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AQUACULTURE SCIENCE

SHELLFISH NEWS

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THE ORMER - A NEW SPECIES FOR CULTIVATION?

In December 2001, Cornwall Seafisheries Committee commenced a one and a half year study into the feasibility of growing the ormer at a variety of sites around the Cornish coastline. Practical assistance was given by SW PESCA to apply for European funding under Objective One for the project, which is aimed at producing a possible source of diversification for Cornish fishermen.

The Ormer – What is it?

The ormer, otherwise known as the 'sea ear' or 'muttonfish' is the European Abalone (*Haliotis tuberculata*). It is a marine gastropod, renowned as a local delicacy in the Channel Islands. The various species of abalone form one of the most highly prized gourmet seafoods throughout the world – but is little known on mainland UK. Many will have marvelled at the beautiful mother of pearl shells, frequently used in jewellery, of the paua (the black lipped abalone) which is a relative of the ormer. However, relatively few people on mainland UK will have savoured the 'steak like' joy of eating abalone other than in exclusive oriental restaurants. Until now.

Why culture the ormer?

Wild stocks of different abalone species throughout the world have been fished to low levels, encouraging the development of aquaculture for this animal. The ormer is an ideal species for aquaculture and the on-growing and hatchery techniques are well known, as it has been cultured in the Channel Islands and off the West coast of Ireland since the late 1970s. The high market value and low mass make the ormer an attractive product to culture by remote rural coastal communities distant from their niche market. Ormer farming has very low impacts both on the environment and visually, in that only seaweed is fed to the animals and just small surface markers are evidence of a 'farm'.

What's happened to date?

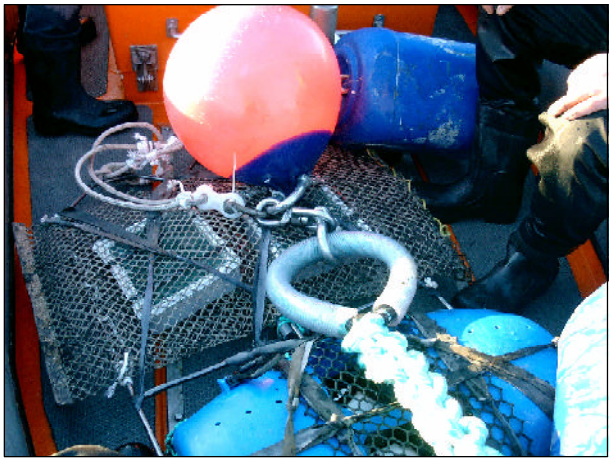
Although workers at the MAFF Conway laboratory and the Portsmouth Hayling Island marine laboratory undertook a significant amount of research work in the early 1980s, no one has ever undertaken significant trials of growing the ormer in mainland UK waters. However, in 1997 a MAFF-sponsored study showed that the temperature regime for Southwest England was similar to that where ormers naturally occur in the Channel Islands and also to that in Western Ireland where they were successfully introduced. This demonstration project aims to put theory into practice.

What's happening now?

Trial sites have been identified offshore of Padstow, Penzance, Isles of Scilly and Falmouth with further related trials offshore of Beer in Devon and Portland Harbour in Dorset. In addition, tank-based ormer culture is being compared within the National Lobster Hatchery at Padstow.

The trial sites at Penzance, Padstow, Beer and Portland Harbour each have caged populations of adult and juvenile animals, while the Falmouth and Isles of Scilly sites have populations of just juveniles, because of the proximity to Special Areas of Conservation (SAC). English Nature have voiced concerns about the potential impact of spawning adults on the SAC environment, so it was agreed to adopt a precautionary approach and only locate juveniles in those areas.

The cages and containers used in the trial are in a number of different configurations. The majority of sites have a steel rod framework measuring 4ft x 2ft, upon which is located a half-barrel cage and an oyster bag containing two 'sandwich boxes' containing the juveniles. The half barrel (blue plastic) has plastic mesh fixed to the bottom along the cut line and a mesh window in the top, to allow a free water flow. The 'sandwich boxes' each holding 25 juveniles, also have a fine mesh window in the top and bottom.



Legend Ormer rig

Adult ormers in a barrel

At the Penzance site, an experimental wire cage made from Aquamesh and based upon sea urchin trays, is being tested. The advantages of this system should be ease of servicing, robustness and resistance against fouling. With this cage the steel framework is not needed, so the problems of rust experienced at most sites are eliminated.

All the rigs are set to be situated about a metre to a metre and a half below the water surface suspended on two buffs or 25 litre containers. Attached to the cage or framework is a rope bridle (1 – 2 metres) leading to a further surface buoy and the heavy main anchor line. In most cases the anchors are made from a concrete filled lorry tyre which provides sufficient weight for the rigs.

Once a fortnight, unpaid volunteers haul the cages and the ormers are measured, checked for injuries or mortalities and fed with freshly collected weed. Each site has two temperature loggers, which are cycled at each inspection period, allowing the data to be downloaded to a PC.

And the future?

If the project is successful we hope to consider setting up a small scale ormer hatchery, possibly in association with the National Lobster Hatchery, that can help support local fishermen who wish to consider ormer culture. The expertise generated within this trial would also be available to help support future ormer farmers in years to come.

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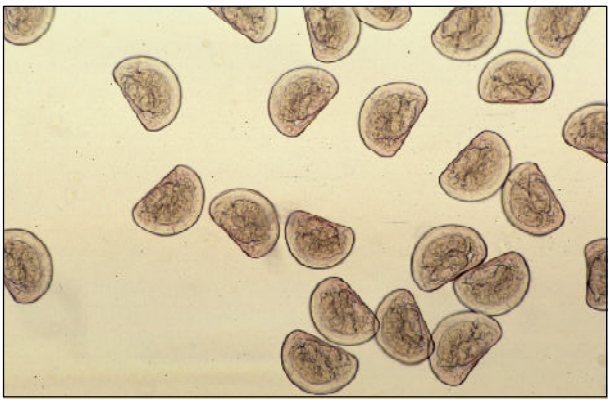
SHELLFISH EMBRYOS TO CHECK POLLUTION

Ian McFadzen, Coastal and Marine Biotechnologies Ltd

Millions of tiny oysters and mussels are being frozen and stored for the future to help combat marine pollution around Britain's coast. Shellfish embryos have long been known to be sensitive indicators of pollution in seawater. Until now bioassays (testing for pollution using these living indicators) could only reliably be done in the summer when the shellfish were reproducing. The alternative in winter was long and costly conditioning of the adults to bring them into spawning condition. The new method combines cryogenic technology with a secret recipe of protective natural compounds to keep the tiny embryo shellfish in a state of suspended animation. The researchers have exploited techniques used in human in-vitro fertilitisation (IVF) to achieve this.

Two scientists, Ian McFadzen and John Wedderburn, have started their own company to develop this revolutionary new technique. Coastal & Marine Biotechnologies Ltd., a spin-out from the Natural Environment Research Council (NERC), was opened in Plymouth on 7 December 2001 by Dr Caroline Jackson, MEP for the South West and chair of the European Parliament's Environment Committee.

Embryos are stored in liquid nitrogen



Rounded 'D-shaped' embryos show water is healthy

The CMB team (left to right: Ian McFadzen, Christine Pascoe, John Wedderburn)

The new method is inexpensive, reliable, quick and easy to perform at any time of the year. It can be used for routine testing of seas around tourist beaches, on board ships, or in response to environmental disasters such as oil spills. Sperm and eggs are mixed to produce live embryos. The embryonic shellfish are frozen to a temperature of minus 196ºC - more than twice as cold as any recorded temperature in Antarctica - and stored in special containers that resemble drinking straws. At this incredibly low temperature living tissue is normally destroyed. But by carefully controlling the cooling process and adding a special cocktail of protective compounds, the animals can survive for at least 50 years in their suspended state. The compounds used are natural and were originally derived from Arctic and Antarctic organisms and tropical plants. When testing is done, the embryos are thawed and placed in seawater where pollution is suspected. If they develop and grow normally, then the water is clean but if they die or show deformities (become ragged or shrivelled around the edges) that will indicate the presence of harmful pollutants. If repeat testing needs to be carried out in the same area over several decades, the same batch of frozen embryos can be used to ensure consistency in the test results.

The freezing technique can also be applied to shellfish breeding programs or used to conserve rare or vulnerable species of marine life.

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MONITORING OYSTER SPATFALL IN THE SOLENT

Dave Palmer, Shellfish Resources Team, CEFAS, Lowestoft Laboratory

Stock assessment

Native oysters, in common with most bivalve populations, exhibit wide fluctuations in the numbers that recruit to the adult stock each year. In 1989, Denis Key, working in the Shellfish Resources Team at CEFAS Lowestoft, suggested an experiment to see if there was any correlation between spat settlement and eventual recruitment. If such a correlation existed then an index could feed into stock assessment models in order to predict future stock size. If there were no correlation, then this would provide important information about mortality patterns in early settlement stages.

An idea for an experiment

Denis Key's idea was to lay large numbers of marked scallop shells on exploited oyster beds prior to the settlement time in early summer. These would then be recovered from fishermen when they caught them in their dredges during the following winter season and any oyster spat that settled on them could be counted. Scallop shells were known to provide a suitable settlement surface for oyster spat. They are also ideal because scallops are rarely found naturally in the Solent and the shells stand out in the dredge catch. The Solent was chosen for this work, as it is the most productive

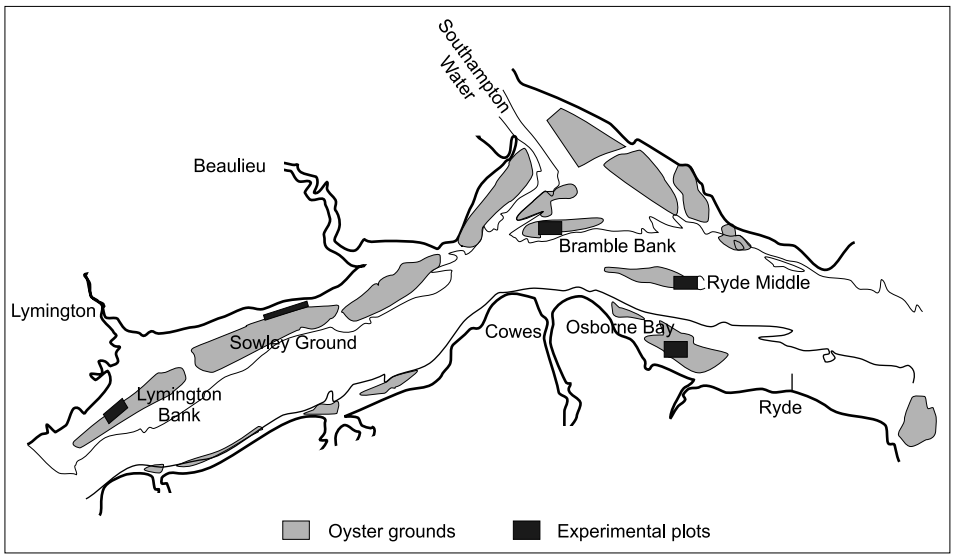


Figure 1. The Solent showing the main oyster grounds and the position of the experimental plots

wild oyster fishery in the UK, and one for which CEFAS has carried out an annual stock survey since 1974. This enabled us to compare the measure of spatfall with information on recruitment to the grounds from the surveys. Figure 1 shows the main oyster grounds in the Solent and the plots on which the marked shells were laid.

The method used

Clean scallop shells were obtained from a shellfish processor and in May 1989 some 800 were laid on each of three beds (Ryde Middle, Bramble Bank and Sowley). The shells were spread evenly over a plot of 36 ha in an area of known high oyster density so as to maximise the chance that they would be dredged. In the first year the shells were marked by sticking a numbered plastic disk to them. However, some disks became detached and in subsequent years it was found to be simpler and more effective to mark shells with a permanent marker pen. A different colour was used in each year so that shells from previous years could be identified.

Denis Key retired in 1991 but the experiment continued until 1995 and over this period the number of shells laid increased to 2,100 on each ground. There were also some enforced changes to the chosen grounds. Bramble Bank proved unsuitable, with no returns coming from it in 1989, and so a plot was seeded in Osborne Bay instead. An attempt to expand the experiment at Lymington failed when dredging stopped in this area due to poor water quality. There were no shells returned from Sowley after 1993 because the population on this ground ceased to be commercially viable.

Findings

Fishermen co-operated well with the experiment although ideally it was necessary to approach them directly and ask for shells, rather than hope for them to be handed in. We were able to do this successfully in 1990 and average returns were 32% of shells laid. However, the timing of the oyster season and other commitments made this impossible in later years and returns probably suffered as a result.

Oyster spat were found to adhere strongly to the scallop shells and we are confident that very few were lost during recovery. Scallops have a flat shell and a cupped shell and equal numbers of each were laid every year. It was found that cupped shells were more likely to be returned and that the number of spat settled on them was consistently higher. On the face of it this indicates that using only cupped shells would improve results but this would have to be weighed against the cost, since there is a market for the cupped shell.

On all grounds and in all years spat were recorded on the returned shells. Figure 2 plots the average numbers of spat per 100 shells from three grounds and compares them with the index of small oysters in the following stock survey. It is clear that while there is some correspondence over short periods, in general this measure of spat-fall does not explain subsequent stock recruitment. Indeed the results from the Sowley ground suggests that while recruitment to the stock was virtually nil, our shells were still being settled with spat. This may mean that some change had occurred on this formerly productive ground that had rendered it unsuitable for the settlement or survival of oyster spat, while our shells continued to provide an ideal settlement surface.

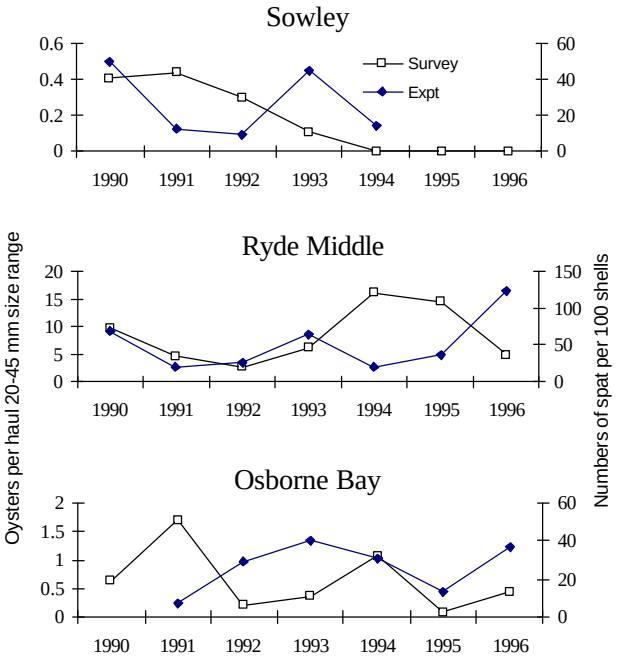


Figure 2. Trends in the number of spat per 100 shells compared to the number of 20-45 mm oysters per haul in the following stock survey

Occasionally there were some shells returned after a second year on the ground. An estimate of survival, about eighteen months after settlement, can be made from the depletion in numbers of live oysters between years. Survival was very variable, with estimates ranging from 0 to 80%. The cause of mortality cannot be known for certain but some shells showed evidence of having been drilled, probably by the rough tingle (*Ocenebra erinacea*), which is common on these grounds.

Conclusions

We conclude from these results that suitability of substrates and post settlement mortality may be at least as important as variation in spat-fall in causing variability in recruitment. Therefore, this technique could not be used to predict recruitment to the fishable stocks. However, suitably modified, it might be used to identify areas where oyster larvae settle, but do not survive. On such beds improvements to the ground, such as laying cultch or reducing predation, might reap dividends.

SHELL DAMAGE STUDIES IN THE WASH COCKLE FISHERY

Colin Trundle and Judith Turner, Eastern Sea Fisheries Joint Committee

Background

One of the most important fisheries within the Eastern Sea Fisheries Joint Committee District (ESFJC) is the Wash cockle fishery, which in 2001 employed over 30 vessels and sustained landings of 8,900 tonnes with a first sale value of over £1.4 million. The Wash is also, however, an area of considerable conservation importance, primarily for its expanse of inter-tidal habitats and hinterland saltmarsh that support vast populations of wetland birds. Recent concerns over declines in shellfish and bird populations in the Wash and the growing environmental duties placed on Sea Fisheries Committees have prompted scientists to investigate the inter-relationships between these populations and the sustainability of methods used to exploit the shellfish resources.

One particular area of concern was the level of damage and subsequent mortality being caused to cockle discards in the mechanised cockle fishery. Hydraulic dredging for cockles has been used in the Wash since the late 1980s, and there have always been concerns over the environmental effects. The problem of shell damage has been considered since mechanised cockle fishing was first developed in the late 1960s, but remains an issue to the present day. Two consecutive studies were undertaken by staff of the ESFJC in attempts to address this problem by developing approved gear that minimised discard damage (thus enabling the Committee to enforce a maximum damage byelaw) and quantifying mortality levels in cockle discards. This article gives a summary of the first study, which is in preparation for a M.Sc. under Dr. Mike Elliott at the University of Hull.

Study aims

The purpose of the study was to quantify the levels of damaged cockles resulting from the hydraulic dredging operation, and to identify factors causing this damage in relation to types of equipment used in the mechanised cockle fishery. It was aimed to obtain this information to guide the SFC and enable recommendations for approved fishing gear to be made, in order to reduce wastage of this commercially and ecologically valuable shellfish resource.

Methods

Fieldwork was carried out over two years (1999-2000). The fleet of vessels working the Wash cockle fishery (out of Boston and King's Lynn) were examined to obtain an inventory of technical information relating to vessel size, dredge, pump and pipe type, and any individual adaptations (such as the use of a buffer tank – a device to reduce the impact with which the catch hits the sorting riddle).

Damage rate assessment involved the sampling of retained catch and rejected discards from vessels during the cockle harvesting operation. For repeatability, each vessel was boarded several times throughout each fishing season, to allow for uncontrollable environmental conditions which could affect the results (e.g. cockle density on the ground, sediment characteristics of the area being fished, sea state). Samples were sorted and categorised according to the level of shell damage into three broad groups: (i) undamaged, (ii) cracked or chipped and (iii) smashed. The second study examined types of shell damage and their significance in more detail. Results from this study will be reported in a future issue of *Shellfish News*.

Levels of shell damage were examined in relation to the vessel characteristics in attempts to identify the gear types and configurations that resulted in the lowest level of damage. Initial examination of the data prompted statistical analysis of correlation between the levels (and severity) of damage and (a) pump type, (b) use of buffer tank, and (c) pipe type. Damage rates were also examined in relation to the size of cockles being fished, to investigate whether this had any influence over the

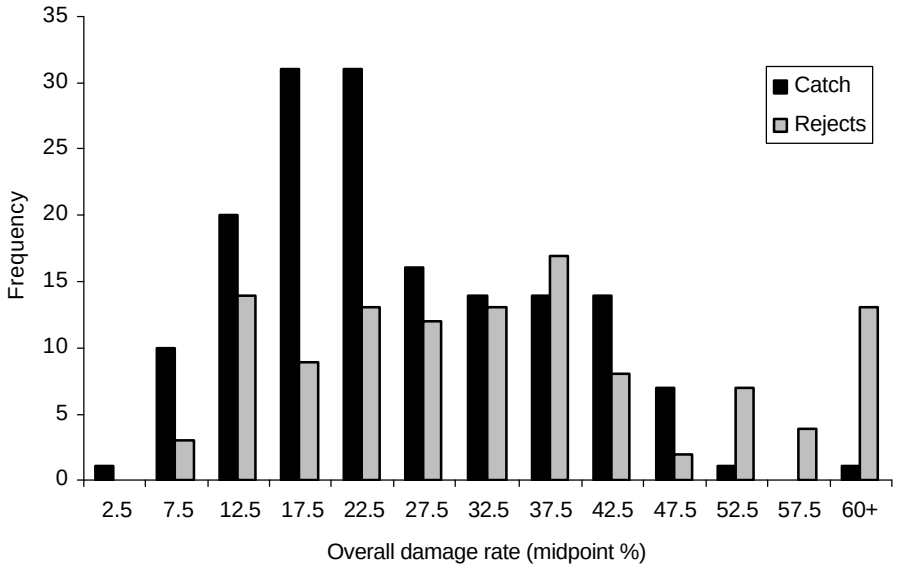
Examples of damaged cockles from a discard sample

levels of damage being identified on each vessel. The shell condition factor of cockles from six sands was also calculated and damage rates were examined in relation to this.

