CENTRE FOR ENVIRONMENT, FISHERIES AND
AQUACULTURE SCIENCE

SHELLFISH NEWS

NUMBER 18

NOVEMBER 2004

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

defra
Department for Environment
Food and Rural Affairs

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

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

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

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

* Articles, news and comment relating to shellfish farming and harvesting are welcomed and should be sent to the editor. The deadline for the next issue is Friday 1 April 2005.

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

Editor: Ian Laing
CEFAS Weymouth Laboratory
Barrack Road
The Nothe
Weymouth
Dorset
DT4 8UB
Tel: 01305 206711 (Fax: 206601)
email: i.laing@cefas.co.uk

Assistant Editor: Denis Glasscock
CEFAS Lowestoft Laboratory
Pakefield Road
Lowestoft
Suffolk
NR33 0HT
Tel: 01502 524304 (Fax: 513865)
email: d.glasscock@cefas.co.uk

www.cefas.co.uk

CONTENTS Page

ARTICLES

UK SHELLFISH RESEARCH AND DEVELOPMENT - THE BIG PICTURE!

Dr Mark James, FRM Ltd

In Spring 2004 all the main public, private and charitable bodies who are known to sponsor aquaculture related R&D in the UK were invited to provide data to be included in the UK Aquaculture R&D database, sponsored by Defra and compiled by FRM Ltd. All the principal sponsors responded and the data has now been added to the original database which was published on the Defra website in November 2003 and can be interrogated online at: *http://www.defra.gov.uk/science/areas/aquatic/default.asp.htm*

The database is designed to be an open access resource which will provide an integrated picture of currently funded research and, increasingly, provide an archive of completed work. This resource will enable the public to gain a basic insight into UK research in this field and provide valuable information for those involved in research and other stakeholders. By collating research project information at a national level, we can help to minimise duplication of effort and facilitate strategic decision making by those who Govern and regulate the aquaculture sector.

This year's update of the database is about to be released on the Defra website and the purpose of this article is to give you a flavour of the research which is, or has recently been, conducted with regard to shellfish.

It is important to note at this stage that the database contains UK sponsored research only and that it may not capture every research project being conducted. We are confident, however, that the vast majority of relevant R&D is included and that as far as possible all the costs associated with monitoring and surveillance work has been excluded.

The total commitment to aquaculture R&D from 1999 onwards, including forward commitments for projects ending as much as four years hence, is approximately £38.9 million - this figure will of course increase as additional projects are funded.

Analysis shows that R&D on salmon and trout is responsible for about a third of expenditure, with work categorised as 'Aquaculture General' accounting for about 29%. The latter category includes a variety of research which is not sector specific but could be considered to have implications for aquaculture.

Shellfish research commands 17% of project costs followed by 12% for marine finfish. The remaining 10% includes work on 'non-food' species of fish and some work on ornamental species.

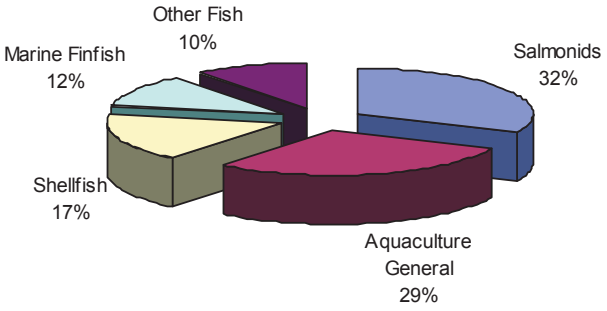


Figure 1. Percentage breakdown by sector of total expenditure on UK aquaculture R&D

So who is paying for this work? The vast majority of funding is derived from public sources. The principal Government or regulatory bodies, Defra, SEERAD and the Food Standards (FSA) provide more than 60% of funds with the research councils BBSRC and NERC contributing a further 32%. The remaining 8% comes from a range of public, private and charitable sources such as The Crown Estate, Highlands and Islands Enterprise and increasingly Seafish. Overall, Defra, SEERAD and BBSRC consistently make the largest contributions.

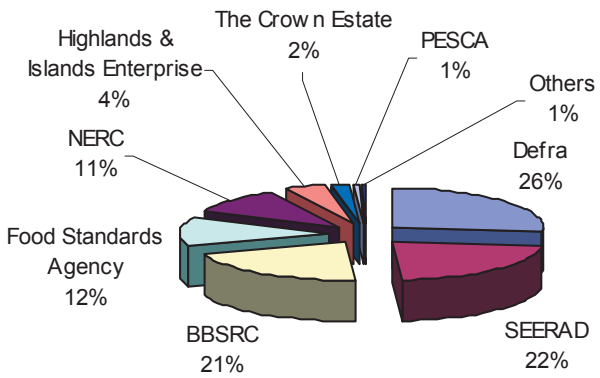


Figure 2. Percentage breakdown of sources of funding committed

Expenditure on shellfish related R&D amounts to more than £6.5 million for the projects funded from 1999 onwards, with the FSA being responsible for 57% of this expenditure.

