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OYSTER SHELLS AS HISTORY BOOKS

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Introduction

A collaborative project was established in 2002 that has brought together geochemistry and archaeology in order to investigate environmental change and the harvesting strategies of ancient peoples. The objectives of this study are to decipher the life history and environmental information contained in shells of the European oyster, *Ostrea edulis*, by analyzing geochemical variations along shell growth. This approach provides an independent measure of age and season of death, as well as a record of environmental change in temperature and salinity through the life of the oyster. By understanding the life history and environmental records contained in modern oyster shells, we can analyze shells from archaeological sites to gain an historical perspective of harvesting practices and environmental change in ancient shellfisheries.

Archaeological Background

Shell middens are found worldwide. These are sites where people must have congregated or lived at various times of the year for hundreds and sometimes even thousands of years. Continuous exploitation of shellfish at these sites resulted in the discard of shellfish, which over time form large mounds of rubbish. Although people ate other food as well such as fish, deer, fruits etc., it is the quantity of shellfish deposited that makes these mounds so impressive. In Brazil the mounds can reach 20 metres in height. In Denmark (the key case study area for this research) the middens tend to stretch length-ways along the ancient coastlines, some measuring up to 300 m long, 20 m wide and 1.5 m deep. Recent calculations have suggested that in just one cubic metre of midden there can be up to 83,000 shells!

Many of the European middens date to the Later Mesolithic period, about 5400-4000 BC, a time before farming when people hunted, gathered and fished for their food. It is argued that coastal resources played a major role in their economy. One of the major topics of debate in Archaeology is the transition to agriculture, one of the most important cultural transformations in the human past. Questions are asked as to why people turned from hunting, gathering and fishing to farming. There are many hypotheses. Some of these focus on changing environmental conditions which could have reduced the availability of marine resources but bettered the conditions for farming, whilst others focus on changing economy and social relations.

A shellmidden in Australia (G.N.Bailey)

Preliminary analysis of the oysters from some of these sites has suggested that further investigation could provide information both on the harvesting practices of people in the past, as well as on environmental change through time. By using incremental growth analysis it has been possible to test in what seasons the oysters were gathered. By taking modern samples of oysters every month for over a year and then sectioning the hinge, the typical growth patterns of the oyster could be monitored and changes identified through the seasons. Oysters grow like trees and an annual line is formed in spring (see Figure 1). This identification of annual lines has also been confirmed using oxygen isotope analysis. The results from an archaeological application have shown that, for many sites, oysters were collected in the spring in the Mesolithic period. However, at the time of the transition to agriculture a change can be seen – the oysters are still being exploited but the gathering takes place through the spring and summer, if not all year round at some sites.

Geochemistry of Oyster Shells

Oxygen isotope ($^{18}O/^{16}O$) composition ($\delta^{18}O$) sampled parallel to shell growth can be used as an indicator of seasonal change in temperature and salinity. Several studies suggest that $\delta^{18}O$ values of shells correspond

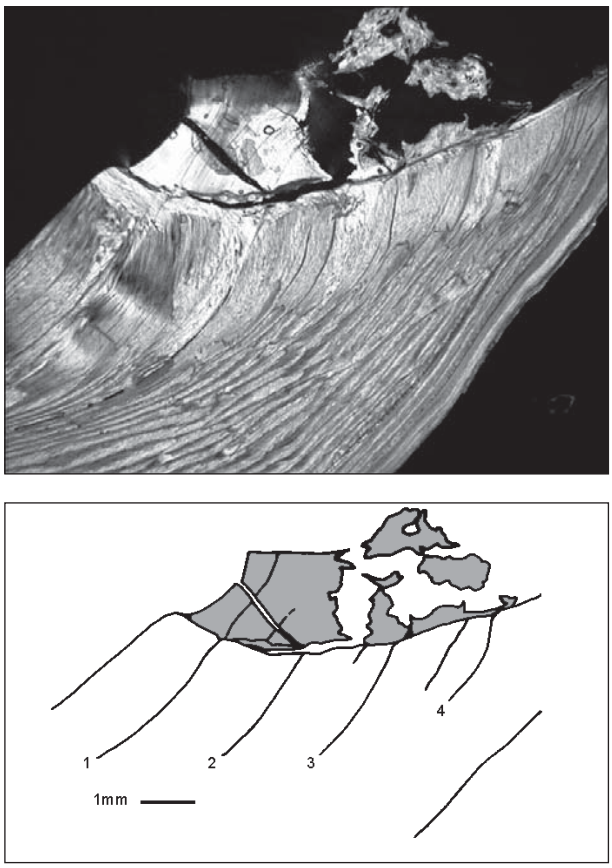

Figure 1. A thin section of the hinge of an oyster collected from the River Blackwater, Chelmsford in October. Four annual lines can be seen

to $\delta^{18}O$ values of inorganic calcite or aragonite (the mineralogy of shells) precipitated under the same environmental conditions. Seasonal temperature change results in a more or less sinusoidal variation in $\delta^{18}O$ such that lower values correspond to warm temperatures and higher values correspond to cold temperatures (Figure 2). In coastal settings, mixing of fresh and marine water can also affect the $\delta^{18}O$ of shells because freshwater has lower $\delta^{18}O$ values than marine water. To decouple the combined effects of temperature and mixing of fresh and marine water, Mg/Ca ratios will also be used as a temperature indicator. By constraining temperature with Mg/Ca ratios, salinity can be estimated using $\delta^{18}O$.

In co-operation with the Essex Oyster & Seafood Company Ltd., water samples adjacent to an oyster bed in the Goldhanger Creek estuary, River Blackwater, Essex, will be collected fortnightly for one year to characterize ambient environmental conditions. Samples will be analyzed for salinity, $\delta^{18}O$, and Mg/Ca ratios. To measure seasonal temperature change, StowAway TidbiT® (Onset Computer Corporation) data loggers will be deployed at the oyster bed and programmed to take measurements at half-hour intervals. These parameters will be used to construct a predictive model shell against which to compare observed shell data from oysters collected alive from the oyster bed at the end of the sampling period. To map observed data onto the predictive model requires assigning dates to observed shell data points. Harvest dates of each live-collected

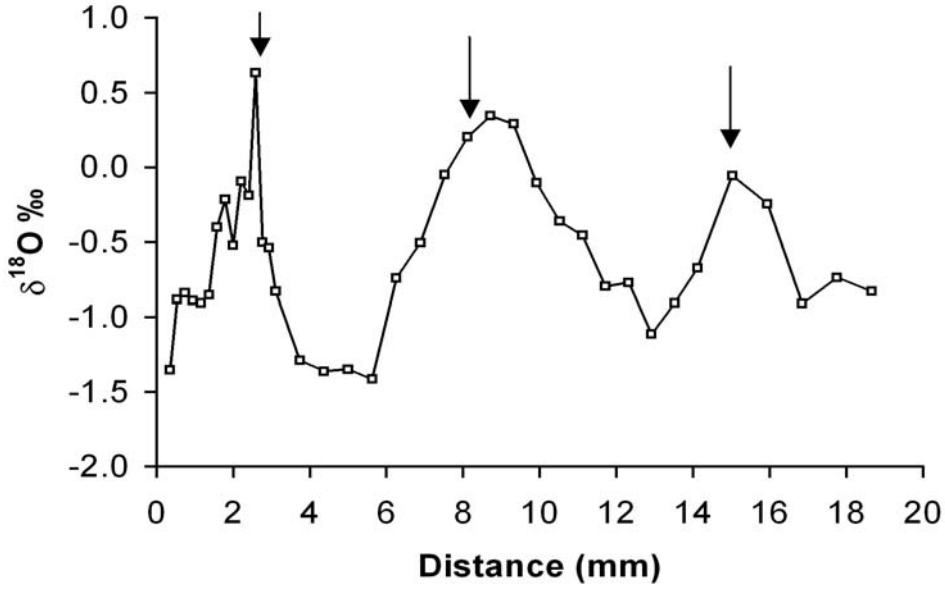

Figure 2. Oxygen isotope composition of oyster shell representing three years of growth. Individual was collected alive in August 1997. Peaks indicate winters and valleys indicate summers. Arrows correspond to winter growth breaks. Growth extension increases towards the right. Units are in per ml relative to the V-PDB standard

oyster can be used to anchor the last increment of growth to the model (i.e., the final increment of shell should record the ambient conditions just prior to the time of harvest). The remaining observed data points are plotted against the model using the predicted $\delta^{18}O$ as a correlation tool, with some rescaling (stretching or compressing) to account for differential growth rates or periods of no growth.

Expected Results

Comparing $\delta^{18}O$ values from live-collected shells to a predictive model allows assignment of dates to observed-shell data points. Date assignments provide the temperature and salinity at the time of shell formation. This knowledge will allow us to evaluate seasonal changes in growth rate, season of death, age of individuals, and environmental information through the life of an oyster. Armed with this knowledge of modern samples, specimens from archaeological contexts can be analysed to reconstruct changes in past environments and in ancient shellfishing practices, which in turn will help us to understand more about the transition to agriculture in Europe.

Acknowledgements

The seasonality work has been funded by the British Academy, Prehistoric Society, Society for Antiquaries and the University of Newcastle. Partial funding for geochemical analysis and field work has been provided by the American Philosophical Society and the American Association for the Advancement of Science/ National Science Foundation. Thanks to the Public Health Laboratories in Truro, Southampton, Chelmsford and Seasalter Shellfish Ltd, Whitstable for providing modern oysters for incremental growth analysis and to David Coward-Talbot of the Essex Oyster & Sea Food Company Ltd. for overseeing the water sampling effort and oyster harvesting for this study.

THE RESPONSE OF SHOREBIRDS TO INTERTIDAL 'ON-BOTTOM' MUSSEL CULTIVATION

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Background

The mussel cultivation industry is the fastest growing and most valuable sector of the bivalve aquaculture industry in the UK. Areas used for cultivation, particularly the intertidal mud-flats and sand-flats used in 'on-bottom' cultivation, are often protected under various national and international conservation measures e.g. the European Habitat Conservation Regulations (Council Directive 92/ 43/EEC Annex 1). It is, therefore, important to establish the impact of expanding the extent of mussel cultivation in such locations.

LINK Project

The Centre for Ecology and Hydrology joined forces with The University of Wales, Bangor and two industrial partners (Myti Mussels Ltd. and Deep Dock Ltd.) to conduct research funded by the Natural Environment Research Council LINK Aquaculture programme. The project aimed to recommend a management plan to improve mussel productivity by determining stocking density and management strategies that would maximise mussel growth rate and reduce predation losses while minimising ecological effects on birds and invertebrate communities. The results concerning mussel growth and mortality were presented in the last issue of *Shellfish News*. Here we describe our experimental approach to determining whether the cultivation of mussels on intertidal mudflats has any affect on the assemblage of shorebirds that feed in that habitat

Sampling in progress on the experimental lays. The difference between the solid high-density cells and the more patchy low-density cells can be seen

The whole of the experimental lay. As in the previous photograph, the patchwork of varying mussel density areas can be seen

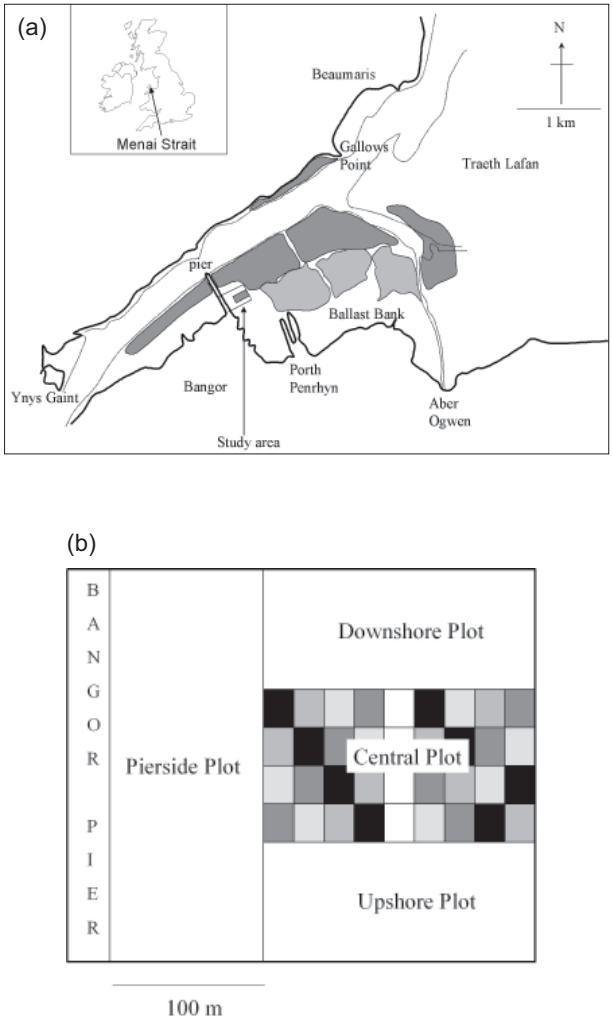

Figure 1. a) Map of the study site showing the three patches of 'wild' mussels (light shading), the five principal commercial mussel lays (dark shading) and the study area (boxed). b) A schematic representation of the layout of the study area showing the pier, the four main plots and the 36 experimental cells of the central plot in which mussels were laid at densities of 7.5 (black), 5 (dark grey), 3 (grey) and 2 (light grey) kg live weight m^{-2} (after Caldow et al. 2003)

The experiment

In August 1999 an area of 4.32ha of intertidal mudflats adjacent to Bangor Pier in the Menai Strait was marked out with bamboo canes and divided into three plots (Figure 1). The central plot was in turn divided into 36 20*20m cells. The number of birds of all species was counted in each of the three marked plots, and in a fourth plot adjacent to the pier, at regular intervals throughout the winter of 1999-2000. This established the initial pattern of bird usage across the study plots. In April 2000, mussels were laid at varying densities in each of the cells within the central plot, which acted as our main experimental area, but also, for commercial reasons, in the downshore plot. The number of all species of birds present in the two 'experimental' plots (central and downshore) and the two 'control' plots (upshore and pierside) was counted on a regular basis over the following two winters to look for any evidence that the presence of mussels altered the birds' usage of the experimental plots relative to the neighbouring control plots.

Results

Twenty-three species of bird occurred within the study area (Table 1). All species seen in the two experimental plots in the first season, before they were covered with mussels, were seen at least once in those areas in the two following years. Thus, purely in terms of species' presence/absence, the laying of mussels had no effect on the bird assemblage.

An oystercatcher foraging on a mussel bed

Detailed analyses revealed, however, that although not identical to begin with, the bird assemblages in the four plots diverged over time. In the first season, when none of the plots had mussels, there was no difference between the bird assemblage in the experimental and control plots. The bird assemblage in the control plots did not change much over time but that in the experimental plots differed significantly between the two seasons in which they had mussels and the first one in which they did not. Thus, in both the second and to a lesser extent third season, there were more obvious differences between the bird assemblages in the control and experimental plots. The main cause of these changes was variation over time in the distribution of five species: redshank, herring gull, curlew, oystercatcher and black-headed gull. These species were the most abundant and frequently sighted species in the study area (Table 1).

However, controlling for any between season and plot differences, only the numbers of curlew and redshank were significantly affected by the presence of mussels. The numbers of both species were significantly higher than expected in those plots/seasons where mussels were present. This was not true of oystercatchers or either species of gull.

Detailed analyses of the count data at the scale of the individual experimental cells between which mussel densities varied showed that, at least in the final year, the average number of both redshank and oystercatchers in a cell was negatively associated with the density of mussels present.

Conclusions

This study found no negative effects of the on-bottom cultivation of mussels on the shorebird assemblage that fed on the mudflats prior to the laying of the mussels. No species were lost from the experimental areas and there was no significant decline in the numbers of any of the five main species in the area. Indeed, the average number of curlew and redshank increased significantly where mussels had been laid. The fact that these two

Table 1. Species of birds recorded within the 'experimental' (Exp) plots and 'control' plots in the three seasons. For the five key species, the mean over-winter density (birds ha^{-1}) across the two experimental plots and the two control plots is given for each season. For all other species, presence is indicated by +. (after Caldow et al. 2003)

Species common name	Species scientific name	Season 1 1999-2000		Season 2 2000-2001		Season 3 2001-2002	
		Exp	Control	Exp	Control	Exp	Control
oystercatcher	*Haematopus ostralegus*	5.63	2.27	6.35	1.09	9.5	1.78
curlew	*Numenius arquata*	4.07	1.56	5.73	2.46	5.88	2.08
redshank	*Tringa totanus*	5.69	4.19	5.59	2.31	6.74	3.1
black-headed gull	*Larus ridibundus*	1.51	1.03	4.1	1.47	3.1	1.49
herring gull	*Larus argentatus*	3.5	3.09	2.7	2.34	3.39	3.43
little grebe	*Tachybaptus ruficollis*				+		
great-crested grebe	*Podiceps cristatus*						+
cormorant	*Phalacrocorax carbo*				+		
little egret	*Egretta garzetta*						+
grey heron	*Ardea cinerea*	+	+	+	+	+	+
mute swan	*Cygnus olor*	+	+	+	+		+
shelduck	*Tadorna tadorna*		+	+	+	+	
wigeon	*Anas penelope*	+		+		+	
mallard	*Anas platyrhynchos*	+	+	+	+	+	+
goldeneye	*Bucephala clangula*				+		
red-breasted merganser	*Mergus serrator*	+	+		+	+	+
dunlin	*Calidris alpina*	+	+	+		+	+
bar-tailed godwit	*Limosa lapponica*			+			
greenshank	*Tringa nebularia*		+			+	+
turnstone	*Arenaria interpres*		+		+		+
common gull	*Larus canus*	+	+	+	+	+	
greater black-backed gull	*Larus marinus*	+	+	+	+	+	
carrion crow	*Corvus corone*	+	+	+	+	+	+
Number of spp.		14	16	15	17	15	15

species responded positively whereas oystercatchers did not was surprising. However, some species of invertebrate (e.g. the shorecrab *Carcinus maenas* and the worm *Tubificoides benedini*) appeared or increased in abundance in areas where mussels hade been laid and may have provided enhanced feeding opportunities for these birds. The fact that, within the experimental mussel lay, redshank seemed to prefer areas where the mussel density was low probably reflects the greater habitat complexity where mussels formed patches within a mud/pool matrix rather than a uniform, elevated, blanket cover. Oystercatcher's lack of positive response reflects the small size of the mussels used to seed the plot. Had the experiment continued, oystercatcher numbers would almost certainly have increased too.

The curlew and the redshank, together with the oystercatcher, are the only species of wader whose populations at Traeth Lafan have surpassed the qualifying level necessary for the site to be considered of national importance for that species. Thus, in terms of the intertidal-feeding bird species of importance within the Traeth Lafan Special Protection Area, the current study suggests that the bottom cultivation of mussels on the mudflats at Bangor is on balance likely to be beneficial. The results of this study cannot, however, be taken as representative of the likely effects of mussel cultivation at all sites. The physical characteristics, the flora and the fauna at a site will influence the effect of mussel cultivation. Therefore, consideration of these features will be essential to an environmental assessment of a proposed expansion or creation of seabed cultivation plots at any other site.

Further information

The full results of this study (from which Figure 1 and Table 1 are reproduced here) have been published recently in the scientific journal Marine Ecology Progress Series. See: R.W.G. Caldow, H.A. Beadman, S. McGrorty, M.J. Kaiser, J.D. Goss-Custard, K. Mould, A. Wilson (2003) Effects of intertidal mussel cultivation on bird assemblages. *Marine Ecology Progress Series*, Vol 259, pages 173-183.

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WHAT HAS HAPPENED TO THE NATIVES!

David Donnan, Senior Fisheries Advisor, Maritime Group, Scottish Natural Heritage

An historic fishery

The native oyster (*Ostrea edulis*) was once one of the most important commercial shellfish in Scotland and they were to be found in profusion in the lochs, estuaries and sounds all around the coast. Middens of oyster shells associated with Roman sites are evidence of their productivity in ancient times, while in the 18th century boats from Prestonpans and Cockenzie were recorded landing 8,000 to 9,000 shells a day from the Firth of Forth. Unfortunately, a combination of factors ranging from over-fishing to industrial pollution has taken their toll on stocks. Today in Scotland the native oyster is restricted to isolated populations in the sheltered waters of west coast sea lochs and only one active fishery remains, in Loch Ryan.

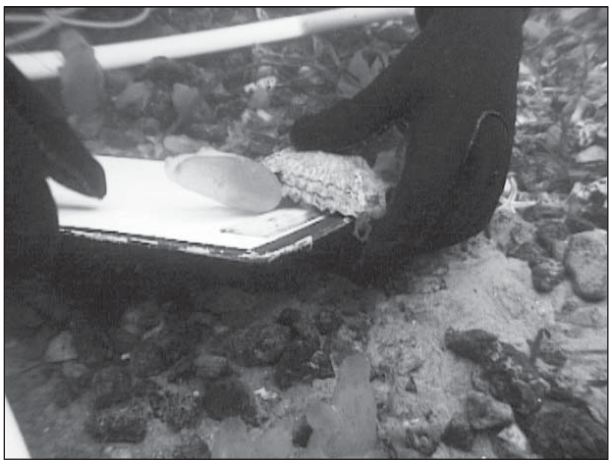
Species Action Plan

However, work has recently begun on a project to study the ecology of the native oyster in Scotland, as a Scottish contribution to the UK Native Oyster Species Action Plan (NOSAP). A variety of factors have contributed to the need to take this research forward.

A wild native

Firstly, there is the severe decline in the distribution and abundance of the species in Scotland, and its absence from sites (such as the Forth) where it was once common. We need to know more about the health of the remaining stocks.

A diver survey



Measuring oysters

Secondly, although the Loch Ryan fishery is the only active native oyster fishery in Scotland there is a growing interest in farming or fishing them at other locations. We need to develop management recommendations to ensure that any exploitation is carried out in a sustainable way – but the basic information needed to do this is currently lacking.

Finally, the native oyster is vulnerable to exploitation pressure and, unfortunately, we have experienced a spate of illegal fishing in Argyll. Although prosecutions have been obtained it is likely that significant damage has been done to stocks and there is a continuing risk because they fetch a handsome price.

The research seeks to address the considerable uncertainties that exist about the current status and ecology of the species in Scotland. In particular, little is known about the reproductive ecology or the level of recruitment at specific sites and it is therefore difficult to gauge what a sustainable level of exploitation may be.

Research Project

The project is being undertaken at the University Marine Biological Station, Millport (UMBSM) by Paula Low, a PhD student funded by UMBSM and Scottish Natural Heritage. Paula started earlier this summer and her objectives include:

- a review of existing data on oyster abundance and distribution in Scotland to give a historical perspective;
- a review of native oyster management practices within the UK and in comparable oyster fisheries overseas;
- assessment of the current status of oyster stocks via a survey of a representative sample of locations in Scotland – with several sites being visited this summer;
- an assessment of the demography and genetic variation of oyster populations at selected study sites;
- On the basis of results, to prepare advice on the conservation management of the native oyster in Scotland.

