Vol 257, pp 87-108.

10. Herpes-like virus in French oysters and clams

Batches of both Pacific oyster (*Crassostrea gigas*) and Manila clam, (*Ruditapes philippinarum*) larvae were affected by occasional high mortality in a French commercial hatchery in June 1997. Histological observation showed the presence of cellular abnormalities in affected animals. Electron transmission microscopy revealed the presence of herpes-like virus particles in infected larvae of both bivalve species. This is the first description of a herpes-like virus infection in larval *R. philippinarum*. Viruses observed in *C. gigas* and *R. philippinarum* were closely related with respect to ultrastructure and morphogenesis. They were detected simultaneously in larvae of both bivalve species indicating possible interspecific transmission. Moreover, PCR analysis using oyster herpes-like virus specific primers allowed amplification of fragments of expected sizes for both bivalve species and demonstrated the presence of viral DNA. The PCR products obtained for both bivalve species and digested by restriction enzymes displayed the same patterns. This suggests that the same herpes-like virus may infect larval oysters and clams. Herpes-like viruses may be one of the causative agents of mortalities observed in bivalve hatcheries.

Reference

Renault, T (trenault@ifremer.fr), Lipart, C., Arzul, I., 2001. A herpes-like virus infecting *Crassostrea gigas* and *Ruditapes philippinarum* larvae in France. Journal of Fish Diseases Vol 24, pp 369-376.

11. Effects of hand raking for cockles on benthic communities

The cockle, *Cerastoderma edule* (L.) is fished in intertidal and estuarine habitats across Northern Europe. Cockles are harvested either mechanically using tractor dredges or suction dredges or by large numbers of individual fishermen using hand rakes.

Examination of both small and large sized plots 14 days after hand raking showed that there were changes to the associated benthic communities, compared with control (undisturbed) plots. Hand raking also led to an initial three-fold increase in the damage rate of under-sized cockles. The small raked plots had recovered 56 days after the initial disturbance whereas the large raked plots remained in an altered state. Samples collected over a year later suggested that while effects of hand raking may be significant within a year, they are unlikely to persist beyond this time-scale, unless there are larger long-lived species present within the community.

Reference

Kaiser, M.J. (m.j.kaiser@bangor.ac.uk), Broad, G., Hall, S.J., 2001. Disturbance of intertidal soft-sediment benthic communities by cockle hand raking. Journal of Sea Research Vol 45, pp 119-130.

12. Effect of scallop dredging on benthic communities

The results of this study indicate that the majority of damage to large benthic invertebrates during scallop dredging occurs unobserved on the seabed, rather than in the by-catch.

Experimental dredging was undertaken on a scallop fishing ground in the north Irish Sea, off the Isle of Man. Divers were deployed immediately after dredges had passed, to record levels of damage to megafauna (larger benthic dwelling animals) left in the dredge tracks. Damage was assessed using a simple 4-point scale adapted for different taxonomic groups. Mean damage levels, and the proportions of the 4 damage scores in the by-catch and on the seabed, were the same in most species. Some common species did show differences. The edible crab *Cancer pagurus* was more severely damaged when not captured, while the starfish *Asterias rubens* and whelk *Neptunea antiqua* received greater damage within the by-catch. Capture efficiency for the megafauna was low, ranging from 2 to 25 % among species.

Reference

Jenkins, S.R.(stu@liverpool.ac.uk), Beukers-Stewart, B.D., Brand, A.R., 2001. Impact of scallop dredging on benthic megafauna: a comparison of damage levels in captured and non-captured organisms. Marine Ecology Progress Series Vol 215, pp 297-301.

13. Environmental impact of suspended culture mussel farming

Two large well established mussel farms in south-west Ireland were studied. At one site, the benthic community was subjected to bulk sedimentation and organic enrichment and macrobenthic infaunal diversity was reduced. Elevated levels of organic carbon were recorded close to the farm and effects were restricted to a radius of 40 metres. At the second site there were no observed effects of mussel biodeposits on the benthos and a diverse macrobenthic community persisted. Variations in the dispersion of biodeposits caused by local current patterns were probably the cause of these differences, and this could also account for differences reported in other studies.