Results summary

Levels of damage in the retained catch and discarded rejects samples varied considerably between vessels and between sampling occasions on each vessel. Mean damage rates (i.e. proportion of category (ii) plus (iii) cockles in sample) in the retained catch for each vessel varied from 11% to 37%, and in the rejected discards from 14% to 63% (see figure below).

Five different types of solid handling pump were identified within the fleet. Approximately half the vessels were fitted with a buffer tank. Flexible pipes were more widely used (three fifths of fleet) than solid pipes (two fifths).



Cockle damage levels (shown as % sample damaged) in Wash cockle fleet, during 1999 and 2000 cockle fishing seasons

Pump type was found to be significant in relation to levels of damage. Overall damage to rejected discards was significantly lower on vessels using a buffer tank than on those not using one. Overall damage to rejected discards was not significantly different between vessels using solid or flexible pipes. In relation to the size of cockles being fished, correlation was seen between damage levels and cockle size in the rejected discards in 2000 but not in 1999. No size effect was seen in catch samples in either year. Category (iii) damaged cockles were found to be significantly larger than category (i) or (ii) cockles in discards. No correlation was identified between cockle shell condition factor and damage rates in the study.

Further recommendations from the study were for:

(1) further statistical analysis of the results (ongoing);

(2) a study to ascertain cockle mortality rates in damaged rejected discards (this is the second study);

(3) more detailed studies of equipment and resultant damage levels, for example sampling of cockles from different points in the dredge, pipes, pump and riddle system of a hydraulic cockle dredger to locate positions where damage occurs;

(4) continued liaison with members of the fishing industry in working to develop least-damaging gear.

Implications for the fishery

These results enabled the Joint Committee to recommend that members of the industry phase out the use of certain pump types in their cockle fishing gear, and that buffer tanks be used at the delivery of catch into the sorting riddle. In enforcing a maximum damage byelaw, ESFJC staff had to work closely with members of the industry in efforts to reduce the damage levels identified on each vessel. This process is continuing in each cockle season. The quantification of an overall stock biomass reduction figure (to include fishery-damaged discard cockles – reported in second study) will assist in developing the Wash shellfisheries management plan, which is being drawn up to meet the ESFJC's obligations under the expanding umbrella of environmental legislation.

Acknowledgements

These studies would not have been possible without the generous assistance and support of the Wash cockle fishermen, the staff of ESFJC, Mike Elliott at the University of Hull, Joss Wiggins at Kent & Essex SFC and the Green Quay aquarium team.

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A NATIONAL STRATEGY FOR MUSSEL SEED

By Sue Utting, Sea Fish Industry Authority

The UK mussel industry

Since the early 1990s, mussel cultivation in the UK has shown major development. Annual production from Fishery Orders in England and Wales has risen from between 1,000 and 3,000 t per year (1990 to 1995) to between 6,000 and 13,000 t per year (1996 to 2000). Most of the increase in production has been the direct result of extensive cultivation on the seabed using Dutch-style dredgers that can move large quantities of mussels in a single trip. On top of this, around 2,000 t of mussels are now produced in Scotland from suspended cultivation.

There is still great potential for further development of the industry, in particular using extensive husbandry techniques where greater financial returns are possible through economy of scale. However, continued expansion of the industry at lower levels of production is also desirable in many of the estuaries and sheltered bays around the UK coast to create employment opportunities, especially in rural communities.

An estimated 85-90 people are directly employed in seabed mussel cultivation in the UK. Assuming a doubling of the industry in the next 10 years, which is not unrealistic with extensive husbandry cultivation techniques, an additional 40-50 direct jobs could be created. Added to this, around 90% of the mussels produced in the UK in 2001 were exported to the continent for further processing. Only 10% went to UK retailers and caterers. If we were to process or add value here in the UK, at least 70-80 extra jobs could be created. A doubling in mussel production could increase this to around 150 new jobs. Additional opportunities in ancillary trades on shore are unknown but are likely to be considerable.

Managing mussel seed as a national resource

To ensure stability for today's industry and to sustain its development in the future, a guaranteed supply of mussel seed is required to support high volume production. Sourcing, moving and relaying large quantities of seed every year is essential. In its strategy, the Shellfish Association of Great Britain has identified the need for seed mussels to be managed as a national resource. Seafish Aquaculture is helping to develop a strategy to sustain the industry through access to additional sources of seed mussels.

To develop a national seed mussel strategy, a number of issues need to be addressed by regional and national groups, including the industry, the various regulatory bodies, their advisors and government. In November 2001, Seafish Aquaculture organised a meeting at Fishmongers Hall, London attended by representatives of the industry, conservation organisations (English Nature and Countryside Council for Wales), Sea Fisheries Committees (SFCs), DEFRA and WAG. At that meeting, it soon became apparent that the management of mussel seed as a national resource will be a longer term objective because of the complexity of issues involved.

As a first step, the location of ephemeral beds of seed mussels, as and when they occur and in particular sublittoral beds, with sustainable removal of seed by quick and safe techniques without detriment to the local environment and ecology, is a more realistic objective.

Extent of existing and additional (new) sources of seed mussels

Ephemeral beds of seed mussels occur sublittorally offshore and they can also be found intertidally. Mussels on these beds are attached more loosely to the substrate than they are on more permanent, stable beds found intertidally. As a result, they can be readily dislodged during autumn gales and get swept away. Those beds not destroyed by physical forces are often lost to common predators such as starfish and crabs.

There is the opportunity for the mussel industry to use the sublittoral seed resource in a sustainable manner through commercial collection and cultivation. Already in some areas of the UK, such beds are used on a regular basis to support extensive mussel cultivation. Seed collection from ephemeral beds ranges from hand picking with rakes in intertidal areas to removal by vessels (> 20 m) using dredges.

Relaying the seed on intertidal beds may also create an enhanced food resource for wading birds and wildfowl in that locality. Equally, there are other ecological and environmental factors that may need to be considered, including any potential effects on the substrate and benthic communities in the collection and relaying sites.

Hand raking mussels (Photo by author)

Dredging mussels (Photo by S.J. Lockwood)

The issues

In England and Wales, some SFCs monitor, to varying degrees, some of the more regularly recurring ephemeral beds, but they have no remit or resources to search for new seed stocks. In Scotland, where there are no SFCs, information is extremely limited and unable to satisfy an increasing UK demand for sustainable seed mussel resources. There are also national and local differences in ownership of seed resources.

When large quantities of seed need to be moved quickly and/or where seed resources are located in deeper waters offshore, using purpose-built dredgers is likely to be the most practical and safest method of collecting seed. Historically, the issue of special licences and permits to collect seed has sometimes been a lengthy process and this has created problems for the industry because ephemeral beds, by their very nature, can disappear almost overnight and the resource is lost.

Where ephemeral beds are within designated conservation areas, removal of seed is usually subject to a greater variety and number of considerations and

constraints than when the bed is in a non-designated area. Theoretically, collection of seed from sublittoral beds ought to be easier to manage since the mussels are not a direct food source for nationally and internationally important birds. A comprehensive monitoring programme, based on local case studies carried out jointly with industry would help to establish some generic principles for sustainable exploitation of sublittoral ephemeral mussel beds. This would allow SFCs, English Nature/Countryside Council for Wales and others to be in a better position to advise on licence and permit applications.

In England and Wales, there are differences between SFC districts in their policies and local byelaws in regard to using seed mussel resources. In the short term, this may create difficulties in developing any strategy that recognises seed mussels as a national resource that can be moved freely from one SFC district to another as and where appropriate, or from one region to another.

However, a regional management strategy to include Wales and the north-west of England may be an appropriate first step, for the following reasons. Firstly, long term data on ephemeral mussel beds are available from areas such as Morecambe Bay, which could be used to draw some conclusions and make generic recommendations on the sustainable exploitation of seed resources. Secondly, considerable experience on extensive cultivation of mussels on the seabed is available in the region and management issues are already being addressed on a regional basis. The development of a regional strategy would provide a practical example that other regions could follow and adopt if so desired.

Further information

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CRAB SHELTER RESEARCH PROJECT

Bill Cook, Biologist, North Western and North Wales Sea Fisheries Committee

Background

There has been an increase recently in the use of artificial shelters as refuges for shore crabs in intertidal areas, where they can be collected for angling bait at low tide. This has prompted many concerns, including the impact on potentially sensitive intertidal soft-sediment communities and on crab populations. A joint project between the North Western and North Wales Sea Fisheries Committee and the Countryside Council for Wales was carried out to assess the ecological effects of using artificial shelters to fish for crabs. An experimental site was set up in the summer of 2000 on an intertidal flat of silty sand on the shore of the Menai Strait, North Wales. Replicate experimental plots were each given one of three treatments. 'Tile Plots' had ridge tiles placed on them to act as crab shelters, and these were tended on a twice-weekly basis to simulate bait collection. 'Trampling Plots' had no tiles, but were walked over twice-weekly at a similar level to the Tile plots. Control plots were left untouched during the 5 month duration of the experiment.

Environmental effects

The main effect of the crab tiles was a reduction in the number of individuals of all species in the sediment under the tiles themselves. The number of species present on the Tile plots was also significantly reduced, but to a lesser degree than for individuals. Species

Examining the ridge tiles. Adult crabs were normally found in the sediment beneath the tiles. Here, the underside of a tile is being examined for juvenile shore crabs and other species that may have settled on the tile or used it for shelter. Heavy cover of Enteromorpha can be seen on the upper surface of the ridge tile in the background. (Photograph by R. Holt.)

diversity and richness showed no significant effects due to treatment, although both of these indices varied seasonally. Trampling alone had much less effect than did the ridge tiles, which was surprising in view of the prevalence of very small worms amongst the infauna. Trampling plots did show significantly lower total numbers of individuals than Control plots after the treatments began, but the difference was much smaller than on the Tile plots. Trampling resulted in no significant difference in numbers of taxa, species richness or diversity. Neither of the experimental manipulations affected sediment composition, but the tiles themselves became colonised by green weed and attracted settlements of species characteristic of rocky shores such as mussels.

Conclusions

It was concluded that placing large numbers of objects such as ridge tiles on intertidal sand or mud flats has the potential to cause considerable local changes in the infaunal community, principally in reducing the abundance of all species. The tiles were effective at retaining crabs, and also served as a refuge for small newly-settled juvenile crabs. However, further study of crab collection for bait on a larger scale would be necessary to predict likely impacts upon crab stocks. A full report of the experiment has just been published.

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SUCCESSFUL LOBSTER PROTECTION INITIATIVE

Phil Coates, South Wales Sea Fisheries Committee (SWSFC)

V-notching

Between 60 and 100 tonnes of lobster (100-175 thousand animals) valued at £0.6-£1 million (first sale value) are taken annually from the SWSFC district. When taken with various other species of crab, crawfish and prawns this amounts to 700-1,000 tonnes of crustacean shellfish valued at up to £2 million at first sale. Most of this is currently exported to Mediterranean countries. Processed and market value may increase these sums four or five fold.

During 2001 and 2002 over 6,330 female lobsters were purchased from fishermen at market value (total cost of £58,634) and returned to the sea, having first had their tails V-notched. The tail clip is a harmless means of marking the animal, the taking of which is prohibited under SWSFC byelaw. The removal of such lobsters from any fishery is an offence to which a fine of up to £5,000 applies. The SWSFC was the first organisation in the UK to legislate for such a measure via a byelaw, made on the 30 August 1996. Other Sea Fisheries Committees have since followed, as has national legislation in England. Each lobster returned will provide eggs and subsequently juvenile lobsters for future years to augment local lobsters stocks. The lobsters that hatch will themselves breed more lobsters giving the stock a much needed boost. Half of the 'buy back' cost of nearly £60,000 was met by grant aid from Europe following an application by SWSFC under the EU PESCA scheme.

A successful scheme

Many fisherman, and especially merchants, did not immediately warm to the scheme. Modifications to the way that the scheme was operated and to the arrangements to the compensation payments to fishermen, in the light of experience and current markets, were necessarily made. By the summer of 2000 the word has spread, and a number of mainly inshore fishermen were supporting the scheme, especially near St Govan's, Fishguard and Cemaes Head. By 2001 these groups has enlarged and catchers from Gower also contributed.

As far as officers of the SWSFC are aware, the arrangements worked exceptionally well. The scheme had the added advantages, from the Committee's point of view, of bringing the officers and the work of the Committee closer to the fishing community, and providing something positive, where previously the SWSFC had been seen as mainly an enforcement body. The release of so many lobsters over such a short period was a tremendous achievement.

The V-notched lobsters were fairly evenly distributed through the SWSFC District, west of Gower. The occasional addition of coloured bands to the claws of released lobsters indicated a rapid dispersal from the coast to the fishing grounds. No tagging was undertaken. Lobster recaptures appeared surprisingly regular in some

areas. Of great interest are the reports from fishermen throughout the District (and both inshore and offshore) of a very large number of discards (juvenile lobsters) of a very small size (50-75 mm). Lobsters of such a small size have very rarely been seen in pots in the past. Fishermen are keen to believe that these result from the V-notching scheme. Further research and contact with other SFCs and CEFAS will identify whether this is a 'local' phenomenon.

Officers believe that that the Committee's increase in lobster minimum size to 90 mm carapace, a reduction in fishing effort on offshore grounds in 1999/2000 and climatic/chance conditions may also have played their part. Whatever, the need is there to build upon the momentum, and maintain these stocks to adulthood which will increase baseline levels, and hence future landings.

Other observations

Non fishermen, especially divers, are believed to have also notched lobsters, including males! This could have negative effects, particularly if undertaken out of conservation merit and to 'deprive fishermen of catch'.

Some fishermen also notched their own lobsters, especially crippled females (1 claw) of low value. This is to be commended. However, those notching juveniles may find that their enthusiasm noticeably reduces future fishing opportunity. SWSFC officers have tempered such enthusiasm in order to avoid, in the future, illegal landings of V-notched lobsters to 'make ends meet', which would undermine the scheme.

It is very disappointing to note the lack of support for the scheme from some sectors. In the North Eastern SFC area scheme, both the fishermen and industry have contributed. In Northumberland SFC and Eire the fishermen have made donations. For the Cornwall SFC lobster hatchery, fishermen and commerce have contributed significant sums. The SWSFC scheme met with positive response from only three vessels. There have been no corporate sponsors. Of particular concern has been the absence of merchant support. The largest agent promised early on to make available holding space, and supply lobster, at cost or free in the case of cripples. In the event that business contributed nothing (other than late support for one fishermen's group). The support of the merchants is important for easy implementation (as in the NESFC scheme), as only by going to merchant collection points can large numbers be collected, especially from peripheral areas, and returned cost effectively. There are probably good reasons for this lack of support, although, as the merchants will ultimately benefit from the scheme, it is a disappointment.

The future

Many fishermen are now very keen to continue the scheme. So might they be, on the basis of little or no financial loss, and potential future gain through fisheries enhanced by increased juvenile production, all paid for by other parties! Moreover, as the V-notch grows out, these lobsters can be legally caught and will have grown in the interim i.e. having been paid for their catch the fishermen can catch them again when they are more valuable. Objective One funding is available, and could continue the scheme, possibly at up to 70% or 80% aid. From the Committee's perspective a paradox exists. On the one hand the scheme has been successful. It has raised the industry's opinion of the Committee, and strengthened the liaison between officers and the industry. It has allowed the release of 6,332 mainly female lobsters, each of which will spawn at least once before being recaptured, releasing tens of millions of eggs from which juvenile lobsters will emerge. If only one juvenile of each batch of eggs reaches adulthood then the scheme becomes cost neutral in the economic sense. In the likelihood of better survival the fishery becomes cash generative. Of course these lobsters are themselves potential spawners before they are caught, and the benefits go on. By such means the near £60,000 spend could produce hundreds of thousands of pounds worth of benefits.

Whilst it is impossible to actually calculate the financial benefits, many would say that the Committee's scarce resources have been well spent. However, under the Committee's increasingly tight budget and with a lack of staff on the ground to prepare for an Objective One bid, or to implement a successor scheme, what priority should be accorded to its continuation? On the other hand, it is arguable that the fishing industry has itself created the shortage of lobsters and that it should itself be supporting initiatives such as the return of all berried lobsters at every opportunity. Why then should public monies be made available to fishermen in a particular sector?

Notwithstanding this, officers have supported the industry's enthusiasm for a replacement scheme, and have offered manpower and technical assistance, such as are available. The involvement of local authority European officers to assist in drawing up a replacement application for EU aid has also been suggested. Discussions are at an early stage on an 'All Wales' scheme also involving Northern Western & North Wales Sea Fisheries Committee.

Lobster fishery management

The Director's personal wish would be some form of further management restrictions, brought in over time, effectively subsidised by benefits accruing to V-notching. Possibly also a restrictive vessel licensing scheme with charges targeted mainly to enhancement of stock.

Minimum landing sizes have probably gone as far as is practical to maintain lobster stocks. Officers believe that

effort control and measures to protect broodstock (maximum size, or ban on landing berried lobsters, etc) could produce further highly significant long term benefits for all lobster fishermen, as well as the local economy. It would perhaps be a shame if the benefits were quickly wiped away by an increase in fishing effort - in response to greater fishing opportunity - even if that does generate extra short term revenue. With careful management the lobster fishery does represent a long-term opportunity with widespread economic benefits. The bonus is that the fishery also usually demonstrates little environmental impact. Perhaps one can have one's cake and eat it?

Further information

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PINK CRAB DISEASE IN EDIBLE CRABS

Grant Stentiford, CEFAS Weymouth Laboratory

The crab fishery

The edible crab (*Cancer pagurus*) is one of the most valuable shellfish species captured in Europe, with a large fishery existing in the waters surrounding the United Kingdom (landings of over 26,000 t and worth £28 m in 2000). Of the crabs landed in the United Kingdom, some are processed and sold locally, while significant quantities (around 13,000 t in 2000) are transported live for sale in continental Europe. The main commercial product extracted from this crab species is the muscle of the claws and body cavity (white meat), the hepatopancreas (brown meat) and the gonad ('coral').

'Pink Crabs'

During the autumn and winter months, a significant proportion of edible crabs captured from the English Channel are reported to display an altered colouration (pink carapace and joints) and exhibit a general lethargy when handled. Crabs with this condition are also distinguished by pink abdomens and genital pores of females. These crabs (termed 'Pink Crab' by fishermen) tend to die following handling and pounding, and during vivier transportation. The condition has been reported in animals taken directly from pots and dead crabs are often found within pots during the winter at sites where 'Pink Crab' is known to occur.

What is wrong with 'Pink Crabs'?

Internally, the blood (haemolymph) of the crabs with this condition is milky and has a distinct pink colouration. The muscle in the claws and the body (white meat) and the hepatopancreas (brown meat) is heavily infiltrated by this cloudy haemolymph and both take on a watery consistency. The heart (normally full of clear haemolymph) is cloudy and discoloured. Through collaborative studies carried out at the CEFAS Weymouth laboratory and the University of Glasgow, the causative agent of this condition has been discovered. The disease is caused by a *Hematodinium*-like dinoflagellate parasite that grows within the haemolymph of infected crabs (see Figures 1A-D). This parasite is similar to that causing large-scale mortalities in the Scottish *Nephrops* fishery and is probably the same as a parasite causing a condition previously described in European edible crab stocks. When the tissues of infected crabs are viewed using microscopy, they are seen to be infiltrated by masses of parasite cells that appear to replace the normal blood cells circulating around the body. Significantly, the structure of the hepatopancreas (Figure 1A and B) and of the muscle (Figure 1C and D) is severely disrupted in infected crabs. The microscopic appearance of these tissues helps to explain their altered consistency upon cooking.