Although still in the early stages a key feature of this work will be the collaboration with shellfish farmers with an interest in native oysters. This is being facilitated in part through SNH's concordat with the Association of Scottish Shellfish Growers (further details of which are available from Douglas McLeod, Chairman of ASSG, by email at DouglasMcLeod@aol.com) and we are particularly grateful for the input that we have received so far.

Ultimately we hope that this research project will help to secure a sustainable future for the native oyster in Scotland, both as a resource with the potential to benefit Scottish communities and as an important component of our natural heritage.

Further information

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WHEN AMERICAN AND EUROPEAN LOBSTERS MEET

Thomas Breithaupt, The University of Hull

Lobster introductions

Recent catches of American lobsters (*Homarus americanus*) in Norwegian waters, presumably escapees from imported batches, have alarmed ecologists. In November 1999 two female lobsters, one with external eggs, were captured by the common lobster fishery in the Oslo fjord. Subsequently, over 24 animals have been found in Norwegian waters. This is a cause for concern as the American lobsters may carry a bacterial disease, Gaffkemia, which can be transmitted to European lobster populations (*Homarus gammarus*). However, the effects of social interactions may be at least as detrimental as the transmission of diseases. The introduced lobsters 'dominate' the local specimens and possibly interbreed with them, resulting in infertile hybrids in *H. gammarus* thereby diluting and diminishing European populations. The above effects acting together may lead to a rapid decline in populations of European lobsters in areas of introduced American lobsters.

Current research

Our current research on American and European lobsters aims to clarify the role that chemical signals play in interspecific social interactions including dominance interactions and courtship. The social behaviour of the American lobsters is dominated by chemical signals (pheromones). Hence it is important to study these pheromones since they mediate and amplify the effects of physical interactions. Eventually, artificial pheromones may be used to control the populations of introduced American lobsters.

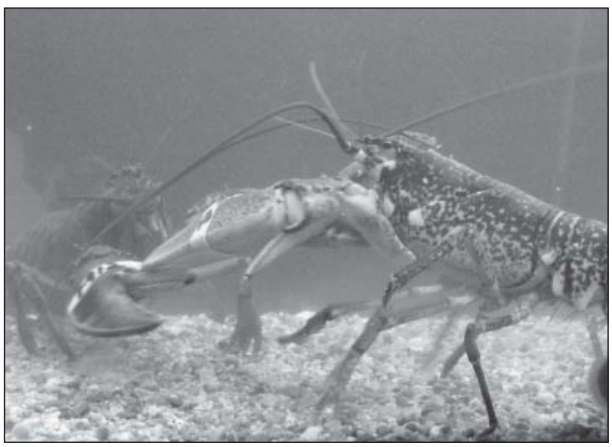
The social behaviour of the American lobsters

The social behaviour of the American lobster has been studied extensively by long-term observations of natural populations in the field and in semi natural environments, or by studying dyadic interactions in spacious aquaria. Today the lobster is one of the best understood marine animals with respect to social behaviour and function of chemical signals. Adult animals were reported in population densities of up to 30 residents per 100 m^2. Field studies indicate that lobsters spend significant amounts of time in shelters, leaving only at night. They dig shelters under eelgrass, rocks, and boulders. Some animals change shelters frequently whereas others occupy the same shelter for many weeks. The dominant male generally inhabits the best shelter. Males and females regularly visit the dominant male shelter. The dominant male defends the shelter and repels all intruders except those females that are about to moult. These females are allowed to enter the shelter. The females moult in the shelter and mating then takes place. Pair formation in lobsters appears to protect mature, post moult females against predation and cannibalism and to insure the reproductive success of dominant males. In the laboratory, females mate almost exclusively with the dominant male.

Dominance interactions and individual scent recognition

In view of the female mate choice the importance of dominance for the reproductive success of males is obvious. When two size-matched lobsters meet for the first time they usually fight. Fighting goes through a series of ritualized behaviours including "threat displays", "antennal touching", "claw pushing", "claw grasping" and sometimes escalates into unrestrained combats with "claw snapping" and "claw ripping". The typical fight ends within 10 minutes after the start with one combatant (the loser) retreating or escaping from the dominant. During the fight the animals (*H. americanus*) exchange urine borne chemical messages. When the same animals meet again the previous loser refuses to fight as it recognizes the dominant animal. This recognition is based on the urine signals of the dominant. Recent studies have shown that the subordinate recognizes the individual urine odour of the dominant.

Studies of shelter competition between *H. americanus* and *H. gammarus* in the lab of Dr Gro van der Meeren (Austevoll Aquaculture Research Station, Norway) indicate that American males generally evict resident European males of the same size from their shelters. We do not know if they share the same chemical signals. If they do, we would expect that the temporal and spatial scale of the interaction will be amplified by the persistency of the chemical signals in the



A European and American lobster fighting

environment. Dominance signals from American lobsters could completely repel the European lobsters from certain areas thereby excluding their access to valuable resources. Our current studies focus on the role of chemical signals in inter-specific dominance interactions.

Courtship and the importance of dominance

Female *H. americanus* always select dominant males for mating. Attracted by odour cues they visit the shelter of the dominant male. Females discriminate and prefer the odour of dominant males over the odour of subordinate males. At the shelter entrance the female releases a burst of urine and is allowed to enter and cohabitate with the resident male. Entering attempts of visiting males are responded with strong aggression of the resident. The female moults during cohabitation and mating follows after 30 minutes. Cohabitation lasts from 1 to 3 weeks.

Females of the European lobster also seem to prefer dominant males over subordinates for mating. Given the possibilities that American lobster males generally out compete their European counterparts and that the males of the two species share the same set of chemical signals it is expected that *H. gammarus* females will preferentially mate with American lobster males that will be dominant over the European males. We are currently testing this possibility by studying a mixed group of European and American lobsters in a semi-natural environment. We are mainly interested in the initial mate choice of the European females and in any incidences of successful inter-specific matings.

The possible benefit of chemical signals to control invasions

Management of invasive organisms has a number of parallels to Integrated Pest Management (IPM). IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques. As in IPM new results and techniques burrowed from "chemical ecology" (chemical communication research) could be adapted to the management of invading aquatic species. Biosensors or animal derived chemical sensors could help detect and monitor invading species. Animal derived chemical signals (specific attractants or repellents) are very powerful in controlling terrestrial species (e.g. insect pest species) and may also be used on aquatic species. Hence, the results from basic research on the chemical ecology of lobsters may be applicable to the development of tools for their management in the field.

We may still prevent introduced *H. americanus* from spreading into European waters. However, basic research is necessary to understand the mechanisms of competition.

THE INTRODUCED RAZOR FISH *ENSIS DIRECTUS* IN THE WASH AND NORTH NORFOLK

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Background

Interest in the commercial exploitation of razorfish in UK waters has increased in recent years and there are a number of small-scale fisheries in Britain based upon two native species *Ensis siliqua* (L.) and *E. arcuatus* (L.). These species are fished by divers or by hydraulic dredge and the catch sold live to continental markets.

In 1997, experimental use of water-jet dredges by local fishermen led to concern about the likely environmental impacts of hydraulic dredges within The Wash and North Norfolk candidate Special Area of Conservation (cSAC). A ban on dredging for razorfish and some other bivalve species within the cSAC was put in place in 1998 while the potential for a sustainable fishery was studied.

Samples from the experimental dredging by fishermen proved to consist almost entirely of the introduced razorfish *Ensis directus*, the American jack-knife clam. This species has become established in European waters since it was first identified in the German Bight in 1979. It is now common from northern Denmark to northern France on the continental North Sea coast and from the Humber estuary on the east coast of England to Rye Bay in the English Channel.

This report summarises the results from a series of stock surveys for *Ensis directus* in The Wash and North Norfolk candidate Special Area for Conservation carried out by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

The surveys

In 1999 and 2003, surveys of the distribution of *Ensis directus* were carried out using a mini Hamon grab. Seventy sites were sampled across the cSAC. In 1999 all the organisms in the grab samples were identified and counted. In the intervening years the distribution, density and survival of spatfalls were monitored by Day grab surveys that sampled around 250 sites. Both of these grabs take a sample of 0.1 m^2 of the seabed but the Day grab does not sample deeply enough to capture adult razorfish. All these surveys were carried out in the shallow sub-littoral, 0-5 m below chart datum. Samples of shells were measured and examined to develop a technique for ageing *Ensis directus*.

Ageing *E. directus*

By following the growth of individual year classes over a number of annual surveys and from microscopic examination of thin shell sections, we were able to show that growth check marks on the shells of *Ensis directus* were formed annually (Figure 1). In common with other shallow-water bivalves this annulus formed at the resumption of shell growth in spring. This allowed us to validate the standard bivalve ageing technique for this species and thus to survey the distribution, survival and growth rate of successive year classes.

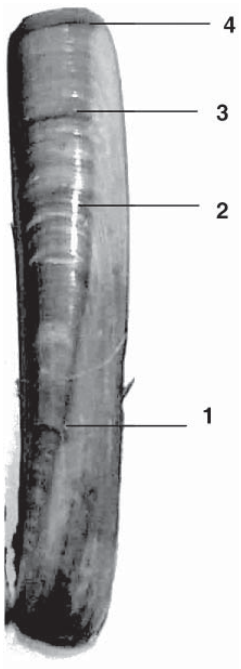


Figure 1. Left valve of Ensis diectus from Cork Hole, sampled February 1999. Numbers 1-4 are year marks

1999 Hamon grab survey

E. directus was found to inhabit a range of substrates from almost pure mud on the banks of channels within The Wash, to clean sand on the North Norfolk coast. Infauna in the areas settled by razorfish was found to be sparse and other than *E. directus*, which made up over 95% of the biomass, consisted mainly of polychaetes. Adult populations of *E. directus* were widespread and reached densities of up to 200 per square metre on some grounds. These populations were dominated by the 1994 year-class with pockets of survivors from the 1993 and 1995 settlements. There were no razorfish from the 1996 or 1997 settlements. Survivors from the 1998 settlement were widespread at densities of up to 80 per sample.

2000-2002 Day grab surveys

The 1999 year-class was more abundant than that of 1998, with densities of up to 288 per sample. However, after their second winter both of these year-classes were reduced to occupying a few sheltered areas. Figure 2 compares the distribution of the 1999 year-class from the 2000 survey with that of the following year. Where they persisted the annual survival rate was 10-15%. Both the 2000 and 2001 settlements failed to survive the first winter. In the former case large numbers of dead shells were observed in the grab samples. From the size distribution these all appeared to have died around the same time suggesting an environmental cause, such as storm disturbance, rather than predation.

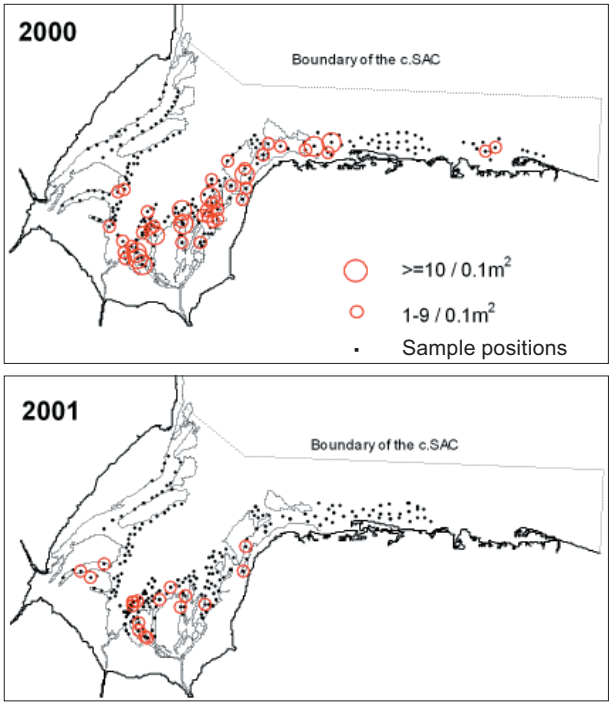


Figure 2. Distribution of 1999 year-class Ensis directus in the Day grab surveys of 2000 and 2001

2003 Hamon grab survey

By 2003, the adult populations sampled in 1999 appear to have died out and the only adults in samples were from the 1998 and 1999 year classes. Figure 3 compares the distribution of adult *E. directus* in the two Hamon grab surveys. This short life span is mirrored on the coast of Europe where studies in the Wadden Sea have found few

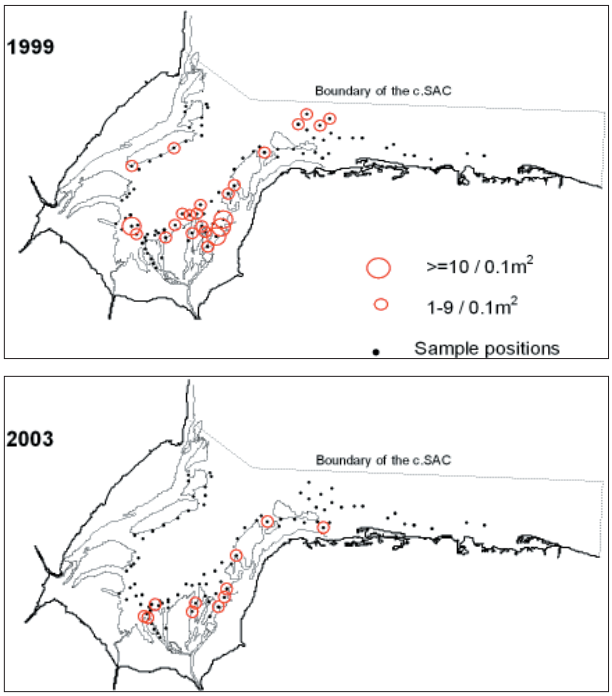


Figure 3. Distribution of adult Ensis directus in the mini Hamon grab surveys of 1999 and 2003

individuals older than 4 years. In contrast, individuals over 30 years old have been recorded for the native *E. siliqua*.

The 2002 year-class was widespread and abundant with densities up to 230 per sample. These razorfish had grown to a significantly larger size than either the 1998 or 1999 year-classes at the same time of year. This may be an important factor in their future survival.

Growth of *Ensis directus*

Figure 4 compares the growth rate of samples of *E. directus* from a number of grounds within the cSAC. Growth was found to be slow, with most populations in The Wash taking four to five years to achieve the minimum legal size (MLS) of 100 mm shell length. By comparison, populations studied in Holland and Denmark reach this size in two to three years.

The maximum reported size for *E. directus* is 186 mm-shell length, but the largest in our samples was 134 mm from the Sunk Sand area where the modal size was 120 mm. The small size of this species relative to the much larger native razorfish may limit its potential market.

Potential exploitation of *Ensis directus*

The results of these surveys suggest that the populations of *E. directus* within the cSAC are extremely dynamic, with recruitment sporadic and frequently failing altogether. Furthermore the relatively slow growth rate, combined with the short natural life span may

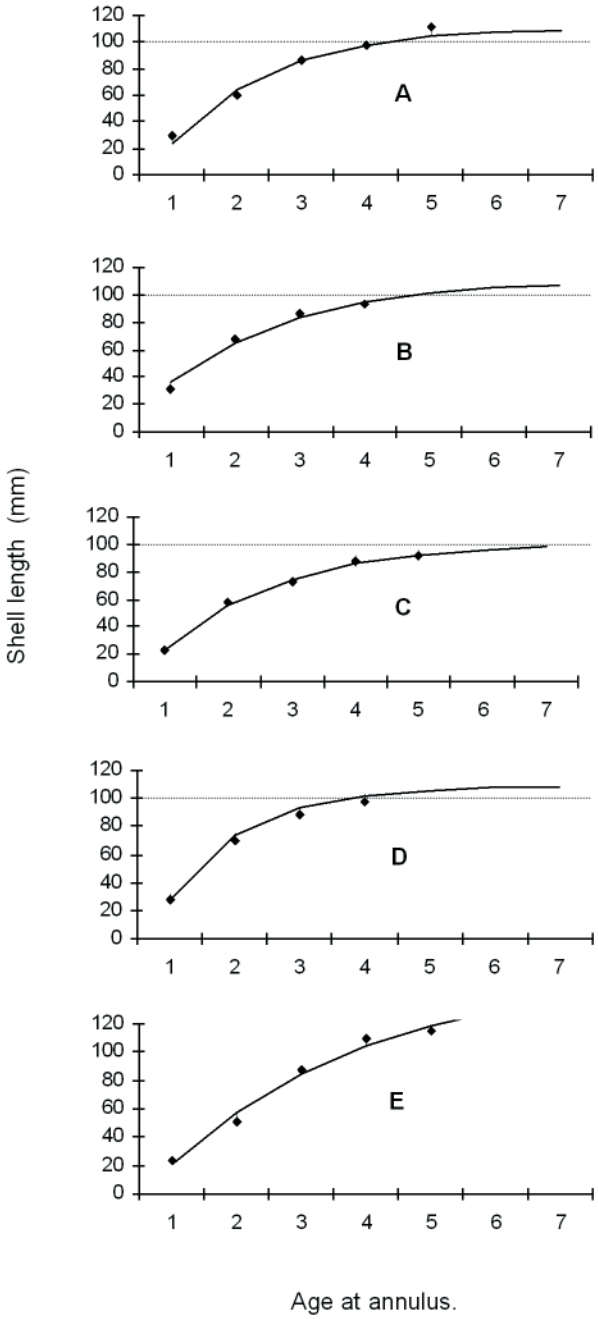


Figure 4. Mean size (symbols) at each annulus and fitted von Bertalanffy curves (continuous line) for five grounds. A: Bar Flat, B: Teetotal Channel, C: Cork Hole, D: Sunk Sand, E: Middle Bank. Dashed hoizontal line denotes MLS

mean that each annual cohort presents a limited opportunity for exploitation. These factors would make any harvest highly variable and cause difficulties for stock management and marketing. However, variable recruitment is a feature of all exploited bivalve populations. With individuals able to spawn at least twice prior to achieving the MLS, it would appear that a carefully managed fishery for *E. directus* within the cSAC offers little danger of over-exploitation.

RECENT ADVANCES IN SCALLOP RESEARCH

Ian Laing, CEFAS Weymouth Laboratory and David Palmer, CEFAS Lowestoft Laboratory

Biennial meeting

Over 100 participants from over 20 countries attended the 14th International Pectinid Workshop in St. Petersburg, Florida, USA in late April this year to hear about the latest results from recent research on scallops. Much of this was of interest to the UK industry and this article reports on some of the more relevant presentations and posters.

Keynote address

Sandy Shumway gave the keynote talk, presenting a wealth of statistics on scallop production. She noted that the UK ranks 5th in the world, by total volume, for scallop capture fisheries and 9th for scallop cultivation. Sandy also advocated the sale and consumption of whole scallops, particularly of valuable species like *Pecten maximus* (in which 50% or more of the 'meat' weight is currently wasted). Some taste trials had shown this to be a very acceptable product. This would enable better competition with species imported from third countries, where hygiene conditions and standards may be lower, although the risks associated with algal toxins would remain an issue. This idea clearly increases the usefulness of the depuration work carried out by CEFAS (see *Shellfish News* Number 14, page 7).

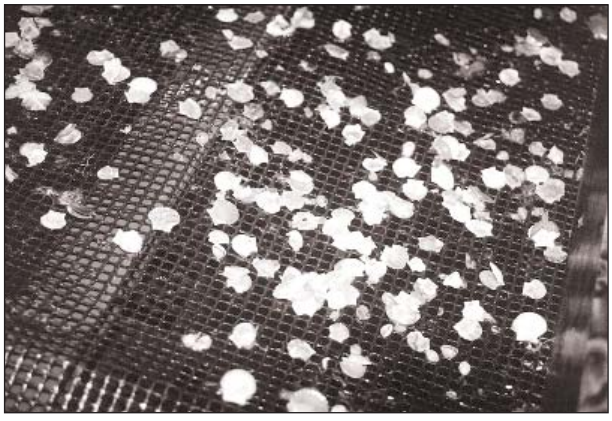
Cultivation

Studies on cultivation of king scallops continue mainly in Norway, Ireland and France. Some other work carried is being carried out in Spain, but this appears at present to be either inconclusive or with nothing very new to report.

Hatchery rearing systems, using low densities of animals and seawater replacement by partial through-flow in re-circulation systems are now standard in Norway. Success at the commercial hatcheries here can be very variable, giving a problem in establishing stable markets. Sissel Andersen presented results of studies designed to improve larval quality, with the aim of increasing recovery rates at metamorphosis. She showed that higher larval concentrations (of up to 25 larvae per ml) had a positive effect on feeding, especially with bigger larvae. Food clearance rates were more efficient at lower concentrations and 10-20 cells per µl are routinely used. Some interesting behavioural studies are awaiting analysis of the data. The Norwegians are introducing seabed licensing, similar to our Several Order system, for scallop farmers.

In Ireland attempts at remote setting, an idea that was the subject of some preliminary studies at the CEFAS Conwy laboratory, have had mixed success and at best have given spat yields of only 1-2% (of the eyed larvae introduced). The larvae for these trials came from the Cartron Point Shellfish hatchery in Co. Clare. Iarfhlaith Connellan reported that they routinely use chemical stimulation (serotonin-based products) to induce the broodstock to spawn. This causes the immediate release of sperm, followed by the eggs about 2-3 hours later. Fresh sperm is then obtained by stimulation of further animals and fertilisation carried out. Also of interests was the fact that the Bermuda hatchery for Calico scallops, where resources for algae culture are limited, are successfully using 'Instant Algae' products for rearing juveniles.

John Slater (Deegagh Point Shellfish Ltd.) gave an interesting account of the method used to determine the time of deployment of wild spat collectors in Mulroy Bay. He takes twice weekly plankton samples, concentrated in a 63 µm mesh, and identifies and measures any scallop larvae found. Samples are taken more frequently when larvae are present. When the mean size is greater that 180 µm and more than 50% of the larvae exceed this size then the collectors are deployed. He maintains that if collectors are put out more than 2-3 days before or after the larvae are ready to settle then very few seed will be obtained. The number of seed collected is in any case still variable from year to year, and this is a major constraint on development of the industry. John also presented the results of some analyses that showed that it is not possible to predict the amount of seed that might be caught from measuring the fecundity of the adults in the stock. This concurs with the experience from French studies, described below.



King scallop spat after separation from other material in the collector bag (Photo courtesy of Seafish)

A paper on spat collection of sea scallops (*Placopecten magillanicus*) in the southern Gulf of St. Lawrence showed that good settlement sites can be identified and that these are where they would be expected to be from studies of larval densities and water circulation. Another paper described some problems with starfish settling on sea scallop collector bags and subsequently predating on the seed, together with some suggested management strategies to reduce the impact of this.