Reference

Chamberlain, J (j.chamberlain@napier.ac.uk), Fernandes, T.F., Read, P., Nickell, T.D., Davies, I.M., 2001. Impacts of biodeposits from suspended mussel (*Mytilus edulis* L.) culture on the surrounding surficial sediments. Ices Journal of Marine Science. Vol 58, pp 411-416.

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14. The stress response in oysters

The stress response is a series of co-ordinated physiological reactions increasing the capacity of an animal to protect itself in the presence of threatening agents. In vertebrates this process is known to involve hormonal signalling to rapidly change key physiological functions. Less is known about neuro-endocrine responses to stress in invertebrates, including molluscs.

Three types of stresses commonly encountered by oysters in aquaculture or in their natural habitat were applied. These were mechanical disturbance (consisting of shaking the animals), temperature and salinity variations. Both circulating noradrenaline (NA) and dopamine (DA) concentrations increased in response to stress. The response to acute mechanical stress was both rapid (less than 5 min) and transient (a return to basal levels was observed after 60-90 min), and reflected both the intensity and duration of the perturbation. In contrast, responses to temperature and salinity variations were long lasting (up to 72 h).

Reference

Lacoste, A, Malham, S.K., Cueff, A., Poulet, S.A., 2001. Stress-induced catecholamine changes in the hemolymph of the oyster *Crassostrea gigas*. General and Comparative Endocrinology Vol 122, pp 181-188.

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15. Stress makes oysters vulnerable to bacterial infection

Oysters are permanently exposed to various microbes, and their defence system is continuously working to prevent accumulation of invading and pathogenic organisms. Impairment of this defence system usually results in mass mortalities in cultured oyster stocks or increased bacterial loads in food products intended for human consumption. Results from this study suggest that the physiological changes imposed by stress, or the addition of stress-response hormones, increase vulnerability to the pathogen *Vibrio splendidus*.

Experiments were conducted to examine the effects of stress on the resistance of juvenile pacific oysters to the pathogen *Vibrio splendidus*. Oysters were challenged with a low dose of a pathogenic *V. splendidus* strain and subjected to a mechanical stress. Both mortality and the degree of infection with *V. splendidus* increased in stressed oysters, whereas they remained low in unstressed animals, Injection of noradrenaline or adrenocorticotropic hormone, two key components of the oyster stress response system, also caused higher mortality and increased accumulation of *V. splendidus* in challenged oysters.

Reference

Lacoste, A, Jalabert, F., Malham, S.K., Cueff, A., Poulet, S.A. (poulet@sb-roscoff.fr), 2001. Stress and stress-induced neuroendocrine changes increase the susceptibility of juvenile oysters (*Crassostrea gigas*) to *Vibrio splendidus*. Applied and Environmental Microbiology Vol 67, pp 2304-2309.

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16. TBT - the recovery continues

In the United Kingdom, the use of TBT-based anti-fouling paints on small vessels was banned in 1987, and a biological study of the Crouch Estuary, a yachting centre on the south-eastern English coastline, was initiated in order to monitor any associated changes. The macrobenthic infauna and epifauna were sampled between 1987 and 1992, and again in 1997, Epifaunal sampling in 1997 showed that an earlier increase in sedentary taxa had been sustained, and also that a large population of the native oyster *Ostrea edulis* had become established upstream. The trend towards improved community composition at inner estuary stations, where TBT concentrations were historically much higher, was also continued. These observations, along with evidence of established populations of a range of ascidian species in the inner estuary after an initial marked increase in densities, provide circumstantial evidence of an underlying improvement in environmental conditions following the TBT ban in 1987.

Reference

Rees, H.L. (h.l.rees@cefas.co.uk), Waldock, R., Matthiessen, P., Pendle, M.A., 2001. Improvements in the epifauna of the Crouch Estuary (United Kingdom) following a decline in TBT concentrations. Marine Pollution Bulletin Vol 42, pp 137-144.

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17. A cell bioassay for shellfish toxins

An alternative to the mouse bioassay for the detection of algal toxins in shellfish is needed, on both analytical and animal welfare grounds. Several alternative methodologies have been described, but none have gained widespread acceptance to date, because each assay measures only one or a small number of related phycotoxins out of the increasing range that needs to be detected. A simple cytotoxicity assay using either the HepG2 or ECV-304 cell lines is described with two end-point measurements, which can detect and distinguish between two unrelated classes of phycotoxins. Morphological examination following 3 h exposure to the sample enables the detection of the diarrhetic shellfish poisons, including okadaic acid and related toxins. Viability testing using the chemical MTT, following 24 h exposure of the same cells to the sample, reveals a second class of toxin, which is most probably the newly-described toxin, azaspiracid. This assay could play an important role in shellfish monitoring in the future.