Economic and ecological consequences of Pink Crab Disease (PCD)

PCD has the potential for considerable commercial and ecological impacts at several levels. *Hematodinium* is ultimately fatal to *Nephrops* and due to the severe pathology associated with PCD, it is likely that crabs also succumb to infection. In seasons where the prevalence of infection is high, this has been shown (in *Nephrops* fisheries) to be linked to reductions in landings per unit effort in the following season. As little is known at present about the prevalence and seasonality of PCD in the field, we can make no inference as to its likely role as an additional mortality factor. However, due to the severe pathology associated with PCD, it is likely that similar effects to those observed within the fisheries for *Nephrops*, and for tanner crabs, snow crabs and blue crabs (in the US, Canada and Alaska) may also manifest themselves in populations of *C. pagurus* which harbour PCD. Monitoring of offshore and inshore stocks and a retrospective analysis of landings data are required in order to establish the potential for such effects on commercial stocks.

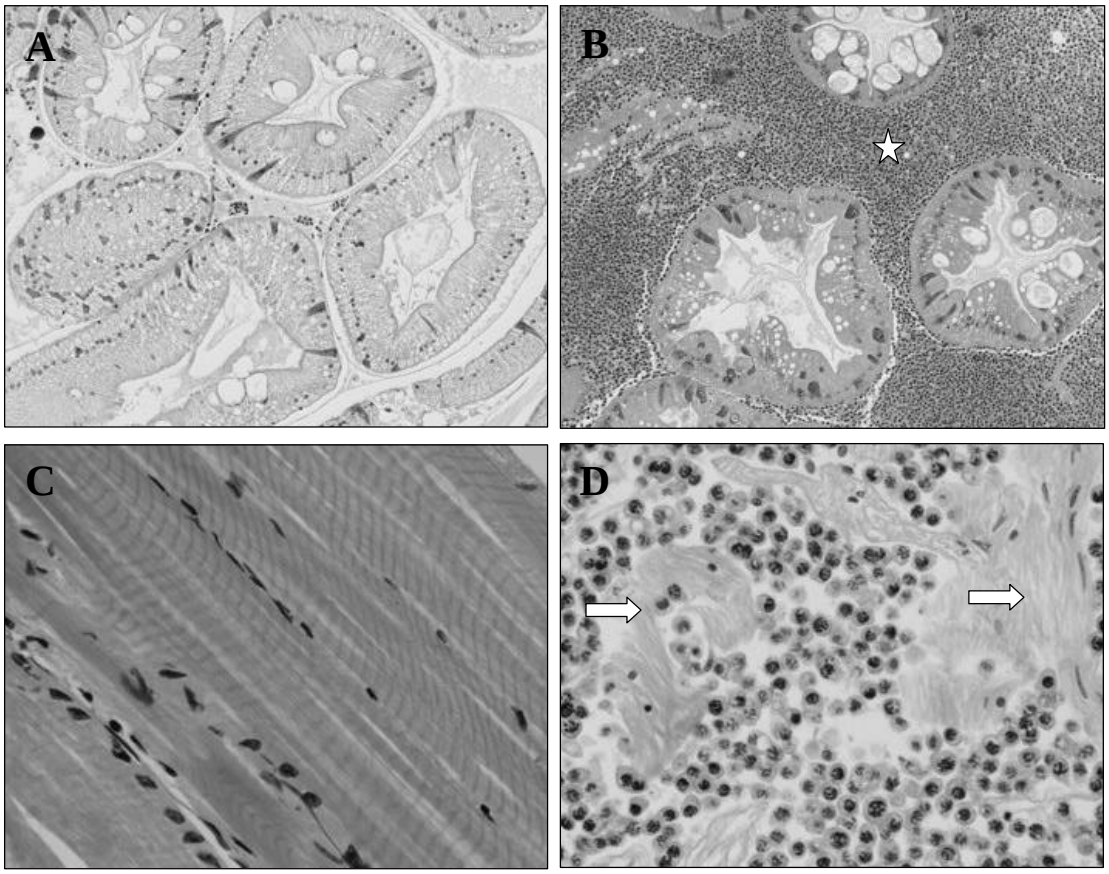

Figure 1. 'Pink Crab Disease' (PCD) in edible crabs. (A). Hepatopancreas (brown meat) of uninfected crab showing normal tubules. (B). Hepatopancreas of crab with PCD. Note the masses of parasitic cells between the tubules (see star). (C) Claw muscle (white meat) of uninfected crab showing normal muscle fibres. (D). Claw muscle of crab with PCD. Note the islands of remaining degenerate muscle (arrow) between masses of parasite cells

The quality and yield of meat from crabs with PCD is also of potential commercial significance. The severe pathology associated with the hepatopancreas and the claw muscle is likely to cause considerable alteration in the yield, texture and appearance of these tissues. Previous studies on the biochemical composition of *Hematodinium*-infected tissues has also suggested that disruptions caused by infection may be implicated in the 'bitter' taste of the meat that accompanies this and other *Hematodinium* infections. Indeed, *Hematodinium* infection in tanner crabs has been termed 'Bitter Crab Disease'.

Future studies

The mode of transmission of *Hematodinium* infections from one crab to another is the subject of some debate. However, a number of studies have suggested that there is a significant risk of its spread through the culling and disassembly of affected animals in the catch at sea. Anecdotal evidence has suggested that the potential for the spread of PCD via these practices, and by others that involve the use of immature crabs as bait for the capture of other species, is significant. In the future, knowledge gained via studies on the transmission of PCD between crabs may be applied to improve current commercial capture and holding practices, which may to some extent be facilitating transmission of this parasite in the field.

Further information

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LOBSTER SNIFFING: HOW LOBSTERS CAPTURE SMELLS FROM THE SEA

Robert Sanders, Media Relations, University of California, Berkeley

Aquatic creatures like lobsters and crabs depend on smell to find food, a suitable mate or to avoid predators, but how do they pluck these odours from the water swirling around them?

Underwater robots

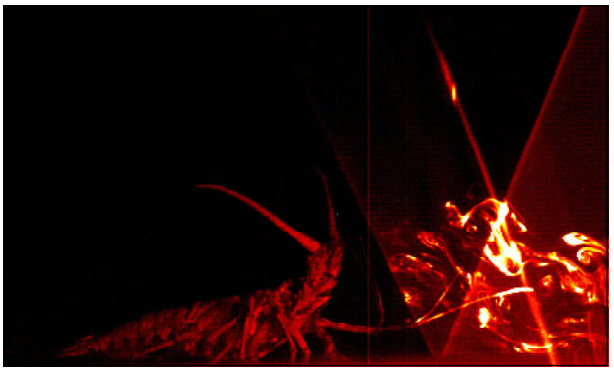
Researchers at the University of California, Berkeley, and Stanford University have been studying the sophisticated way in which spiny lobsters sniff their way around a watery world. This may provide strategies for robot builders looking for efficient ways to create odour sensors. The work is supported by the United States of America's Office of Naval Research. A lobster's extraordinary ability to sniff out all kinds of odour trails in the water is just what the Navy would like an unmanned vehicle to be able to do. It is hoped that these studies will provide important clues about how to develop a new class of sensitive chemical sensors that the Navy needs in order to locate and identify unexploded ordnance in very shallow marine waters. These sensors could be fitted to unmanned vehicles or robots that are able to go into toxic sites where you could not send a scuba diver. Mimi A.R. Koehl, professor of integrative biology in the College of Letters & Science at Berkeley said, "We are learning how animal antennae capture odour molecules from the water around them. We want to understand which designs of odour-catching antennae work successfully in nature so that they could provide inspiration for man-made antennae."

Lobster sniffing

Lobsters and other crustaceans sniff by flicking a pair of antennules, dragging them through the water to bring chemosensory hairs on the ends of the antennules into contact with odour molecules. On some lobsters, the antennules can be rather short, though in the foot-long Caribbean spiny lobster *Panulirus argus*, they are between 3 and 4 inches long, with split ends. On the outer edge of one of the split ends of each antennule is a brush of hairs sensitive to chemicals. The question the researchers asked is whether the incessant flicking of antennules can pick up fine details of the swirling odours, and how odour molecules penetrate into the brush of chemosensory hairs. The Berkeley researchers first made high-speed videos of a lobster flicking its antennules in order to determine how fast, how far and how often they flick, and the angles of the down and return strokes.

A mechanical lobster

Once they digitised the images and measured these details, they created a mechanical lobster that flicked in the same way. The mechanical lobster was simply the moulted shell of a spiny lobster filled with epoxy resin. Fresh antennules from lobsters could be mounted on this mechanical lobster and moved by a computerised motor to reproduce the motion of a flicking antennule.



A discarded lobster shell fitted with a motor-operated antennule that mimics the flicking used by lobsters when they sniff. A laser illuminates fluorescent dye in the turbulent water, allowing scientists to study how odours penetrate the lobster's nose. PHOTO CREDIT: Mimi Koehl/UC Berkeley, Meg Wiley & Jeffrey Koseff/Stanford.

They placed the mechanical lobster downstream of an 'odour' source in a large water flow tank in the Environmental Fluid Mechanics Laboratory at Stanford University. Since odours are invisible, instead of the aroma of a tasty item, such as a rotting fish, the researchers substituted a fluorescent dye. The tank, operated by Jeffrey R. Koseff, professor of civil and environmental engineering at Stanford, and his colleagues, simulated the degree of turbulence a lobster might encounter while strolling along the ocean bottom. Because they needed to see only the narrow slice of the odour plume hitting the antennule, which is only one millimetre wide, they shone a thin sheet of laser light through the plume. While flicking the antennule, they made high-speed, close-up videos of the eddies and filaments in the dye plume to determine if and how the dye penetrated the array of chemosensory hairs at the antennule's tip.

Captured scents

What they found was that, during the downstroke, the lobster pushes the antennule through the water just fast enough for the water and dye to penetrate into the brush of sensory hairs, maintaining much of the detail in the swirls of dye. On the return stroke, however, it sweeps more slowly, and the water is unable to move between the hairs. The fine filaments of dye that penetrated between the hairs during the downstroke are trapped within the brush of hairs until the next rapid downstroke. The lobsters sniff when they flick, and with each flick their antennules capture a detailed map of the swirling odours in the water.

What this means is that, in the lobster's real world, small differences in odour concentration in a plume are preserved and captured by the array of hairs, though it is unclear how the lobster take advantage of this detailed information.

Next steps

The big question now is how various crustaceans use the odour maps to locate the source of the odour. Lobsters and other crustaceans are very successful at finding the sources of odours in the messy, turbulent water flow in the ocean. By understanding the physics, we can gain insights for the design of man-made chemical-sensing antennae that can be used in the same kind of environments. The next phase of the study will get neuroscientists involved who can relate odour concentrations in the hairs to electrical signals in the brain of the lobster.

Further information

http://www.berkeley.edu/news/media/releases/2001/11/30_lobst.html

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BIRD DETERRENT USED IN OIL SPILLS

Phoenix Marine Wailer

This unit (see photograph) was developed originally at the request of the New Brunswick Department of Aquaculture to deter Sea-Ducks, such as Scoters and Eiders, which predate cultivated mussels grown in coastal waters. Several units have been deployed for this purpose.

The Phoenix Marine Wailer

In 1995 a scientific study was conducted for the Marine Spill Response Corporation of Washington D.C., by Ron Hounsell, a Wildfowl and Marine Bird Scientist recently retired from the Canadian Wildlife Service. The purpose of the study conducted in Miramichi Bay, New Brunswick was to determine the efficacy of the unit to deter sea birds from oil spills.

An effective deterrent

Under the environmental conditions in the present study, the Marine Phoenix Wailer (MPW) appeared to be an effective open-water bird deterrent device within an effective range of 500 metres. Unlike other deterrent devices used in past oil spill deterrent operations, the MPW sustained its deterrent capabilities over the entire period of the study (28 days) when the device was operating. This sustained deterrent capability has potential application to on-water bird deterrent operations during oil spills since oil-contaminated areas often require an extended period of time for site clean-up operations to be completed.

Presently, a similar trial is being carried out by Dr. Desley Whisson, University of California and the California Fish and Game Department, using the latest Phoenix Wailer circuitry.

Further information

http://www.phoenixagritech.com/marine.html

THE TASMANIAN PACIFIC OYSTER INDUSTRY

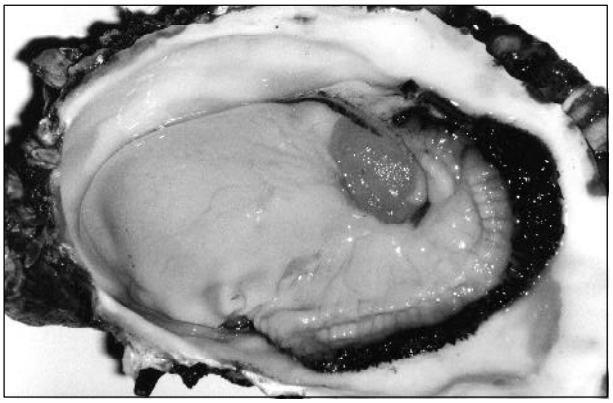
Peter Hoare, ex Tasmanian oyster grower and oyster industry representative, Tasmanian Aquaculture Council

History

It is not widely known that Tasmania had a larger oyster industry one hundred years ago than it has today. In those days it was based on the Native Flat Oyster, *Ostrea angasi*. It formed a part of the diet of the inhabitants of southern Australia as well as Tasmania before white settlement and it supplemented the meagre diet of the early settlers.

Cultivation techniques were first used in 1880 with wild caught spat. The success of farming was short lived and the industry reverted to dredging until its demise by the end of WWII. At its height annual exports of oyster meat (shucked - in barrels of brine) to the United Kingdom (London) reached 20 million.

The Pacific oyster, *Crassostrea gigas* was introduced to Tasmania in 1947 by the Commonwealth Scientific Industrial Research Organisation (CSIRO) who obtained the original stock from Japan. A small industry soon developed based on wild caught spat (on tarred sticks) similar to methods used by the NSW Sydney Rock Oyster industry. As the industry grew, after several years of poor wild spat falls, it was obvious a reliable source of spat was required. In 1979 several growers amassed enough capital to build an oyster hatchery at Bicheno, on the East coast. Without this the embryo industry would have died.



Grade 'A' Pacific oyster

From its humble beginnings post World War II the last 10 years has seen the industry come of age. Production has reached some 2.6 million dozen from 96 leases, mainly inter–tidal, covering some 1,500 hectares, contributing A$10 million to the State's economy.

Three hatcheries now provide seed stock to satisfy the growing demand, including export of seed to the growing South Australian Pacific oyster industry. Direct employment is about 300 with nearly four times that figure employed in a supporting role.

TASEA Enterprises, a Tasmanian grower and marketing company, was formed in 1993. The company handles much of the Tasmanian oyster crop, conducts research to discover further market opportunities and is involved with aspects of product quality.

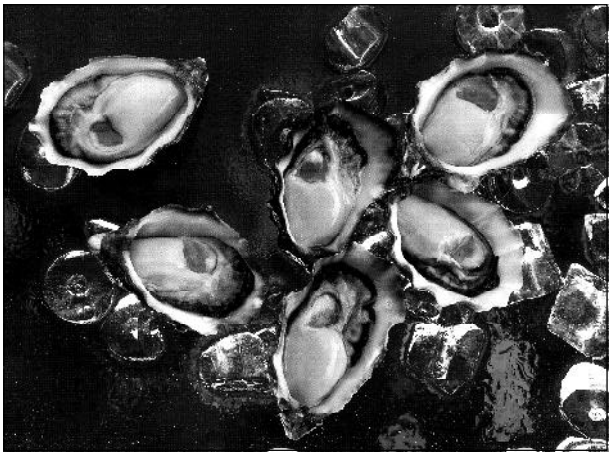
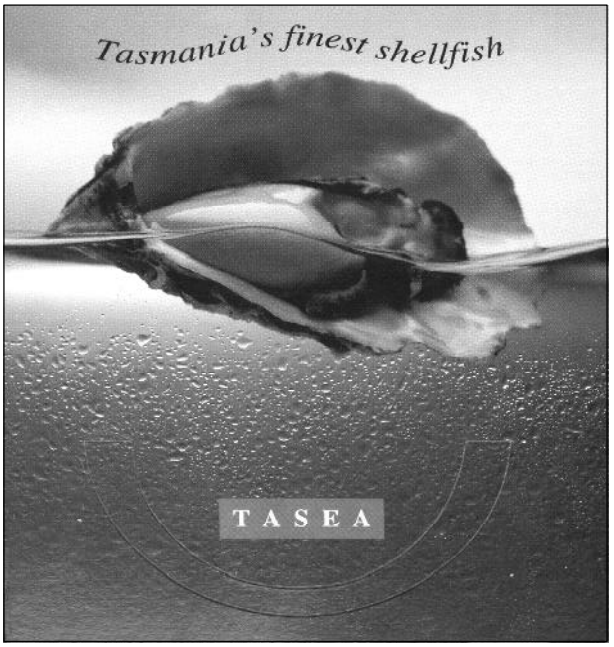


Image from the promotion brochure



Promotion card for restaurant table tops

Quality Assurance

Whilst Tasmania has had a water quality assurance program in place for some 15 years a serious outbreak of Hepatitis A in 1998 from contaminated Sydney Rock Oysters from farms at Wallis Lake in New South Wales brought the grower responsibility sharply into focus.

Public health scares are not confined to the area in which they occur and the Judges decision in the resulting class action in the Federal Court of Australia, brought by the victims, found not only the local council guilty of negligence for (accidentally) discharging sewage into the water but also the growers for selling a product unfit for human consumption.

The Tasmanian Shell Fish Quality Assurance Program (TSQAP) has employed world's best practice by conforming to the United States FDA shellfish guidelines and has become the model adopted by the Australian Shellfish Quality Assurance Advisory Committee (ASQAAC) for the Australian Shellfish Sanitation Control Program. The program constantly monitors all shellfish growing areas in the State. Any detected rises in coliform levels above the allowable standards or increases in toxic dinoflagellate activity results in immediate cessation of harvesting and closure of the growing area. Depuration is not used in Tasmania and is not an option. Through ASQAAC, and along with all other states, Tasmania is currently piloting the introduction of a National Biotoxin Monitoring Program, which will consolidate the state program already in place.

Key issues

With increased public awareness of aquaculture in Tasmania and objections to the pacific oyster in particular, expansion of the industry through a Marine Farm planning process has been tortuous and difficult. The Pacific oyster has adapted itself well in Tasmanian waters and some environmentalists see wild set as an important objection. In NSW, Victoria and Western Australia it is classified a noxious pest (as is the rabbit and fox)! Only Tasmania and South Australia have embraced it as a valuable species for aquaculture. Victoria and Western Australia have prohibited its cultivation and NSW reluctantly have allowed farming in Port Stephens only.

Environmental issues will dictate future development of the industry. Offshore sites for sub-tidal culture will be more acceptable than shoreline inter-tidal leases.

Matters of concern are disease risks. The European experience is not one to be followed. Regular disease surveillance of farmed and wild oyster populations, translocation protocols and continued prohibition of live shellfish imports from New Zealand and elsewhere will go a long way to reduce the risk of a major disease outbreak.

The Wallis Lake issue seriously damaged consumer confidence. The industry is therefore constantly being reminded of its obligation to ensure the quality of the product both in relation to safety (public health) and with regard to consumer appeal.

Research and Development

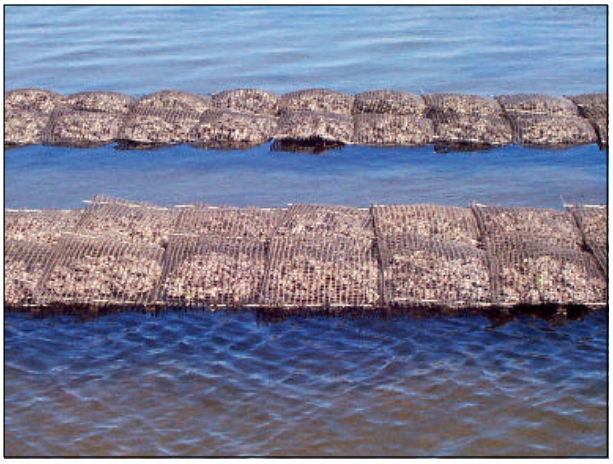
The Tasmanian Oyster Research Council (TORC) was established some 12 years ago to initiate and co-ordinate R & D for the State's pacific oyster growers. TORC is an industry body funded by a levy on seed sales to Tasmanian growers. As all the State's growers are reliant on hatchery seed for their production, it embraces the whole industry. The recent formation of SAORC, a similar body in South Australia, will continue participation of research projects for equal benefit.