A summary of the attempts by the French over the last 20 years to re-establish the king scallop fisheries in the Bay of Brest were described. Since 1989 sea ranching, combined with management to reduce fishing pressure, including temporary closure of some areas, has been successful and these methods are being tested at other sites. Hatchery-reared scallops as small as 15-30 mm are re-seeded at a density of one per 10 m^2. It was claimed that two thirds of market-size scallops in the fishery now come from ranched stock, with the other third from natural recruitment. For the latter it was suggested that optimum environmental conditions are the major factor for success, with fecundity of the broodstock relatively unimportant. Problems have been experienced in rearing sufficient hatchery seed to supply the enhancement programmes. Currently 10 million seed are raised per year, although more than this could be deployed, particularly now that additional new areas are being considered.

The Norwegian experience with sea ranching has shown such very high predation levels, particularly by crabs, that they are testing crab-proof fences to overcome this. They have developed a successful prototype that has given 90% survival, compared with total loss of stock with no fence. The fence requires regular checking and maintenance, particularly to remove seaweed fouling, which can act as a 'bridge' for crabs to enter.

Various indicators of stress, including biochemical markers, righting, recessing and escape behaviour were evaluated in studies on the effects of transport. One conclusion was that stress levels begin to increase when scallops are left out of water for more than 9 hrs, fitting nicely with the recommendations from the CEFAS work on depuration of scallops that they should be processed within 10 hours. Other studies showed that scallops are more sensitive to raised ammonium concentrations during transport than other types of bivalves and that delayed mortality can occur for several days following exposure at lower concentrations and that the cumulative mortality can be considerable.

Several papers, with various scallop species, described work similar to the CEFAS LINK-funded studies on environmental requirements for cultivation and also reached the conclusion that temperature is the main determining factor.

Only one paper dealt with disease in cultivated scallop species, and this was on the (relatively good) health status of *Argopecten purpuratus* in Chile.

Fisheries

If there was a theme to the fisheries and resource management presentations, it was perhaps the use of closed areas and stock enhancement as management tools.

The population of *Pecten maximus* within a closed area off Port Erin in the Isle of Man was shown to have a significantly older age structure than that of the exploited area around it. This leads to calculations of greater reproductive biomass. CEFAS recently collaborated with Port Erin to produce a model for predicting the likely effects of closed areas on the fishery around the island. The Isle of Man government is keen to press ahead with closed area management and the results will be watched with interest by the rest of the UK scallop fishing industry and those seeking to manage it.

An overview of the very successful enhancement project in Golden Bay, New Zealand showed what can be achieved with the necessary resources. Reseeding from spat collectors set in the wild, combined with rotational harvesting practises, have resulted in a stable fishery.

Stocks of the Bay scallop, *Argopecten irradians* were shown to have recovered spectacularly on the gulf coast of Florida following a ban on fishing and a reseeding program. Similarly there have been improved landings from the U.S. fishery for *Placopecten magellanicus* and the Queensland fishery for *Amusium balloti*, both following the introduction of spatial closures.

A scallop dredger

However, all authors were wary of attributing such improvements directly to the management actions and it was emphasised that in organisms displaying wide variations in recruitment, measurement of the effect of such actions is difficult.

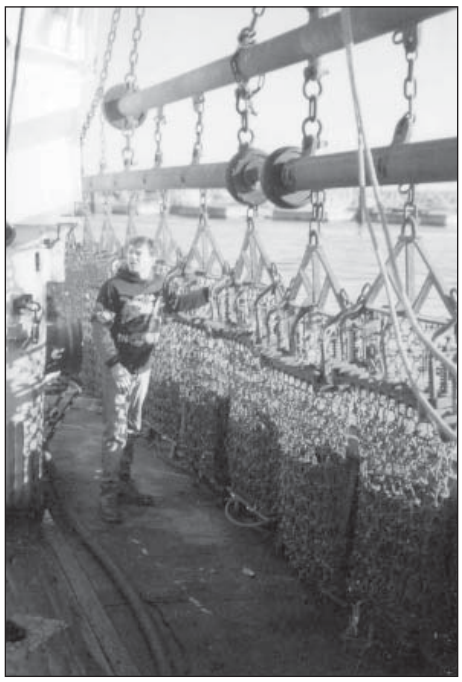
During one session there was a free discussion on the relationship between stock size and recruitment and whether it was possible to define the former so as to stabilise the latter. This is an important factor for the advocacy of spatial closures but there were no clear answers from anyone present. In general it was felt that the role of environmental factors, particularly temperature, was so great that it masked any stock-recruitment relationship. There were concerns that successful spawning may require higher stock densities than those left after exploitation in some populations, in other words individual scallops may simply end up too far apart. This might justify the creation of closed areas, but no hard data on this issue seems to be available from any of the fisheries.

In summary while stock enhancement has been shown to be effective for some species, where fishing effort can be heavily regulated, the evidence for the use of closed areas, while encouraging, remains circumstantial. To put this in perspective, the effect of El Niño events on the recruitment of *Argopecten purpuratus* in Chile was the subject of one poster. Landings increased by more than an order of magnitude following the strong El Niño periods of 1983 and 1998. This is attributed to an increase in reproductive output; shortened larval period; increased growth; a reduction of predator biomass and elevated oxygen levels leading to a greater than normal carrying capacity on the ground. However, an oral presentation by Wolfgang Stotz concluded that management to conserve these huge stocks for future exploitation was largely wasted, since predation by crabs rapidly reduced them to normal levels.

Rather more gradual environmental effects were reported from the Bay of Fundy, where a rise in average sea temperature over 12 years has been accompanied by an increase in the reproductive capacity of *Placopecten magellanicus*. In turn, increased numbers of spat were recorded from collector bags.

A number of papers looked at the availability of suitable substrates for scallop settlement. A study in Quebec showed that adding scallop shell to the sea-bed increased species diversity and density, including that of the scallop *Chlamys islandica*. This could have implications in Britain, where the shells from the bulk of the scallop catch currently end up in landfill sites.

Richard Briggs reported on a project to map habitats across the Northern Ireland scallop grounds by analysis of dredge by-catches, together with surveys employing under-water cameras and RoxAnnTM ground discrimination technology. This is of interest to CEFAS in relation to the mapping of fishing grounds in the English Channel.



A row of scallop dredges

Belinda Vause (Port Erin) presented results from spat collectors and surveys around the Isle of Man. These suggest that while spat numbers correlate poorly with eventual recruitment, it is possible to use survey results to predict the level of recruitment of queen scallops (*Aequipecten opercularis*) up to two years ahead. This may prove to be a useful marketing tool, allowing the industry to seek markets ahead of a surge in production.

Aside from the CEFAS presentation on the effectiveness of dredges there was a poster from FRS Aberdeen on dredge efficiency in the *P. maximus* fishery in Scotland. Efficiency estimates from that study were very much in line with those from the CEFAS work. Meanwhile in Canada development of the butterfly trawl for catching *Chlamys rubida* and *C. hastata* has led to reduced habitat impact and improved product quality.

VALIDATION OF A RAPID METHOD FOR THE DETECTION OFMARINE BIOTOXINS

Elizabeth Smith, Fiona Mackintosh and Susan Gallacher
FRS Marine Laboratory, Aberdeen, Scotland, AB11 9DB

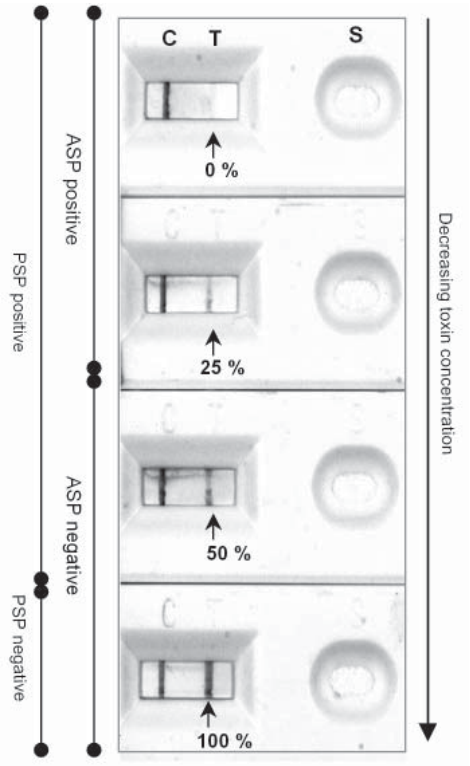
Background

The safety of bivalve molluscs for human consumption can be jeopardised by the presence of marine biotoxins such as diarrheic, paralytic and amnesic shellfish poisoning (DSP, PSP, ASP) toxins. DSP toxins are associated with nausea and diarrhoea, while both the PSP and ASP toxin groups produce neurotoxins, which can lead to severe illness and mortalities in humans. Current EU regulations require the competent authority to monitor shellfish for the presence of these toxins. If they are detected above the regulatory limit then restrictions on shellfish harvesting are imposed. To date, the main tools for DSP and PSP toxin monitoring have been bioassays, which are known to be susceptible to matrix interference and can in some instances underestimate toxicity. High-performance liquid chromatography (HPLC) is used for ASP monitoring and, although accurate, is costly, requires high maintenance and skilled operators.

EU regulations also require that end-product testing is undertaken. However, current methods do not allow this to be easily accomplished, particularly on-site at shellfish processors. Additionally, the shellfish industry has expressed its requirement for toxin detection methods that would enable producers to avoid harvesting product unsuitable for consumption. There is therefore a need for simple, cheap, quick, reliable and accurate detection methods for DSP, PSP and ASP toxins in shellfish.

Such a method for PSP and ASP toxins, in the form of commercial test kits called Jellet Rapid Test for PSP and Jellet Rapid Test for ASP (formerly MIST Alert™ for PSP and MIST Alert™ for ASP), has been developed which utilises immuno-chromatography in a dipstick format (see box and diagram below). These kits can, within 20 minutes, indicate whether PSP or ASP toxins are present (positive/negative) in shellfish extracts, although they do not allow the levels of the toxins to be quantified. This technology is not presently available for DSP toxins although the manufacturers are currently developing further kits for compounds associated with DSP.

The UK Food Standards Agency commissioned Fisheries Research Services (FRS) to investigate whether Jellet Rapid Tests might be suitable for use in UK monitoring programmes and assess its applicability at shellfish farms and processors as a shellfish harvest management tool and end-product test. This article summarises the results of these studies.



The Jellet Rapid Test

Strips consist of an absorption pad (S), a membrane striped with a mixture of toxin analogues (the 'T' line) and an antibody detection reagent (the 'C' line), a sample pad and a conjugate pad containing the antibodies. A visible 'T' line indicates absence of toxin in the sample and no line indicates the presence of toxin. The 'C' line indicates that the sample fluid has sufficiently resuspended and mobilised the antibody colour complex. As the level of toxin increases, the 'T' line progressively disappears. Remnant 'T' lines are scored as having 50, 25 or 0 % of colour intensity relative to the 'C' line.

Jellet Rapid Test for PSP – samples are considered positive if the 'T' line is 50 % or less compared to the intensity of the 'C' line

Investigation into the use of Jellet Rapid Tests in shellfish toxin monitoring

Over 800 shellfish samples consisting of a range of species (mussels, scallops, oysters, cockles and razor fish) from the UK PSP toxin monitoring programme and 500 from the Scottish ASP toxin monitoring programme were tested simultaneously by Jellet Rapid Tests and the approved monitoring methods.

When PSP toxins are detected at levels greater than 40 µg saxitoxin (STX) equivalents 100 g^{-1} sampling frequency increases, and, if levels exceed 80 µg STX equivalents 100 g^{-1}, restrictions on harvesting are imposed. The Jellet Rapid Test for PSP detected toxin in all samples (n =139) found to contain PSP toxins at and above the regulatory limit (80 µg STX equivalents 100 g^{-1} shellfish flesh), as determined by the conventional test. Additionally, the kit gave a positive result for 97% of samples containing toxin between 40 µg STX equivalents 100 g^{-1} shellfish flesh and the regulatory limit. Overall a 'false positive' rate (defined as any shellfish sample that tested negative according to the bioassay but gave a positive result by the Jellet Rapid Test) of 15% was recorded.

The Jellet Rapid Test for ASP detected domoic acid (DA), the principal compound associated with ASP, in all samples containing the regulatory limit for ASP toxins (20 µg DA g^{-1} shellfish flesh). However, this kit also detected low levels of toxin (< 2.5 µg DA g^{-1}) in some shellfish species, particularly king scallops. This suggests that some shellfish tested by the Jellet Rapid Test for ASP would give a positive result when levels of DA are below the regulatory limit and would still be marketable. Results were also evaluated using the lower 4.6 µg DA g^{-1} trigger level for ASP toxins. This level was introduced in Commission Decision 2002/226/EC to establish marketing conditions for king scallop gonad and adductor muscle. Thirty-five percent of king scallop gonad and adductor muscle extracts found to contain ASP toxins below this level, using traditional HPLC methodology, gave a positive result using the Jellet Rapid Test for ASP. Due to this low detection limit further field trials were not undertaken.

Investigation into the use of the Jellet Rapid Test for PSP in shellfish harvest management and end-product testing

As the Jellet Rapid Test is intended for use in both monitoring by scientific personnel and by shellfish farmers and processors, it was important to establish whether the kit could be used by individuals with no scientific training. A trial was set up in which non-scientific personnel at FRS were asked to test shellfish samples and read results using the Jellet Rapid Test for PSP. Results were then cross-checked by scientists. Most 'non-scientists' correctly followed instructions and toxin positive and negative samples were always correctly identified.

A shellfish processor using the Jellet Rapid Test

Following this trial, shellfish farmers and other professionals in the industry were supplied with the Jellet Rapid Test for PSP, received training and practice in sample extraction and were asked to periodically test their shellfish using the kit. An aliquot of each shellfish extract analysed, the kit and the participant's interpretations of the result were returned to FRS. Results were reinterpreted and extracts reanalysed using the Jellet Rapid Test by an experienced user within the laboratory. Again, participants successfully identified all positive samples correctly.

Conclusions

Results from these trials suggest that the Jellet Rapid Test for PSP may be used as a screen to eliminate negative and low PSP toxicity shellfish samples from routine monitoring programmes prior to quantitative analysis of PSP toxin positive samples. In viewing its ease of use, the kit may have a role as a quick harvest and end product test. The Jellet Rapid Test for ASP is currently too sensitive to use as a screen for some shellfish, for example king scallops.

Further information

A report on the results from the trials has been submitted to the UK Food Standards Agency. Other publications of relevance are given below:

MACKINTOSH, F. H., SHANKS, A. M., GALLACHER, S., SMITH, E. A. (2002) Assessment of MIST Alert™: a commercial qualitative assay for detection of paralytic shellfish poisoning (PSP) toxins in bivalve molluscs. *Journal of AOAC INTERNATIONAL* 85, 632-641.

Mackintosh, F. H., Smith, E. A. (2002) Evaluation of MIST Alert™ for the detection of paralytic and amnesic shellfish toxins in Scottish Shellfish. *Journal of Shellfish Research* 21, 455-460.

Jellet F. J., Roberts, R., Laycock, M. V., Quilliam, M. A., Barrett, R. E. (2002) Detection of paralytic poisoning (PSP) toxins in shellfish tissue using MIST Alert™, a new rapid test, in parallel with the regulatory AOAC mouse bioassay. *Toxicon* 40, 1407-1425
Further information can also be obtained from:

Elizabeth Smith or Fiona Mackintosh, FRS Marine Laboratory, 375 Victoria Road, Aberdeen, AB11 9DB.
email: mackintoshf@marlab.ac.uk

Acknowledgements

We thank the support staff at FRS for their assistance in the 'non-scientific' trials and participants of the field trial for their time and assistance. This work was conducted under FSA contract B04006.

SANDS OF CHANGE
PORTRAIT OF THE COCKLE FISHERY IN MORECAMBE BAY: NOVEMBER 2002 - OCTOBER 2003

Jim Andrews, Chief Executive, North Western & North Wales Sea Fisheries Committee

Summary

Morecambe Bay in northwest England has traditionally supported a relatively small cockle fishery, worked predominantly during the winter by groups of local fishermen. All this changed in November 2002 with the appearance of a large fishing boat which dried out on a cockle bed off Morecambe, attracting up to 250 fishermen to work on that bed throughout the winter. This bed was closed by the SFC in the spring, but high levels of fishing continued elsewhere in the Bay throughout the spring and summer, and show little sign of abating in the autumn of 2003. At one time over 400 hand gatherers were fishing to 4 boats on one cockle bed in the summer.

This report describes the development of this fishery, and management responses to it by the SFC. It goes on to consider lessons that can be learnt from the fishery, which may prove useful for discussion on the future of inshore fisheries and environmental management.

Morecambe Bay and its Fisheries

Morecambe Bay is a large shallow embayment in northwestern England (see Figure 1). The Bay has an enormous area of inter-tidal sand and mud flats, larger even than the Wash on the east coast. Five rivers run into the Bay. The sandy estuarine environment is a haven for all sorts of marine and coastal life, from commercial fish and shellfish to rare and endangered wildlife.

The fishing industry operates from several locations around the Bay. Small fishing fleets are based in ports at Barrow, Morecambe, and Fleetwood. Shore fishing (netting and long lining for fish, trawling for shrimps behind tractors, cockling and musseling) takes place all around the Bay, principally along the Bardsea/Aldingham shore, from Flookburgh, along the Morecambe/Heysham shore, at Middleton, Pilling, and Knott End.

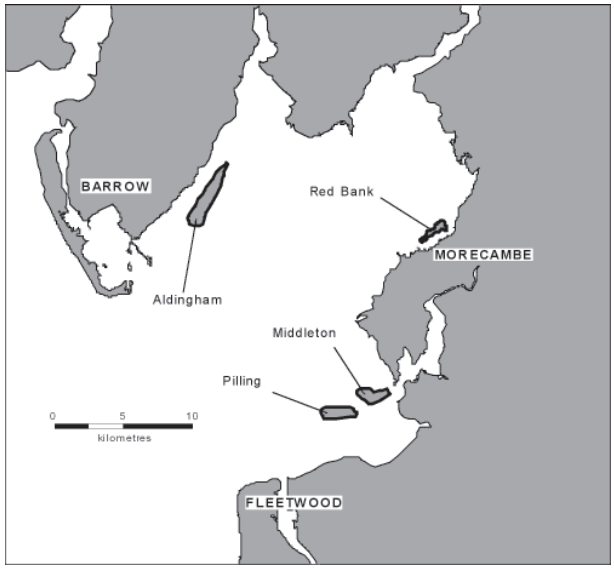


Figure 1. Heavily fished cockle beds in Morecambe Bay

Cockles are usually present in the Bay in sufficient abundance for commercial gathering, but the quantity and density of cockles is very variable. This has meant that the local industry has remained quite poorly developed when compared to locations like the Wash, Burry Inlet or Thames estuary where large, stable stocks have enabled the industry to specialise and expand.

Typically no more than a couple of dozen local fishermen fish for cockles in the Bay during the winter. These fishermen would probably fish for shrimps and finned fish at other times of the year. Over the past 10 years or so there has been an influx of itinerant mussel fishermen to the area, but little outside interest in cockles. Prior to the recent explosion of fishing activity, there had been only one episode of intensive fishing for cockles in the Bay, in the winter of 1986/87. At that time approximately 100 itinerant gatherers came to the area, attracted by good stocks and high cockle prices at the time.

Changing times

The generally tranquil nature of the Bay was shattered in November 2002 with the arrival of the large suction dredger '*Thorsten J*' in Morecambe. This boat anchored on a cockle bed known as 'Red Bank' just a few hundred metres from Morecambe promenade. Just a few local fishermen had worked on Red Bank since the early autumn.

The day after the *Thorsten J* arrived, several dozen fishermen were brought into the area from Merseyside and Deeside. These men worked on the shore, raking cockles by hand and transporting them to the *Thorsten J,* which had dried out on the cockle bed. A crane on the vessel was used to lift tonne sacks of cockles into the hold. When the tide came in the vessel shipped the cockles to Heysham harbour nearby, where they were loaded on to lorries. Within a few days of *Thorsten J* arriving, the number of fishermen working at Red Bank had swelled to over 150. This high level of activity was sustained into the New Year, dropping off slightly in January and February in colder weather and as stocks dwindled.

By March 2003, the cockle stock at Red Bank had become depleted, and the SFC closed the bed. Within a few days the same vessel and fishermen had found a new fishery further south in the Bay, near to Pilling.

With the improving weather, other vessels joined the *Thorsten J*: cockle dredging boats the *Mac Siccar* and *Second Degree*; and a small coaster, the *Basse Indre*. After a few weeks at Pilling the activity moved north, and a vast bed at Aldingham became the hub of activity for the summer, with over 400 people working on it.

As the fishery progressed changes were observed in the pattern of fishing. Initially the gangs were poorly organised and were generally associated with established fishermen. Slowly the gangs became better organised and equipped. New leaders emerged, displacing some of the original organisers. The composition of the gangs also changed, so that by the summer of 2003 most of the people working on the shore were from overseas, appearing to be either Oriental, Eastern European, or from the Middle East. The British involvement has reduced significantly, and seems now to be confined to organising the transport of the cockles from the bed, and their shipment onwards to European markets or processing plants in the UK.

There are no official figures for cockle landings, and it is hard to estimate the value of the fishery over the past 11 months. Conservative estimates by NW&NWSFC staff would place a value of about £5,000,000 on the fishery.

Why did this happen?

There are thought to be three main causes of this sudden change in fishing practice in the Bay:

- Closures elsewhere: many of the other cockle fishing areas in the country are closed to a greater or lesser extent. In some cases the closures are associated with concerns about stocks (Thames Estuary); elsewhere restrictions have been imposed to protect wildlife (Wash, Dee, and further afield the Wadden Sea in Holland); the large cockle beds in the Solway are closed while the Scottish Executive introduces new management measures; and in other areas 'DSP' closures have prevented fishing (Burry Inlet).

The fishing vessels Thorsten J (foreground), Basse Indre and Mac Siccar (background) on Pilling sands, June 2003. The small dots in the picture are fishermen; NW&NWSFC staff estimate approximately 150 present on that day. The bags alongside Thorsten J each contain 1 tonne of cockles

- High prices: a result of the closures elsewhere has been a reduction in supply, which has raised prices to unprecedented levels. During the summer of 2003 prices as high as £1500 per tonne were being offered for large cockles for sale into European markets.
- Healthy stocks: bucking the general trend, and against all expectations, an exceptionally good 2001 spatfall survived through to maturity throughout the Bay. By November 2002 these cockles had reached a fishable size.

These three factors conspired together. In November 2002, Morecambe Bay was virtually the only area in the country that was open to fishing and with a decent stock of cockles. Fuelled by the high prices being offered, cockle fishermen flocked to the area from far and wide. Many travelled hundreds of miles and spent weeks away from home. It is interesting to note that the only local people who supported the fishery were proprietors of Bed and Breakfast establishments in Morecambe.