Reference

Flanagan, A.F., Callanan, K.R., Donlon, J., Palmer, R., Forde, A., Kane, M. (marian.kane@nuigalway.ie), 2001. A cytotoxicity assay for the detection and differentiation of two families of shellfish toxins. Toxicon Vol 39, pp 1021-1027.

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18. Bacteria can digest shellfish toxins

Bacteria could be involved in the clearance of paralytic shellfish toxins (PST) from bivalve molluscs. Investigations into which, if any, bacteria were able to grow at the expense of PST were made on several common shellfish species. These species were blue mussels, oysters, razor fish, cockles, and queen and king scallops. Bacteria associated with these shellfish were isolated on marine agar. Selected isolates from groups demonstrating 90% similarity were screened for their ability to metabolise a range of PST using a novel screening method. Results were confirmed by high-performance liquid chromatography. Results suggest that molluscan bacteria have different capacities to utilise and transform PST. These findings raise questions as to the possible role of bacteria resident in the shellfish food transport system. Some researchers have suggested that the microflora play a role in supplying nutritional requirements of the host, This study demonstrates that bacteria may also be involved in PST transformation and elimination in molluscan species.

Reference

Smith, E.A. (smithe@marlab.ac.uk), Grant, F., Ferguson, C.M.J., Gallacher, S., 2001. Biotransformations of paralytic shellfish toxins by bacteria isolated from bivalve molluscs. Applied and Environmental Microbiology Vol 67, pp 2345-2353.

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19. Quantitative analysis of PSP toxins

A new Liquid Chromatography method for the determination of paralytic shellfish poisoning (PSP) toxins has been successfully tested for the quantitative determination of PSP toxins in shellfish. All aspects of the method were studied and modified as necessary to improve its performance for routine regulatory purposes. The chromatographic conditions were changed to shorten analysis time. All of the compounds could be separated and quantitatively determined in spiked samples of mussels, clams, and oysters. The non-hydroxylated toxins could be quantified at concentrations as low as about 0.02 mug/g (2 mug/100 g) of tissue while the hydroxylated toxins could be quantified at concentrations as low as about 0.1 mug/g (10 mug/100 g). Average recoveries of the toxins through the complete cleanup procedure were 85% or greater for spiked extracts of oysters and clams and greater than 73% for mussels.

Reference

Lawrence, J.F., Niedzwiadek, B., 2001. Quantitative determination of paralytic shellfish poisoning toxins in shellfish by using prechromatographic oxidation and liquid chromatography with fluorescence detection. Journal of AOAC International Vol 84, pp 1099-1108.

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20. PSP in north-east England

Paralytic shellfish poisoning (PSP) toxin associated with the dinoflagellate *Alexandrium tamarense* is found on the north-east coast of the UK in late spring/early summer. Severe outbreaks are sporadic, and knowledge of the cause and origin of the phytoplankton blooms and whether they develop from a diffuse source or from a seed population is uncertain. Recent observations of the circulation of the region demonstrate a persistent southward near-coastal flow associated with strong bottom fronts bounding a pool of cold dense bottom water isolated below the seasonal (spring/summer) thermocline. Flows extend continuously for 500 km from the Firth of Forth to Flamborough Head, before passing offshore to the Dogger Bank. These observations suggest that dinoflagellates originating from the high concentrations of *A. tamarense* cysts in the sediment of the Firth of Forth act to maintain a dinoflagellate population in the coastal region south to Flamborough Head, thereby maintaining the risk of PSP outbreaks.

Reference

Brown, J., Fernand, L., Horsburgh, K.J., Hill, A.E., Read, J.W., 2001. Paralytic shellfish poisoning on the east coast of the UK in relation to seasonal density-driven circulation. Journal of Plankton Research Vol 23, pp 105-116.