Major projects have included research into the genetic diversity of pacific oyster stocks since their introduction, with a view to selectively breeding desired traits to produce a 'bigger and better oyster'. The selective breeding program is ongoing and has been one of the Fisheries Research and Development Corporation (FRDC) success stories. Commercial trials of the improved family lines are taking place on selected farm sites in the two States. Further information on this can be found in the article following this one. Other projects include an ongoing oyster disease testing program with an industry funded Pacific Oyster Health Program (POHP) which also looks to issues such as translocation, biosecurity and disease contingency planning within the Australian Aquavet program.

The encouraging results of the selective breeding program have resulted in a scaling down of triploid and tetraploid research. Market and grower acceptance of triploid oysters was not good due to discolouration of the meat. FRDC funding for selective breeding also involves South Australia who have co-operated with controlled grow out sites for trial stock produced in the Tasmanian hatchery.

Strategic planning by TORC has identified sub-tidal growing techniques and continued improvement of genetic traits as main priorities for future research as well as bio-security and environmental risk assessment.

Tas Pacific Oyster farm inter-tidal rack and basket method



Bags temporally laid on top of baskets to 'heal' oysters after grading before sale to on-growers

Research providers in Tasmania include CSIRO Marine Research Division and the Tasmanian Aquaculture and Fisheries Institute (TAFI), a joint body formed in 1998 between the University of Tasmania and the Department of Primary Industry Water and Environment. It is of particular interest that CSIRO are currently developing a genetic manipulation program for oysters aimed at addressing the problem of wild set – a problem causing the environmentalists some concern at present. TAFI is also involved with environmental issues, presently investigating the effects of shellfish farming on the benthic environment.

Shellfish research is very much 'industry led', but underwritten by strong funding from the Fisheries Research and Development Corporation.

Future Growth and Investment

The Tasmanian Industry expects to double production in the next few years. To support this growth the Tasmanian (shellfish) hatcheries are gearing up to meet the increased demand from both local and South Australian growers.

The increase in demand for the domestic live oyster market must come from improving the quality or lowering the cost of production. Future markets will include frozen and value added oysters for the 'ready to eat' supermarket category. Also top quality product to export to SE Asia. Sub tidal growing techniques will lower production costs, and, with good marketing will provide opportunities into other markets for the Pacific oyster.

A typical harvest ready for collection from the farm

Further information

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THE AUSTRALIAN STUD OYSTER

Bryony Bennett, CSIRO Marine Research Communication Group

A superior oyster

The stud oyster, sire of a long line of large, luscious, seductively-proportioned and sensuously-hued seafood to tempt the Aussie palate, will soon become a reality. Lines of superior oysters that grow faster and look better will be developed as a result of a landmark agreement to commercialise a selective breeding program developed by Tasmanian scientists. The deal promises to boost the quality and efficiency of Australia's $25 million-a-year Pacific oyster farming industry.

The new technology will be adopted via Australian Seafood Industries, a company recently established by the Tasmanian Oyster Research Council, the South Australian Oyster Research Council and the South Australian Oyster Growers' Association. It will ensure both oyster growers and consumers benefit from higher-yielding, faster

growing and more uniform Pacific oysters, with the shape and colour favoured by local and overseas markets.

Seed Pacific oysters, bred to be faster growing and more uniform

Collaboration between scientists and industry

Scientists from CSIRO Marine Research and the Tasmanian Aquaculture and Fisheries Research Institute (TAFI) at the University of Tasmania began selectively breeding Pacific oysters in 1995, with funding from the Fisheries Research and Development Corporation (FRDC) and the former Co-operative Research Centre for Aquaculture. They also have received considerable support from industry. The agreement — between Australian Seafood Industries, CSIRO, TAFI and FRDC — ensures the continuation of this collaboration. Director of TAFI, Professor Colin Buxton, says, "the commercialisation of this research emphasises the importance of scientists working hand in hand with industry. It will provide for superior lines of Pacific oysters, and their associated breeding records, to be made available to commercial oyster hatcheries".

The industry stands to gain enormously from securing rights to the selective breeding technology. A better Pacific oyster will improve the viability of the Australian industry, helping it to compete more effectively with New Zealand products in domestic markets and to expand further into export markets. The oyster-breeding program is using conventional genetic selection techniques similar to those used for centuries to improve the quality and productivity of domestic livestock.

Tasmania and South Australia are among the few places in the world where Pacific oysters are farmed in a closed system. In many other parts of the world, stocks are recruited from the wild, so they cannot be improved through genetic selection.

Research background

The selective breeding program takes advantage of the abundant genetic variation that exists in Tasmania's wild and farmed Pacific oyster stocks. It began in 1996/7 with a few fast-growing oysters and six family lines and now involves more than 100 families, each containing some 6,000 oysters. Some families are now in their fourth generation. In close collaboration with industry, all families have been spawned at commercial hatcheries at Bicheno on Tasmania's eastern coast. After spawning they are brought to TAFI in Hobart and grown for 12—15 weeks to almost 2 mm in diameter before being transferred to a nursery site in northern Tasmania. They are then grown out at five farm sites, three in Tasmania and two in South Australia.

From increased growth rates achieved so far, it looks as though it will be possible to reduce the growing period by at least 25 per cent. Selection for maturity and uniformity of size will contribute to a further reduction in production costs due to reduced handling. Other benefits will include the development of Pacific oyster strains suited to particular farm locations, and the eradication of deleterious traits such as shell deformities.

In related research, molecular markers have been developed so that Pacific oyster families can be identified through DNA analysis. A preliminary genetic map of the chromosomes locating major Pacific oyster genes for growth has also been developed.

Further information

http://www.marine.csiro.au/

SEA URCHINS – THE NEW CAVIAR?

Ioan Einion, FIS.com

New breeding techniques to ensure sustainable sea urchin stocks for human consumption are currently being developed in Scottish deep sea lochs by fish farmers and marine scientists. The lochs are in north-west Sutherland and the spiny shellfish is rapidly on its way to becoming one of Scotland's most lucrative exports, which will hopefully have a culinary appeal to rival that of caviar.

Loch Duart Ltd has been developing the breeding programme. The firm's sales director Andrew Bing said "There is a huge market in Europe and our aim is to grow around 100,000 items per annum by 2003 for customers in France, Holland, Belgium, Switzerland, Germany and the emerging UK market."

Sea urchin roe is the only edible part of the shellfish and is now recognised as a substitute for high-class sturgeon caviar at many restaurants. A 100 g serving can fetch as much as £10 and the international market for the roe is estimated to be worth £200 million. The current major exporters for sea urchin roe are the US, Chile, Korea, Iceland and Norway. The main market is Japan where the commodity is regarded as a delicacy and is given as year-end gifts. France and Spain are also principal importers.

Sea urchins have been considered a delicacy in the UK since pre-Roman times and until about a century ago they were part of the normal diet for many coastal communities. During the 1970s, French stocks became exhausted and native Irish stocks followed suit a decade later. Since then, prices have risen dramatically and Scottish fish farmers have been looking for a way to cash in on the potential market.

Green sea urchins (*Psammechinus miliaris*) are indigenous to Scotland but are too small to be commercially viable. However, after six years of intensive research, scientists from the government-funded marine laboratory at Dunstaffnage near Oban have managed to develop ways of breeding the shellfish in sufficient numbers to sell on to salmon farmers to complement their existing stocks. The research has revealed that the shellfish thrive on the high-protein pellets fed to farm-raised salmon.

Further information

FIS World News (http://fis.com/fis/worldnews), Friday, January 04, 2002
Shellfish News, Number 12, November 2001, page 24.

ANNOUNCEMENTS

UK MICROBIOLOGICAL LABORATORIES UNDERTAKING SHELLFISH TESTING

Resolutions of Third Meeting

A periodic meeting of laboratories undertaking microbiological testing of bivalve shellfish was held at DEFRA, Nobel House, London on 25 September 2001. The group comprises representatives from CEFAS Weymouth (the National Reference Laboratory), the FSA (Food Standards Agency), the Public Health Laboratory Service (PHLS), 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, 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. Advice would be produced on standardisation and accreditation of methods for *E. coli* and *Salmonella* targeted at end-product testing laboratories. Information on standard methods would be provided, as would details of the PHLS/CEFAS shellfish EQA scheme. The group would seek to place the advice in appropriate publications.

2. Specific advice would also be provided to end-product testing laboratories with regard to number of shellfish to be opened for testing, together with homogenisation and sub-sampling procedures. It was agreed that where standard methods did not currently specify a number for individual shellfish species, a minimum of 6 shellfish should be opened, homogenised and sub-sampled. The advice would include an explanation of any difference that variation in such procedures might make to the final results.

Further information

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SCOTTISH EXECUTIVE DESIGNATES 75 EXTRA SHELLFISH WATERS

Peter Johnson, FIS Europe

Shellfish farmers have received a major boost with the news that the number of protected waters around Scotland's coast has been better than trebled from 33 to 108.

The additional sites ought to result in improved protection for shellfish and other sea life around large areas of the coast. Added responsibilities have been given to the Scottish Environmental Protection Agency for guaranteeing seawater quality.

In answer to a written Parliamentary Question, Minister for the Environment and Rural Development Ross Finnie said: "Seventy five waters - stretching from Shetland to the Solway Firth - are to be designated for protection and take account of the views expressed in the recent consultation exercise."

"Our shellfish industry is a prime example of sustainable development. It provides valuable jobs in some of our remotest areas, and the quality of the water in which shellfish grow is important when marketing the product world-wide."

"These designations will be good for the industry and good for the wider environment and I am pleased to acknowledge the support of Scotland's shellfish industry in achieving the new designations."

Under the 1997 Regulations, which implement the Shellfish Waters Directive (79/923/EEC) in Scotland, measures are required to protect and improve waters that sustain shellfish life, thereby contributing to the quality of shellfish consumed by people.

The following areas will be designated as shellfish waters:

Argyll & Bute: Camas Nathais, Colonsay, Dunstaffnage, Gometra, Inverneill (Loch Fyne), Keills (Knapdale), Kerrera, Lealt (Jura), Linne Mhuirich, Lismore, Loch a'Chumhainn, Loch Craignish, Loch Feochan, Loch Gruinart, Loch Melfort, Loch Scridain, Loch Stornoway (Knapdale), Loch Striven, Lynn of Lorn, Shuna, Sound of Kerrera, Sound of Shuna, Tobermory, Ulva, West Loch Tarbert (three areas).

Dumfries & Galloway: Mull of Galloway.

Highland: Ardtoe and Loch Ceann Traigh, Black Islands (Kyle), Cuil Bay, Eddrachillis Bay, Enard Bay, Inner Loch Torridon, Isle Ornsay, Kyle of Tongue, Kylerhea, Little Loch Broom, Loch Ainort, Loch Caroy, Loch Dunvegan (two areas), Loch Eishort, Loch Ewe, Loch Glendhu, Loch Harport, Loch Hourn, Loch Inchard, Loch Leven, Loch Moidart (North Channel), Loch Moidart (South Channel), Loch Nevis, Loch Sligachan, Loch Sunart.

North Ayrshire: Fairlie.

Orkney: Bay of Ireland, Deer Sound, Inganess Bay, Sandside Bay, St Catherine's Bay (Stronsay).

Shetland: Busta Voe and Linga Voe, Cat Firth, Colla Firth, Gruting Voe, Ronas Voe, Ura Firth, Voe of Clousta, Wadbister Voe, Whale Firth, Yell (Basta Voe).

Western Isles: Loch Eynort, Loch Grimshader, Loch Leurbost (two areas), Loch Roag.

Further information

http://www.scotland.gov.uk/pages/news/2002/03/SE5574.aspx
FIS World News (http://fis.com/fis/worldnews), March 2002.

BURRY INLET COCKLES AWARDED MARINE STEWARDSHIP COUNCIL ECO-LABEL FOR SUSTAINABILITY

The Burry Inlet Cockle Fishery, South Wales, became the fifth fishery in the world, and the only mollusc fishery so far, to be awarded the Marine Stewardship Council (MSC) sustainability label last year. The fishery was awarded its certificate, as a responsible and well-managed fishery, by Moody Marine, an independent company based in the United Kingdom.

The fishery is based on hand raking and sieving of cockles from within the Burry Inlet estuary. This type of fishing is 'low-impact' in ecological terms. It is licensed and regulated by the South Wales Sea Fisheries Committee (SWSFC) under a Regulating Order issued under the Sea Fisheries (Shellfish) Act 1967. Regulation, combined with regular and effective inspections, has led to a management system with operational criteria that require exploitation of the cockle stock to be responsible and sustainable. Scientists from SWSFC and/or CEFAS make an annual scientific assessment of the cockle biomass.

The fishery yielded over 7,000 tonnes of cockles to 55 full-time licence holders in 2000. Although cockles are mainly sold locally they are also sold to UK retailers, and some are exported to Spain, Holland, France and Portugal.

Phil Coates, Director of the SWSFC, said: "I am thrilled to accept this award on behalf of the South Wales Sea Fisheries Committee (SWSFC), the local fishing industry and World Wildlife Fund (WWF) USA who have sponsored our costs. Much of the Committee's work is in the vanguard of fisheries - environmental management, of which the Burry Inlet Cockle fishery is just one example".

"Certification to the MSC Standard is an independent external audit of our management performance as a stamp of future quality assurance, and one which we are only too pleased to endorse. Consumers can now be assured that the Burry Inlet cockle, always noted as being 'the most meaty, wholesome and flavoured' around, now comes from one of the best managed fisheries whose long-term future is secured by SWSFC."

Brendan May, Chief Executive of the MSC, commented: "We are extremely pleased that the Burry Inlet cockles fishery has been recognised as sustainable according to our International Standard and we hope it will encourage more fisheries to come forward to be recognised as responsible and well managed. This is an important boost to the UK fishing industry and for consumers concerned about the uncertainty which faces the future of our fisheries."

The full certification report can be found on the internet at:
http://www.msc.org/Docs/Burry%20Cockle%20Certification%20Report.pdf

The MSC was established in 1997 by Unilever and WWF. It has been independent since 1999 and is chaired by the Rt. Hon John Gummer MP. The MSC programme is open to fisheries irrespective of the size, scale, type, location or intensity and this is reflected in the two dozen fisheries currently at some stage of the fisheries certification process. The MSC's role is to recognise, via a certification programme, well-managed fisheries and to harness consumer preference for products from seafood products bearing the MSC label of approval. The MSC is currently building on its successes in certifying fisheries in the United States, United Kingdom and Australia. There are about 20 to 30 more fisheries at some stage of the certification process.

Further information

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A NEW OYSTER SHUCKER

From: FIS New Technology and Products

This oyster shucker was developed for small processing operations or restaurants.

The oyster shucker

For a restaurant the machine can be mounted on a rolling cart that has refrigerated wells beneath for fresh oysters in the shell and another well for shells. It can be mounted next to a raw bar, where it becomes a curiosity item because of the sound of air dumping after each cycle. The machine can be fitted to run with an inexpensive portable CO_2 gas cylinder on a cart as well.

A single shucking head is standard, but larger processing operations can use a multi-head design for increased capacity. Properly handled, even a more delicate shell like a scallop can be shucked as well (although extra care must be taken to minimise breakage with smaller sizes).

An inexperienced person can shuck up to 14 oysters per minute. The top shell is popped off leaving the oyster intact and still connected to the bottom of the shell.

Features include:

- Eliminates the contamination of dirty oyster shucking gloves
- The operator cannot be stabbed and bleed on the oyster being shucked
- Will operate off a small air compressor at 80 psi.
- A busy raw bar does not have to pre shuck raw oysters for the busy happy hours; it can keep up with demand as needed
- All stainless, only need to hose off the machine after each shift

Further information

http://www.mrfish.com/buy-sell-trade.html
E-mail: mrfish@mrfish.com

‘FRESHER UNDER PRESSURE’™ TECHNOLOGY TAKES OFF

Adopted in the USA

The innovative Ultra High Pressure (UHP) process for the automatic shucking of oysters is rapidly becoming accepted technology in the USA. One company alone is now producing around 50,000 UHP oysters per day. Originally, research into UHP was focussed upon removal of Vibrio strains, which had caused considerable issues in the USA industry and still occur today with non-UHP product. UHP kills all strains of Vibrio but from a more commercial point of view, automatically and perfectly shucks the oyster. Additionally, the oyster meat is slightly larger post-UHP due to slight ingress of process water and remains so during shelf life. Customers for this process include Motivatit Seafoods, Inc., Louisiana, producers of the ‘Gold Band’ oyster and Nisbet Oyster, which is the first West Coast company to adopt Fresher Under Pressure™ technology for use with oysters.

How UHP works

High Pressure can kill micro-organisms by interrupting with their cellular function without the use of heat that can damage the taste, texture, and nutritional value of the food. Hydrostatic pressure creates no shear force to distort food particles. Thus, any moist food such as a whole grape can be exposed to ultra high-pressures without being crushed. You can create a hydrostatic pressure by squeezing on a water-filled plastic bottle. No matter how hard you squeeze, you can not crush a grape placed inside. One of the unique advantages of ultrahigh-pressure processing is that pressure transmission is instantaneous and uniform. Pressure transmission is not controlled by product size and no edge or thickness effect takes place. The ‘mechanism’ of high-pressure based bacteria kill is low energy and does not promote the formation of new chemical compounds. Vitamins, texture and flavour are basically unchanged. For example, enzymes can remain active in high pressure produced orange juice. Due to the low compressibility of water, the amount of energy needed to compress food is relatively low. UHP is more energy efficient than many high temperature food production methods. In addition, UHP requires only electricity and water and results in no dangerous emissions.

Here at last is a proven way to radically improve the sales and marketing attraction of oysters to the home and export market.

Further information

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http://www.fresherunderpressure.com

MAJOR NEW EDITION OF CRUSTACEAN FARMING BOOK

Crustacean Farming: Ranching & Culture
Authors: John F. Wickins & Daniel O’C. Lee
Second edition

The second edition of an extremely well-received book, *Crustacean Farming*, deals with all cultivated crustaceans of commercial significance, shrimp, prawns, crayfish, lobsters, crabs, and spiny lobsters, and examines the criteria by which both the feasibility and desirability of farming proposals are assessed. The characteristics and production methods of farmed and candidate crustacean species are described in sufficient detail to enable areas of profitable involvement to be distinguished from other opportunities presenting only very high risks and possibilities for serious loss. Coverage extends right from broodstock acquisition and management through to the operation of hatcheries, nurseries and on-growing units to key aspects of processing and marketing. New to this second edition are ranching and re-stocking operations together with the culture of ornamental shrimp and small crustaceans used as live food in fish and shellfish hatcheries. The sections on crustacean diseases, genetics and nutrition have been extended in the light of recent research advances.

The consequences of recent research and technical developments are considered, together with concerns over genetic and animal welfare issues. Specific areas where further advances in technology are needed to improve the reliability or productivity of farming systems are highlighted. This important book is a vital tool and reference work for all those involved with crustacean farming world-wide.

The book is an illustrated hardback, with 464 pages (ISBN 0632054646), published by Blackwell Publishing.

Special offer

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NEWS FROM THE TRADE ASSOCIATIONS

SHELLFISH ASSOCIATION OF GREAT BRITAIN (SAGB)

A legacy of modern oyster farming

Peter May died on 28 March 2002
Another of the pioneers of modern oyster farming died recently. Peter May, who founded Exe River Shellfish at Starcross in the early 1970s was a born fighter, with 27 years' SAS experience and then as a bomb disposal expert, before starting to farm oysters and mussels.

It was not many years after the start of the new business that TBT antifouling paints started to be used on a wide scale for small craft. Oysters, which had grown well in the Exe and Teign in the early days, began to grow into the distorted 'hedgehogs', which later came to be recognised as a symptom of TBT poisoning. Peter was Chairman of the Mollusc Committee of the Shellfish Association of Great Britain through some of those years, when it led a highly successful campaign to have these paints banned on small craft. However, it was near impossible to make a profit from farming Pacific oysters during those years. Not only was most of the production misshapen with very small meats, but also growth rates were slow. There is no doubt that, in spending time and effort on that battle, Peter had less time for his business. By the time the initial problem had been overcome and TBT had been banned for small boats in 1987 he decided to sell up. Fortunately by that time David Jarrad, then Peter's assistant in the firm, was in a position to buy the company and develop it.