Fisheries Management Response

NW&NWSFC staff were instantly informed of the arrival of the *Thorsten* J at Morecambe by local fishermen. NW&NWSFC immediately investigated its activities, and considered how the situation could be managed.

It quickly became clear that while the *Thorsten J* was too large to fish within the District, it was serving as a transport craft rather than a fishing vessel. The SFC maximum vessel size byelaw therefore did not apply to it (although at 43 m long, it was nearly 30 m longer than the permitted maximum size). Nothing could therefore be done to prevent it operating.

Similarly, the SFC was unable to do anything to regulate the number of fishermen working on the shore, despite repeated requests from local fishermen to do something to protect their winter's livelihood. The only option available to stop the itinerant fishermen from working would have been to close the bed to all fishermen, irrespective of their provenance.

NW&NWSFC staff decided that the best management strategy available was to ensure good compliance with the Committee's byelaw setting a minimum size for cockles. While this would not regulate the quantity of cockles removed, it would at least ensure that juveniles were not taken. Fishery Officers visited the bed nearly every day to check compliance with this byelaw (Byelaw 13: cockles must be unable to pass through a 20mm square aperture). Gatherers were encouraged to 'riddle' the cockles to ensure that small individuals were returned to the bed. On several occasions fishermen were told to return cockles they had removed from the bed. The industry co-operated well with the Fishery Officers, and no prosecutions had to be made.

As the winter progressed, NW&NWSFC scientific staff monitored the effect of intensive fishing activity on the cockle bed. Concerns emerged about the population structure in parts of the bed. In one area there was a high proportion of undersized cockles, and in another there was a significant spatfall. The Committee responded by closing parts of the bed using its powers under byelaw. By March 2003, surveys indicated that the bed had been depleted by the fishing activity. The Committee resolved to close it to fishing completely.

NW&NWSFC Fishery Officers and scientific staff adopted the same management and monitoring approach when the fishing activity moved on to Pilling, and then to Aldingham. A good rapport between enforcement staff and the industry enabled informal day-to-day management of fishing activity. Informal agreements to leave certain parts of the shore containing large quantities of spat and undersized cockles were generally well observed.

At the time of writing, fishing is now concentrated in the northern part of the Bay near Aldingham. The industry is waiting for the cockle bed at Morecambe to open. NW&NWSFC staff are working with English Nature, the local authority and other interests to develop a management strategy for this fishery over the winter.

Social Issues

From the day that fishing began in Morecambe, the NW&NWSFC has been besieged with complaints about the fishing activity from local fishermen, residents, councillors, and local MPs. Most of these complaints have been related to 'social' (or anti-social) problems associated with the fishing activity.

At the various locations where cockling has taken place around the bay, fishermen have choked local car parks, turned local beaches into quagmires, revved up noisy quad bikes in quiet villages in the early morning, left piles of litter and dead shellfish behind, and have even spent part of the summer sleeping rough in a local graveyard. None of these activities have made them welcome. Concerns have been raised by local people about the 'black economy' aspects of the activity, with claims that many of the fishermen involved are either claiming benefits from the DSS, and/or failing to declare their income to the Inland Revenue. As the number of foreigners involved in the fishery increased, so did complaints about fishing by illegal immigrants.

The NW&NWSFC has no power to regulate any of these activities or deal with any of these varied issues. However a few years ago the Committee produced a 'Code of Conduct' for inter-tidal shellfisheries. This is a voluntary code. NW&NWSFC staff have encouraged compliance with it, but with little success.

The NW&NWSFC has liased closely with other statutory bodies, and has relayed complaints about illegal activities to them. In response, the DSS and police organised a 'raid' when cockling was taking place at Pilling. A small number of illegal immigrants were detained, and several infringements of road traffic regulations were detected.

Environmental Issues

Morecambe Bay is one of the most important areas for wildlife in the UK. There are several Sites of Special Scientific Interest (SSSI) in the Bay. It is also a designated Special Protection Area (SPA) for birds, and a candidate Special Area of Conservation (cSAC) for other wildlife. These designations have implications for fisheries management.

The NW&NWSFC is closely involved with wildlife conservation in the Bay, and has been working with English Nature (EN) and other statutory bodies on the management of the SPA and cSAC for many years. This close liaison has enabled the SFC and EN to adopt a pragmatic response to the management of cockling, through regular meetings and discussions with local and national EN staff. EN staff appreciate the difficulties faced in managing the fishery, and SFC staff recognise that protecting wildlife is vital.

At the time of writing, EN and the SFC are preparing to assess the re-opening of the cockle beds near Morecambe as a 'Plan or Project' under the Habitats Regulations. Such assessment has become routine for most SFCs in recent years. It is generally found that with appropriate management, most fishing activities can proceed without causing undue harm to wildlife. It is hoped that EN and the NW&NWSFC can find a mutually acceptable way to open and manage this fishery in a way that protects wildlife while allowing a valuable fishery resource to be exploited.

Conclusions

The cockle fishery in Morecambe Bay has presented great challenges for the NW&NWSFC over the past 11 months. At the same time it has provided valuable experience. This may be relevant to other aspects of inshore fisheries management, and may provide valuable guidance for the future at a time when the management of inshore fisheries and the environment in the UK is under great scrutiny.

On reflection, our experiences fall into two categories: the good and the bad. Each is considered briefly below.

The good

- Local management through the SFC was able to respond immediately to the change in fishing practices, avoiding a fisheries calamity;
- SFC byelaws provided fisheries conservation measures for a fishery not protected by EC or national legislation;
- Scientific advice from expert SFC staff was available to provide regular up to date management guidance;
- Local Fishery Officers were able to direct all of their effort to the management of the fishery with no distractions or other calls on their time;
- Local accountability of SFC staff through members of the Committee (local authority councillors and local fishermen) with a keen interest in the fishery and an informed view of the situation;
- Liaison with the industry by the SFC helped protect fish stocks and secure support for conservation measures;
- Good relations with other authorities meant that the SFC was able to encourage action on 'social' issues and keep other bodies briefed on fisheries matters; and
- Environmental protection has been secured by well established links with English Nature, and familiarity with environmental duties and responsibilities.

The bad

- Antiquated legislation prevented the SFC from doing the one thing it most wanted to - regulate effort by restricting the number of fishermen; and
- Limited resources as a relatively small organisation, the stress of managing the fishery has fallen on the shoulders of just a few people.

'WET DREDGING' FOR COCKLES – FURTHER TRIALS IN THE RIBBLE ESTUARY

Bill Cook
North Western and North Wales Sea Fisheries Committee, University of Lancaster, Lancaster LA1 4YY

Introduction

A thorough trial of tractor-towed 'wet dredge' cockle harvesting took place in the Ribble Estuary during the winter of 2001/2, and was reported in *Shellfish News* No. 14. The wet dredge is a simple device towed behind a tractor in shallow water at the edge of the receding tide. The top few centimetres of the sediment containing the cockles are removed by a blade and the sorting of the catch takes place on a bar grid onto which seawater

is sprayed, washing the sediment, small cockles and other invertebrates back into the water. This first trial showed that wet dredging seemed to be an effective harvesting method offering a potential advantage in managing the cockle fishery, but an unexpected result was appreciable mortality of small, rejected cockles after passing through the dredges. These small cockles were only a few months old, around 8-15 mm shell length, and were present at most unusually high densities of up to 10,000 per m².

A second trial began in February 2003, and up to 5 dredges worked regularly, with at least 3 being present on most tides. Around 300 tonnes of cockles were taken. Since wet dredges can only work the edge of the tide as it ebbs, the amount of time spent fishing depends on the width of the bed and its slope. On the Ribble fishing was possible for about 2 hrs per tide, with catch rates of 500 kg per hour being achieved.

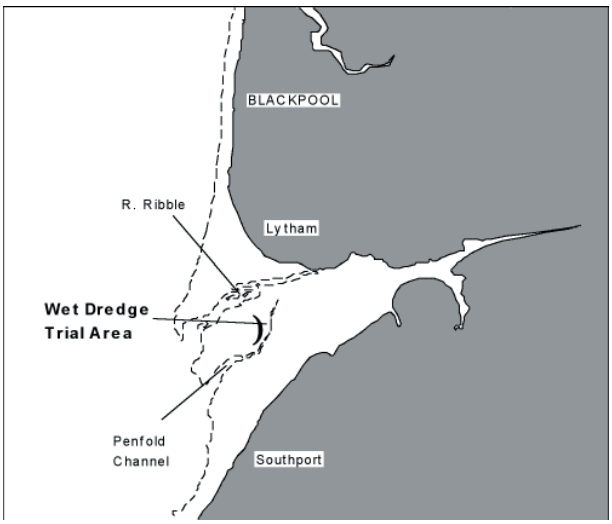


Figure 1. The Ribble Estuary showing the dredged area in the Penfold Channel

The dredging activity was monitored by Fishery Officers on a very regular basis, checking for compliance with the Committee's minimum size and for any signs of excessive damage to the catch and discards. All of the dredges that operated during the period performed well. More detailed observations were made of the effects of wet dredging on the undersized, rejected cockles. Very little spatfall had taken place in 2002, so the vast majority of the cockle population was still of the 2001 year class. Consequently, the reject cockles were much larger than in the first trial, being 20-27 mm in shell length, and cockle densities had reduced considerably since the spring of 2002, although much of the area still held 500-1000 per m² at the start of the trial.

Survival of Discards

To check discard survival, rejected cockles were gathered from the surface of the dredge tracks as the tide ebbed off. They were held in an aquarium for 1 week alongside control samples from the same area. The controls were cockles carefully hand-gathered from within undisturbed sediment. There was no mortality for either batch of cockles: by the end of the week all cockles appeared to be healthy and filtering normally. This trial was stopped during a very cold spell of weather, with temperatures well below freezing and sea ice present near the bed. There were fears that this might stress the cockles and lead to mortality after discarding, so 3 further samples of rejects and carefully-gathered controls were taken. These were kept under observation in an aquarium for 11 days. During this time none of the control samples and less than 1% of the rejected cockles died. This high survival contrasts with the results obtained in 2001/2 when there was up to 70% mortality of the small rejected cockles after 11 days.

Catch Size Selection

The size distribution of cockles discarded by a wet dredge compared with a sample collected from nearby, undisturbed sediment is shown in Figure 2. The dredge was fishing a stock that was predominantly undersized (defined as a cockle that will pass through a 20 mm square gauge, equivalent to a shell length of around 26 mm), and the majority of the catch was therefore discarded.

Despite the predominance of undersized cockles very few undersized specimens were found in the dredge catches. Those that were found were usually small specimens lodged inside the shell of a larger, dead cockle.

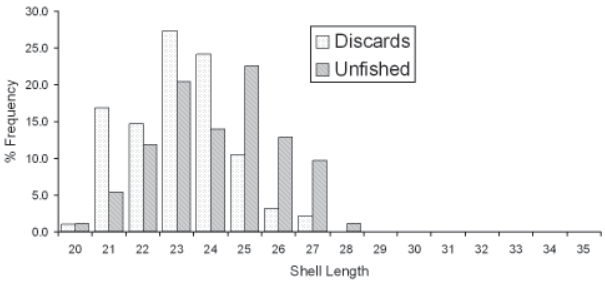


Figure 2. Size distribution of discarded and unfished cockles from the Penfold Channel, February 2003

Conclusions

The 2003 wet dredge trial has been very successful, and has resulted in a valuable spring fishery. Fishing intensity has been much higher than in the previous trial, and has been largely confined to 1 limited location, with most fishing taking place in an area less than 15 ha. This was fished regularly by several dredges for a period of 3½ months. Despite this, there do not seem to have been problems of discard mortality. This suggests that the mortality seen in the previous trial was indeed the result of the small cockles being in a weakened condition, possibly due to their exceedingly high density and the time of year. However, as there was virtually no spatfall in 2002, the performance of the dredges when reject cockles are of small size but at more typical densities remains untested.

The area was also fished by hand-gatherers from April 2003, with up to 30 gatherers working. The two methods of fishing did not conflict; indeed they were largely separated both in space and time. The dredging took place on a gently sloping sandflat above a low-water channel, and had finished well before the time of low water. The hand-gatherers by contrast mainly fished the area close to the channel, and on most occasions were just beginning to work when the dredges were leaving the beach.

As reported in the previous article, the nature of cockle fishing has altered radically in the NW of England over the past year. We are now seeing very large travelling gangs gathering cockles, which are being removed from the beds by vessels that dried out there at low water. Many hundreds of gatherers may be present on a tide. We believe that the wet dredging on the Ribble, combined with a partial closure of the bed to fishing, may well have reduced the intensity of the hand-gathering fishery in that estuary by levelling out cockle densities over much of the exploited area. Although at first the dredged area held large numbers of undersized cockles, the excellent size selection of the dredges coupled with high discard survival rates meant that fishing could continue over a sustained period. Catch rates were only slightly depressed when the trial ceased at the end of May, and the average cockle size was larger, supporting evidence that the discards had survived and grown to recruit to the harvestable stock.

A 'wet dredge' fishing in shallow water at Southport

ANNOUNCEMENTS

UK MICROBIOLOGICAL LABORATORIES UNDERTAKING SHELLFISH TESTING

Resolutions of Sixth Meeting : 1 April 2003

A periodic meeting of laboratories undertaking microbiological testing of bivalve shellfish was held at Whitehall Place, London on 1 April 2003. The group comprised representatives from CEFAS Weymouth (the National Reference Laboratory), the Public Health Laboratory Service, the Marine Laboratory Aberdeen and Belfast City Hospital.

The remit of the group is:

1. To provide, with reference to Council decision 1999/313, a UK technical forum for discussion of issues relating to microbiological testing of shellfish.
2. To agree, where possible, common methods and approaches relating to shellfish testing for use throughout the UK and their quality assurance.
3. To advise the central UK competent authority, and the devolved administrations, of the views of testing laboratories as outlined above.
4. To enable CEFAS Weymouth, as the UK National Reference Laboratory (NRL), to represent the views of UK testing laboratories in the European laboratory framework specified in Council decision 1999/313 and to co-ordinate with UK laboratories initiatives arising at the European level.

The group agreed the following resolutions:

1 The group recommends the use of the current ISO 6579 for the analysis of salmonella in shellfish and for other methods to be validated against this.

2 The group agreed that the condition of a sample arriving in a laboratory should be assessed and noted.

3 The group recommended that further data be gathered regarding the temperature and time of sample transportation to aid guidelines on sample transport time to be drawn up.

4 The group agreed the NRL should progress an open meeting for UK laboratories testing bivalve molluscs under directive 91/492.

EU SHELLFISH PROJECT FOR SW ENGLAND

A massive boost to the environment and economy of the South West has been secured by a partnership of local organisations. They have won a big share of £6.5 million of new EU funding.

Led by the Environment Agency, the 'Cycleau' Partnership includes Cornwall County Council, Devon Wildlife Trust, South Hams District Council, Teignbridge District Council and groups in France and Ireland. Environmental scientists at the University of Exeter will be assisting the international partnership to achieve its aims.

Project Cycleau ['watercycle' in French] is a multi-national EU Programme seeking to improve the way in which coasts and estuaries are managed. The Cycleau funding comes from Europe's INTERREG programme for inter-regional co-operation. The purpose is to bring together communities from different European regions facing similar environmental and economic challenges – in order for them to find simple, adaptable and transferable solutions to their common problems. The project involves estuaries in South-West England, Brittany and Ireland and is led by the Environment Agency, SW Region.

Included in the programme is the Dart Estuary in Devon, arguably one of the finest quality estuaries in the UK. Recent funding awarded under the Cycleau Project presents an opportunity, amongst many objectives, to give reality to long-held ambitions for a thriving mariculture enterprise on the Dart, sustainable in environmental and socio-economic terms. The focus here will be the promotion of commercial oyster production and the development of a sustainable dredging policy for the estuary. A manager is currently being recruited to oversee implementation of the project.

The money – from the European Regional Development Fund – will be spent over the next three years on a variety of environmental and economic development projects.

Key proposals for the West country include:

- A new sustainable dredging strategy for the river Dart in Devon to improve shellfish farming and benefit recreational boating.
- An innovative new method of improving water quality in the Red River in Cornwall by removing historic mine pollution.
- Grants for farmers and landowners on the river Axe in Devon, river Char in Dorset and the Fal and Helford rivers in Cornwall to help reduce water pollution and fertiliser run-off.
- Using the latest mapping and surveying technology and increasing public access to information to improve the management of the Exe estuary in Devon.
- Testing of new pollution control booms in the Fal estuary for better protection against oil spills.
- A multi-national approach to water quality testing and the regeneration of the shellfish industry on the Teign Estuary.
- Developing a more sustainable approach to the management of the Slapton catchment in the South Hams in Devon.

Welcoming the news of the Cycleau funding award, Richard Cresswell, Regional Director of the Environment Agency in the South West said, "This is a significant success that will bring real benefits to the people, economy and environment of the South West. It has taken a great deal of careful planning and hard work and I congratulate all those involved in the partnership.

CORNISH SHELLFISH SURVEY

Cornwall Sea Fisheries Committee has been awarded an Objective 1 Fisheries Grant for £17,250 to undertake a three-year survey of shellfish stocks around the Cornish coast.

Shellfish such as crabs and lobsters are an important part of the Cornish fishing industry, but there is surprisingly little information concerning their stocks in Cornwall. Although there is data on shellfish landings, there is not much information about the sizes and amounts of smaller shellfish and other species that are caught then returned live to the sea.

This survey will involve monthly surveys at sea with the help of six vessels spread around the Cornish coast. Records will be kept of the size and sex of different species, the presence of berried (egg-bearing) females, whether the shellfish are damaged or diseased and additional information such as the location of fishing gear, the type of pots and baits used, and weather conditions, including the monitoring of water temperatures using probes attached to the pots.

The data will be collated into a final report in 2006 and will be used to improve the future management of shellfisheries in Cornwall's inshore waters.

Sam Davis, the fishery officer responsible for the survey work, said "The response I've had from the skippers and crews involved in the survey has been fantastic, they have all been really keen to help. The data gathered so far is showing how diverse the fishery is from one area to another, a fact better known to fishermen than scientists, I suspect."

Eddy Derriman, Chief Fishery Officer at Cornwall Sea Fisheries Committee, added "We have wanted to do a survey of this kind for many years, as we recognise the value of shellfisheries around our coast. With the help of Objective 1 funding, we will have a baseline of information against which we can monitor trends in the future."

Alison Elvey, Objective 1 Fisheries Programme Manager stated "Work like this which helps decision makers make better informed decisions on fisheries management are brilliant. It is great seeing the fishermen getting involved as they know more than anyone what the fisheries are like."

NORTH & WEST WALES V NOTCHING PROGRAMME

The North West and North Wales Sea Fisheries Committee (NW&NWSFC) was awarded a grant of nearly £200,000 of EC Objective 1 funding in July 2003 for an ambitious fisheries conservation programme. This will help to protect lobster stocks in north and west Wales.

Under this programme, NW&NWSFC will release 15,000 lobsters back into the sea over the next 3 years. These lobsters will be 'berried' (pregnant) females. Each lobster will be marked with a 'V' notch cut into its tail. The 'V' notch gives the lobster legal protection from being caught for a few years. During this time she will be able to reproduce several times, boosting egg production and safeguarding recruitment to lobster stocks. A Research Assistant is being recruited to help with this programme.

SCALLOP CONSERVATION

Measures to conserve scallops are due to come into force by the end of the year.

The draft legislation will be based on proposals from the industry for technical measures to complement scallop licensing, which was introduced in 1999.

The Department for Environment, Food and Rural Affairs consulted over the summer on a draft statutory instrument that will limit the number of dredges which can be used, the number of teeth on the dredge tooth bar and the size of belly rings. The legislation will extend the current ban on French dredges in the Channel to other areas. EU minimum landing sizes will apply – that is 100 mm except in ICES areas VIId and VIIa (north of 52° 30' N) where the mls is 110 mm. To aid enforcement, the carriage of scallops below 110 mm will be banned in VIId.

The legislation will apply to all UK vessels in waters off the English coast and Welsh waters outside the territorial sea. It will apply to English and Welsh vessels wherever they are. The Scottish Executive have recently put in place measures which apply to Scottish waters and vessels and Northern Ireland already has its own legislation.

Responses to the consultation are available through the main Defra library, Nobel House, Smith Square London SW1P 3JR. A number of respondents suggested that the limits on dredge sizes should not be applied unilaterally outside 12 miles because it would disadvantage UK vessels fishing alongside those from other Member States. Ministers are currently considering the responses to the consultation paper and whether any adjustments need to be made in the light of these responses. Defra will write to all those with a scallop entitlement before the new measures come into effect.

Further information

Sean Ryan, Sea Fisheries Conservation Division, Room 112 Whitehall Place East, London SW1A 3HH. Tel: 0207 270 8255. Email: sean.ryan@defra.gsi.gov.uk

NEW LOOK FRS WEB SITE

The Scottish Fisheries Research Service (FRS) has recently launched a redeveloped web site.

The web site contains a wealth of information on the research carried out by FRS at the FRS Marine Laboratory in Aberdeen, the FRS Freshwater Laboratory near Pitlochry and its outstations throughout Scotland.

"The main aims of the development project were to provide a website design to reflect the high professional standards of FRS with simplicity and ease of navigation. The website has been developed to portray the corporate identity of FRS, and in order that visitors recognise the agency as part of the Scottish Executive," explained Alastair Johnstone, Assistant to the Chief Executive, FRS. "An improved search engine allows visitors to quickly locate relevant information."

The web site's principal audience comprises a mix of Scottish Executive policy makers, Ministers, MSPs, scientists and the research community, fishing and aquaculture industries, environmental bodies, the media and general public.

The project gives FRS full content management capabilities with a solid foundation for new features to be integrated into the site in the future. The structure of the site has been designed to meet Government guidelines for accessibility.

The web site can be found at: http://www.frs-scotland.gov.uk

TOXIN MONITORING RESULTS

Weekly reports from the algal toxin monitoring programme in Scotland have been redesigned to make the most up-to-date information easier to interpret.

The algal toxin monitoring programme continues to provide information for the shellfish industry but, from early September, the fishing areas closed due to Food and Environment Protection Act orders and the areas affected by shucking advice will be presented as easy-to-read maps.