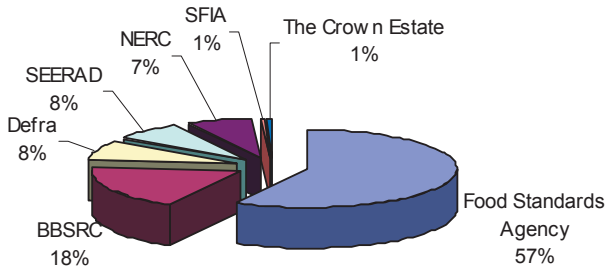


Figure 3. Percentage breakdown of sponsors contributing to shellfish R&D

If the expenditure on shellfish R&D is analysed with respect to subject area, an interesting picture emerges. Although the definition of subject area may be subjective in some cases, it is possible to pick out important areas of research, and retrospectively at least, assess the balance of funding between different subject areas. As shown in Table 1., clearly illustrates, the vast majority (~67%) of shellfish R&D work focuses on issues related to public health and food safety – hence the significant investment made by the FSA. About a fifth of all expenditure is devoted to work on the detection and possible depuration of viruses and other pollutants. Developing and refining testing regimes for algal toxins is also reflected as an important subset of the work funded largely by the FSA and accounts for at least 40% of expenditure in this area. Unlike finfish aquaculture where somewhere in the region of 66% of expenditure is committed to combating disease, for shellfish this figure is only 7%.

Table 1. Allocation of funds to designated subject areas 1999 onwards

Shellfish R&D Subject Groupings	Total Project Cost	Percentage of Total Cost
Viruses	£1,274,724	19
Pollution other	£1,146,549	17
Toxin testing*	£939,951	14
Toxins General*	£810,126	12
Disease	£433,353	7
Environmental impact	£413,228	6
Genetics	£390,832	6
Cultivation and husbandry	£283,857	4
Physiology	£226,756	3
Reproduction	£199,794	3
ASP⁺	£154,770	2
PSP⁺	£105,800	2
DSP⁺	£88,471	1
Economics	£66,286	1
Shellfish general	£27,500	<1
Grand Total	**£6,561,997**	

** includes collective work on ASP/DSP/PSP etc.*
⁺ toxin specific work

Similarly, expenditure on R&D related to the environmental impact of salmon and potentially, marine finfish culture accounts for a significant amount of R&D work, whereas for shellfish, studies focus primarily on the potential impacts of mussel seed dredging, or interactions with predatory birds and accounts for around 6% of project costs.

As a result of devolution and various reorganisations of Government departments, the responsibility for funding aquaculture research has, to some extent, been dissipated and has become more regionally focused. Whilst, in principle, this could mean that R&D is tailored to fit more 'localised' requirements, the levels of funding available from any one organisation can make it difficult to take forward research projects of any scale. Typically, the average annual cost of a research project is around £62,000 with an average total project cost of £170,000. Some technologically advanced projects or projects with a heavy fieldwork commitment can be considerably more expensive.

We are currently in a situation where sponsors of research, who would have once supported a piece or research independently, may now need to seek co-funding from other public and private sources. Regrettably, such partnership working – particularly at the administrative level, is not well developed. Figures from the R&D database suggest that since 1999, only about 2% of projects (by value) have been multi-sponsored. To maintain a research base with substantive projects taking place outwith the main Government agency laboratories, this percentage must increase. In addition, sponsors will need to dovetail their research management and liaison procedures to facilitate cost effective support of important research.

In many respects the aquaculture industry is the 'customer' for much applied R&D. Depending upon your point of view, research projects conducted with respect to fish disease and, to some extent, shellfish hygiene regulations are addressing trade issues. As R&D customers, it is important that the various aquaculture sectors make every effort to develop coherent, strategic and prioritised research requirements - based on informed consultation through recognised trade bodies such as the Shellfish Association of Great Britain and the Association of Scottish Shellfish Growers.

The Committee for Aquaculture Research and Development (CARD), together with the recently formed Scottish Aquaculture Research Forum (SARF), represent a pan UK and a national body whose remits are to co-ordinate and fund aquaculture R&D.

With limited funds and potentially divergent interests, it will be increasingly important for each of the industry sectors to make a strong case for the research required to underpin the sustainable development of aquaculture in the UK.

As an industry, the shellfish sector is largely populated by 'owner operators' and unlike the salmonid or to a lesser extent the emerging marine finfish sector, there is no levy system through which a research and development fund is accumulated. In many respects, the inability of the shellfish sector to contribute even modest cash resources to projects is a limitation. In-kind, or as the EU prefers to call them 'auditable resources', can be an important part of a research project – but more often than not, the real limitation is hard cash!

As we move towards what will inevitably be a more competitive research environment, the shellfish community should actively consider means of developing an R&D funding pot which would do much to encourage further support from public and other private sources.