Since giving up active oyster farming, Peter worked as an EU fisheries inspector, mainly aboard Spanish boats fishing in the North West Atlantic; never one to duck a tough life!

Today River Exe Shellfish Farms and Abbotsbury Oysters, also owned by David Jarrad, are leaders in the business. Last year was another one full of problems, as much of River Exe Shellfish's business is through direct sales at county shows, many of which were cancelled because of foot and mouth disease. Running an oyster farm is fraught with problems, but David is optimistic now that the shows are opening up again. Abbotsbury Oysters has its own retail outlet and seafood bar, beside the purification tanks. The water classification in the Fleet was downgraded from Class A to Class B eighteen months ago and SAGB is continuing to press the Environment Agency to ascertain whether there is any explanation for this, or whether it is simply an artefact of the classification system. What is not in doubt is that the oysters are of superb quality, much improved by new management practices, and the health record is excellent.

Abbotsbury Oysters

Shellfish association calls for national development strategy

Last year the Shellfish Association of Great Britain (SAGB) drew up a proposed strategy to develop both the UK's shellfisheries and shellfish aquaculture. The Association feels strongly that the UK has lacked the foresight to develop one of its valuable resources in the way that, for example, Ireland has done in recent years. Shellfish are now the most valuable component of UK fishery landings, but shellfish aquaculture has been slow to develop, and is beset by problems of water classification, algal toxins, and demands for environmental impact assessment from conservation bodies. This is despite its credentials as one of the most environmentally benign of food production methods. Problems for those in the industry are compounded by the large number of authorities involved and the almost complete lack of integration in planning.

The Association sees as a pre-requisite, a new Coastal Management Act to provide the basis for management and optimal exploitation of inshore fisheries out to 12 miles, with an effective control over other member state vessels fishing their historic access areas. Within this zone, there is a need for an integrated development body, with regional representation, to co-ordinate activities. This could be based on a revised Sea Fisheries Committee structure, at least in England and Wales.

The Association believes that an improved system of tenure for shellfish farming and re-stocking is needed to give long-term security for investors, possibly through a modernisation of the terms of Several and Regulating Orders. There would need to be localised planning to identify resources and draw up management plans for

optimum exploitation. Stock monitoring and research programmes need to be re-vitalised to ensure sustainability. Where appropriate, stock enhancement should be encouraged.

The methodology for applying shellfish hygiene legislation needs to be more coherent and transparent, and also needs to be combined with more effective pollution control. Best practice needs to be applied throughout the production cycle, from cultivation or exploitation, with a minimisation of environmental impact, through processing and transportation. Co-operative ventures in processing and in transport need to be encouraged, to bring the benefits of economies of scale to small producers.

The SAGB has been actively promoting this key package of proposals but the fisheries profile seems to have sadly slipped down the list of Government priorities. All involved in the industry are encouraged to pressurise for a long-term strategy for the optimum exploitation of inshore shellfisheries.

Further information

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ASSOCIATION OF SCOTTISH SHELLFISH GROWERS (ASSG)

VIEWS FROM THE ASSG

Consultation and the FSA

Industry members will recall the SEERAD consultation on 'aquaculture regulations' of last year. One of the concerns I expressed at that time was that the shellfish sector was, to a large extent, no longer actually regulated by SEERAD, and that the Food Standards Agency (FSA) now exercised a significantly greater influence over our operations, from Harvesting Area Classifications through biotoxin monitoring to hygiene standards for delivery of product. As a result the consultation was addressing finfish issues rather than the outstanding concerns of the shellfish sector.

My reaction was, therefore, a combination of relief and satisfaction when a letter from St Magnus House landed on my desk announcing a "review of the shellfish programmes that [FSA] maintains in Scotland in support of EU Shellfish Hygiene Directive 91/492". The justification for the review ("the increasing scale and complexity of current arrangements") and the terms of reference for the effort ("kept deliberately broad to allow a flexible and responsive approach") are understandable and laudable, as well as, from the industry's viewpoint, timely and responsible.

This opportunity to communicate our concerns and practical difficulties over some of the policies currently adopted by FSA must be grasped by all shellfish operators, not simply left to trade association representatives. The views from the beach, the boat and the depuration centre must be incorporated into the exercise, and to this end I hope that there will be a broadly based input to the review.

If we are to achieve industry objectives, such as the revision of the 'Trigger Value' for ASP in scallops incorporated in the recent Commission Decision, then we must seek to maximise our synergy and our natural alliance of interest with public health organisations such as the FSA. We cannot succeed by cutting ourselves off from their not insignificant governmental influence, never mind their regulatory responsibilities. And when the European equivalent is created in the near future it will be similarly essential to inform the officials there of our views and enhance their understanding of industry's concerns.

But the regulatory environment is only a platform from which the industry must develop on a profitable and sustainable basis. There is an urgent requirement to seek a satisfactory solution to the variable geometry of optimisation between the conflicting demands of protection of consumers from exposure to risk and the maintenance of a commercially viable production sector. This is the case in the current example of the Commission Decision over the tiered marketing regime for scallops, where a minimal problem is being resolved with an exaggerated and excessive response. Industry will suffer significant constraints, for no measurable improvement in public health protection.

Other consultation

Meanwhile, other consultations continue, ranging from a second round on the implementation of the 'Water Framework Directive', through a Phase Two of a Scottish Parliament Committee investigation of aquaculture, the Scottish Executive evaluation of a

framework of strategic principles for aquaculture and 'Locational Guidelines for Aquaculture', to 'Contaminants in Food'. Participation in decision-making is hard work!

Marketing

Turning to the commercial world of sales/prices/ margins, despite all the talk from market 'experts' about the European market being mature, stable, predictable, etc, reality checks can still throw up cold water showers of the unexpected! And Regulatory restraints and physical constraints can still lead to major market movements (that is, prices!!). When the price of scallops declines sharply following the lifting of FEPA orders on harvesting, and when mussel prices strengthen significantly as a result of unexpected poor growth rates and meat condition in Dutch and French supplies, its the hot-wired operators who can take advantage. And the Scottish cultivation sector still appears to lack the scale, strength, stability and long term vision to be able to take advantage of market perturbations. With the overwhelming majority of output committed under medium/long term contracts, there is no real ability to exploit the advantages that appear on the 'spot' market.

There is a vast gap in the provision of market intelligence, a gap that has been noted for many a long year, but limited resources have always prevented either the industry or its public sector support mechanisms from replicating the *'Bord Iascaigh Mhara'* (BIM) data gathering network (including an 'eyes-and-ears' office in Paris). Without such insights into real-time trends in market volumes and values there is always the potential that the shellfish sector will slip into the commercial 'black hole' that has consumed the Scottish salmon farming industry, an unprofitable slog, characterised by bitter internecine price competition reflecting neanderthal 'hog cycle' psychology ("incremental volume will offset market price reduction to maintain revenue").

Perhaps the resources of *'Scotland Europa'*, or a proportion of the commercial personnel resource based at the Scottish 'Embassy' in Brussels at Rond-Point Schuman, could be brought into the loop of support for our industry. After all, overseas assistance for commerce should not be limited to the organisation of trade missions and a credible source for market data and legislative developments could be a powerful tool of support for our sector.

In the 'protein war' aftermath of food safety concerns (e.g. BSE, FMD, dioxins, PCBs, 'Angel Dust', gender benders and E coli 0157, to name but a few), shellfish has the opportunity of self-promotion as a natural, sustainable, additive free, culinary- and consumer-friendly alternative. But only if we manage to avoid any collateral damage from the fallout of these consumer concerns. Long term success will require the adoption of an inclusive and comprehensive vision, side-stepping the desperate short-termism that tends to plague all primary producers.

Role of the ASSG

The ASSG will continue its efforts to protect growers from inappropriate legislation and to encourage the creation of a supportive regulatory framework, while also promoting the development of tools to improve market transparency. These dual aims are intended to enhance the expansion of a dynamic shellfish cultivation sector, contributing to the sustainable prosperity of rural and coastal Scotland.

Further information

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SCALLOP ASP STEERING GROUP

The *ad hoc* UK *'Scallop ASP Steering Group'* (SASG) has been established following on from the meeting in Brussels on 7 December 2001 between representatives of the scallop sector from Scotland (catching sector, divers, cultivators and processors), Ireland and France and DGs SANCO and FISH, plus the Chairman of the DG SANCO advisory ASP Expert Working Group. The remit of this group is to defend the interests of the industry, which are not incompatible with safeguarding the public health standards for consumers.

This is an inclusive, not exclusive, approach. SASG will welcome all contributions of comments, proposals, networking opportunities, but there is a clear need for a central organisation to channel effort towards the common objective and avoid wasteful duplication of effort and resources.

The Brussels meeting had opened with a series of introductory statements from the main representatives, which from the Scottish representatives included:

- Identification of the economic costs of the proposed measures in terms of impact on industry, whilst reiterating our primary concern for consumer welfare;

- Highlighting that the incremental health safeguards for the consumer were uncertain but the socio-economic impacts were clear;
- Stating that we recognised that the issues to be debated at this meeting were primarily those of the science, not the economic impact.

It was agreed that the central objective of this meeting was to initiate a discussion on the scientific basis of the ASP Expert WG recommendations, which in turn had formed the rationale for the drafting of Commission Decision SANCO/1953/2001 (Rev-5), which had been 'Technically Approved' at the SVC meeting of October 2001.

The main thrust of the DG SANCO/CRL arguments can be summarised as:

- The Directive/Law says that product with a toxin loading of more than 20 ppm of Domoic Acid should not be placed on the market. Therefore, operating a regime with a mean of 20 ppm was illegal (by definition, at a mean of 20 ppm there must be some proportion above 20 ppm).
- On the basis of the data, in particular in view of the inter-animal variability, it was therefore essential to enforce a lower cut-off point ('Trigger Value'), which, with the target of achieving a 1 in 1,000 probability with a 50% co-efficient of variation, was 4.6 ppm.
- Any other regime (recognising that ASP toxification events in scallops were relatively long lasting) would lead to consumers suffering chronic, long term exposure, with unknown negative health effects.

The objectives of SASG, in the aftermath of the Brussels discussions, are to:

- Co-ordinate communication with EU Institutions, UK Government, relevant agencies and fellow industry representatives;
- Manage representational and PR efforts, in order to present a coherent and consistent approach;
- Establish the specification of a Programme of research project proposals;
- Submit the Programme of projects to a comprehensive 'pool' of potential funding agencies, including the Enterprise Networks (both HIE and SE), local authorities, agencies (such as SFIA, FSA and SEPA), Research Councils, and other organisations (such as Crown Estates, Fishmongers' Company) who will be invited to operate as a consortium to co-operatively fund the programme of research.

The Outline Programme of Research initially includes the following projects:

- Establish a formal legal opinion on the relative merits of the opposing DG SANCO and industry interpretations of the Directive (91/492), respectively: DG SANCO - an absolute prohibition of 'placing on the market' scallops with ASP in excess of 20 mg/Kg (i.e. 20 mg/Kg is a ceiling value); INDUSTRY - that given the guidance to sample (10 animals/animal parts) and assess the 'batch' on the basis of a geometric mean, it is the average that must not exceed 20 mg/Kg;
- Carry out a market research survey of typical/median scallop 'portions' in meals, both catering and domestic, in the main European markets for scallops (UK, France, Spain, Belgium and Italy); this data is critical to the determination of a credible risk assessment of consumer 'exposure' to toxin loading in scallop products;
- Review the statistical manipulation of the data sets used in the analysis presented in the report to the ASP Expert Working Group by the UK NRL for marine biotoxins in January 2001 ("Domoic Acid in the King Scallop");
- Review the data sets used in the analysis referenced above, as there is established evidence that pre-spawning gonad toxic concentration can rise dramatically post-spawning, as the toxin appears to be associated primarily with the digestive loop passing through the gonad. Yet in post-spawning conditions the gonad would not be marketed, i.e. the reality is that human exposure to toxin would have declined while non-discriminating monitoring would indicate that the risk had risen significantly;
- Initiate a robust toxicological investigation of the validity of both the Action Level and the proposed Trigger Value, combined with a project to establish NOAEL and LOAEL values, with the objective of identifying Daily and Weekly Tolerable Intakes; this work should include collaboration with Canadian authorities (who have had the greatest involvement with ASP, albeit with mussels, since the 1987 outbreak);
- In the longer term, define the criteria and establish a joint industry/Government Quality Control Scheme, supplementing the statutory HACCP schemes that the recast EU Food Hygiene Regulation will require for the processing sector, to assuage any consumer concerns over the safety of scallop products.

The SASG would welcome any further detailed suggestions for specific research projects aimed at establishing the disproportionate nature of the imposition of a Trigger Value of 4.6 mg/Kg.

Steering Group representation is as follows:

- Cultivation Sector: Doug McLeod (ASSG/EMPA);
- Capture/processing sector: John Hermse (Scallop Association);
- Processor/scientific advisor: Gordon Goldsworthy (ASSG/Loch Fyne Seafarms Ltd);
- Producer/processor representative: Clive Askew (SAGB).

Participation of the Scottish representatives at the meeting was part-funded by Highlands & Islands Enterprise and The Highland Council.

MONITORING REPORTS

THE MARINE BIOTOXIN MONITORING PROGRAMMES FOR ENGLAND AND WALES: 2001 - 2002

Michael Gubbins and Wendy Higman, CEFAS Weymouth Laboratory
Steve Milligan, CEFAS Lowestoft Laboratory

Introduction

The monitoring programme for algal biotoxins is a requirement of the Shellfish Hygiene Directive 91/492/EEC which is implemented in England and Wales by the Food Safety (Fishery Products and Live Shellfish Hygiene) Regulations 1998 as amended. This legislation requires EU member states to monitor for the possible presence of toxin producing plankton in production and relaying areas, and biotoxins in live bivalve molluscs.

In England and Wales the monitoring is divided into two separate programmes; flesh monitoring, where shellfish samples are collected from commercially active harvesting areas and tested for algal biotoxins; and water monitoring, where water samples are collected from selected harvesting areas and examined for potentially toxic algae species. The monitoring year runs from April to March and wherever possible the flesh and water sampling points correspond with the microbiological sampling points, as these are well defined and lend homogeneity to the different programmes.

The flesh monitoring programme for 2001-2002 included all areas in England and Wales where commercial harvesting takes place. Samples were collected on a monthly basis except in areas with a historic occurrence of algal biotoxins or toxic algae. In these areas samples were collected fortnightly between 1 April and 28 September 2001. On detection of biotoxins at greater than maximum permitted levels the affected sites were tested on a weekly basis until two consecutive negatives were obtained.

The water monitoring programme for 2001-2002 continued as a rolling programme, with water samples collected from selected shellfish harvesting areas, including all sites which have a history of potentially toxic algae or algal biotoxins. The purpose of the water monitoring programme is to give an early warning of the possibility of the presence of algal biotoxins in shellfish flesh.

The Food Standards Agency (FSA) has overall responsibility for ensuring that this monitoring programme is effectively carried out, and the CEFAS Weymouth Laboratory is responsible for identifying the sampling areas and co-ordinating the programme. The regional Food Authorities are responsible for collecting the water and shellfish samples from the designated sites, which are then sent to the CEFAS Lowestoft Laboratory for water analysis, and to the CEFAS Weymouth Laboratory for flesh analysis. Where biotoxin action limits are exceeded, the FSA determines the necessary course of action.

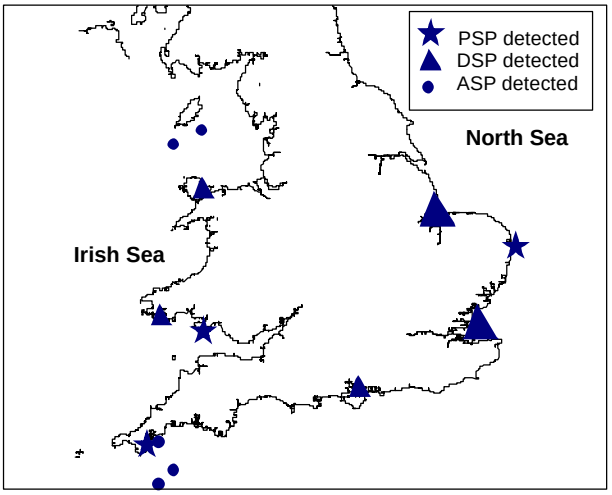
The results of the monitoring year April 2001 to March 2002 are reviewed below.

Results of the 2001/02 sampling programme

For the monitoring year commencing 1 April 2001, 34 harvesting areas were included in the primary shellfish testing programme, and 20 harvesting areas in the primary water testing programme. Additionally, there were 4 ports where samples of scallops were obtained. During this time 195 water samples were analysed from 23 harvesting areas, and 1,326 flesh samples were analysed from 67 harvesting areas. On these samples a total of 774 tests for PSP, 1,173 tests for DSP and 768 tests for ASP were carried out, giving a total of 2,715 tests undertaken during this period.

The map opposite shows the incidence of algal biotoxins in the 2001-2002 monitoring year. PSP toxins were found in 5 samples from 4 areas, however all of these positives were below the action limit and all were in areas where PSP had been found in previous years. DSP tests were positive for 166 samples from 5 areas, the most significant ones being the Thames (including Pegwell Bay and the Colne for the purpose of this report) the Burry Inlet and the Wash. The other affected areas were Anglesey in North Wales and the Solent. The Thames had several zones shut down during June, July and August and again in October and November and remained closed into April. The Burry Inlet cockle fishery was closed in July 2001 and remained closed at the time of production of this report (April 2002). The Wash was found to be positive during January 2002, and remained closed into March. ASP toxins were found in 10 samples from 3 areas: The Fal (an inshore fishery), and two offshore fisheries: the Irish Sea around the Isle of Man and the South West English Channel off Plymouth (see map). Only one of these samples exceeded the maximum permitted level (set at 20 µg/g) and this was a sample from IS 15 off the SE coast of the Isle of Man where ASP was detected at 20.7 µg/g in

whole shellfish. A subsequent sample from this box was found to be below the action limit.



Algal biotoxins detected in shellfish flesh in England and Wales during 2001-2002

Action taken to protect customers

The action limits used for water samples and the maximum permitted limits used for shellfish samples are listed in Table 1. If, when analysed, the water samples exceed the specified action levels, then samples of shellfish within the same harvesting area are collected for biotoxin screening. If the maximum permitted levels for ASP or PSP toxins exceed the maximum permitted levels, or if DSP is detected then the harvesting area will be closed, preferably by means of a voluntary closure agreement. If for any reason a voluntary agreement is not possible or the detection of toxicity is over a large area then the production area is closed by statutory means.

Table 1. Action limits and maximum permitted levels

Water		Shellfish flesh	
Algal Group	Action Limit (cells/l)	Toxin	Maximum Permitted Levels
Alexandrium Spp.	Presence	PSP	80 µg per 100 g
Dinophysis/ Prorocentrum Spp.	100	DSP	Presence
Pseudonitzschia Spp.	150,000	ASP	20 µg per g

PSP

A total of 774 tests for PSP have been carried out during the 2001-2002 monitoring programme, and the results of these tests are summarised below. No samples tested during the year exceeded the maximum permitted level (MPL) for PSP set at 80 µg per 100 g flesh. However PSP toxicity below the MPL was detected in 5 samples of shellfish from 4 areas: The Fal on the SW English coast, Blythburgh Creek on the East coast, Milford Haven in SW Wales and scallops landed at Fleetwood on the NW English coast. All of these samples were from areas where PSP has been found in previous years. The highest level of PSP detected during the year was found in mussels from Malpas and Turnaware in the Fal during June at a level of 51 µg STX/100 g. This corresponded with the presence of *Alexandrium* cells in water samples taken at Turnaware during June and July when a maximum concentration of 200 cells/l was found in June. Toxins were also found in mussels from Blythburgh Creek in July and at Coedcanlas Spit in Milford Haven during July, however the concentration found in the shellfish flesh was less than the maximum permitted level. The scallop sample landed at Fleetwood was caught off the Scottish coast during July and again this sample was below the action limit. Three other sites around the country did show to a greater or lesser extent the presence of *Alexandrium* cells in water samples taken during the year, these sites were: Weymouth Harbour, Wyke (Portland harbour) and Fowey, all areas where *Alexandrium* has been identified in previous years. The highest concentration was again found in Weymouth Inner Harbour, which yielded a count of just over 855,000 cells/l during July. This area has a history of *Alexandrium* blooms and as before there was no associated toxicity in shellfish sampled from the area. Once more the Fal Estuary was the only area where the presence of *Alexandrium* in water samples was coincidental with PSP toxins being found in shellfish flesh.