These maps, and other information on the monitoring programme results can be found on the FSA web site at: http://www.foodstandards.gov.uk/foodindustry/shellfish/algaltoxin/

NEW BOOK

An atlas of histology and cytology of marine bivalve molluscs

Edited by H. Grizel

This atlas provides the reader with extensive information on the histology and cytology of marine bivalve molluscs of interest for commercial purposes. The seven species of bivalve mollucs involved are: *Crassostrea gigas, Ostrea edulis, Pinctada margaritifera, Pecten maximus, Ruditapes philippinarum, R. decussatus* and *Mytilus edulis*. The eight principal organs are described (mantle, gills, palps, digestive gland, heart and haemocytes, kidney, gonads and nervous system). In each case, photonic microscopy, scanning and transmission electron microscopy micrographs, accompanied by explanatory diagrams, illustrate the different types of tissues and cells. Complementary information is provided on the anatomy, functions and histochemistry of several cellular types. References are given for each organ. This book is designed to meet the needs of malacologists, pathologists and other researchers, as well as those of teachers or simply readers with an inquiring mind. Based on previously existing and new data, we have prepared a long voyage to let you explore the tissues and cells of seven commercially marketed bivalve molluscs. Starting with the mantle covering their soft bodies and secreting the protective shell, as well as fine pearls, on to the gonads and the complex formation of gametes, the reader will discover numerous cell types, their functions and the fine workings of cells and their organelles. This accurate, concise publication provides a wealth of illustrations that will help non-specialists find their way through the maze of mollusc tissues. It will provide specialists with a comprehensive reference book on normal tissues and healthy cells. Lastly, to reach an international readership, we have chosen to publish this book in a bilingual French/English version. Come out of your shell and discover this highly original atlas!

This illustrated hardback book (ISBN 2-84433-111-4) has 202 pages. The cost is 70 euros. Further information can be obtained from: ALT Brest – Service Logistique – 3, rue Edouard Belin – BP 23 – 29801 Brest Cedex 9 Tél. 02 98 02 42 34 – Fax 02 98 02 05 84 email : logistique.brest@alt-sa.com.

BOOK REVIEW

Biotechnology and Genetics in Fisheries and Aquaculture

A.R. Beaumont and K. Hoare

In the preface the authors, Andy Beaumont and Kate Hoare, explain that *Biotechnology and Genetics in Fisheries and Aquaculture* was produced following frequent requests from graduate students at the university of Bangor who wished to have the course lecture notes on Genetics in Aquaculture packaged into a handbook. What emerged is an excellent overview of genetic variation and its measurement, and a comprehensive introduction to the concept of genetic structure in relation to natural populations and the importance of genetic variation in the hatchery. The book also explains the science behind the production of gynogens, ploidy manipulation and the production of transgenic fish by genetic engineering.

The authors have produced a textbook, which covers the subject in sufficient detail and clarity to stimulate those with a biotechnology bent to undertake further reading, without overwhelming a reader who merely wishes to understand some of the basic principles.

Unfortunately the book does not address the topic of diseases of fish and shellfish with the same rigour. Given that one of the major constraints on aquaculture is disease, and that the number of molecular methods in the Office International des Epizooties (OIE) diagnostic manual for aquatic animal diseases has increased dramatically over the last decade, the subject of disease and its diagnosis warrants more than the single paragraph in a chapter dedicated to genetic considerations in the hatchery. It should also be noted that the book was not intended as a manual and therefore the text contains only limited detail on methodology.

Nonetheless, this is an ideal text for relative newcomers to Genetics in Fisheries and Aquaculture that would not be out of place on a bookshelf of those already well established in the field. A good read and excellent value for money at £39.50.

David Stone, Virology and Molecular Genetics, CEFAS Weymouth Laboratory

Editors note: This illustrated hardback book (ISBN 0632055154), published in March 2003, has 176 pages. The normal price is £39.50 (+p&p) but it is available to readers of Shellfish News for only £31.50. Contact Blackwell Publishing Direct Orders c/o Marston Book Services on Tel: + 44 (0) 1235 465500, Fax: + 44 (0) 1235 465556, Email: direct.order@marston.co.uk and quote 'Beaumont Special Offer'

NEWS FROM SEAFISH

AQUACULTURE DEVELOPMENT

1. Seafish and DEFRA recently co-sponsored 'Approaches to the detection and identification of faecal sewage contamination in coastal waters,' a workshop which took place at the Dunstaffnage Marine Laboratory on 17 September.

The workshop was arranged and chaired by Mark James of Fisheries Resource Management Ltd and included representatives from the shellfish industry, FSA (Scotland), SEPA, FRS Aberdeen, CEFAS Weymouth, EA, Scottish Executive and BIM, as well as invited speakers from the USA and France.

The day provided an opportunity to compare some of the research methods that are available for the detection of faecal coliforms – as potential methods for pollution source tracking and for further development of end product standards. A short report will soon be published, detailing outputs from the workshop and a summary of the issues raised. For a copy of the report please contact Sue Utting on 01492 650884 (s_utting@seafish.co.uk)

The ASSG Annual Conference that took place on 18 and 19 September also followed a similar vein with presentations and discussion focusing on water monitoring for microbial contamination and biotoxins. Both events clearly highlighted the need for more transparent and effective communication between the various regulatory bodies and industry.

2. Craig Burton, Seafish Aquaculture Development Executive (Scotland & Northern Ireland) gave the opening address at the recent Aquaculture Europe event held in Trondheim, Norway.

In the absence of Richard Slaski, Craig spoke on 'The Economics of Integrated Aquaculture,' which presented the view that any move towards integrating fish farming and mussel (or seaweed) culture will need to be affordable to the industry and profitable as a business in its own right.

Environmentally there may be benefits of growing aquatic species together, mainly by using species lower down the food chain to reduce nutrient input from fish farming (and potentially from other anthropogenic sources). However, from data currently available, he stated that this would be a challenge in economic terms. The paper will be submitted for publication in Aquaculture International.

For copies, contact Craig Burton on 07876035771 (c_burton@seafish.co.uk)

SEAFISH LAUNCHES NEW USER-FRIENDLY WEB SITE

Information about all sectors of the UK seafood industry can now be found at the touch of a button thanks to Seafish's new website, www.seafish.org.uk

This user-friendly site is easy to navigate and contains a wealth of information about Seafish (the Sea Fish Industry Authority), the UK seafood industry and the benefits of eating seafood.

The site has many new features including the recipe database, which contains hundreds of easy to follow recipes to encourage consumers to buy and prepare seafood dishes.

"We need to make sure that all of our investors find our material accessible and easy to understand. As a service to industry we also need to promote the benefits of eating seafood to consumers and raise awareness of the career opportunities within all sectors," explains John Rutherford, Seafish Chief Executive. "Our new website is an extremely important tool which will help us to achieve all of this."

The website is divided into three main areas:

- At Sea, with information about fishing at sea and seafood farming in the UK.
- On Land, which describes how seafood is bought, sold and processed in the UK.
- On Plate, which contains a wealth of information about seafood, including fascinating facts about seafood, how to cook it and where to eat it.

Other special features include:

- a suppliers database with details of UK merchants, wholesalers and processors;
- a bulletin board with requests from overseas businesses that would like to buy from or sell seafood products in the UK.
- searchable databases with details of Seafish award holders, projects and publications;
- a search engine which enables you to search the whole site for the information you're looking for;
- a diary of events, which covers everything from our own events to local seafood festivals, conferences and exhibitions; and
- a section specifically for the media, with all the latest news and media information

BIVALVE MOLLUSC CD-ROM

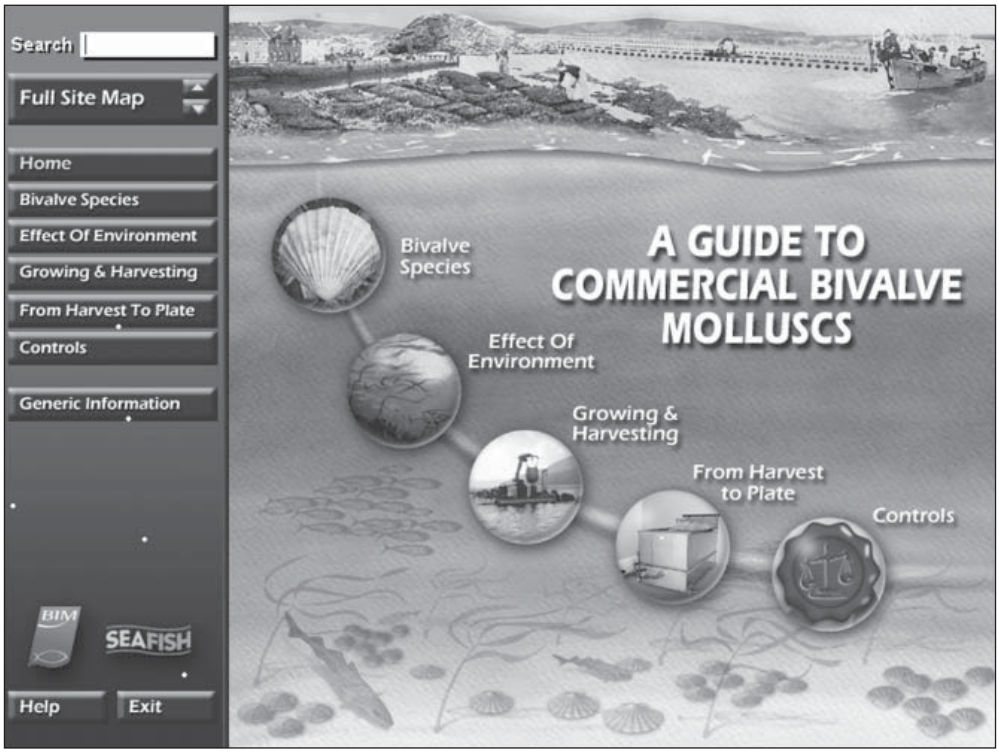
People will soon be able to access a wealth of information about Bivalve Molluscs thanks to a new interactive CD-ROM being developed by BIM and Seafish.

The Guide to Commercial Bivalve Molluscs, due out in the new year, will provide anyone working in this sector with everything they need to know, from handling and cleaning to storing and distributing. It will include information on:

- specific bivalve species;
- environmental factors;
- legislation affecting the sector;
- economics of the bivalve growing and harvesting industry in the UK and Ireland;
- various support organisations, for example Defra, Seerad, Dardni, BIM, the Countryside Council for Wales, the Association of Scottish Shellfish Growers,the Food Standards Agency, the Welsh Development Agency and the Marine Biological Association of the UK.

The CD will be provided free of charge to many businesses, organisations and individuals working in, or with an interest in, this sector.

For more information contact Martin Pyke at Seafish on 01482 327 837 or email m_pyke@seafish.co.uk



CLYDE FISHERY GROUP

The establishment of a local fishery management group is the route to a sustainable future for the Clyde inshore fishery, according to a new study published by Seafish.

The research was carried out earlier this year to investigate the performance of the Clyde fishery and present a picture of the issues currently facing the local industry. The findings show there is potential for a significant, sustainable and viable future through the establishment of a local fishery management group.

Seafish Fisheries Economics Manager Jim Watson said: "Although the economic position of the local fleet is fragile, we believe a strong future can be built with the establishment of a local management group.

"We encourage local stakeholders to work together to agree objectives and develop practical fisheries management measures that will improve efficiency and opportunities to maximise sustainable returns from the fishery."

For copies of the Key Features or full report, contact Jonathan Bryson on 0131 524 8662 (j_bryson@seafish.co.uk) or Jim Watson on 0131 5248663 (j_watson@seafish.co.uk)

NEWS FROM THE TRADE ASSOCIATIONS

SHELLFISH ASSOCIATION OF GREAT BRITAIN (SAGB)

THE NEXT BIG PUSH FOR IMPROVED WATER QUALITY

The Shellfish Association of Great Britain began to meet 100 years ago with the aim of ensuring the safety of molluscan shellfish, in particular oysters, sold in Britain. At that time there were very serious diseases, such as typhoid being transmitted by oysters. Early surveys by the Local Government Board and the Fishmongers' Company of the situation of shellfish lays in relation to sewage outfalls showed that some of the important producing areas were in very close proximity with sewers. The discharges were, of course, completely untreated. The notorious outbreak of 'enteric fever' in Winchester and Southampton caused by oysters from holding ponds in Emsworth was investigated and it was clear that there were only a few metres between the town outfall and the oyster ponds. These were the very first 'Sanitary Surveys' of shellfish beds. In the USA such surveys, together with faecal coliform counts on the growing waters later became the basis of public health controls on molluscan shellfish.

In Britain purification became the normal way of dealing with outbreaks of shellfish related diseases, though this was not always successful. In the 1960s a purification plant was built at Saltash but immediately it was used people became ill from an unidentified form of gastro-enteritis. It became apparent that purification did not always work when the shellfish came from heavily polluted waters. A later example of this was in the early 1980s, when Solent clams were held in old oyster breeding ponds on Hayling Island. Because of its proximity to the sewage outfall from Havant, the relaying site was almost certainly more polluted than the water from which they had been originally fished. When these clams were exported to the USA they soon produced outbreaks of illness, which were for the first time identified as being of viral origin, Norwalk virus, today known as Norovirus.

The European control measures developed following these problems with trade with the USA were formalised as Directive 91/492/EEC, to which the trade has been obliged to operate since January 1992. That Directive carried no powers to bring about improved water quality, though that had already been brought forward in the Shellfish Waters Directive 79/923/EEC.

In the 1990s, the Shellfish Association complained formally to the European Commission about lack of action by the UK to make improvements to protect shellfish waters under the Shellfish Waters Directive.

This was successful and has brought about real improvements during the current 5-year round of investment plans by the water companies, known as Asset Management Plan 3 (AMP3).

Some of the historic areas with poor water quality have been dramatically improved. Southampton Water, which 30 years ago was polluted by raw sewage, as well as an almost permanent thin film of oil, has been a good Class B for several years now. The Taw-Torridge estuary in North Devon has had massive improvements in sewage treatment and disposal, though some infrastructure remains to be improved. The water classification has improved marginally, but a large prohibited area remains, so more remains to be done. There are many major improvement schemes still to be completed within AMP3 and so some areas are likely to be cleaned up by the end of the existing programme.

The Shellfish Association is in the process of giving its views to the Environment Agency of the priorities it sees for the next 5-year round. The Association considers it important to concentrate improvement effort at sites that may be associated with continuing outbreaks of gastro-entiritis. We understand, and CEFAS has agreed that very few estuaries in Britain now produce any regular confirmed outbreaks of shellfish related illness. However, if things go wrong, one bad site can cause many illnesses and do much damage to the trade. One site in the Irish Republic, which is currently closed down, did cause a number of illnesses. The Association has asked CEFAS to make information it has acquired about such outbreaks available to the Environment Agency. The Association is now in the process of finalising its list of priority areas and will ask CEFAS to confirm that its list includes all their identified high-risk areas before submitting it to the Environment Agency.

Whilst the Association believes that any direct evidence of sources of shellfish related outbreaks is the top criterion for improvement action, other evidence, such as the existing classification status is also important. There are some remaining Prohibited areas which are far too extensive to be policed and therefore represent a risk to public health and the reputation of the established shellfish trade. These, where designated as Shellfish Waters, together with remaining Class C areas, are all due to be targeted under an existing Government commitment in enacting the Shellfish Waters Directive to raise all Shellfish Waters to at least Class B.

Finally, there are a small number of Class B areas which return predominantly Class A compliant results, but which fail designation as Class A under UK compliance criteria. In some of these the reasons for failure are unclear and may well be caused by animal faeces. This is why the Association supports the continuation of work on animal/human typing of bacteriophages. At a recent workshop held in Oban, the CEFAS phage typing method stood out as having real practical application in separating animal from human sources, compared with some very laborious methods based on building 'libraries' of bacterial types. The work at CEFAS has shown that in two areas studied, this method has indicated that animal inputs are greater than previously thought. Although this work is at a preliminary stage and needs to be tested in a wider range of sites it is clearly of huge importance in giving a real understanding of sources of pollution. We believe it will be of great value to the Environment Agency and Water Companies, as without such knowledge large sums could be spent on inappropriate improvements to sewage infrastructure. It has great potential to overcome the shortcomings of other methods currently used, E.coli and untyped phages, both of which fail to separate animal and human sources and direct counting for viruses, which may be confused by fragments of dead viruses.

Whilst much has been achieved in its first 100 years, the Shellfish Association of Great Britain continues to press for improvements in the quality of shellfish growing waters. Today it also carries this message at a European level through its membership of the European Mollusc Producers Association based in Paris.

Further information

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ASSOCIATION OF SCOTTISH SHELLFISH GROWERS (ASSG)

VIEWS FROM THE ASSG

ASSG Annual Conference Success

The latest in the 'international' series of ASSG Conferences was held in Oban in mid-September, with the focus on issues surrounding food safety of shellfish.

The first day of the event encompassed microbiological concerns. Topics ranged from monitoring of designated waters and harvesting areas for *E. coli* to the use of ribotyping for tracking of faecal contamination. There was a robust exchange of views over the relevance and appropriateness (relative to the perceived problem and the resulting effect on the industry) of the proposal to extend the criteria for depuration efficacy to include the 95% removal of bacteriophage. The proposal was explained by a representative from the EU Community Reference Laboratory (CEFAS, Weymouth), however I don't think there were too many in the audience who 'bought' the explanation. There are too many question marks remaining over the need for the additional indicator, including its relevance (particularly in Scotland), the supporting analysis, the resulting impact on the depurated products (a potential 50% mortality rate from a 5 day/20 degree C depuration cycle) and the costs for the industry. My reading of the meeting was that an overwhelming majority believed that any such proposal should be put on hold, while the entire issue of an additional viral indicator should be reconsidered at length. This approach should include industry and the wider scientific community at an early stage as well as CEFAS and the regulators.

The perspective from French, Irish and Canadian speakers added a particular spice of international comparability to the day's exchange of views, which were followed by an excellent Conference dinner, where discussions naturally continued.

The second day focused largely on the marine biotoxin issue, ranging across the toxins, the impact on different species and management concerns. Again, the international comparisons, from Ireland and Canada, made the UK members of the audience realise that much remains to be done before our regime is equally effective and supportive of the industry, although it was clear that a significant amount of research was being conducted into these areas by scientists at various locations.

Following on from these 'natural' constraints on shellfish production the Conference was informed about heavy metal and hydrocarbon contamination, with the results of a survey of Scottish shellfish and a description of the impact on the mussel sector of the sinking of the 'Prestige' oil tanker off the coast of Galicia last year.

All in all, a successful Conference, including a refreshing and revealing view of differing experiences and perspectives from overseas, and an informative exposition of the intricacies of some issues that as producers we may not wish to address but that we must confront. All the better if it can be done in a constructive fashion, contributing to the debate amongst policy and decision makers and encouraging the application of good science.

International Issues

A week later I was sitting in an auditorium at a Conference in Guangzhou, southern China, with a presentation on 'Quality and Safety of Shellfish Products' uploaded into the PC and ready to roll, covering these same topics. That is, protection of consumer health (but at what price), introduction of the bacteriophage standard, history of biotoxin events in Europe and the need for a credible management regime, and so on. To my growing dismay, the first two speakers covered exactly the same topics, albeit thankfully from a Chinese perspective, but I wondered whether the audience would have the stomach for a third helping of food safety commentary! As it turned out, the European spin plus some of my illustrations were sufficient to differentiate my presentation from the earlier ones. But it brought home to me forcefully how, beyond the rhetoric of commonality that we all come out with, there are indeed truly common themes of microbiology, biotoxins and other contaminants that affect our industry around the globe and influence policy makers in all countries.

The presentations that I enjoyed during the following days continued to reinforce my feeling of the community of concerns relating to the shellfish and indeed finfish sectors of aquaculture, as we listened to papers on carrying capacity, integrated management, polyculture and environmental management.

Change the continent and you change the weather, but the issues confronting our industry remain pretty much the same!

Optimism in Norway

The 'International Workshop on Mussel Farming Technologies and Development', organised by the European Aquaculture Society in Trondheim last August, between their annual Conference and the 'Aquanor' exhibition, turned out to be a well attended affair (over 100 registrations), with a number of interesting presentations. Modelling to optimise

farm characteristics, both long line and tube, biomass auditing and the relationships between current speed/ direction, feed availability and biotoxin intensity were among the technical papers.

In addition, Paolo Caricato from DG Sanco gave a detailed exposition of the established requirements (Directive 91/492) for shellfish supplies to the European Union, along with some indications of possible changes currently under discussion. Mary Ferns (President of the Irish Shellfish Association) gave a mussel producer's perspective from another small northern country.

However, the most significant aspect of the meeting, in my view, was the positive – indeed buoyant - attitude of the producers and researchers. This was not a 'rose tinted' outlook, more one that recognised there were problems associated with the creation of a 'new' industry in Norwegian waters, but that with the dedication of investigative research and the application of ingenuity there was every chance that these problems could be overcome.

Interestingly there was a general appreciation of the benefits of collaborative marketing, particularly for expert markets, with the example of the 'Scottish Shellfish Marketing Group' frequently mentioned as a template for the Norwegian producers to follow. However, this appreciation was matched by an equally profound lack of belief that the individualistic Norwegians would ever agree to work together in such a co-operative fashion!

Problems in France

An apparent unfortunate side effect of the long, hot, dry summer in southern France has been a sudden outbreak of mass mortalities in the oyster and mussel farms in the Thau lagoon near Sete in the Languedoc. By mid-August water temperatures had risen to levels of 30 degrees and, with blooms of algae in the lagoon, the oxygen levels had declined to below 50% in general, and in certain areas had fallen to as low as 2%.

As a result, mortalities have been reported across the area, with rates as high as 40% in the production zones around Marseillan and Meze. The situation was worsened by a series of severe thunderstorms, which have washed minerals into the lagoon, increasing the eutrophication of the waters as well as reducing salinity.

By late August it was estimated that 10,000 tons of dead oysters would have to be removed from the lagoon, with losses totalling over €20 million. Over 300 companies (typically SMEs) – 50% of the total number in the region, which employs some 4,000 - have been affected. Shortages of Thau oysters for the Christmas market next December are already being forecast (so higher prices for oysters are likely – the old 'silver lining' concept appears to be applicable here!).

The Thau lagoon

The growers in the lagoon were already unhappy, as there is a threat to reclassify the area as a partial 'B' Harvesting Area, requiring depuration for the first time, a cost increase they could do without!

Meanwhile, in Arcachon, on the French Atlantic coast, the hot summer has triggered a massive spat fall of oysters, with consequential problems of clumping and swamping of the 2 and 3 year old adults. The growers are resorting to spraying heated water to kill the unsustainable population of seed oysters. After two years of poor harvests, the fear is that over supply from this summer's extravagant spat fall will lead to downward pressure on prices when the excessive volumes hit the market in 18 – 24 months time.

So, next time you are feeling under the cosh as a shellfish grower, remember that you're not alone in being pursued by troubles!