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21. A new method for ASP detection

Domoic acid and its analogues are the toxins responsible for incidents of amnesic shellfish poisoning (ASP) in several places world-wide. An analytical method using liquid chromatography coupled with electrospray ionization mass spectrometry (LC-MS) is being developed. Different chromatographic and mass spectrometry conditions are being evaluated with the aim of achieving the best chromatographic performance combined with the optimum mass spectrometric response. From the results obtained it seems that LC-MS is powerful tool for the selective and sensitive determination of domoic acid and its isomers in naturally contaminated samples.

Reference

Pineiro, N.,Vaquero, E., Leao, J.M., Gago-Martinez, A. (anagago@uvigo.es), Vazquez, J.A.R., 2001. Optimization of conditions for the liquid chromatographic-electrospray ionization-mass spectrometric analysis of amnesic shellfish poisoning toxins. Chromatographia Vol 53, Part 2, pp S231-S235.

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22. ASP review

There are indications that toxic algal blooms are increasing worldwide because of pollution of coastal waters and distribution of the organisms responsible by ships' ballast water. This mini-review deals with the marine biotoxin domoic acid, also known as amnesic shellfish poison. This toxin is produced mainly by the pennate diatoms of the genus *Pseudo-nitzschia*. Besides contamination of seafood, these organisms have also been involved in human and marine wildlife mortality.

Pseudo-nitzschia blooms characteristically occur in a low light regime and at a wide range of salinity, at a time when the temperature is falling. Laboratory studies have shown that the production of domoic acid, a water-soluble amino acid, is related to silicon, phosphorus, nitrogen and trace metal (mainly iron) availability. Domoic acid has no known function in defence or primary metabolism. It has been suggested that it has a role in excretion of excess photosynthetic energy or for binding trace metals. The variability in domoic acid production by different *Pseudo-nitzschia* species, or the presence of toxic and non-toxic strains of the same species, cannot be explained. The conclusion is drawn that an increase in toxic blooms of *Pseudo-nitzschia* might be possible, especially because of the expected increase in nutrient availability from pollution and desert dust. Global warming may have an influence as well, by lengthening the growth period for *Pseudo-nitzschia*, enlarging their global distribution and increasing the dust load through desertification.

Reference

Mos, L. (lizzy.mos@96.student.wau.nl), 2001. Domoic acid: a fascinating marine toxin. Environmental Toxicology and Pharmacology Vol 9, pp 79-85.

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23. Saving the pearl mussel

The freshwater pearl mussel *M. margaritifera* is an endangered species and is now fully protected under law in most countries. River engineering work has historically been responsible for the decline and extinction of a number of pearl mussel populations and potentially remains a significant threat. Guidance is urgently needed so that river managers can integrate ecological and socio-economic factors when considering the impact of proposed activities on *M. margaritifera* populations.

To safeguard the remaining important populations, a simple conflict resolution framework is suggested for the appraisal of proposed developments in rivers with pearl mussel populations. Operations likely to harm mussels and permanently damage their river bed habitat should not proceed. In exceptional circumstances the translocation of small numbers of adult mussels may possibly be considered as a potential management tool, but mussel translocation has been little used and should be considered experimental and a last resort.

Reference

Cosgrove, P.J. (petercosgrove@cairngorms.prestel.co.uk), Hastie, L.C. (hastiel@abdn.ac.uk), 2001. Conservation of threatened freshwater pearl mussel populations: river management, mussel translocation and conflict resolution. Biological Conservation Vol 99, pp 183-190.

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24. Deterring eider ducks

One of the most commonly employed methods of reducing damage by diving ducks to mussel stocks on mussel farms in Atlantic Canada and in Scotland is chasing birds by boat. While effective in the short term the frequency of chases is often restricted by high costs. Tests in Scotland used underwater recordings of chase-boat engines, replayed at regular intervals on continuous loop tapes through an underwater loudspeaker in an attempt to reduce predation pressure by eiders on mussel farms. Trials of the underwater playback system (UPS) gave 50-80% reductions in eider numbers, while a control trial with the playback of an unassociated noise gave no reduction in numbers. The mean return time of birds to the farm after chasing by boat also increased significantly. As the presence of workers on mussel farms reduces the number of eiders feeding there, the UPS is a useful deterrent when workers are not present. The long-term habituation of ducks to the system was negligible when workers are absent, providing there is occasionally reinforcement of the deterrent by boat chasing.