DSP

A total of 1,173 tests for DSP were carried out in the 2001-2002 monitoring year, and the results are summarised below. Toxicity was detected in 166 samples from 5 areas, and although this shows a drop in prevalence over the previous year, the effect was significant on three areas in particular. The Burry Inlet has been closed to harvesting since June, the Thames has been affected for several months during the season and the Wash has been affected since January 2002. The earliest detection occurred in May, when DSP was found in mussels sampled from Wreck Marker in the Colne (tested and reported by the MLA).

The occurrence of DSP in The Thames, The Wash and the Burry Inlet in particular has caused large scale closures (TPOs and Voluntary Closures) within these shellfisheries. The Burry Inlet, a significant cockle harvesting area, has been closed to harvesting since July when cockles from the NE monitoring point tested positive for DSP. Since then, over 250 samples have been tested from this small estuary of which 67 have been positive. During this period mussels from within the estuary have tested negative for DSP. Areas within the Thames estuary were affected from June until September, and then again in November and December

with cockles testing positive for DSP, again as with the Burry Inlet other shellfish species sampled from the Thames during this time have all tested negative for DSP. Within the Solent area toxicity occurred in one sample of native oysters from Netley collected in June (This sample was sent in error by the sampling authority to the MLA, who undertook the test and reported the positive). The Wash has tested positive for DSP for the first time since monitoring started, again cockles were the affected species. Although the fishery is closed for harvesting during the winter, it is a significant area for cockle harvesting.

The peak DSP frequency was reached during March 2002, a month in which there were 27 samples positive for toxicity in three areas (Thames/Pegwell Bay, Burry Inlet and the Wash), and the total positives for all the summer months (July-September) was 43. In contrast to the high number of flesh samples that were positive for toxicity, there were only 23 water samples in which algae associated with DSP were identified. The highest levels were recorded off Blyth in Northumberland during July when a count of 5,500 cells/l was recorded. The positives affecting the country's shellfish grounds meant that a number of closure orders were placed over the period of the monitoring programme, and significantly two closure orders are still in place: one covering the Burry Inlet in Wales for cockles. This site has been positive for DSP since June 2001 and toxicity has been identified in samples taken in every month since then up to the end of March 2002.

ASP

A total of 768 tests for ASP have been carried out this monitoring year, and the results are summarised below. Toxicity was detected in 12 samples from three areas (Irish Sea, South West English Channel off Plymouth and The Fal) during the 2000/01 monitoring programme. However, only one of the samples exceeded the action level for ASP, and subsequent tests on other samples were negative for ASP. The highest level recorded, and the only one to exceed the action level, was in whole scallops from IS 15 (in the Irish Sea off the Isle of Man) landed at Fleetwood. This was measured at 20.7 µg/g. Follow up samples for this positive were undertaken on processed scallops from the same area and these tests were negative. The remaining 11 ASP positives were all below the action limit. Cells of *Pseudonitzschia* spp., the organism responsible for ASP, were found in only 14 water samples, at levels up to 39,000 cells/l^{-1}, which is below the action limit. The number of times ASP was detected in scallops (60% of the ASP positives in England and Wales were in scallop samples), coupled with the closures in scallop grounds in Scottish waters this year confirms that this is an important toxin with regards to this species.

THE MARINE BIOTOXIN MONITORING PROGRAMMES FOR SCOTLAND: 2001 - 2002

Godfrey Howard, Eileen Bresnan and Joyce Petrie, Fisheries Research Services, Marine Laboratory, Aberdeen.

Introduction

Fisheries Research Services (FRS) has conducted an extensive monitoring and surveillance programme for marine biotoxins in bivalve mollusc flesh in Scotland since 1991 and for the causative phytoplankton since 1995. The monitoring programmes are operated to comply with the requirements of the shellfish hygiene directive, 91/492/EEC, and with the current UK implementing legislation, The Food Safety (Fishery Products and Live Shellfish) (Hygiene) Regulations 1998, as amended.

The programmes are undertaken on behalf of the Food Standards Agency (Scotland) (FSAS).

Marine biotoxins are produced by certain species of phytoplankton and can accumulate in the tissues of filter feeding bivalve molluscs. The toxins pose a health hazard to human consumers, and the monitoring programmes are designed to ensure that no potentially hazardous shellfish are placed on the market for human consumption.

The monitoring is carried out on bivalve mollusc samples from classified harvesting areas, and from offshore scallop fishing grounds; sampling is undertaken throughout the year. The programme is based upon a sampling frequency of monthly during the period October to March, and weekly, fortnightly or monthly during the period April to September. The sampling frequency is based on a risk assessment of each site, which takes account of the shellfish production and the historical occurrence of toxins. Sampling frequency is increased if toxins are detected, and species other than bivalve molluscs may be tested.

During the period 1 April 2001 to 28 February 2002, 673 phytoplankton samples were analysed from 25 inshore sites around Scotland, and from 7 offshore areas. A total of 6,298 shellfish samples were analysed, of which, 1,876 were analysed for Paralytic Shellfish

Poisons (PSP), 1,583 for Diarrhetic Shellfish Poisons (DSP), and 2,839 for Amnesic Shellfish Poisons (ASP).

Results of the 2001 – 2002 Monitoring Programmes

Phytoplankton

During May and June *Alexandrium* spp. were recorded in high numbers along the east coast of Scotland and in the Orkney and Shetland Islands. The maximum number recorded during this period was 2,200 cells.l^{-1} on 1 June in Scapa Bay, Orkney. A bloom of an *Alexandrium minutum* 'type' species was recorded in the Outer Hebrides in July. The highest number recorded during this time was 3,210 cells.l^{-1}.

Dinophysis cells were routinely recorded in Scottish coastal waters during 2001, with numbers peaking during July and August. In contrast to previous years when *D. acuminata* and *D. acuta* dominated the *Dinophysis* spp. community, in 2001, *D. norvegica* was also present in large numbers. The maximum number of *Dinophysis* spp. recorded was 33,800 cells.l^{-1}, found in Loch Inchard on the north-west coast on 30 July.

Pseudo-nitzschia spp. were routinely found in water samples from coastal and offshore samples, although frequently at levels less then 50,000 cells.l^{-1}. The maximum cell number recorded was 510,200 cells.l^{-1} in Loch Spelve on the Isle of Mull on 20 April. This bloom was composed mainly of *P. delicatissima* 'type' cells. *P. seriata* 'type' cells were recorded in high numbers later in the year with 321,700 cells.l^{-1} recorded in Loch Ewe on 22 September.

Shellfish

Inshore Harvesting Areas

The occurrence of PSP was first noted in early May when toxins were detected in mussels from Loch Dunvegan, Skye at 31 µg STX/100 g tissue. By late May, toxins had been detected at other sites in Skye, Loch Torridon, the Firth of Forth, and at several sites in Shetland. Levels in Loch Torridon and in Mid Yell, Shetland exceeded permitted levels and Voluntary Closure Agreements (VCA) were introduced. At the beginning of the season, VCA agreements were initiated by FRS, but from 1 September became the responsibility of FSAS. Harvesting restrictions and VCAs were also introduced in early June for mussels at St Abbs (142 µg STX/100 g), Scapa Flow (145 µg STX/100 g) and Inganess (299 µg STX/100 g) in Orkney, and Linga Voe (211 µg STX/100 g) and Clousta Voe (164 µg STX/100 g) in Shetland. Levels in Loch Torridon had increased from an initial 80 µg STX/100 g on 21 May to 220 µg STX/100 g on 4 June. In early June PSP toxins had been detected over large areas of the west coast and the Western Isles, Loch Inchard (112 µg STX/100 g), West Loch Roag (101 µg STX/100 g), Loch Hourn (214 µg STX/100 g), Loch Dunvegan (405 µg STX/100g), Loch Greshornish (148 µg STX/100 g) and Loch Scridain (79 µg STX/100 g). Further VCAs were introduced as necessary. By mid-July levels had dropped in most areas, and by the end of that month PSP was not detected in inshore areas except for some low residual levels at few sites.

While PSP was proving a problem in some areas, DSP toxins were also being detected in others. Unusually, in April, DSP was detected in mussels from Kylesku, and at three sites in Shetland. These outbreaks were short-lived. Nothing further was detected until late May, when mussels from Loch Leven proved positive and also from Loch Ewe and Loch Torridon in early June. Queen scallops from Broadford Bay also proved positive at this time. By mid-June, further positives had been detected in mussels from Scapa Flow, Loch Broom, and Glenuig Bay. During July DSP was detected in a large number of additional areas, including Lochs Inchard and Eriboll, Lochs Greshornish and Harport, and was appearing at sites in Shetland, and at St Abbs. During August, further positives were detected in mussels at more west coast sites, including Loch Laxford, Little Loch Broom, Loch Beag, Loch Kishorn, Queens from Loch Fyne and mussels from Loch Striven in the Clyde were also positive. Mussels from the Dornoch Firth tested positive in September. The FSAS implemented harvesting restrictions and VCAs where appropriate; in some instances these remained in force for some months, severely affecting shellfish harvesting at some sites.

At inshore aquaculture sites, ASP did not pose any problems, except at a few sites where scallops were farmed. Low levels of ASP toxins were detectable in whole scallops from Loch Ewe in April, but in late May levels here in whole scallops were found at 25 µg DA/g, and in scallop gonad tissue at 27 µg DA/g in Broadford Bay, and 64 µg DA/g in Loch Sligachan. By the end of June, levels at these sites had fallen to below the permitted level of 20 µg DA/g. Residual levels were still detectable at these and other sites near Kyle. In mid-July those at Loch Ewe again rose; 60 µg DA/g was detected in whole scallops in mid-August, and 26 µg DA/g in scallop gonad tissue from Kyle, and 43 µg DA/g in whole scallops from Broadford Bay. ASP levels continued to rise, and by early September, levels in whole scallops in Loch Ewe were >100 µg DA/g. In mid-September levels >100 µg DA/g were detected in whole scallops from sites in Lochs Crinan and Caolisport, and in October at Loch Ainort. These levels of toxicity have remained in whole scallops at most of these sites, and are still prevalent in mid-March. Harvesting restrictions were imposed as necessary, but in cases where whole scallops were affected, if gonad tissue levels were satisfactory, FSAS would allow shucked and processed material onto the market.

Offshore Scallop Grounds

In the course of the year, monitoring detected all three toxin groups in scallops from offshore fishing areas.

In early May PSP toxins were detected in scallops from grounds in Orkney, north of Kirkwall at 54 µg STX/100 g tissue, by late May toxins were more widespread, affecting east coast scallop grounds, and Scapa Flow. Levels in whole scallops on the east coast grounds were found at up to 108 µg STX/100 g tissue, in Scapa Flow up to 84 µg STX/100 g tissue, and north of Kirkwall up to 158 µg STX/100 g tissue. PSP levels continued to rise, in early June reaching 251 µg STX/100 g tissue in north Orkney, 321 µg STX/100 g tissue in Scapa Flow, and 167 µg STX/100 g tissue in the Moray Firth. Toxins were also being detected in North Minch grounds at 205 µg STX/100 g tissue. By late August , levels had fallen in most areas to below 80 µg STX/100 g tissue, however, isolated occurrences above this were still detectable. A resurgence of toxins in mid-October resulted in detected PSP levels of 314 µg STX/100 g tissue in the Moray Firth and 152 µg STX/100 g tissue in south-east Orkney. While isolated peaks were still detected in November, levels generally fell, although toxins were still detectable in March 2002.

Positive DSP results from whole scallops were found in most areas in May and June when tested by bioassay. However, subsequent chemical assays found little or no trace of DSP toxins. From August, chemical assays were used routinely, and no DSP was detected above trace levels.

ASP toxins continued to cause problems in scallop fisheries, and were continually detected throughout 2000, 2001, and early 2002. The toxins affected all major scallop fishing grounds during the course of the year. Scallop samples were obtained on a regular basis throughout the year from all grounds by fishing vessels specifically chartered for this task by the FSAS. Of the scallop samples analysed, 14% of gonad tissue samples had a toxin content of <20 µg DA/g tissue, while 6% had >20 µg DA/g tissue; of the whole animal samples, 12% had <20 µg DA/g tissue, 21% had between 20 and 99 µg DA/g tissue, and 17% had >100 µg DA/g tissue. FSAS imposed fishery closures under the Food and Environment Protection Act 1985, in areas affected by PSP, and where ASP toxins in scallop gonad tissue exceeded the permitted level of 20 µg DA/g tissue. In areas where ASP toxins in gonad tissue were below this level, but the total toxin loading in the whole animal was above it, then a requirement was imposed that scallops harvested from such areas must be processed before being placed on the market for human consumption. These restrictions were revoked whenever levels fell below the permitted limit. At the time of writing (late-March) six FEPA Orders were in force with restrictions on eight whole or part boxes, while shucking/processing requirements are in place for 93 whole or part boxes.

Further information

The Food Standards Agency (Scotland) will publish a summary of the annual reports for the Shellfish and Phytoplankton Monitoring Programmes in Scotland on their website later in the year, and full reports will also be available on request from the FSAS for a small administration fee.

THE *BONAMIA* AND *MARTEILIA* SAMPLING PROGRAMME 2001

Ian Laing, CEFAS Weymouth Laboratory

UK gains Approved Zone status

A programme of sampling and testing has been carried out since 1993 in support of the application by the UK for approved zone status in respect of the two oyster diseases Bonamiosis and Marteiliosis (EU Directive 91/67). All results have been forwarded to Brussels. The draft Commission Decision establishing UK approved zones with regard to *Bonamia ostreae* and *Marteilia refringens* was presented for an opinion at the March 2002 meeting of the Standing Committee on the Food Chain and Animal Health (formerly known as the Standing Veterinary Committee). It was approved unanimously (Commission Decision 2002/300/EC of 18 April 2002).

The UK has now achieved approved zone status for the whole coastline for *Marteilia* and approved zone status for the whole coastline for *Bonamia* except in the three restricted areas where the disease is found. These areas are (1) from the Lizard to Start Point; (2) from Portland Bill to Selsey Bill and (3) from Shoeburyness to Felixstowe.

Approved zone status has also been agreed for Northern Ireland, the Channel Islands, and the Isle of Man. The Irish Republic has gained approved zone status for *Marteilia* (whole coastline) and *Bonamia* (whole coastline apart from Cork Harbour, Galway Bay, Ballinakill Harbour and Clew Bay). No other areas in Europe have approved zones for these shellfish diseases.

Approved zone status enables us to operate import controls aimed at preventing the introduction of these diseases from elsewhere in the EU, where they are known to occur, or where no sampling and testing is carried out. Movements within the UK are also controlled according to the health status of these areas.

Anyone wishing to deposit or relay molluscan shellfish taken from the controlled (restricted) areas listed above must apply for permission to the Fish Health Inspectorate at the CEFAS Weymouth Laboratory (for England and Wales) or the Fisheries Research Services at the Marine Laboratory, Aberdeen (in Scotland). Contact details are at the back of this issue of Shellfish News.

Sampling results for England and Wales in 2001

For *Bonamia*, Table 1 gives a summary of the results for all sites from which samples of native oysters (*Ostrea edulis*) were taken in autumn 2001. The usual sample size at each site was 30 oysters. Sites in the unrestricted areas (i.e. those free from *Bonamia* and *Marteilia*) were also sampled in spring 2001. No cases of *Bonamia* were detected in these samples.

All samples were also examined for *Marteilia*. This was not detected in any samples. In addition, all oysters were routinely examined for evidence of any other clinical disease.

In Table 1 the results for 2001 are compared with those for the previous 4 years. The level of *Bonamia* infection remains generally low, although results for 2001 appeared to be slightly higher than in the previous few years. The average for all the sampled farm sites was 21.3% of oysters infected, compared with 16.96% the previous year and 17.4% in 1999. The average for all the fishery sites sampled was 5.2%, compared with 4.28% the previous year and a 9-year average of 4.5%. In making these comparisons it must be remembered that different sites may be sampled in consecutive years.

All samples of native oysters taken from farm sites in Scotland tested negative for *Bonamia* and *Marteilia*, as in previous years.

Further information

Shellfish farmers should note that if they have a mortality problem with their stock then they are legally obliged to report it to the appropriate Fish Health Inspectorate (Weymouth or Aberdeen) for investigation. The Inspectorate will then identify the causes and where appropriate take any action to limit the spread of disease and minimise economic losses to the industry.

Table 1. Summary of results of native oyster sampling for Bonamia 1997-2001

Year	**Restricted Area 1** The Lizard to Start Point		**Restricted Area 2** Portland Bill to Selsey Bill		**Restricted Area 3** Shoeburyness to Landguard Point		**Unrestricted Areas**	
	Sites	% infected (range)	Sites	% infected (range)	Sites	% infected (range)	Sites	% infected (range)
1997	10	0-16	30	0-30	14	0-53	8	0
1998	12	0-23	31	0-17*	13	0-47	8	0
1999	5	6-13	21	0-16	16	0-34	8	0
2000	8	0-13	24	0-27	14	0-50	6	0
2001	11	0-30	22	0-26	15	0-60	5	0

** Apart from one on-growing area where prevalence was 63-80%. This area was de-stocked and de-registered.*

SHELLFISH PRODUCTION

FARMED SHELLFISH PRODUCTION IN THE UK IN 2000

The disruption to the shellfish farm visiting programme in England and Wales last year, due to the Foot and Mouth Disease outbreak, meant that it was not possible to complete production statistics for 2000 in time to include a summary in the November 2001 edition of Shellfish News. These figures are now available and appear below. Data for England and Wales are shown separately for the first time. The total value of the shellfish produced for the table was an estimated £11.3 million, from over 15,660 tonnes. This represents a significant increase in production over 1999 by 50% (weight) and 48% (value). The bulk of this increase is due to mussel cultivation.

The above figures do not include production of native oysters from the Solent Several and Regulated grounds. These oysters are 'cultivated' in the sense that the grounds are managed, including the relaying of cultch. The value of this production is estimated at an additional £2.4 million (SAGB data). The value of hatchery/ nursery seed production, much of which is exported, is also not included. The SAGB estimate this at an additional £0.5 million, giving an overall total value for the UK industry of about £14.2 million.

Production (tonnes) of farmed shellfish in the UK in 2000.

	Scotland	England	Wales	Northern Ireland	UK Total
Pacific oyster	247	297	16		
Native (flat) oyster	4	115	0		
Oysters (total)	*251*	*412*	*16*	*386*	*1,065*
Scallops	39	0	-	-	39
Queens	58	-	-	-	58
Mussels	2,003	6,131	5,093	1,095	14,322
Clams	-	28	-	2	30
Cockles	-	147	-	-	147
Estimated Value (£000s)	3,000	4,500	2,540	1,243	11,283

A. England and Wales

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

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

In 2000 there were 112 farm sites active in England and 9 in Wales. All the Welsh farms and all but 13 of the English farms produced shellfish for sale.

Farmed production of native oysters, mussels and Manila clams all increased in 2000, compared with 1999. Levels of production of these species were equal to the highest that they have been in the last 10 years. Farmed cockle production showed a significant increase over 1999, and cockles now seem to have become established as a farmed species. There was a slight drop in Pacific oyster production, as well as a decline in the already modest total of palourdes that were farmed in 2000, compared with 1999.

The majority of mussels are produced in East Anglia and Wales, with the remainder produced in south-west and north-west England (see Figure 1).

The south-west of England is the main area for Pacific oyster production, with just over half of the total from this region. The estuaries of south-east England, including East Anglia, make up a large proportion of the remainder, with the south of England and Wales also contributing (see Figure 2).

The majority (70%) of farmed native oyster production takes place in the Essex estuaries, with the remainder from south-west England, although this does not include production from the Fishery Orders in the Solent.