Further information

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SHELLFISH PRODUCTION

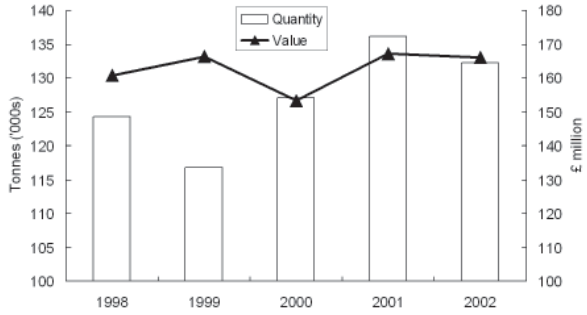
SHELLFISH PRODUCTION IN THE UK IN 2002

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

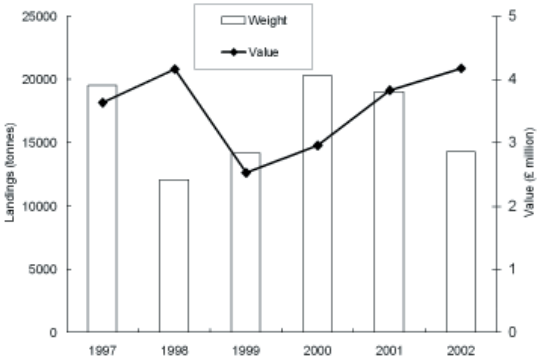
Source: Defra, UK Sea Fisheries Statistics 2002, HMSO, London.

About 132,000 tonnes of shellfish were landed in the UK in 2002, representing a decrease of about 3% compared with the previous year. This small decline follows two years of increases in landings and the 2002 figure still represents an increase of almost 13% over production in 1999. Shellfish comprise about 25% of the total catch by weight of fish, including shellfish, landed in the UK and about 34% of the total value. Shellfish landings were worth over £166 million in 2002, which is just 1.3% lower than in 2001. Weight and value of shellfish landings in the UK over the last 5 years are shown on the figure.



Weight and value of shellfish landings in the UK (1998 – 2002)

Overall, there was little change in landings of individual species in 2002, compared with 2001. Nephrops made up the largest single component of the total catch by weight, at 21%, and accounted for 41% of the total value. Crabs (18% by weight, 17% by value) were the next most important species. These relative values were similar to those in 2001. Cockles comprised 11% of the catch in 2002, compared with 14% in 2001 and contributed about 2.5% to the total value, a slight increase over 2001 due to a substantial (45%) increase in the unit price (see figure). They are still one of the lowest value species on a per weight basis. Scallops, which made up 15% of the catch in 2002, accounted for 18% of the total value. Lobsters were once again the most valuable species on a per weight basis, with a price per tonne of over £10,000. They contributed 7% to the total value of the catch. Lobster landings in 2002 were similar to those in 2001, following a decline from 1,800 tonnes in 1999 to just over 1,000 tonnes in 2001.



The value of cockle landings has recovered to pre-1998 levels, despite a fall in the weight of catch.

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.

Total Shellfish landings in the UK in 2002

Type	Tonnes	Value (£'millions)	Unit Value (£ per tonne)
Cockles	14,289	4.17	292
Crabs	23,302	26.05	1,118
Lobsters	1,167	11.68	10,011
Mussels	17,167	4.52	263
Nephrops	28,525	69.02	2,420
Periwinkles	230	0.22	959
Queen Scallops	10,842	4.19	386
Scallops	19,939	29.99	1,499
Shrimps	1,529	2.58	1,686
Squid	2,102	4.97	2,363
Other Shellfish	13,172	8.93	
Total Shellfish	**132,263**	**166.22**	

Production (tonnes) of farmed shellfish in the UK in 2002

	Scotland	England	Wales	Northern Ireland	UK Total
Pacific oyster	249	380	12	335	976
Native (flat) oyster	15	116	-	25	156
Scallops	39	0	-	-	39
Queens	19	-	-	-	19
Mussels	3,236	1,424	10,962	728	16,350
Clams	-	42	-	14	56
Cockles	-	147	-	-	147
Estimated Value (£ million)	5.0	1.28	4.94	1.45	12.67

2. Farmed Shellfish Production

A summary table of farmed shellfish production in the UK in 2002 is given below. The total value of the shellfish produced for the table was an estimated £12.67 million, from over 17,700 tonnes. The table does not include production or value of native oysters from the Solent Several and Regulated grounds. These appear in the Fishery Order table in Section 3, below. These oysters are 'cultivated' in the sense that the grounds are managed, including the relaying of cultch. The figures also do not include hatchery/nursery seed production, for on-growing, much of which is exported.

Overall production of farmed shellfish production for the table in 2002 was broadly similar to that in the previous two years. The estimated value of production in 2002 increased by about 14% compared with 2001.

A. England and Wales

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

The accompanying tables shows the statistics collected by the CEFAS Fish Health Inspectorate during their disease inspection visits to shellfish farms and the summary is presented in the context of previous years to demonstrate trends.

In 2002 there were 111 registered farm sites in England, a net decrease of 3 on the previous year. These sites belonged to 89 businesses, the same number as in 2001 although there were seven new businesses registered in 2002, balanced by seven de-registrations. The equivalent figures for Wales are 9 farms belonging to 9 businesses, with one new business registration in 2002. The English shellfish farm businesses employed 215 people (123 full time, 86 part-time and 6 casual workers) in 2002. The Welsh employment total was 33 (21 full time and 12 part-time workers).

Farmed production of pacific oysters, manila clams and cockles all increased slightly in 2002, compared to 2001. The increase in pacific oyster production was particularly notable, the amount harvested returning to that of the early to mid 1990s. Over half of this production takes place in the South West of England, from just 11 sites, with a further 28% from 17 farm sites in East Anglia. Production of other species was broadly similar to that in previous years. Farmed cockle production appears to have stabilised at the 100-150 tonnes per annum level.

Total shellfish production, by weight, continues to be dominated by mussels. The vast majority of these mussels (89%) are produced at 8 farm sites in Wales. Most native oyster farming takes place in the Essex estuaries, with 63% of the total production from 11 farm sites.

Farmed shellfish (table) production in England and Wales 1997-2002 (in tonnes)

	Native oysters	Pacific oysters	Mussels	Manila clams	Hard clams	Palourdes	Cockles
1997	68	401	11,684	32	0	0	0
1998	106	330	9,295	19	0	12	43
1999	93	386	8,009	17	0	12	43
2000	115	313	11,224	25	0	3	147
2001	127	225	13,367	29	4	1	105
2002	116	392	12,386	37	4	1	147

Farmed juvenile (seed) shellfish production in England and Wales 1997-2002 in thousands (1000's)

	Native oysters	Pacific oysters	Manila clams	Palourdes	Hard Clams	Scallops
1997	1,810	127,591	19,571	0	0	50
1998	2,200	110,035	20,000	4,010	0	50
1999	2,270	125,500	20,000	4,000	0	0
2000	2,000	63,230	19,200	2,100	0	0
2001	600	318,211	50,000	30,000	62,000	0
2002	0	178,142	163,000	0	0	0

Hatchery seed production of pacific oysters decreased from the exceptionally high level of 2001 but was still greater than in any of the previous four years. Large numbers of Manila clam seed were reared for export, but there was no seed production of other clam species in 2002.

The National lobster hatchery in Padstow, Cornwall released over 2,200 juvenile lobsters in 2002, more than double the number in 2001.

B. Scotland

Source: "Scottish Shellfish Farm Production Survey 2002" (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 183 companies registered as active before the survey. One hundred and eighty two returns were received, the company that did not respond made only a small contribution to production in 2001, and the figure previously given for production has been used in the 2002 survey. Production returns are recorded from 174 companies, while eight became non-producing during the year. One 'wild' mussel fishery registered as a shellfish farm has been excluded from this report. During 2002 thirteen companies registered while eleven de-registered.

Activity

The survey shows that 102 companies (59%) produced shellfish for sale, both for the table and for on-growing. The remaining 72 continued in operation, but had no sales during 2002. The number of active companies continued to decrease from a peak of 229 in 1990, to 183 at the end of 2002. These companies farmed 288 active sites, of which 136 (47%), placed shellfish on the market. The industry employed 128 full-time and 219 part-time workers during 2002, an overall decrease of 7% over the previous year. This reflects the ongoing trend in more efficient husbandry and marketing practices. The number of companies registered as active increased by 10 during 2002, and the number of active sites increased by 11%. This trend reflects the development of new sites, particularly for mussel production. 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. Historically, production data has been collected by company only. However this year data was collected both by company and by site. This resulted in the provision of more accurate site information, where 136 sites were shown to have produced shellfish for sale, an apparent decrease of 21% since 2001. As new mussel sites reach their productive phase the number of producing sites should increase. 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. The number of companies producing more than 100 tonnes of mussels has decreased from 12 to 10 since 2001. Those 10 companies produced 65% of the total mussel production in Scotland. The number of companies producing pacific oysters did not alter significantly in 2002, although their scale of production decreased by 11% since 2001. The ten companies producing over 100,000 Pacific oysters produced 85% of the Scottish total.

Production

Total production was dominated by mussels (3,236 tonnes) and 3.1 million Pacific oysters (249 tonnes). Small volumes of queens (19 tonnes), scallops (39 tonnes) and native oysters (15 tonnes) were also produced. Pacific oyster production decreased by 11%, although markets were maintained and demand remained high. Over 85% of pacific oysters were produced in the Strathclyde region, where the scale of production amongst larger companies decreased. Native oyster production increased by 85%. This accounts for a small percentage of total oyster production, targeting a niche market. Mussel production increased by 8%, as markets were developed, and prices remained high. The greatest increase in regional production was in Shetland, by more than 50% to 1,246 tonnes. Strathclyde

produced 1,272 tonnes and between both regions they produced 78% of Scottish production. Queen production decreased by 60% through continued variation in natural settlement. Production of farmed scallops increased, however production was again affected by environmental influences causing area closures, preventing sales for human consumption. Nine Several Orders have been granted for scallop fisheries, eight for commercial companies and one for research and development. One Several Order which had been used for research purposes was withdrawn during the year. Reports from industry indicated a strong market for scallops and queens throughout the year. 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.

Environmental and Health issues

Approved Zone status for the notifiable diseases Bonamia and Marteilia was maintained in 2002 (under EC Directive 91/67) after testing confirmed the absence of these diseases in Scottish waters. Samples were taken from eight 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 Fish Health Inspectorate under the Directive. On these visits, facilities, stock health, movement records and registration details are checked. It is the responsibility of farmers to inform the Department of any abnormal, unexplained mortality on their sites. Mortalities were reported to be the result of predation by eider ducks, crabs, starfish and oystercatchers. Losses were also reported due to storm damage, mechanical grading and illegal fishing. Tubeworm infestation caused marketing difficulties for two companies.

Summary

The 2002 survey has shown that:

- Mussels and Pacific oysters are the main species produced in terms of value and tonnage;
- There was an increase in the number of producing companies;
- The proportion of companies producing shellfish for table sales rose from 56% to 59%;
- Production of mussels increased;
- Production of Pacific oysters decreased;
- Manpower decreased by 7%;
- There was a substantial increase in the production of native oysters, although scale of production remains low;
- There was a continued decrease in the production of queens;
- There was an increase in the production of scallops;
- Environmental influences affected scallop sales during the year;
- Approved Zone status for the diseases Bonamia and Marteilia was maintained during the year;
- For shellfish health purposes, a third of all shellfish sites were inspected during 2002;
- The industry continues to be dominated by small producers, although there is a continued trend toward large companies contributing significantly to the annual production of all species.

The market for all species was buoyant and prices remained stable throughout the year. It is predicted that annual production will continue to increase steadily, although environmental influences may continue to impact on scallop production.

C. Northern Ireland

Mr David Martin
DARDNI, Fisheries Division, Annexe 5, Castle Grounds, Stormont Estate, Belfast, BT4 3PW.

Shellfish production statistics for Northern Ireland in 2002 are included in the summary table, above. The industry currently employs 52 full time and 63 part time personnel. This represents an annual increase in employment of 30% and 24% respectively for these groups. Production of oysters was similar to that in 2001, but production of mussels declined by 25%, which despite higher prices accounted for a decrease in the estimated total value of farmed shellfish production by 9% compared with 2001.

3. Shellfish Production from Several and Regulated Fisheries

Source: Annual Returns

In England and Wales there are currently 16 Several Fisheries, 7 Regulated Fisheries and 2 Hybrid Order Fisheries. Hybrid Orders are Regulating Orders where the grantee has the power to assign Several plots within the fishery. Scotland has 9 Several Fisheries, primarily for scallops and one Regulated Fishery, covering most shellfish species, around the Shetland Islands. Farmed shellfish production from the Scottish sites is included in the report above.

For England and Wales, information was obtained for all sites, and is included in the table. There was shellfish production at 14 of the 16 Several Fishery sites. One of the other sites has been affected by adverse hygiene classification, which effectively prevents harvesting of the shellfish on the beds, although the situation is expected to improve soon. 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 significant quantities of 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 shows an estimated total value of production from the Fishery Orders in 2002 of just under £12.64 million. This is a small (2%) increase on the estimated value for 2001 (£12.39 million), but follows year on year increases in which the total value of production from Fishery Orders is almost double that of four years ago. Mussel production reached a record figure of over 14,000 tonnes and, for the first time since 1990, the weight of landings exceeded that for cockles. The estimated value of mussel production was also the highest to date, making up over half the total value of production from Fishery Orders. Welsh Fisheries contributed 83% of this amount. All of the mussel production from Fishery Orders is also recorded as coming from registered farms, with the majority of mussel farming taking place within Fishery orders.

The total production of cockles decreased significantly from 2001, to just under 14,000 tonnes in 2002. The lower landings are attributed to various factors including closures brought about by detection of DSP toxins. The yield from these fisheries has returned to the values obtained in the late 1990s. Most cockle production is from managed fisheries, with a very small proportion (less than one percent) from farming. A significant increase in the unit price for cockles has meant that the record value of the crop of over £4 million in 2001 was maintained in 2002.

Production of clams from Fishery Orders showed a further increase in 2002 of about 14% compared to 2001. Total production has more than doubled in the last 3 years. The estimated value of these clams fell however, from £774,000 in 2001 to £610,000 in 2002. Clam farming accounts for only a small proportion of the total Fishery Order production, the remainder coming from a managed fishery. Over 75% of the clams cultivated in England and Wales come from outside Fishery Order areas.

There was a small (6%) increase in production of flat oysters compared with 2001, maintaining the high level of production of the previous year. Care should be taken in interpreting year on year differences in production, however, as the figures are invariably estimated from incomplete information. The estimated total value of these oysters also increased by about 6%, to over £1.4 million. Further progress has been made with the native oyster recovery programme, in line with the aims of the Biodiversity Action Plan. A report on this can be found on page 33 of the previous (May 2003. Number 15) issue of *Shellfish News*.

The level of production of Pacific oysters from Fishery Orders in 2002 was similar to the previous year. All Pacific oyster production in England and Wales is from registered shellfish farms (and is included in the farmed production figures) showing that only around 16% of the total production of this species takes place in Fishery Orders. The reported estimated value decreased, by about 16%, compared with 2001. Although reported values are often variable it is clear that the unit price obtained for these oysters is considerably less than it was 10 years ago.

Production/Landings (tonnes) of shellfish from Fishery Orders in England and Wales in 2002

Type	Several	Regulated	Hybrid	Total	Estimated Value (£,000s)
Pacific oyster	29.6	5	12	46.6	41
Native (flat) oyster	101	1,049	22	1,171	1,406
Clams	-	5	300	305	610
Mussels	11,664	288	2,076	14,028	6,452
Cockles	-	10,049	3,947	13,996	4,102

UK SHELLFISH IMPORTS AND EXPORTS

Source: H M Customs and Excise.
Data prepared by Statistics (Commodities & Food) Accounts and Trade, ESD, Defra

The UK is a net exporter of shellfish, with over 88,000 tonnes leaving the country in 2002, compared with imports of just less than 59,000 tonnes. The trade surplus, of almost 30,000 tonnes, decreased in 2002, from over 38,000 tonnes in 2001. This was mainly due to an increase in imports of frozen shrimps and prawns, which have risen steadily over the last 3 years. Trade in selected shellfish species, together with the totals for crustaceans and molluscs are shown in the table.

UK trade in selected shellfish in 2002 (tonnes)

	Exports	Imports
Crabs	13,902	939
Lobsters	1,101	1,495
Shrimps and Prawns	27,228	43,558
Crustaceans Total	**58,153**	**47,399**
Mussels	11,112	4,277
Oysters	910	433
Scallops	8,498	1,101
Molluscs Total	**30,462**	**11,519**

Crustaceans account for the bulk of all trade, making up 66% of total exports and 80% of the imports. Shrimps and Prawns provide most of this trade in crustaceans, with the bulk of the exports, over 23,000 tonnes, going elsewhere in Europe, with almost half this total going to Italy and Spain. Over 70% of shrimp and prawn imports come from outside Europe, with Asian countries, particularly India and Bangladesh, being the main suppliers. Most of the crabs exported from the UK go to Spain and France, with further significant quantities going to Portugal. These three countries are also the main consumers of exported lobsters. Virtually all imported lobsters are live animals, coming from Canada (79%) and the USA (21%).

For molluscs, about 75% of the mussels exported are as a live/fresh or chilled product. Over half of these (4,448 tonnes) are sent to France, with the Netherlands and Ireland taking the rest. In contrast, about 80% of imported mussels come in frozen, or possibly preserved in some other way, with over 1,000 tonnes imported from New Zealand. France and Spain take the majority of the UK oyster exports, all in a live/fresh or chilled state. Over 70% of oyster imports come from Ireland. About two thirds of the scallops exported are frozen, most going to Italy, Spain and France. France is the major importer of UK live/fresh or chilled scallops, taking 75% of the total of 2,418 tonnes.

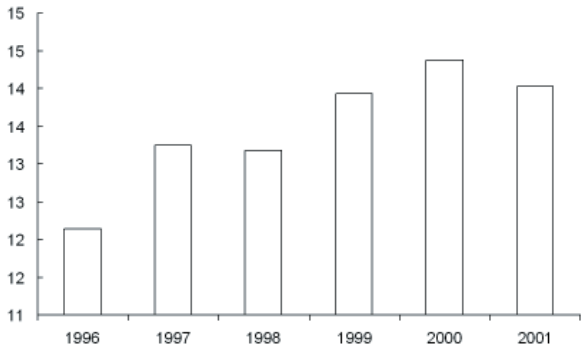
WORLD SHELLFISH PRODUCTION

A. Overview

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 2001 are now available.

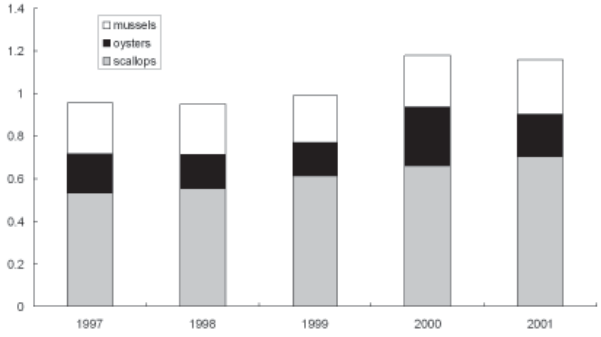
Landings

Total world landings of shellfish in 2001 were just over 14 million (metric) tonnes. This is in comparison to total finfish landings of almost 78 million tonnes. There was a slight fall in the figure for shellfish in 2001, giving a return to the level in 1999 (see figure). Crustaceans make up 46% of the shellfish total with almost half of this from landings of shrimps and prawns.



World shellfish landings (million metric tonnes)

World landings of scallops, oysters and mussels over the last 5 years are shown separately on another figure. There has been an increase of about 21% in the quantity of these mollusc species landed over this time. This is mainly due to an increase of over 30% in scallop landings, with mussels and oysters each increasing by around 8% in the same period.



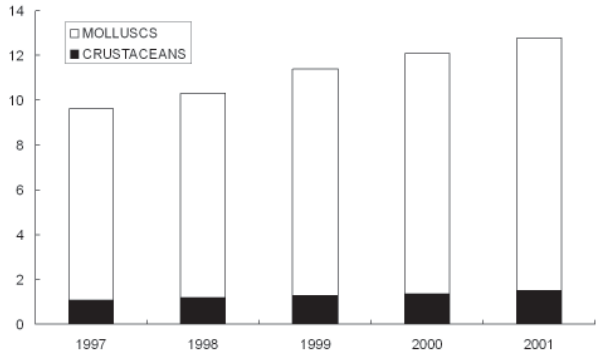
World landings of scallops, oysters and mussels (million metric tonnes)

Cultivation

The chart shows that world shellfish aquaculture production continues to grow. Shellfish (crustaceans and molluscs) account for about 48% of total world marine or brackish water aquaculture production, by weight, and 56% of the value. The total production also includes marine fish as well as aquatic plants (mainly

seaweed), together with relatively very small quantities of other invertebrates, amphibians and reptiles.

There was an annual increase in production by volume of about 5.4% in 2001, to 12.76 million tonnes from just over 12 million tonnes in 2000. This percentage increase was similar to that for the previous year. The increase in mollusc production, of 4.75%, was lower than that in previous years, but this was offset by an increase in crustacean production of over 10%. As can be seen from the chart, molluscs make up almost 90% of the total production by weight, but the greater unit value of crustaceans gives them roughly equal value, at around 9.5 billion US dollars each. There was a 7 % increase in the total value of these cultivated shellfish, from just over 18 billion US dollars in 2000 to almost 19.5 billion US dollars in 2001.



World Aquaculture - shellfish production (million metric tonnes)

Around 90% of all shellfish production is from Asia, although Europe contributes about 7% of total world mollusc production.

The Pacific oyster (*Crassostrea gigas*) is by far the most important individual species, making up over a third of total mollusc production. Production of this species passed the 4 million metric tonnes mark for the first time in 2001, with an increase of over 5% in production compared with that in 2000. Only 3.3% of this production is in Europe, with France by far the major producer (see below).

Manila clams contribute a further 18% of the total world aquaculture production of molluscs. In Europe, production takes place predominately in Italy, where 50,000 tonnes were harvested in 2001.

Mussels make up only about 4% of total world mollusc production. Spain produces almost half of all cultivated mussels in Europe, with a yield of almost 246,000 tonnes in 2001.

B. French shellfish farming

The first comprehensive national survey of the oyster and mussel farming sector in France has shown that there are about 3,800 companies involved, farming 20,000 hectares. In 2001 they produced 109,000 tonnes of oysters and 73,200 tonnes of mussels. Most (78%) of the companies are single-person operations, while total employment represents 10,400 full time job-equivalents. The average age of employees is 44. The biggest single region of production by far was the department of Charente-Maritime (below Brittany on France's west coast) from where 31% of the output comes. Three companies out of four market and sell their products directly to the consumer. This direct sale sector accounts for 28% of the total tonnage; wholesalers account for 23%; retail multiples 17% (another 9% find its way to retail multiples via other purchasing medium); and fishmongers 14%. Only 4% of production is exported.

C. Shellfish production in Ireland in 2002

Source: BIM

The shellfish-farming sector in Ireland enjoyed a year of good market demand, buoyant prices and few closures due to biotoxins.