Reference

Ross, B.P. (benross@snh.gov.uk), Lien, J., Furness, R.W., 2001. Use of underwater playback to reduce the impact of elders on mussel farms. Ices Journal of Marine Science Vol 58, pp 517-524.

Shellfish in the Press

The following pages contain clippings from various newspapers and periodicals of items of interest to the shellfish farmer and harvester.

Because of copyright requirements the review of press cuttings is not available in this web edition

INFORMATION FILE

WHERE CAN I GET HELP OR ADVICE?

Policy Matters

Department for the Environment, Food and Rural Affairs,
Nobel House, 17 Smith Square, London SW1P 3JR
(Switchboard tel. 020 7238 3000)
(General fax. 020 7238 6591)

Several and Regulating Orders, shellfish farming -
Fisheries Division II, Room 308 Nobel House,
(Tel. 020 7238 5947) (Fax. 020 7238 5938)

Shellfish Health -
Fisheries Division II, Room 308 Nobel House,
(Tel. 020 7238 6049) (Fax. 020 7238 5938)

Public shellfisheries, excluding Regulating Orders -
Fisheries Division III, Room 425A Nobel House
(Tel. 020 7238 5593) (Fax. 020 7238 5721)

Shellfish Licensing Scheme -
Fisheries Division IV, Room 420 Nobel House,
(Tel. 020 7238 6730) (Fax. 020 7238 6474)

Grant Aid -
Fisheries Division 1B, Room 441 Nobel House,
(Tel. 020 7238 5710) (Fax. 020 7238 5951)

Marine Environment Protection and Pollution -
Marine Policy Branch, Rural and Marine
Environment Division, Room 150 Nobel House
(Tel. 020 7238 5880) (Fax. 020 7238 5881)

Shellfish Hygiene -
Food Standards Agency, Room 816c, Aviation House,
125 Kingsway, London, WC2B 6NH
(Tel. 020 7276 8956) (Fax. 020 7276 8907)

Monitoring of fishing activities, licensing -
Sea Fisheries Inspectorate, Room 513 Nobel House
(Tel. 020 7238 5811) (Fax. 020 7238 5814)

Research and Development Programmes -
Chief Scientist's Group, Room 811, 1A Page Street,
London SW1P 4PQ
(Tel. 0207 904 6000) (Fax. 0207 904 6013)

You can also visit the DEFRA website at http://www.defra.gov.uk/

National Assembly for Wales Agriculture Department,
Division 2B, New Crown Buildings, Cathays Park,
Cardiff CF1 3NQ
(Tel. 029 2082 3567) (Fax. 029 2082 3562)
(*http://www.wales.gov.uk*)

Scottish Executive Environment and Rural Affairs Department,
Pentland House, 47 Robbs Loan, Edinburgh EHG14 1TW
(Tel. 0131 244 6224) (Fax. 0131 244 6313)
(*http://www.scotland.gov.uk/who/dept_rural.asp*)

Department of Agriculture and Rural Development for Northern Ireland,
Fisheries Division, Annexe 5, Castle Grounds,
Stormont, Belfast, BT4 3PW
(Tel. 028 9052 3431) (Fax. 028 9052 2394)
(*http://www.dardni.gov.uk/core/dard0450.htm*)

Scientific and technical advice

Cultivation techniques, health regulations and disease control (England & Wales) -
CEFAS Weymouth Laboratory, Barrack Road,
The Nothe, Weymouth, Dorset DT4 8UB
(Tel 01305 206600) (Fax 01305 206601)

Shellfish hygiene classifications and purification plant approvals (England & Wales) -
CEFAS Weymouth Laboratory, Barrack Road,
The Nothe, Weymouth, Dorset DT4 8UB
(Tel 01305 206600) (Fax 01305 206601)

Shellfish stocks (England & Wales) -
CEFAS Lowestoft Laboratory, Pakefield Road,
Lowestoft, Suffolk, NR33 0HT
(Tel 01502 562244) (Fax 01502 513865)

Pollutants and their effects -
CEFAS Burnham Laboratory, CEFAS Laboratory,
Remembrance Avenue, Burnham-On-Crouch, Essex,
CMO 8HA
(Tel. 01621-787200) (Fax 01621 784989)

You can also visit the CEFAS website at http://www.cefas.co.uk

Shellfish stocks, cultivation, hygiene, and disease control (Scotland) –
Fisheries Research Services, Marine Laboratory,
PO Box 101, Victoria Road, Aberdeen AB9 8DB
(Tel. 01224 876544) (Fax. 01224 295511)
(*http://www.marlab.ac.uk*)