Farmed shellfish (table) production in England and Wales 1995-2000 (in tonnes)

Year	Native oysters	Pacific oysters	Mussels	Manila clams	Hard clams	Palourdes	Cockles
1995	110	288	5,047	11.5	0.5	0	0
1996	111.4	584	7,618	11.5	0.3	0	0
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**
% of 1999 production	124	88	142	150	-	27	338

Farmed juvenile (seed) shellfish production in England and Wales 1995 -2000 in thousands (1000s)

Year	Native oysters	Pacific oysters	Manila clams	Palourdes	Scallops
1995	2,100	111,812	106,989	54,500	7.5
1996	1,610	66,020	13,150	2,800	50
1997	1,810	127,591	19,571	0	50
1998	2,200	110,035	20,000	4,010	50
1999	2,270	125,500	20,000	4,000	0
2000	**2,000**	**63,230**	**19,200**	**2,100**	**0**
% of 1999 production	88	50	96	53	-

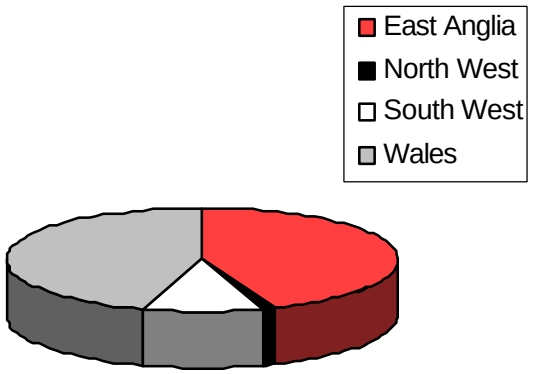


Figure 1. Percentage Production of Mussels for the Table by Region

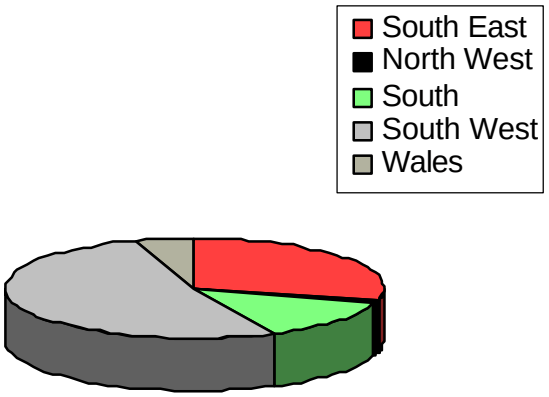


Figure 2. Percentage Production of Pacific Oysters for the Table by Region

Hatchery seed production of both oysters and clams fell compared to that in 1999. Lack of hatchery-produced king scallop seed continues to be a constraint for the industry although some new initiatives are seeking to address this problem.

B. Scotland

A full report was published in the November 2001 edition of *Shellfish News*. A summary of the figures is included in the Table for UK production.

C. Northern Ireland

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

Shellfish production statistics for Northern Ireland in 2000 are included in the summary table, opposite. There was a 16% increase in value compared with 1999. This was mainly due to increased mussel production of almost 1,000 tonnes. Oyster production fell slightly, being 10% lower than in 1999.

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. Global increase in oyster production

There was a substantial growth of global pacific oyster (*Crassostrea gigas*) production (cultured and wild caught) between 1988 and 1997. The increase was almost two and a half fold, from 1.33 to 3.09 million metric tons during this period. This species dominated the market as the major oyster in the world to be commercially harvested. However, there are several species similar to pacific oysters, but with different species names. It is possible that all of these were lumped together under the 'pacific oyster' category for the production statistics. In any case, these statistics help to identify trends in production and possibly the future market outlook.

Reference

CHEW, K.K., 2001. World-wide Statistics for Oysters & Clams. Aquaculture Magazine Vol. 27, pp. 72-76.

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2. Eating shellfish reduces risk of heart attacks

Eating fish and shellfish weekly reduces the risk of fatal heart attacks, according to a study in middle-aged and older men in Shanghai, China.

Between 1986 and 1989, 18,244 men aged 45-64 years in Shanghai, China, participated in a prospective study of diet and cancer. All participants completed an in-person, structured interview and provided blood and

urine samples. As of September 1, 1998, 113 deaths from heart attacks were identified. After adjusting for age, total energy intake, and known cardiovascular disease risk factors, men who consumed greater than or equal to 200 g of fish/shellfish per week had a relative risk of 0.41 of having a fatal heart attack, compared with men consuming less than 50 g per week. Similarly, dietary intake of n-3 fatty acids derived from seafood was also significantly associated with reduced mortality from heart attacks. Neither dietary seafood nor n-3 fatty acid intake was associated with a reduced risk of death from stroke or ischemic heart disease, other than heart attacks. However, approximately a 20% reduction in total mortality associated with weekly fish/shellfish intake was observed in the study population.

Reference

YUAN, J.M. (jyuan@hsc.usc.edu)., ROSS, R.K., GAO, Y.T., YU, M.M.C., 2001. Fish and shellfish consumption in relation to death from myocardial infarction among men in Shanghai, China. American Journal of Epidemiology Vol 154, pp 809-816.

3. In-situ bioassays using oysters and mussels

Embryos and larvae of bivalves are frequently used in marine eco-toxicology for the purpose of assessing seawater quality, because they are very sensitive to pollutants and provide rapid responses. Laboratory studies, however, cannot accurately simulate natural conditions. Bivalve embryo-larval studies were conducted in situ at the marina of Arcachon (southwest French Atlantic coast), in order to assess 'biological quality' of the water. This is the first reported investigation of the marine environment in which bivalve embryos have been used in situ.

One experiment conducted in winter 1999 (10°C) with embryos of the Mediterranean mussel, *Mytilus galloprovincialis*, has shown that such tests are practicable in winter at low temperatures. This study did not show any deterioration in 'biological quality' of the water. Four series of experiments were subsequently performed during summer 2000 (ambient water temperatures of 19-22.4°C) with embryos of the Japanese oyster, *Crassostrea gigas.* The results show that the 'sea water biological quality' deteriorates from the port entrance towards its inner part. These embryos are very suitable for this type of study, as they tolerate summer temperatures (both species) as well as winter temperatures (mussels), allowing bio-monitoring to be conducted throughout the year.

Reference

GEFFARD,,O. (ogeffard@ifremer.fr), HIS, E., BUDZINSKI, H., SEAMAN, M., GARRIGUES, P., 2001. In situ monitoring of seawater quality with the embryo-larval bioassay of *Crassostrea gigas* and *Mytilus galloprovincialis*. Comptes Rendus de l' Academie des Sciences Serie III-Sciences de la Vie Vol 324, pp 1149-1155.

4. Identifying bivalve larvae

The identification of larval marine invertebrates to species or even higher taxonomic levels by morphological examination is notoriously difficult. Many diagnostic features are absent or poorly formed at early stages in development. This is particularly true for the larvae of bivalve molluscs, for which a routine and accurate method of identification would prove valuable to both ecologists and fishery managers. A simple molecular genetic method to identify specifically larvae of the European oyster, *Ostrea edulis*, is presented. The test is based on PCR amplification of highly species-specific microsatellite loci and is sensitive enough to register the presence of a single larval individual in a mixed sample of 20 mg wet weight plankton (approximately 250 larval animals). This work demonstrates that microsatellite loci can be used as highly sensitive and specific taxonomic indicators, for studies of planktonic larvae. Details of three novel microsatellite loci are also given for *O. edulis*, increasing the suite of molecular tools available for use in population genetic studies of this commercially important species.

Reference

MORGAN, T.S. (adr2@soc.soton.ac.uk), ROGERS, A.D., 2001. Specificity and sensitivity of microsatellite markers for the identification of larvae. Marine Biology Vol 139, pp 967-973.

5. An oyster growth model

A model was developed that is capable of simulating growth and condition of oysters in the ecosystem of Marennes-Oleron Bay. The simulations indicate that growth of oysters is strongly regulated by the phytoplankton concentration, while detritus has little contribution.

A dynamic energy budget model was developed to simulate the growth of pacific oysters in response to varying environmental conditions. The model is designed to incorporate the effects of endogenous (core weight and storage of energy reserves) and exogenous (temperature, quantity and quality of food) factors and to be applicable to a variety of ecosystems. Assimilation and metabolic rates are modelled as functions of core weight, while reproduction is entirely dependent on storage of reserves. In addition to reproduction, a variable in terms of energy requirements for gametogenesis is introduced in this model. Calibration of the model was done through sensitivity analysis and by comparing the output from simulations with observed data from the field.

Reference

REN, J.S. (j.ren@niwa.cri.nz), ROSS, A.H., 2001. A dynamic energy budget model of the Pacific oyster *Crassostrea gigas.* Ecological Modelling Vol 142, pp 105-120.

6. Physiological indicators in oysters

Lysozyme activity and protein concentration in the haemolymph of the flat oyster *Ostrea edulis* were investigated. These biochemical constituents could be an indication of the physiological condition and vitality of the defence system of an animal. They were examined over an 18 month period to determine their relationship with the strain of oyster, the season, the site, and parasitism by *Bonamia ostreae.*

Haemolymph protein concentration exhibited seasonal fluctuations and varied between strains. Levels of protein in oysters highly infected with *Bonamia* were slightly depressed but not significantly so. Haemolymph lysozyme varied greatly between individuals but no correlation was found between lysozyme levels and infection of oysters by *Bonamia*.

Reference

CRONIN, M.A. (STZ08076@ucc.ie), CULLOTY, S.C., MULCAHY, M.F., 2001. Lysozyme activity and protein concentration in the haemolymph of the flat oyster *Ostrea edulis* (L.). Fish and Shellfish Immunology Vol 11, pp 611-622.

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7. Stress in oysters

Stress can exert a profound influence on oyster immune functions and may explain why stress and the outbreak of disease are often linked in shellfish culture.

This study investigated the consequences of a 15 minute mechanical disturbance on immune parameters in pacific oysters (*Crassostrea gigas*). As indicated by noradrenaline and dopamine measurements, the mechanical disturbance caused a transient state of stress in oysters. The number of circulating hemocytes, and the migratory and phagocytic activity and reactive oxygen species production of hemocytes were measured before, during and after application of the stress. Results show that all immune functions were significantly degraded during stress and a transient period of immuno-stimulation was observed from between 30 minutes and 4 hours after the end of the disturbance.

Reference

LACOSTE, A. (lacoste@sb-roscoff.fr), MALHAM, S.K., GELEBART, F., CUEFF, A., POULET, S.A., 2002. Stress-induced immune changes in the oyster *Crassostrea gigas.* Developmental and Comparative Immunology Vol 26, pp 1-9.

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8. *Mytilicola* infestation of oysters

Infections of a population of *Crassostrea gigas* by the parasitic copepod *Mytilicola orientalis* were examined at an oyster-growing site at Dungarvan, County Waterford, Ireland. Twenty-one samples, each consisting of 20 to 30 oysters were examined over 2 years. Condition, sex, reproductive stage, length, weight, glycogen content and other parasite burdens of the oysters were recorded in relation to the degree of infection of *Mytilicola*. It was found that 14.38% of oysters were infested. Mean abundance was 0.6 copepods per oyster. A maximum of 20 copepods was found in any one oyster. *Mytilicola* had no effect on condition, growth, sex, reproductive stage or glycogen content of the oysters, but was correlated with the amount of shell burrowing by *Polydora* sp.

Reference

STEELE, S. (stlsus@yahoo.com), MULCAHY, M.F., 2001. Impact of the copepod *Mytilicola orientalis* on the pacific oyster *Crassostrea gigas* in Ireland. Diseases of Aquatic Organisms Vol 47, pp 145-149.

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9. Vibrio is the cause of summer mortality in oysters

Juvenile pacific oysters *Crassostrea gigas* cultured in the Bay of Morlaix (France) have suffered unexplained summer mortalities for over a decade. In the present study, we tested the hypothesis that a bacterial pathogen could be responsible for this phenomenon. A first attempt failed to isolate a bacterial pathogen from moribund or weak oysters. Only non-pathogenic, probably opportunistic, bacteria were isolated. As an alternative approach, we focused on oysters presenting reduced stress-response capacities (determined by circulating noradrenaline measurements). This is characteristic of juvenile oysters entering an early phase of the disease. Cultures of bacterial isolates on TCBS plates revealed that a *Vibrio* strain was present in diseased oysters and scarce or absent in healthy oysters, Experimental infections indicated that this *Vibrio* could cause mortalities of juvenile oysters when injected at concentrations ranging from 10^4 to 10^8 CFU per oyster. As with the summer mortality problem, the *Vibrio* isolate caused more deaths at higher temperatures. Also, it could not be transmitted horizontally, it did not affect adult oysters and it induced a stress-response in juvenile oysters. The pathogen was identified as *Vibrio splendidus.*

Reference

LACOSTE, A., JALABERT, F., MALHAM, S., CUEFF, A., GELEBART, F., CORDEVANT, C., LANGE, M., POULET, S.A. (poulet@sb-roscoff.fr), 2001. A *Vibrio splendidus* strain is associated with summer mortality of juvenile oysters *Crassostrea gigas* in the Bay of Morlaix (North Brittany, France).

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10. Two types of Alexandrium in the UK

There are at least two distinct populations of *Alexandrium tamarense* in UK waters. One of these produces the toxin responsible for paralytic shellfish poisoning (PSP) while the other does not.

Polymerase chain reaction was used to amplify and sequence the LSU rDNA gene of 21 isolates of *Alexandrium tamarense* collected from the United

Kingdom. Analysis revealed two distinct genetic lines. In all cases, the strains shown to be non-toxic by ELISA or high-performance liquid chromatography were assigned to a 'Western European' lineage, whereas those producing the PSP toxin, which included toxic isolates from the Orkney Islands, were assigned to the 'North American' lineage.

Reference

HIGMAN, W.A. (w.a.higman@cefas.co.uk), STONE, D.M., LEWIS, J.M., 2001. Sequence comparisons of toxic and non-toxic *Alexandrium tamarense* (Dinophyceae) isolates from UK waters. Phycologia Vol 40, pp 256-262.

11. Detecting PSP

This study compared five methods of measuring the toxins responsible for paralytic shellfish poisoning, including the long-used mouse bioassay, a commercially available cell culture test (MIST(R) Quantification kit), HPLC analysis, and two newly developed radioreceptor assays utilising mammalian sodium channels and saxiphilin. Each method has different virtues and it may be that a multi-method approach would be beneficial in a shellfish-testing regime.

Methods were carried out with toxic shellfish extracts prepared according to the AOAC official method. The best correlation between predicted toxicity values were those between HPLC analysis when compared with both radioreceptor assays and the mouse bioassay, as well as that between the saxiphilin and the sodium channel radioreceptor assays. In all cases, statistically significant correlation existed between the toxicity measurements of the same extracts. The ratios between some methods were not unitary as measured by the slopes of the regression lines used for correlation analyses. HPLC analysis predicted more toxicity than all the bioassays. The saxiphilin assay underestimated toxicity relative to the mouse bioassay, the MIST(R) kit determinations and the sodium channel assay. The sodium channel assay predicted less toxicity than the mouse bioassay and the MIST(R) kit. Of all of the techniques used, the MIST(R) kit correlation with the mouse bioassay was nearest to one.

Reference

LLEWELLYN, L.E. (L.Llewellyn@aims.gov.au), DOYLE, J., JELLETT, J., BARRETT, R., ALISON, C., BENTZ, C., QUILLIAM, M., Measurement of paralytic shellfish toxins in molluscan extracts: comparison of the microtitre plate saxiphilin and sodium channel radioreceptor assays with mouse bioassay, HPLC analysis and a commercially available cell culture assay. Food Additives and Contaminants Vol 18, pp 970-980.

12. Detecting ASP (1)

Amnesic shellfish poisoning is a potentially lethal human toxic syndrome that is caused by domoic acid (DA) from marine phytoplankton belonging to the genus *Pseudonitzschia*. A new sensitive liquid chromatographic-mass spectrometry (LC-MS) method has been developed for the determination of DA in various marine biological samples. The detection limits can be better than 0.008 µg DA/ml. This method was applied to determine DA in scallop (*Pecten maximus*) tissues, which subsequently led to the closure of several shellfish harvesting sites on the West Coast of Ireland.

Reference

FUREY, A., LEHANE, M., GILLMAN, M., FERNANDEZ-PUENTE, P., JAMES, K.J. (kjames@cit.ie), 2001. Determination of domoic acid in shellfish by liquid chromatography with electrospray ionization and multiple tandem mass spectrometry. Journal of Chromatography Vol 938, pp 167-174.

13. Detecting ASP (2)

During 1998 and early 1999, shellfish samples from sites in Scotland were found to contain the amnesic shellfish poisoning toxin, domoic acid (DA).

Two different techniques, liquid chromatography with UV diode-array detection (LC/UV) and liquid chromatography with mass spectrometric detection (LC / MS), were used to detect and confirm DA in shellfish extracts. The LC/UV method was validated for routine monitoring by recovery experiments on spiked mussel and scallop tissues with a certified mussel tissue used as reference material. Crude extracts of selected samples as well as extracts cleaned with strong anion exchange (SAX) were analysed by both LC/UV and LC/MS. Good correlation between the two methods was found for cleaned extracts. Analyses of crude extracts by LC/UV produced false-positive results in 2 crab samples, whereas LC/MS analyses always gave accurate results. It was concluded that LC/UV is a valid approach for routine monitoring of DA in shellfish when cleanup is performed with a SAX cartridge to prevent false positives.

A variety of shellfish species were surveyed for DA content, including king scallops, queen scallops, mussels, crabs, and razor fish. The highest concentration of DA was 105 µg/g in king scallops.

Reference

HESS, P. (philipp.hess@marine.ie), GALLACHER, S., BATES, L.A., BROWN, N., QUILLIAM, M.A., 2001 Determination and confirmation of the amnesic shellfish poisoning toxin, domoic acid, in shellfish from Scotland by liquid chromatography and mass spectrometry. Journal of AOAC International Vol 84, pp 1657-1667.

14. ASP in Scottish scallops

The king scallop, *Pecten maximus,* is a valuable economic resource in the UK. The industry relies on supplying premium 'roe-on' processed scallops to the continental market. In July 1999, king scallops harbouring

the amnesiac shellfish poisoning (ASP) toxin, domoic acid (DA), in gonadal tissue at levels above the regulatory limit (20 µg/g DA) were detected across a wide area of northern and western Scotland. In response, a survey of the southern extent of the closed harvest areas was initiated to describe the geographical variability of ASP toxin levels as well as to determine the anatomical distribution of the toxin, and identify, isolate, and culture the causative *Pseudo-nitzschia* species.

Toxin analysis was conducted using a liquid chromatography-tandem mass spectroscopy (LC-MS/MS) procedure. The DA content of tissues followed the predictable rank order of - all other tissue > gonad > adductor. The toxin levels within all other tissue (580-760 µg/g DA) consistently accounted for 99% of the total individual toxin burden. DA levels in the gonad (11 µg/g DA) were an order of magnitude below levels in all other tissue and contributed to less than 0.5% of the total individual toxin burden, although levels above the regulatory limit were detected in some individual gonad samples. Adductor muscle tissue contained the lowest concentrations of DA (0.38-0.82 µg/g DA), and was typically within two to three orders of magnitude below levels in all other tissue. None of the scallops examined had DA concentrations in the adductor muscle tissue exceeding the regulatory limit. Toxin variability among individuals and sites was high. The results do give an indication of the scale on which microhabitat differences may influence ASP toxicity in king scallop populations, because significant differences in toxin levels were found in all other tissue and gonadal tissue between groups of individuals only 25-m apart. In total, seven species of *Pseudo-nitzschia* were identified from west coast waters. A suspected causative species, *P. australis*, was found to produce high levels of DA, in culture. The high individual variation in toxicity and the occurrence of DA in the gonad at levels above the regulatory limit clearly demonstrate the complexity of managing the king scallop fishery during ASP events.

Reference

CAMPBELL, D.A. (Scottish Association of Marine Science, Oban PA34 4AD,Argyll, Scotland), KELLY, M.S., BUSMAN, M., BOLCH, C.J., WIGGINS, E., MOELLER, P.D.R., MORTON, S.L., HESS, P., SHUMWAY, S.E., 2001. Amnesic shellfish poisoning in the king scallop, *Pecten maximus*, from the west coast of Scotland. Journal of Shellfish Research Vol 20, pp 75-84.