The bottom mussel sector continued to show impressive growth with output rising to over 23,000 tonnes. In conjunction with the industry, other agencies and Irish government departments (both North and South), BIM carried out a detailed assessment of production and seed requirements. This formed the basis for an interim management regime for seed mussel transplanting during the 2002 season. Output of bottom mussels in 1998 was 11,306 tonnes. The dramatic production in growth over the last five years has brought with it market opportunities – but also problems in managing the seed mussel resource and getting adequate support infrastructure in place.

Rope grown mussel output continued to recover from its low of 4,045 tonnes in 2000, reaching an estimated 9,000 tonnes. This was valued at €11.1 million in 2002. It enjoyed a continued rise in prices, which were up 37% in comparison to 2001.

Pacific oyster production also expanded in 2002, to 5,500 tonnes valued at €11 million, increasing by 12% in volume terms with a concomitant 23% rise in price per kilo over the 2001 position. A promising feature of this sector has been the success of bottom farming techniques, which will expand the natural resource base for production. Combined native and Pacific oyster production increased to over 6,000 tonnes, valued at €13.6 million.

D. Shellfish production in Jersey in 2002

Source: *Greg Morel, Fisheries Officer - Research & Development*
Department of Agriculture & Fisheries, Howard Davis Farm, Trinity, Jersey JE4 8UF. Tel 01534 866226, Fax 01534 866201, E-mail G.Morel@gov.je

The table below shows the areas farmed and the production of shellfish from 1998-2002. Despite fluctuations in the area utilised, there has been a steady increase in shellfish production over the last 5 years. Last year (2002) there was a 22% increase in production compared with the previous year.

Farmed shellfish areas and production in Jersey, C.I.

	1998	1999	2000	2001	2002
Intertidal area (hectares)	42.75	57.1	46.6	53.6	54.5
Subtidal areas (hectares)	100	150	166	166	100
Pacific Oysters (kg)	196,097	188,482	240,692	389,775	475,643
Scallops (kg)	2,537	1,887	1,949	1,914	1,544
Mussels (kg)		7,500	57,500	78,000	96,370
Total (kg)	198,634	197,869	300,141	469,689	573,557

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. Storage of concentrated algae diets

Three species of microalgae commonly used as feed for bivalves, *Pavlova lutheri, Isochrysis aff. galbana* (clone T-Iso) and *Chaetoceros calcitrans* forma *pumilum*, were produced with standard techniques and then harvested by a flocculation procedure. This method was effective for *C. calcitrans* and *P. lutheri* though a partial deterioration of cells was observed for the latter, whereas flocculation heavily damaged T-Iso cells

Quality of concentrates prepared at 1 degree C was analysed over 4 weeks of storage. *P lutheri* concentrates did not exhibit significant changes in gross composition over the storage period, whereas the value of the pheophytin a/chlorophyll a ratio increased, from 0.05 to 0.35. In T-Iso concentrates, a dramatic decrease in protein and carbohydrate content occurred during the first week of storage. The chemical composition of concentrated *C. calcitrans* cells did not substantially change during the first 3 weeks of storage; after this period the organic matter decreased significantly (by 18%).

The effectiveness of three-species (*P. lutheri* +T-Iso + *C. calcitrans*) and various two-species (*P. lutheri* +T-Iso; *P. lutheri* + *C. calcitrans*; T-Iso+*C. calcitrans*) fresh or concentrated diets were evaluated on Pacific oyster (*Crassostrea gigas*) with larval and juvenile feeding trials, lasting 1 and 4 weeks, respectively. For larvae, concentrated diets of *P. lutheri*+T-Iso and T-Iso+*C. calcitrans* stored for 7-14 days gave better growth than the equivalent fresh diets. In the juvenile trial, the use of the same concentrates for a longer period (4 weeks) gave significantly lower growth compared to the corresponding fresh microalgae. In this case, the longer time of storage (8-36 days) probably prejudiced the quality of the stored concentrates. This fact was confirmed by means of larval consumption assays of fresh and concentrated microalgae. Indeed, for *P. lutheri* delivered as fresh microalgae, larval grazing was twice that of concentrated cells.

Reference

Ponis, E., Robert, R. (rrobert@ifremer.fr), Parisi, G., 2003. Nutritional value of fresh and concentrated algal diets for larval and juvenile Pacific oysters (*Crassostrea gigas*). Aquaculture Vol 221, pp 491-505.

2. Sea urchin cultivation

Several species of sea urchins are now being cultivated for commercial purposes and with the continued increased demand for sea urchin gonads as a food product, new species are being assessed for their aquaculture and market potential. This study focussed on establishing protocols for the production of common

sea urchin *Echinus esculentus* larvae and juveniles to assess its potential as an echinoculture species.

Two trials were carried out, the first trial evaluated the influence of three single species and mixed microalgae diets on larval morphology. In the second trial, the effects of different rations of one of the diets (*Dunaliella*) were examined.

Larval length, width, post-oral arm length and rudiment length were significantly effected by diet. A diet of Dunaliella or a mixed *Dunaliella/Phaeodactylum* diet prompted more rapid metamorphosis. The food rations were increased as the larvae acquired the 3rd and 4th pair of larval arms. Larvae fed the Standard Ration (1,000-5,000 cells per ml) were significantly larger (longer and wider) and had significantly longer rudiments than those in the High Ration (3,000-15,0000 cells per ml) treatment. The number of larvae metamorphosing and settling onto substrates was significantly higher with the Standard Ration compared to with the High Ration. Optimising the larval diet shortened the larval stage from 21-23 days in the first trial to 16 days in the second trial. The maximum percentage of metamorphosing individuals which survived to post-larvae or juveniles (10 days after they were first judged competent to settle) was 46.6%, suggesting that the common sea urchin is a viable candidate for aquaculture.

Reference

Jimmy, R.A., Kelly, M.S. (mke@dml.ac.uk), Beaumont, A.R., 2003. The effect of diet type and quantity on the development of common sea urchin larvae *Echinus esculentus*. Aquaculture Vol 220, pp 261-275.

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3. Oyster fattening in France (1)

Oyster farming in France is a traditional activity. Each year, 149,000 tons of oysters are fattened before being sold. More and more oyster farmers supplement the diet of oysters by microalgae to optimise the fattening process and to improve both the growth and flesh quality. In the present study, a comparison was made of oysters supplemented with two different microalgae: *Skeletonema costatum* and *Tahitian Isochrysis.*

The growth of oysters was improved when they were fattened with microalgae, leading to an increase in the condition index. The chemical composition of oysters was influenced by the chemical composition of the microalgae, especially the level of glycogen, which was significantly increased for oysters supplemented with microalgae. The fatty acid profile of oysters fattened with microalgae was positively correlated with the fatty acid profiles of the algae. These results show the effectiveness of supplementation by microalgae on the growth and on the biochemical composition (glycogen and fatty acids especially) of oysters.

Reference

Pennarun, A.L. (pennarun@enitiaa-nantes.fr), Prost, C., Haure, J., Demaimay, M., 2003. Comparison of two microalgal diets. 1. Influence on the biochemical and fatty acid compositions of raw oysters (*Crassostrea gigas*). Journal of Agricultural and Food Chemistry Vol 51, pp 2006-2010.

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4. Oyster fattening in France (2)

Oyster farming is of real economic interest in France. Oyster farmers attach more and more importance to improving the growth and the quality of their oysters. Some fatty acids known to be aroma precursors originate from microalgae such as *Skeletonema costatum* and *Tahitian Isochrysis*. These microalgae were used to fatten oysters in order to observe their role in the development of aroma in the oysters.

It was found that the microalgal diet causes changes in aroma composition. Aroma concentration depends on the fatty acids that are aroma precursors. Some aromas are characteristic of the diet of *S. costatum*, such as 6-methyl-5-hepten-2-one (ether odour), and others are characteristic of *Isochrysis*, such as 3-nonyne (cucumber, marine odour), 6-(E)-nonen-1-ol (green and fresh odour), and 4-ethylbenzaldehyde (aniseed odour). Moreover, the organoleptic qualities (odour, taste, and texture) of oysters are modified by the diet of microalgae.

Reference

Pennarun, A.L. (pennarun@enitiaa-nantes.fr), Prost, C., Haure, J., Demaimay, M., 2003. Comparison of two microalgal diets. 2. Influence on odorant composition and organoleptic qualities of raw oysters (*Crassostrea gigas*). Journal of Agricultural and Food Chemistry Vol 51, pp 2011-2018.

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5. Stress and the immune response

Stress is thought to cause increased disease susceptibility and mortality in a number of invertebrates but currently very little information is available on mechanisms linking physiological states of stress and reduced disease resistance in these organisms. In this study, we examined the possibility that stress alters immune functions, the principal line of defence against pathogens, in a molluscan model, the abalone *Haliotis turbeculata.*

Immune parameters were investigated in abalones subjected to a 15-min mechanical disturbance which, as indicated by noradrenaline and dopamine hemolymphatic levels, resulted in a transient state of physiological stress. During the application of the stress, immune parameters such as the number of circulating hemocytes, the migratory activity, the phagocytic capacity and the respiratory burst responses

of hemocytes, decreased significantly. All parameters returned to initial values within 15-30 min after the end of the disturbance and a transient period of immunostimulation occurred between 100 and 480 min after the stress. These results indicate that in the abalone, as in vertebrates, a link exists between stress and the immune system. This may begin to answer why stress and disease outbreaks are linked in shellfish.

Reference

Malham, S.K. (s.malham@bangor.ac.uk), Lacoste, A., Gelebart, F., Cueff, A., Poulet, S.A., 2003. Evidence for a direct link between stress and immunity in the mollusc *Haliotis tuberculata*. Journal of Experimental Zoology Part A-Comparative Experimental Biology Vol 295A, pp 136-144.

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6. Mussels are survivors

Following a major oil spill, it was observed that although the immune system of the marine mussel, *Mytilus edulis*, was considerably suppressed, there were no oil-induced mortalities. In contrast, mass mortalities were noted in the edible cockle, *Cerastoderma edule*, and the razor-shell, *Ensis siliqua*. Much of the current knowledge on bivalve immunology has come from work on mussels and so a study comparing immune cells and functions in the above three species was initiated.

The results show that immune cells and functions differed extensively in these three closely related species, with mussels showing a much higher level of immunological vigour. This may be linked to its considerable resilience to adverse environmental conditions. This also suggests that mussels may not be particularly representative of bivalves in general in terms of immune reactivity and that a wider range of species should be included in studies in this area.

Reference

Wootton, E.C., Dyrynda, E.A. (e.a.dyrynda@hw.ac.uk), Ratcliffe, N.A., 2003. Bivalve immunity: comparisons between the marine mussel (*Mytilus edulis*), the edible cockle (*Cerastoderma edule*) and the razor-shell (*Ensis siliqua*). Fish & Shellfish Immunology Vol 15, pp 195-210.

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7. Bacteria in cockles

Population dynamics of marine invertebrates is controlled by a variety of abiotic and biotic factors. Among these, some have received lesser attention from marine ecologists because of their `discrete' nature. This is the case of parasitism and bacterial load. In the present study, we focused on the role that both parasites (digenean trematodes) and heterotrophic aerobic bacteria might play in the mortality and burying behaviour of cockles, *Cerastoderma edule*.

The bivalves were sampled monthly during 1 year from two sites in Arcachon Bay (French Atlantic coast). Mortality rates were assessed after transferring normally buried and unburied (i.e. found lying at the sediment surface at low tide) cockles to the laboratory. The digenean and bacterial loads in the cockles were determined for animals collected in both positions (normally buried and unburied). Mortality rate was significantly higher for cockles found out of the sediment at low tide, suggesting that this abnormal position was a prelude to cockles' death. Comparison of digenean load of cockles showed no significant difference between buried and unburied bivalves. In contrast, bacterial load was significantly higher in unburied cockles than in normally buried animals.

The effect of high concentration of a marine bacterial strain (*Pseudomonas fluorescens*) on cockles' burying behaviour and mortality was tested in the laboratory. Results showed that these bacteria could trigger the emergence of animals from the sediment, but did not of themselves cause death of the cockles. These field observations and laboratory experiments suggest that bacteria, rather than digenean trematodes, could play a role in the emergence of cockles and, hence, affect their survival in the wild.

Reference

Blanchet, H. (hu.blanchet@epoc.u-bordeaux.fr), Raymond, N., Montaudouin X de, Capdepuy, M., Bachelet, G., 2003. Effects of digenean trematodes and heterotrophic bacteria on mortality and burying capability of the common cockle *Cerastoderma edule* (L.). Journal of Expimental Marine Biology and Ecology Vol 293, pp 89-105.

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8. Oyster eating habits

Oyster consumption has been decreasing in the United States. Investigating consumer attitudes and preferences can help identify factors involved in this decrease. This study used data obtained through a nationwide survey to determine factors that influence both the decisions to consume oysters and frequency of consumption. Results indicate there is a significant difference in the reasons people choose to eat oysters or not and the reasons oyster consumers choose how frequently to eat oysters. Concern for product safety significantly influenced the decision of how frequently to consume but not whether or not to consume oysters. Consumers also indicated a potential willingness to pay for measures that would increase product safety.

Reference

House, L. (lahouse@ufl.edu), Hanson, T.R., Sureshwaran, S., 2003. US consumers: Examining the decision to consume oysters and the decision of how frequently to consume oysters. Journal of Shellfish Research Vol 22, pp 51-59.

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9. Azaspiracids found in France and Spain

Some incidents of human intoxications throughout Europe, following the consumption of mussels have been attributed to Azaspiracid Poisoning (AZP). Although first discovered in Ireland, the search for the causative toxins, named azaspiracids, in other European countries has now led to the first discovery of these toxins in shellfish from France and Spain. Azaspiracids were identified in mussels (*Mytilus galloprovincialis*, 0.24 µg/g) from Galicia, Spain, and scallops (*Pecten maximus*, 0.32 µg/g) from Brittany, France. Toxin profiles were similar to those found in the equivalent shellfish in Ireland in which AZA1 was the predominant toxin.

Reference

Magdalena, A.B., Lehane, M., Krys, S., Fernandez, M.L., Furey, A., James, K.J. (kjames@cit.ie), 2003. The first identification of azaspiracids in shellfish from France and Spain. Toxicon Vol 42 pp 105-108.

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10. Detecting enteritic viruses

Twenty-two samples of shellfish were examined using a rapid and sensitive technique to concentrate and detect viral RNA in shellfish tissues.

After recovery of viral particles, RNA was extracted, transcribed into cDNA and amplified using "nested PCR". Testing with enterovirus-specific RT-PCR produced positive results in over 13% of specimens. The virus detection procedure appears to be effective. In some circumstances it could be a better test of water quality than conventional monitoring techniques.

Reference

Zanetti, S., Deriu, A., Manzara, S., Cattani, P., Mura, A., Molicotti, P., Fadda, G., Sechi, L.A., 2003. A molecular method for the recovery and identification of enteric virus in shellfish. Microbiologica Vol 26, pp 157-162.

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11. Monitoring for viruses

Molluscan shellfish are known to be carriers of viral and bacterial pathogens. The consumption of raw oysters has been repeatedly linked to outbreaks of viral gastroenteritis and hepatitis A. Switzerland imports over 300 tons of oysters per year, 95% of which originate in France. To assess the level of viral contamination, a 3-month monitoring study was conducted.

The sensitivities of several previously described methods for determining virus concentration were compared, and one protocol, using dissected digestive tissues, was finally chosen. Eighty-seven samples consisting of five oysters each were analysed for Norwalk-like viruses (NLVs), enteroviruses, and hepatitis A viruses from November 2001 to February 2002. The oysters were imported from 31 French, 3 Dutch and 2 Irish suppliers. Eight oyster samples from six French suppliers were positive for NLVs, and four samples from four French suppliers were positive for enteroviruses; two of the latter samples were positive for both viral agents. No hepatitis A viruses were detected.

A great variety of strains of NLVs were detected. The data obtained indicated that imported oysters might be a source of NLV infection in Switzerland. However, further studies are needed to determine the quantitative significance of the risk factor.

Reference

Beuret, C. (christian.beuret@gr.admin.ch), Baumgartner, A., Schluep, J., 2003. Virus-contaminated oysters: a three-month monitoring of oysters imported to Switzerland. Applied and Environmental Microbiology Vol 69, pp 2292-2297.

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12. High Pressure Treatment kills bacteria

Four types of shellfish (mussels, prawns, scallops and oysters) were pressure treated at 300, 400, 500 and 600 MPa for 2 min at 20 degrees C and stored for up to 28 days at 2 degrees C. The shellfish were sampled before and after pressure treatment and at 7-day intervals for total aerobic counts, psychrotrophic counts, pseudomonads and coliforms.

Randomly selected isolates were identified from the shellfish before and after pressure treatment and after storage at 2 degrees C. Pressure treatment readily inactivated psychrotrophic bacteria, coliforms and pseudomonads. The range of bacteria present in the shellfish also decreased after pressure treatment. This was predominantly because of inactivation of Gram-negative bacteria, leading to an increase in the proportion of Gram-positive species isolated. The main types of bacteria isolated from pressure-treated shellfish, after storage, were Bacillus, *Acinetobacter/ Moraxella* and lactic acid bacteria. Together these made up 96% of the bacteria isolated from all the pressure-treated shellfish.

Reference

Linton, M. (mark.linton@dardni.gov.uk), McClements, J.M.J., Patterson, M.F., 2003. Changes in the microbiological quality of shellfish, brought about by treatment with high hydrostatic pressure. International Journal of Food Science and Technology Vol 38, pp 713-727.

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13. Water quality and marinas

Recreational pleasure and fishing boats are potential sources of human faecal contamination because the sanitary wastes from boat occupants may be discharged into the surrounding water. The impacts of such faecal

contamination from boats is potentially high in marinas where boats are often kept and occupied for varying periods of time. The nature and extent of such faecal contamination from boats in marinas of different design and use is still inadequately understood.

In this study the levels of faecal coliform (FC) bacteria were measured in the waters of a confined and an open water marina over a 6-day period encompassing a holiday weekend. Levels of FC rose with increasing occupancy by boats and boaters during the study period and then declined again. FC levels were higher in waters of a confined or basin marina than in waters of an open or unconfined marina. In both confined and open water marinas, FC levels were highest in water samples collected near boats but they also became elevated on occasion in water samples taken a distance of 305 metres from boats. Concentrations of FC in marina waters exceeded the standards and guidelines for shell-fishing and primary contact recreation waters. Therefore, greater consideration of human health risks from enteric microbes in marina waters is recommended.

Reference

Sobsey, M.D. (sobsey@email.unc.edu)., Perdue, R., Overton, M., Fisher, J., 2003. Factors influencing faecal contamination in coastal marinas. Water Science and Technology Vol 47, pp 199-204.

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14. Bacterial source tracking

Introduced pathogens from faecal material can make their way into the aquatic environment from a number of sources within a river catchment. These sources typically include sewage outfalls, seepage from septic tanks, and urban and agricultural runoff. Shellfish, as filter feeders, are particularly susceptible to contamination in faecally contaminated waters. A range of microbiological indicators have been developed to assess the levels of contamination and likely risks to public health. This paper outlines the application of bacterial source tracking (BST) in a shellfish growing area in part of the Port Stephens estuary along the north coast of New South Wales, Australia.

The approach is based on the premise that bacterial isolates from different faecal sources will have significantly different resistance patterns to the battery of antibiotics and concentrations tested. Faecal streptococci (FS) were isolated from several possible faecal sources: beef and dairy cattle, chickens and humans. The resistance patterns of these isolates to four different concentrations of four antibiotics were compared to those of FS isolates obtained from samples collected upstream and in the vicinity of the oyster leases. The results were used to determine the most probable source of each of the unknown isolates taken from Tilligerry Creek, the drainage channels to the-estuary, and the shellfish leases. Preliminary results are presented in this paper and they suggest that there is no single significant source of faecal contamination in this area. Rather, there are contributions from a range of sources. The findings may have implications for the ways in which land use activities and catchments are managed in similar estuarine locations with a shellfish industry.

Reference

Geary, P.M. (ggpmg@cc.newcastle.edu.au), Davies, C.M., 2003. Bacterial source tracking and shellfish contamination in a coastal catchment. Water Science and Technology Vol 47, pp 95-100.

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15. Natural anti-microbials - do they work?

Several natural anti-microbials may contribute to extending food shelf life and improving its safety by reducing the presence of pathogens such as Listeria, Salmonella or Staphylococcus, according to research work funded by the EU. Protection of food products such as fruit juices, pork sausages, beer, beef or salmon fillets may be provided through different combinations of chitosan, which is extracted from shellfish, bacteriocins produced by bacteria and components from essential oils.

The scientists developed mathematical models for growth of *Listeria monocytogenes* and *Pencillium chrysogenum* in a model food, using natural preservatives, pH, water activity and temperature as variables.

Results emphasised the synergistic effects of the antimicrobials, but also included other components such as salt, hydrogen peroxide, sulphite, organic acids and EDTA. New bacteriocins from two lactic acid bacteria were found to protect beer and beverages, and a combination of chitosan, carvacrol and hydrogen peroxide showed to be efficient in surface cleaning of stainless steel, reducing counts of Listeria, Salmonella, Staphylococcus and Saccharomyces. Finally, a novel combination of chitosan and carnocin allowed a reduced content of sulphite addition to chilled pork sausages, improved shelf life and a reduced risk of *Listeria innocua*. Other synergistic effects between the preservatives were also found.

Reference

Project No: FAIR-CT96-1066; Project Co-ordinator: Prof Sibel Roller, Thames Valley University, London W5 2BS, UK (Sibel.Roller@tvu.ac.uk).

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16. Environmental effects of cultivation

Most studies on organic enrichment of the seabed from shellfish farming have concluded that the effect is small and much less than that caused by finfish farming. In Tasmania, Australia, commercial farming of shellfish is

an important and expanding rural industry. The principle species grown is the Pacific oyster, *Crassostrea gigas*, which was introduced into Tasmania from Japan in the late 1940s and early 1950s. Small quantities of the native blue mussel, *Mytlis planulatis* are also cultured. Production of Pacific oysters in 1997/1998 was 2065 tonnes, and valued at US$6.2 million. Mussel production over the same time period was 343 tonnes, with an estimated gross vale of US$382 000. In 1995, 1351 ha were available for farming, and recently an additional 700 ha has become available, mostly in sub-tidal waters. Pacific oyster farming is predicted to significantly increase over the next few years, and is expected to contribute in the order of US$20–30 million per annum to the Tasmanian economy by 2005, and to employ 400–500 people full time. The mussel culture industry has also been identified as having potential for major expansion to 1500 tonnes per annum in the next few years.

However, in contrast to the proactive view of industry and government for the development of shellfish aquaculture in Tasmania, there is increasing community concern about the effects that shellfish farming may be having on the environment. Sections of the community have vigorously opposed expansion of shellfish farms in many bays and estuaries around Tasmania. This has occurred even though the densities of shellfish on the farms are much lower than in many other countries. Also, Tasmanian farming techniques of intertidal off-bottom rack culture or suspended from longlines in deep water are less damaging to the environment than some practises used elsewhere, such as cultivation directly on the bottom and harvesting by dredging.