Department of Agriculture for Northern Ireland,
Fisheries Division, Annexe 5, Castle Grounds,
Stormont, Belfast, BT4 3PW
(Tel. 028 9052 3431) (Fax. 028 9052 2394)

SEAFISH - Aquaculture Development Officers:
For Scotland: Craig Burton, Marine Farming Unit,
Ardtoe, Acharacle, Argyll, PH36 4LD
(Tel. 01397 875402) (Fax. 875001)
(email: c_burton@seafish.co.uk)
For England and Wales: Sue Utting, P.O. Box 68,
Colwyn Bay, North Wales, LL28 5WR
(Tel/Fax. 01492 650884)
(e-mail: s_utting@seafish.co.uk)

SEAFISH Technology, Seafish House, St. Andrew's Dock, Hull, HU3 4QE (Tel 01482 327837) (Fax 01482 223310)

You can also visit the SEAFISH website at http://www.seafish.co.uk

Advice on commercial activities

The Shellfish Association of Great Britain,
Fishmonger's Hall, London Bridge, London, EC4R 9EL
(Tel. 020 7283 8305) (Fax. 020 7929 1389)
(*http://www.shellfish.org.uk*)

The Association of Scottish Shellfish Growers,
Mountview, Ardvasar, Isle of Skye, IV45 8RU (Tel/Fax: 01471 844324)

Wildlife conservation and status of on-growing sites

Joint Nature Conservation Committee,
Monkstone House, City Road, Peterborough PE1 1JY
(Tel. 01733 562626) (Fax. 01733 555948)
(*http://www.jncc.gov.uk*)

English Nature,
Northminster House, Peterborough, PE1 1UA
(Tel. 01733 455000) (Fax. 01733 568834)
(*http://www.english-nature.org.uk*)

Countryside Council for Wales,
Ffordd Penrhos, Bangor, LL57 2LQ
(Tel. 01248 385500) (Fax. 01248 355782)
(*http://www.ccw.gov.uk*)

Scottish Natural Heritage,
12 Hope Terrace, Edinburgh, Scotland, EH9 2AS
(Tel. 0131 447 4784) (Fax. 0131 446 2277)
(*http://www.snh.org.uk*)

Other Useful Numbers

Crown Estate Commissioners,
Crown Estate Office, Marine Estates Division,
16 Carlton House Terrace, London SW1Y 5AH
(Tel. 020 7210 4322, Dr Tony Murray)
(Fax. 020 7839 7847)
(*http://www.crownestates.co.uk*)

Central contact for local Sea Fisheries Committees -
The Association of Sea Fisheries Committees of England and Wales, 24, Wykeham Village,
Scarborough, North Yorkshire, YO13 9QP
(Telephone and Fax: 01723 863169).

LINK Aquaculture,
c/o Freshwater Fisheries Laboratory, Faskally,
Pitlochry, Perthshire, PH16 5LB
(Tel. 01796 472060) (Fax. 01796 473523)
(*http://www.linkaquaculture.co.uk*)

CEFAS PUBLICATIONS

The following booklets and leaflets are available:

From the CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, DT4 8UB,
(Tel no: 01305 206600; Fax no: 01305 206601):

A Guide to Importing Fish
A Guide to Shellfish Health Controls
Don't Import Disease (leaflet and poster)
Combating Fish Disease
The Fish Health Inspectorate and You - Service Standards and Code of Practice for Enforcement
SVC Alert leaflet
Marine shellfish cultivation in the UK: Background to the industry
Cultivation of Pacific oysters
Cultivation of Manila clams
Bivalve cultivation: criteria for selecting a site
The hatchery rearing of king scallop (*Pecten maximus*)
Techniques for the production of juvenile lobsters (*Homarus gammarus* L.)
Storage and care of live lobsters

From the CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 0HT,
(Tel no: 01502 562244; Fax no: 01502 513865):

Shellfish News (back copies of some issues. Numbers 6-11 can also be viewed and/or downloaded as .pdf files from the CEFAS web site *http://www.cefas.co.uk*)
Mussel cultivation in England and Wales.
The scallop and its fishery in England and Wales.