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15. Toxic algae and DSP in mussels

Between 1994 and 1999 the relationship between the toxic *Dinophysis* algae species and diarrhetic shellfish toxins in blue mussel (*Mytilus edulis*) was studied in Flodevigen Bay on the south coast of Norway.

The highest concentrations of toxins in blue mussel were observed during the period of lowest productivity, from November to February. Shortly after the onset of the spring phytoplankton bloom, toxins in mussels dropped to zero and remained low until September. There was no relationship between toxins in mussels and the concentrations of the three *Dinophysis* species studied. Of these, *Dinophysis acuta* was probably the main source of toxin in mussels.

The results suggest that the toxin content in *D. acuta* cells was highly variable, with the highest concentrations observed at the end of the growth season in November and December. In addition, the accumulation of toxin seemed to be counteracted by the presence of high concentrations of alternative food sources for the mussels.

Reference

DAHL, E. (einer.dahl@imr.no), JOHANNESSEN, T., 2001. Relationship between occurrence of Dinophysis species (*Dinophyceae*) and shellfish toxicity. Phycologia Vol 40, pp 223-227

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16. Herpesvirus found in scallops

Sporadic high mortalities of larval French scallops (*Pecten maximus*) were reported. Electron microscopy of moribund larvae revealed particles with the characteristics of a herpesvirus, in association with cellular lesions. PCR and DNA sequencing showed that the virus is a variant of the oyster herpesvirus-1 that has already been described in clams and oysters. This is the first description of a herpesvirus infection of a scallop species. The virus was transmitted successfully from an extract of infected scallop larvae to uninfected scallop and oyster (*Crassostrea gigas*) larvae, demonstrating that it is able to infect both species. Detection of viral DNA in asymptotic adult scallops by in-situ hybridisation indicates that the herpesvirus may have been transmitted from adults to larvae. It is notable that, unlike most herpesviruses, this virus has a wide host range reflected by its ability to infect several species of marine bivalves.

Reference

ARZUL, I., NICOLAS, J.L., DAVISON, A.J., RENAULT, T. (trenault@ifremer.fr), 2001. French scallops: A new host for ostreid herpesvirus-1. Virology Vol 290, pp 342-349.

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17. One herpesvirus infects all bivalves

Since 1972, herpes-like virus infections have been reported in several marine bivalve species around the world. Viral detection was often associated with high mortality rates in larvae and spat.

To determine whether a single virus is able to infect different bivalve host species, we carried out experimental transmission assays. As a first step, 8 assays were performed to infect axenic *Crassostrea gigas* larvae with virus from infected *C. gigas* larvae using a previously described protocol. The protocol

appeared reliable and PCR was confirmed as a powerful technique for detecting viral DNA in experimentally infected oysters. The defined protocol was then applied to infect different bivalve species. Interspecies viral transmission was demonstrated under laboratory conditions. The same phenomenon may occur in private hatcheries and may be promoted by intensive rearing conditions. This hypothesis is reinforced by reports of concomitant mortalities in the larvae of several bivalve species and by the first molecular analysis of infected larval samples.

Reference

ARZUL, I., RENAULT, T. (trenault@ifremer.fr), LIPART, C., 2001. Experimental herpes-like viral infections in marine bivalves: demonstration of interspecies transmission. Diseases of Aquatic Organisms Vol 46, pp 1-6.

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18. No major effect of domoic acid on mussels

The effects of domoic acid (DA) on the blue mussel *Mytilus edulis* were investigated. DA was injected at concentrations ranging from 1-500 ng/g (body weight). No neurotoxic effects were detected within the incubation times used of 48 h and 7 d.

The vitality of haemocytes remained in all mussels at the level of control samples within 48h, and increased significantly after 7 d. At DA concentrations ranging from 1 to 100 ng/g, there may have been a greater phagocytosis activity in the haemocytes, but there was no alteration in their number for both incubation times. When DA concentration reached 500 ng/g the number of haemocytes doubled in 48 h, without any change in phagocytosis activity. Primary DNA lesions in digestive glands of all injected mussels were determined in an acute phase of poisoning (within 48 h), but this was rapidly repaired after 7 d of incubation.

Reference

DIZER, H., FISCHER, B., HARABAWY, A.S.A., HENNION, M.C., HANSEN, P.D. (pd.hansen@tu-berlin.de), 2001. Toxicity of domoic acid in the marine mussel *Mytilus edulis*. Aquatic Toxicology Vol 55, pp 149-156.

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19. Microbial contamination reduced by wetlands

Coastal areas are considered to be desirable regions to live and recreate. However, as human use of coastal land and water increases, so does the incidence of aquatic-borne disease from contact with contaminated water and eating contaminated shellfish. Movement of humans into coastal areas both greatly increases the number of sources of microbial pathogens and radically alters the landscape through increased construction activity and paving of former natural areas.

On a regional scale, increases in human population over a 14-year period in coastal North Carolina were strongly correlated with increases in shellfish bed closures due to high fecal coliform bacterial counts. On a watershed scale, an analysis of several tidal creeks found strong correlations between mean estuarine fecal coliform bacterial counts and watershed population and with percent developed area (especially with percent impervious surface coverage). Conversion of natural landscapes to impervious surfaces (roads, drives, sidewalks, parking lots and roofs) removes the land's natural filtration capability, allows for increased concentration of pollutants at the land's surface and provides a means of rapid conveyance of pollutants to downstream waterways. An analysis of rural watersheds in the coastal plain found that stream fecal coliform counts and turbidity were both strongly correlated with rainfall in the previous 24 h in watersheds containing extensive industrial swine and poultry operations, as well as watersheds containing more traditional agriculture and cattle husbandry. In contrast, in watersheds rich in swamp wetlands these relationships were not significant, even in watersheds containing extensive animal production.

Based on these findings, we suggest that waterborne microbial pathogen abundance can be minimised in urbanising coastal areas through reduced use of impervious surfaces and maximal use of natural or constructed wetlands for passive treatment of storm water runoff. In animal husbandry areas, retention of natural wetlands and management practices designed to minimise sediment runoff can reduce inputs of pathogenic microbes into streams.

Reference

MALLIN, M.A.,, ENSIGN, S.H., MCIVER, M.R., SHANK, G.C., FOWLER, P.K., 2001. Demographic, landscape, and meteorological factors controlling the microbial pollution of coastal waters. Hydrobiologia Vol 460, pp 185-193.

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20. Testing shellfish for viruses

As part of an effort to develop a broadly applicable test for Norwalk-like viruses and hepatitis A virus (HAV) in shellfish, a rapid extraction method that is suitable for use with one-step reverse transcription (RT)-PCR-based detection methods was developed. This method should facilitate the implementation of RT-PCR testing of commercial shellfish. All of the required reagents are commercially available.

This method can be performed in less than 8 hours on hardshell clams (*Mercenaria mercenaria*) and Eastern oysters (*Crassostrea virginica*) and, when coupled with RT-PCR-based detection, can yield results within 24 h. It is very sensitive. Detection of HAV in live oysters experimentally exposed to contaminated seawater was demonstrated. An adaptation of this method was used to

identify HAV in imported manila clams implicated in an outbreak of food-borne viral illness.

Reference

KINGSLEY, D.H. (dkingsle@dsc.edu), RICHARDS, G.P., 2001. Rapid and efficient extraction method for reverse transcript ion-PCR detection of hepatitis A and Norwalk-like viruses in shellfish. Applied and Environmental Microbiology Vol 67, pp 4152-4157.

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21. Effects of cockle dredging

There is world-wide concern about the effects of bottom-dredging on benthic communities in soft sediments. Suction dredging for cockles had long-lasting negative effects on recruitment of bivalves, particularly the target species, in sandy parts of the Wadden Sea basin. Initially, sediment reworking by suction dredging (especially during autumn storms) probably caused losses of fine silts. Negative feedback processes then prevented the accumulation of fine-grained sediments conducive to bivalve settlement.

In autumn 1988, almost a third of the 50 square km intertidal system around the island of Griend in the western Dutch Wadden Sea was suction-dredged for edible cockles and this study assessed the subsequent effects. An adjacent area not directly touched by this fishery and an area from which the mussel (*Mytilus edulis*) beds were removed served as reference areas. Sediment characteristics, together with the total stock size and settlement densities of cockles, Baltic tellin (*Macoma balthica*) and soft-shelled clam (*Mya arenaria*), were documented during 11 successive autumns before (August-September 1988) and after (August-September 1989-98) suction-dredging in fished and un-fished areas. Four other areas in the Dutch Wadden Sea, where changes in densities of juvenile bivalves from 1992 to 1998 were measured, served as additional reference locations.

Between 1988 and 1994, median sediment grain size increased while silt was lost from sediments near Griend that were dredged for cockles. The initial sediment characteristics were re-attained by 1996. After the removal of all mussels and most cockles the abundance of *Macoma* declined for 8 years. From 1989 to 1998, stocks of cockles, *Macoma* and mussels did not recover to the 1988 levels, with the loss of cockles and *Macoma* being most pronounced in the area dredged for cockles. Particularly low rates of settlement in fished areas until 1996, i.e. 8 years after dredging, resulted in a decline in bivalve stocks. A comparison of settlement in the short (1992-94) and medium (1996-98) term after cockle-dredging in several fished and un-fished areas spread over the entire Dutch Wadden Sea showed a significant negative effect of dredging on subsequent settlement of cockles. *Macoma* also declined, but not significantly.

Reference

PIERSMA, T. (theunis@nioz.nl), KOOLHAAS, A., DEKINGA, A., BEUKEMA, J.J., DEKKER, R., ESSINK, K., 2001. Long-term indirect effects of mechanical cockle-dredging on intertidal bivalve stocks in the Wadden Sea. Journal of Applied Ecology Vol 38, pp 976-990.

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22. Survival of scallops during dredging

There is potential for high levels of mortality in undersized discarded great scallops *(Pecten maximus*), and scallops which encounter dredges but are not captured.

The effect of simulated dredge capture on the swimming escape response of the great scallop was assessed in order to determine the potential for mortality in undersized discards. Three experiments were carried out. Firstly, to find how the effect of simulated dredging on the escape response varied with season and scallop size, secondly, to assess the time taken for scallops to recover following simulated dredging, and thirdly, to determine the interactive effects of dredging, exposure to air and recovery time. In all experiments, simulated dredging caused a significant increase in the response time of scallops and a significant decrease in the number of valve adductions performed. These effects of dredging occurred irrespective of season (spring versus autumn) and scallop size. Exposure to air also had a negative effect on the escape response. This was evident in both dredged and non-dredged scallops. Determination of the period taken to recover showed that although some recovery was evident after 1h, the negative effects of simulated dredge capture were still apparent after a period of 24 h.

Reference

JENKINS, S.R. (stu@liverpool.ac.uk), BRAND, A.R., 2001. The effect of dredge capture on the escape response of the great scallop, *Pecten maximus* (L.): implications for the survival of undersized discards. Journal of Experimental Marine Biology and Ecology Vol 266, pp 33-50.

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23. Mussels and starfish

Near the island of Sylt in the Wadden Sea (German Bight, North Sea), starfish *Asterias rubens* (L.) co-occur with their preferred prey, mussels *Mytilus edulis* (L.), which form extensive beds from the intertidal down to the subtidal zone. Mussel density within these beds is significantly lower in the subtidal than the intertidal zone. Laboratory and field experiments were conducted to check if this was due to starfish predation.

Feeding experiments showed that starfish eat all sizes of mussels, but preferred clean subtidal mussels more than barnacle-overgrown intertidal ones. This preference

coincided with higher abundance of starfish in the shallow subtidal area, but their abundance was too low to account for the decreased mussel density in this area. However, starfish may indirectly reduce mussel recruitment in the subtidal zone. This is due to juvenile starfish predating on the barnacles that grow on mussels. This epigrowth strongly enhances recruitment in mussels. Such an indirect effect on mussel recruitment may affect mussel density more than adult starfish predation. An exception may be mass invasions of starfish on subtidal mussel beds. One such event happened during this study, clearing a large patch of mussels.

Reference

SAIER, B. (bsaier@awi-bremerhaven.de), 2001. Direct and indirect effects of seastars *Asterias rubens* on mussel beds (*Mytilus edulis*) in the Wadden Sea. Journal of Sea Research Vol 46, pp 29-42.

24. A model of shellfish management and bird behaviour

Human interests often conflict with those of wildlife. In the coastal zone humans often exploit shellfish populations that also provide food for populations of shorebirds. There has been considerable debate on the consequences of shellfishing for the survival of shorebirds, and conversely the effects of shorebird predation on the shellfish stocks remaining for human exploitation. Until now, it has been difficult to determine the impact of current shellfishery practices on birds or to investigate how possible alternative policies would affect their survival and numbers. One long-running contentious issue has been how to manage mussel and cockle shellfisheries in a way that has least effect on a co-dependent shorebird, the oystercatcher, which also consumes these shellfish.

This study used a behaviour-based model to explore the effects that the present-day management regimes of a mussel (Exe estuary, UK) and a cockle (Burry inlet, UK) fishery have on the survival and numbers of overwintering oystercatchers. It also explored how alternative regimes might affect the birds. The model includes depletion and disturbance as two possibly detrimental effects of shellfishing and some of the longer-term effects on shellfish stocks. Importantly, model birds respond to shellfishing in the same ways as real birds. They increase the time spent feeding at low tide and feed in fields and high shore areas at other times. When shellfishing removes the larger prey, birds eat more of the smaller prey. By providing quantitative predictions of bird survival and numbers for a range of alternative shellfishery management regimes, the model can guide management policy in these and other estuaries.

The results suggest that, currently, at neither site does the shellfishery cause oystercatcher mortality to be higher than it would otherwise be in the absence of shellfishing. At present intensities, shellfishing does not significantly affect the birds. However, the results also show that changes in management practices, such as increasing fishing effort, reducing the minimum size of shellfish collected or increasing the daily quota, can greatly affect oystercatcher mortality and population size. Also, the detrimental effect of shellfishing can be greatly increased by periods of cold weather or when prey are unusually scarce.

Reference

STILLMAN, R.A. (rast@ceh.ac.uk), GOSS-CUSTARD, J.D., WEST, A.D., DURELL, S.E.A.L.D., MCGRORTY, S., CALDOW, R.W.G., NORRIS, K.J., JOHNSTONE, I.G., ENS, B.J., VAN DER MEER, J., TRIPLET, P., 2001. Predicting shorebird mortality and population size under different regimes of shellfishery management. Journal of Applied Ecology Vol 38, pp 857-868.

25. On-growing king scallops

The effect of stocking density of the scallop (*Pecten maximus* L.) in suspended culture using pearl and lantern nets on growth and carbohydrate content of the adductor muscle was assessed in two populations from Mulroy Bay and Bantry Bay for 1 year.

The results showed that in all treatments, the growth rate increased significantly from June to September. In general, the carbohydrate content in the striated muscle decreased from maximum levels in September to a minimum in March. The carbohydrate content of the smooth muscle was lower than the striated and gradually increased throughout the experiment. The scallops from Bantry Bay had a significantly higher growth and carbohydrate content than the spat from Mulroy Bay. Spat cultured in lantern nets had a significantly higher growth rate than those cultured in pearl nets. In addition, spat cultured at low densities had a higher growth rate and carbohydrate content during the summer than those cultured at high densities.

Reference

MAGUIRE, J.A., BURNELL, G.M., 2001. The effect of stocking density in suspended culture on growth and carbohydrate content of the adductor muscle in two populations of the scallop (*Pecten maximus* L.) in Bantry Bay, Ireland. Aquaculture Vol. 198, pp. 95-108.

26. Depurating scallops

Preliminary trials were undertaken to assess the potential for depuration (purification) of diver harvested king scallops (*Pecten maximus*) under a range of temperatures and shellfish to water ratios. Scallops taken from class B waters were held for 42 hours in standard design depuration systems. Bacteriological analysis indicated a significant decrease in *E. coli* and total viable count (TVC) at all temperatures and water ratios

after the 42 hour depuration period. Mortalities at temperatures above 20.5°C and increased ammonia levels at low shellfish to water ratios indicated that acceptable deputation conditions lie between 6.6°C and 15.6°C at shellfish to water ratios in excess of 1:12. Scallops held upside down also depurated effectively, although less effectively than in scallops held the right way up.

Reference

HEATH, P. (p.heath@qub.ac.uk), PYKE, M., 2001. King scallop (*Pecten maximus*) depuration trials. Journal of Shellfish Research Vol 20, pp 117-120.

27. Hatchery reared lobsters need careful handling

We conducted a series of five laboratory experiments (7-18 days in duration) to test the interactive effects of stocking density, aeration rates, and food types on survival of American lobster (*Homarus americanus*) larvae through their first three planktonic stages (I-III) to the postlarval stage (IV). Experimental units and culture protocols were designed to replicate a 1:100 scaled-down version of equipment used in association with a fishermen-sponsored, stock enhancement lobster hatchery located in Cutler, Maine, USA.

The first four trials revealed that extremely high rates of aeration (about 240 ml air per second) were necessary to distribute larvae and food sufficiently to reduce cannibalistic encounters. However, the best survival from stage I-IV (at stocking densities of 7-26 per litre, fed ad libitum with enriched Artemia) was only 24%. The final experiment (stocking density of 20 per litre) yielded a mean survival rate of about 75%. The greater success of this final trial is attributed to how the stage I larvae were managed prior to their culture. In the first four trials, unfed larvae were collected from a relatively small (46 cm x 30 cm x 20 cm), screened capture basket located near the discharge pipe of a broodstock holding tank at the hatchery where they may have resided for more than 12 hours. Larvae used in the final laboratory experiment were collected directly from the broodstock tank within 30 min after being liberated from the mother's swimmerets. Larvae at relatively high densities within the screened box probably had many more cannibalistic encounters prior to their culture than those collected directly from the broodstock tank and, therefore, suffered high rates of mortality during the first four laboratory trials.

Mass rearing methods for larval American lobsters developed in conjunction with these laboratory experiments were used successfully by staff at the Cutler Marine Hatchery from 1988 to 1992. During this period, survival from stages I-IV averaged 44%, and approximately 875,000 stage IV animals were released to the wild. These culture methods have withstood the test of time as a private lobster hatchery in Maine adopted our protocols in 1993, and they continue to be in use. Further, the general techniques described here have been used since 1994 to culture European lobsters (*Homarus gammarus*) at a commercial lobster hatchery in the southeast of Ireland.

Reference

BEAL, B.F., CHAPMAN, S.R., 2001. Methods for mass rearing stages I-IV larvae of the American lobster, *Homarus americanus* H. Milne Edwards, 1837, in static systems. Journal of Shellfish Research Vol. 20, pp. 337-346.

28. Hatchery lobsters find shelter

Hatchery-reared lobsters are highly dependent on finding shelter after release. The ability of 'training' to enhance quick shelter-seeking behaviour was investigated.

Single, emergent-phase lobsters were released in tanks, either with or without shelter. All lobsters were observed for at least 10 minutes after each release; walking direction from the release position and time elapsed before they entered the shelter (when available) were recorded. In additional treatments, some lobsters were exposed to a mock predator, in the form of a series of short touches, and times before they reached shelter were compared with those of lobsters not so touched.

Hatchery-reared lobster juveniles quickly adapted to new environments and shelters, but experienced juveniles found a shelter sooner than those that had previously been in the tank with no shelter. The time taken to reach shelter decreased in lobsters that were touched. Experienced lobsters spent longer looking for shelter when placed in a tank without any.

Reference

VAN DER MEEREN G.I (gro.van.der.Meeren@imr.no), 2001. Effects of experience with shelter in hatchery reared juvenile European lobsters *Homarus gammarus*. Marine and Freshwater Research, Vol. 52, pp 1487-1493.

Shellfish in the Press

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

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

INFORMATION FILE

WHERE CAN I GET HELP OR ADVICE?

Policy Matters

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Advice on commercial activities

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

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

Wildlife conservation and status of on-growing sites

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

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

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

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

Other Useful Numbers

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

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

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

CEFAS PUBLICATIONS

The following booklets and leaflets are available:

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

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

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

Shellfish News (back copies of some issues). Numbers 6-12 can also be viewed and/or downloaded as .pdf files from the CEFAS web site (*http://www.cefas.co.uk/publications/shellfish_news.htm*)
Mussel cultivation in England and Wales.
The scallop and its fishery in England and Wales.