The benthic environment under and near three shellfish farms in Tasmania, Australia, which had had a relatively high level of production over many years was investigated. Benthic samples were collected along transects which ran across the farms, generally from 100 m upstream to 100 m downstream. Sediment deposition, redox values, sediment sulphide concentrations, organic carbon content and water turbidity levels near the bottom were significantly different between the farms but not between sites outside the farm, at the boundary and sites within the farm. Video recordings at one farm showed dense coverage of fine filamentous algae and patchy bacterial mats directly under some longlines and this algae is thought to have fallen off the mussel longlines. At another farm dense beds of seagrass were observed in the videos both under trays of oysters and outside the farm. The benthic infauna did not show clear signs of organic enrichment and the types and numbers of benthic infauna were similar inside and outside the farms, although there were differences between farms. It was concluded from these results that shellfish farming is having little impact, much less than salmon farming, on the benthic environment in Tasmania. Thus extensive monitoring of shellfish farms would appear not to be necessary.

Reference

Crawford, C.M. (Christine.Crawford@utas.edu.au), Macleod, C.K.A., Mitchell, I.M., 2003. Effects of shellfish farming on the benthic environment. Aquaculture Vol 224, pp 117-140.

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17. Oystercatchers and the Burry Inlet cockle fishery

The Burry inlet, South Wales, supports a licensed cockle fishery and occasional mussel fishery. It is also an important over-wintering ground for oystercatchers. In recent years mussels have settled over parts of some cockle beds, preventing the cockle fishery there and leading to a request by the industry to remove this ‘mussel crumble’. Conservation managers, however, were concerned that the mussel crumble might be providing a high-quality food source for the oystercatchers, making its removal detrimental to the birds.

A behaviour-based model of oystercatcher feeding on cockles and mussels was developed for the Burry inlet and its predictions tested against the distribution of birds across the shellfish beds and the amount of time they spent feeding. The model was then used to explore whether the birds were currently food-limited and what would be the effects on their mortality rate and body condition if the mussel crumble were to be removed, thereby re-exposing underlying cockle beds.

The model predicted successfully the proportion of birds feeding on the different types of food and the amount of time that the birds spent feeding on neap tides. It was predicted that, at current bird population sizes, there would have to be a 50% reduction in shellfish stocks and the areas of shellfish beds from 2000-01 levels to cause noticeable extra bird emigration or mortality. A given area of mussel bed was predicted to be able to support more birds than the same area of cockle bed, but the greater overall area of the cockle beds meant that they were more important than mussels in determining the number of birds supported by the inlet. The simulated removal of mussel crumble to expose underlying cockles had no effect on predicted bird mortality and body condition at 2000-01 shellfish stock levels. However, it was predicted that there were circumstances under which the mussel crumble might increase the inlet’s capacity to support birds, but only when the existing area of cockle and mussel beds was substantially reduced.

Reference

West, A.D. (adwt@ceh.ac.uk)., Goss-Custard, J.D., McGrorty, S., Stillman, R.A., Durell, S.E.A.L.V., Stewart, B., Walker, P., Palmer, D.W., Coates, P.J., 2003. The Burry shellfishery and oystercatchers: using a behaviour-based model to advise on shellfishery management policy. Marine Ecology-Progress Series Vol 248, pp 279-292.

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18. The Wash shellfisheries and birds

The Wash, in eastern England, supports internationally important populations of 11 species of shorebird. A major commercial shellfishery provides potential conflict between fishermen and nature conservation interests. During the 1990s, high fishing mortality and low recruitment substantially reduced the stocks of cockles and mussels.

Population models constructed from estimates of survival and recruitment indicated that declines in the availability of cockles and mussels were associated with changes in oystercatcher survival between 1970 and 1998, including three periods of mass mortality. The recruitment of juvenile birds to both oystercatcher and knot populations was affected. Emigration of knot may also have taken place.

Cockle recruitment was dependent on climatic conditions, whereas mussel populations tended to be stable. The decline in mussel stocks, due to over-fishing, increased the vulnerability of the oystercatcher population to mass-mortality episodes in poor cockle years. The key to preventing major oystercatcher kills in future is to ensure sufficient mussels are available in poor cockle years. Recent cultivation of mussels in inter-tidal areas has been beneficial and is an important management tool for maintaining bird populations.

Reference

Atkinson, P.W. (phil.atkinson@bto.org), Clark, N.A., Bell, M.C., Dare, P.J., Clark, J.A., Ireland, P.L., 2003. Changes in commercially fished shellfish stocks and shorebird populations in the Wash, England. Biological Conservation Vol 114, pp 127-141.

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19. Slipper limpets

In 1934 the American slipper limpet *Crepidula fornicata* was first recorded in the northern Wadden Sea in the Sylt-Romo basin, presumably imported with Dutch oysters in the preceding years. The present account is the first investigation of the *Crepidula* population since its early spread on the former oyster beds was studied in 1948.

A field survey in 2000 revealed the greatest abundance of *Crepidula* in the intertidal/subtidal transition zone on mussel (*Mytilus edulis*) beds. Here, average abundance and biomass was 141 per square metre and 30 g organic dry weight per square metre, respectively. On tidal flats with regular and extended periods of emersion as well as in the sub-tidal areas with swift currents in the gullies, *Crepidula* abundance was low. The main substrate of attachment was live mussels. Compared with the years following their initial introduction, *Crepidula* is more abundant today and has shifted from the now extinct oyster beds to the epifaunal community of the mussel beds. Their present abundance is considerably lower than at more southern European coasts where the species may dominate the epifauna. Low winter temperatures are suggested to have limited the population expansion in the northern Wadden Sea.

Reference

Thieltges, D.W. (dthieltges@awi-bremerhaven.de), Strasser, M., Reise, K., 2003. The American slipper limpet *Crepidula fornicata* (L.) in the northern Wadden Sea 70 years after its introduction. Helgoland Marine Research Vol 57, pp 27-33.

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20. Mussel spat collectors

Traditional mussel culture in the Wadden Sea, southern North Sea, is carried out by taking seed mussels of about 1-4 cm shell length from natural beds and transplanting them to permanently water covered sites. Apart from the damage done to the natural beds, the ratio of seeded to harvested mussels is only about 1: 1-1.3, i.e. about the same tonnage of mussels seeded is recovered. In addition, this technique relies exclusively on natural spat falls, which do not occur regularly. In order to overcome these difficulties spat collectors have been deployed in the Jade Bay, southern North Sea. These provided suitable settlement grounds for mussel larvae. Blue mussels reached weights of about 8-9 kg/m collector rope with maximum shell lengths of 4-5 cm within one growing season

Reference

Walter, U. (uwe.walter@terramare.de), Liebezeit, G., 2003. Efficiency of blue mussel (*Mytilus edulis*) spat collectors in highly dynamic tidal environments of the Lower Saxonian coast (southern North Sea). Biomolecular Engineering Vol 20, pp 407-411.

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21. Inshore potting agreement

The management of fisheries in European Union (EU) waters has generally been regulated through government institutions and agreed quota allocations. This top-down management approach may have contributed to the continued decline of targeted fish stocks by forcing fishers to compete for limited resources without engendering a sense of resource stewardship. In attempting to reverse this decline, scientists and managers should examine management systems that do not solely depend on top-down approaches, and the Inshore Potting Agreement (IPA) is an example.

The IPA is a voluntary fishery management system designed and operated by inshore fishers of south Devon, England. The IPA was conceived to reduce conflict between static-gear (pot and net) and towed-gear (trawl and dredge) fishers, and is regarded as a successful fisheries management regime by fishers and managers because it has effectively allowed fishers from both sectors to operate profitably on traditional fishing grounds. Another study determined that the IPA has incidentally protected benthic habitat complexity.

Fishers from the static-gear and towed-gear sectors were interviewed to determine the evolution and function of the IPA, and to establish the factors that ensure the high level of regulatory compliance amongst fishers from both sectors. Towed-gear fishers gave significantly different responses to the same questions asked of static-gear fishers, and were generally less satisfied with the existence of the IPA. Multivariate analyses of the interview data suggested that fishers who thought the IPA was a good system also thought the system provided pot protection, but had experienced inter-sector conflict. Fishers who thought the IPA provided no personal benefit also thought that static-gear fishers should be more restricted, and that towed-gear corridors or more seasonal-use areas should be established within the existing IPA area. However, fishers from both sectors agreed that the IPA has maintained traditional practices of the local fishing industry, and that the system has conserved target finfish and scallop species. A number of factors were identified as critical to the success of the IPA. These included the voluntary nature of the agreement, the limited number of organisations representing fishers and very high level of membership of those organisations, and the simplicity of the system. Regulatory compliance is enhanced through the ability of fishers' organisations to respond rapidly to inter-sector conflict issues.

Reference

Blyth, R.E. (osp818@bangor.ac.uk), Kaiser, M.J., Edwards-Jones, G., Hart, P.J.B., 2002. Voluntary management in an inshore fishery has conservation benefits. Environmental Conservation Vol 29, pp 493-508.

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22. No choice of substrate?

Many soft-bottom benthic invertebrates display sediment-associated patterns of dispersion. Habitat selection experiments have shown that the larvae of some species can choose to settle in favourable habitats, and this process could establish the patterns observed in the field. However, many soft-bottom benthic animals, including the cockle (*Cerastoderma edule*) show post-larval relocation. Active habitat selection in these post-larval stages may be responsible for adult distribution, rather than any selection at initial settlement.

We investigated sediment selection in post-larval stages of cockles on an inter-tidal mudflat using a field survey and experiments. Our 1225 square metre grid survey showed that there was no correlation between the smallest individuals and sediment characteristics. Larger size groups showed increasingly strong associations with sediment type, in the case of cockles with sandy sediments.

In the sediment choice experiment, the numbers of bivalves recruited into muddy, sandy and muddy depression (to detect small-scale hydrodynamic effects) treatments after 2 days in the field were recorded. It was found that all bivalves were too large to be initial settlers; they were thus relocating individuals. Neither the survey nor the experiment provided any evidence that relocating individuals could choose the sediment in which they alight. The sediment-related distribution patterns observed in adults of these species must therefore be due to other mechanisms, possibly post-settlement predation by crabs and/or the ability to migrate from less-suitable sediments until the preferred habitat is found.

Reference

Huxham, M. (m.huxham@napier.ac.uk), Richards, M., 2003. Can postlarval bivalves select sediment type during settlement? A field test with *Macoma balthica* (L.) and *Cerastoderma edule* (L.). Journal of Experimental Marine Biology and Ecology Vol 288, pp 279-293.

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23. Cultured scallops are more vulnerable to predators

As the survival of juvenile scallops released onto the seabed is of critical importance in programs seeking to enhance scallop populations, the basis of the vulnerability of seeded cultured scallops needs to be understood. High mortality rates following seeding operations could reflect weaker predator escape responses by cultured scallops.

Behavioural responses, as well as morphometric (shell size and thickness) and biochemical measurements of cultured and wild sea scallops *Placopecten magellanicus* (35 to 45 mm shell height) in the Gulf of St. Lawrence, eastern Canada were compared.

Cultured scallops had larger somatic tissues and higher muscle energetic contents than their wild counterparts. This may reflect the more favourable temperatures and better food supply during suspension culture. When faced with the starfish predator *Asterias vulgaris*, cultured scallops responded with a greater number of claps, longer clapping period and faster recuperation of clapping performance. However, wild scallops had stronger shells and showed a much more intense escape responses, with a higher clapping rate, to the starfish. These differences probably make cultured scallops slightly more vulnerable to predation by grasping predators (crabs) and asteroids.

Reference

Lafrance, M., Cliche, G., Haugum, G.A., Guderley, H. (helga.guderley@bio.ulaval.ca), 2003. Comparison of cultured and wild sea scallops *Placopecten magellanicus*, using behavioural responses and morphometric and biochemical indices. Marine Ecology-Progress Series Vol 250, pp 183-195.

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24. Queen scallop swimming behaviour

The swimming behaviour of commercially exploited scallop species has important implications for both fisheries and aquaculture. In fisheries, the behaviour of scallops in response to fishing gear has important implications for gear design and use. For example, the recessing habit of king scallops (*P. maximus*) means this species can only be targeted effectively using toothed dredge gear that digs into the substratum. In contrast, more mobile species, such as queen scallops (*A. opercularis*) can be targeted by gears such as trawls, which utilise swimming behaviour to catch the scallops whilst in the water column.

Swimming is brought about by a series of rapid valve adductions, which force water from the mantle cavity and propel the animal ventral edge foremost. Typically, such action allows scallops to rise off the seabed at a steep angle before swimming horizontally for a short distance and then sinking passively to the seabed. Queen scallops are generally considered to be a mobile species, which lie on top of the substratum and swim readily. Individuals showed a swimming response at up to 1.5 m away from approaching divers or fishing gear and attained a vertical height of between 0.1 and 0.7 m above the substratum, although occasionally they were observed up to 1.5 m in height.

Modified dredges were used on *Aequipecten opercularis* (queen scallop) fishing grounds off the Isle of Man in the north Irish Sea to determine seasonal variability in swimming behaviour in queen scallops and its effect on dredge fisheries. Scallops, which evaded dredge capture by swimming up into the water column, were captured by a specially designed net deployed above the dredge gear. The gear was used over a 20-month period and the number and size distribution of queen scallops captured in both the net and dredges were recorded. A sub-sample of captured scallops was maintained in running seawater tanks and used to assess two components of swimming behaviour, the time taken to respond to stimuli and the number of shell claps carried out until exhaustion.

There was considerable seasonal variability in the proportion of queen scallops that avoided dredge capture by swimming. Very low numbers of queen scallops were found in the net during the winter and spring. Net capture increased in June, and was high throughout the summer and autumn when up to 42% of the scallops (greater than 55 mm in height) that were actually captured in dredges, swam over the dredge mouths. The proportion of the number of captured scallops that escaped the dredge but were found in the net was strongly positively correlated with seawater temperature. Swimming experiments in the laboratory indicated that the observed seasonal variability in net capture was probably a result of the scallops taking less time to respond to stimuli at higher temperatures, rather than any change in their ability to perform a large number of shell claps.

There was no relationship between reproductive status and the proportion of actively swimming scallops. Analyses of size distributions indicated that swimming activity in the largest scallops might be limited but no effect of the amount of shell fouling was found on the ability of scallops to avoid dredge capture.

Reference

Jenkins, S.R. (sjen@mba.ac.uk), Lart, W., Vause, B.J., Brand, A.R., 2003. Seasonal swimming behaviour in the queen scallop (*Aequipecten opercularis*) and its effect on dredge fisheries. Journal of Experimental Marine Biology and Ecology Vol 289, pp 163-179.

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25. Detecting bonamia in native oysters

Screening of heart smears is one of the OIE recommended methods for diagnosis of the protistan *Bonamia ostreae* in the native oyster, *Ostrea edulis*.

Within a recent study, 130 oysters were brought to the laboratory from Lake Grevelingen, a Bonamia-endemic area as part of a planned experiment. A sub-sample of 30 oysters was screened using heart smears, to determine baseline prevalence of infection at time zero, and no infection was observed. The remaining oysters were maintained in the laboratory and screened over a six-month period, but three weeks after the trial began two oysters out of 100 had Class 4 infections, and further infection was observed over the remaining months. These results indicate that oysters found at the beginning of the trial to be free of Bonamia, using a standard method (heart smears), were in fact infected. The oysters may have been experiencing a latent infection; latent infections cannot be detected by presently recommended screening techniques. Alternatively the sample size used may have been too small. The results raise concerns about limitations of the diagnostic methodology for *Bonamia ostreae* for research and regulatory purposes.

Reference

Culloty, S.C., Cronin, M.A., Mulcahy, M.F., 2003. Possible limitations of diagnostic methods recommended for the detection of the protistan, *Bonamia ostreae* in the European flat oyster, *Ostrea edulis*. Bulletin of the European Association of Fish Pathologists Vol 23, pp 67-71.

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26. Detergents interfere with bivalve filtration

Effects of several surfactants and chemical mixtures on marine bivalves were studied. An anionic surfactant, sodium dodecylsulphate (SDS), and a cationic surfactant, tetradecyltrimethylammonium bromide (TDTMA) inhibited the filtering activity of oysters

(*Crassostrea gigas*). Some chemical mixtures that included surfactants also exhibited similar effects. Those mixtures inhibited the filtering activity of oysters and mussels (*Mytilus galloprovincialis*). It is suggested that bivalve filtration activity might be used as an indicator to assess environmental hazards from man-made chemicals that can contaminate marine systems.

Reference

OSTROUMOV, S.A., 2003. Studying effects of some surfactants and detergents on filter-feeding bivalves. Hydrobiologia Vol 500, pp 341-344.

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27. TBT ten years on

Organotin (OT) compounds were determined in surface sediments and mussels from two major estuaries of the UK, the Mersey and the Thames, approximately one decade after legislation banning the use of tributyltin (TBT) compounds on small boats.

Tributyltin concentrations in the Mersey sediments ranged from 0.007-0.173 µg (as Sn) per g dry wt, increasing from the most upstream site, Fiddlers Ferry, towards the middle section of the estuary, and were highest at Stanlow, perhaps indicative of sources from the Manchester Ship Canal. A further peak in TBT concentrations occurred at New Brighton, opposite Liverpool Docks. Tributyltin was the predominant butyltin (BT) species in sediments (approximately 50%). Furthermore, BTs in mussels were correlated with total extractable tin in sediment, though in contrast to sediments, 85% of the total tin in mussels was made up of BTs, and the most predominant of these was TBT. Concentrations of TBT in mussels increased from 0.058 µg Sn per g dry wt at the mouth of the estuary to 0.214 µg per g dry wt at their upstream limit, close to the entrance to the Manchester Ship Canal. Triphenyltin (TPT) compounds were detected in only one sediment sample (New Brighton) and one mussel population (Egremont).

Tributyltin concentrations in sediments from the Thames Estuary were marginally lower (0.002-0.078 µg Sn per g dry wt) than those found in the Mersey. Highest concentrations were present in the upper estuary and decreased seaward. Again BTs contributed only a small percentage (<1%) towards the total tin loading in Thames sediments, but represented most of the tin burden (80%) in mussels. In contrast to sediments, TBT levels in mussels from the Thames Estuary were slightly higher than the Mersey (concentrations ranged from 0.100 µg Sn per g dry wt at the mouth to 0.302 µg Sn per g dry wt upstream) suggesting that TBT bio-availability is disproportionately higher in the Thames. Phenyltins were not detected in Thames samples.

Reference

HARINO, H. (j-harino@kawachi.zaq.ne.jp), O'HARA, S.C.M., BURT, G.R., CHESMAN, B.S., POPE, N.D., LANGSTON, W.J., 2003. Organotin compounds in Mersey and Thames Estuaries a decade after UK TBT legislation. Journal of the Marine Biological Association of the United Kingdom Vol 83, pp 11-22.

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 110, 10 Whitehall Place East,
(Tel. 020 7270 8227) (Fax. 020 7270 8827)

Shellfish Health -
Fisheries Division II, Room 106, 10 Whitehall Place East,
(Tel. 020 7270 8826) (Fax. 020 7270 8827)

Public shellfisheries, excluding Regulating Orders -
Fisheries Division III, Room 112,
10 Whitehall Place East
(Tel. 020 7270 8256) (Fax. 020 7270 8310)

Shellfish Licensing Scheme -
Fisheries Division IV, Room 314,
10 Whitehall Place East,
(Tel. 020 7270 8128) (Fax. 020 7270 8146)

Grant Aid -
Fisheries Division 1B, Room 328,
10 Whitehall Place East,
(Tel. 020 7270 8041) (Fax. 020 7270 8019)

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)

Monitoring of fishing activities, licensing -
Sea Fisheries Inspectorate, Room 13,
10 Whitehall Place East
(Tel. 020 7270 8326/8160/8328) (Fax. 020 7270 8345)

Research and Development Programmes -
Science Directorate, Cromwell House,
Dean Stanley Street, London, SW1P 3JH
(Tel. 020 7238 3000) (Fax. 020 7238 1590)

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

Welsh Assembly Government, Agricultural and Rural Affairs Department,
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*)

Shellfish Hygiene

England - Food Standards Agency
Aviation House, 125 Kingsway, London, WC2B 6NH
(Tel. 020 7276 8000) (*http://www.food.gov.uk*)

Food Standards Agency (Scotland),
St Magnus House, 25 Guild Street, Aberdeen AB11 6NJ
(Tel 01224 285100);

Food Standards Agency (Wales),
Southgate House, Wood Street, Cardiff CF10 1EW
(Tel 029 20 678918);

Food Standards Agency (Northern Ireland),
10C Clarendon Road, Belfast BT1 3BG
(Tel 02890 417711)

Scientific and technical advice

CEFAS Weymouth Laboratory,
Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB
(Tel 01305 206600) (Fax 01305 206601) -
Cultivation techniques; health regulations; disease control; shellfish hygiene classifications and purification plant approvals; shellfish water quality and effluent discharges (microbiology) (England & Wales)

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

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

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

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

SEAFISH - Aquaculture Development Officers:
For Scotland and Northern Ireland: Craig Burton
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(e-mail: m_syvret@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.org

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).

For information on LINK Aquaculture and CARD R&D - Mark James, Fisheries Resource Management Ltd., Coillie Bhrochain, Bonskeid, Pitlochry, Perthshire, PH16 5NP. (Tel./Fax: 01796 474473).
(http://www.linkaquaculture.co.uk and http://www.frmltd.com).

USEFUL PUBLICATIONS

CEFAS

A variety of booklets and leaflets are available, including:

- A Guide to Shellfish Health Controls
- The Fish Health Inspectorate and You - Service Standards and Code of Practice for Enforcement
- Bivalve cultivation: criteria for selecting a site
- Scallop cultivation in the UK: a guide to site selection
- Storage and care of live lobsters

The above may be obtained from the CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, DT4 8UB, (Tel no: 01305 206600; Fax no: 01305 206601)

A catalogue of CEFAS publications is available from the CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, (Tel no: 01502 562244; Fax no: 01502 513865). Electronic copies of many of these publications can be found on the CEFAS web site at *http://www.cefas.co.uk/publications/default.htm*
Back copies of issues 6-15 of *Shellfish News* can also be viewed and/or downloaded as .pdf files from the CEFAS web site (*http://www.cefas.co.uk/publications/shellfish_news.htm*). Many of the illustrations are in full colour in the web edition.

Seafish Aquaculture

Detailed information on the technical and economic aspects of cultivation for individual shellfish species is available from Seafish Aquaculture. They publish a series of 'hyper-books' on CD-ROM that covers all aspects of cultivation. Economic models are also available.

For further information contact the Aquaculture Development Officer for your area (see above for contact details, or *http://www.seafish.org/sea/aquaculture.asp?p=ec200* for further information).

A full list of Seafish publications can be found on the Seafish web site at *http://www.seafish.org/resources/publications.asp?p=da*