At a strategic level, the development of shellfish cultivation and husbandry techniques, genetic improvement, disease resistance and other areas outwith the domain of the FSA receive little R&D funding compared to other aquaculture sectors. The stimulation of applied research in these areas will require increasing industry participation and sponsorship.

The Foods Standards Agency continues to be the single largest sponsor of shellfish research and is currently reviewing the shellfish R&D it supports before prioritising future commitments in this area.

Seafish is now committing approximately £200,000 per year to research which focuses on the marine finfish and shellfish sectors. Much of this funding is being committed to highly practical work and the first results from the Innovation and Development Primer Award projects are encouraging. One of the most important initiatives is the Seafish PhD Bursary scheme which is supporting a student for three years to develop strategies to determine and alleviate the impact of faecal contamination on shellfish aquaculture.

Seafish is also a member and sponsor of SARF which has an annual budget of approximately £280,000 and is in the process of commissioning prioritised research in a range of areas of direct relevance to Scottish shellfish growers. Projects will include work on carrying capacity, a GIS to assist coastal resource planning and, in principle, work which may improve our understanding of the non-compliance issue that occurs for shellfish growers in some designated waters.

Defra continues to sponsor work directly and through the funds it allocates as part of its commitment to CARD. Much of the Defra – CARD funding has now been allocated and has supported a range of shellfish related work, including the International workshop on approaches to the detection and identification of faecal sewage contamination in coastal waters (funded in association with Seafish) and management of a project to evaluate factors affecting native oyster stock regeneration. A review of the biological, technical and economic feasibility of native oyster stock regeneration, also funded in association with Seafish, is now underway. This project involves CEFAS Weymouth and the Central Science Laboratory in a multidisciplinary research effort which will help to provide an objective view of the way forward for native oyster stock regeneration. Over the past five years Defra has also supported sandwich students based at CEFAS Weymouth to conduct research into shellfish quality problems caused by organic waste pollution in harvesting areas. Work on the ecology of subtidal mussel seed beds continues at University College of North Wales as part of a three year study to improve our understanding of the potential impact of harvesting and translocation of ephemeral mussel seed settlement.

SEAFISH PROVIDE FUNDING SUPPORT FOR AQUACULTURE RESEARCH AND DEVELOPMENT

In February 2004, Seafish had a call for aquaculture research and development (R&D) proposals. This was all part of the organisation's strategy to continue to provide funding for aquaculture after Seafish withdrew from Ardtoe at the end of 2003. The funding, which was set up last year, will be used to encourage the development of competitive and sustainable aquaculture in the UK and to help producers make informed decisions about their businesses.

R&D Priority areas being supported

The aquaculture priority areas and criteria for applications were agreed at the outset through discussion with the respective industry Trade Associations - the Shellfish Association of Great Britain, the Association of Scottish Shellfish Growers and the British Marine Finfish Association. Guidance from other national and European Strategies for Aquaculture Development was also taken into account when considering which areas to support. The procedures have all been endorsed, and will continue to be monitored and reviewed through the Seafish Aquaculture Advisory Committee. Further information is available on the Seafish website (www.seafish.org.uk/sea/aquaculture).

Grants offered

Three types of grant were offered through the first call, namely:

- Technology and Innovation Primers – maximum value £3,000, over 12 months maximum duration and with a 50% matched funding requirement.

- Postgraduate Studentship/Bursary Scheme – maximum £37,500, over 3 years maximum duration and with any additional funding provided by the host university or research institute.
- Collaborative Awards – maximum value £60,000, over 3 years maximum duration and with a 60% matched funding requirement.

The Technology and Innovation Primers grants were aimed primarily towards the industry to provide marine finfish and shellfish producers with the opportunity to engage in applied, near market technology development. The other two types of grant will enable Seafish to support high calibre, collaborative research and development between industry, the research community and other sponsors.

Successful first call

This call for proposals in 2004 was extremely successful. A total of 32 applications were received with a combined value of £2,693,000 and an amount of £761,000 requested from Seafish. Since a sum of £150,000 had been set aside for this call, this meant that it was over-subscribed by approximately five times.

Of the 32 applications received and assessed by a review panel of industry experts, 12 projects will be supported (listed in Table 1) with funding ranging from £1,500 to £60,000 per project. Through this Seafish initiative, the UK aquaculture industry will benefit over the next three years to a value of £753,000 for a Seafish investment of £249,000.

This round of successful bids will build on the foundation of three projects that Seafish agreed to co-sponsor in 2003/04. These projects, each of 3-years, are on the ecology of seed mussel beds, on cannabilism in cod and on the role of light to prevent maturation of cod. Seafish funding for these projects amounts to an additional investment of £75,000, matched with £305,600 from other co-sponsors.

Additional Seafish funding for aquaculture R&D

Seafish will also be funding projects through the Scottish Aquaculture Research Forum (SARF), with a commitment of at least £50,000 support in 2004/05 (provided projects can be agreed by October).

Table 1. Successful project applications in each award category

Technology and Innovation Primers
Development and testing of in-tank grading systems for cod juveniles (Machrihanish Marine Farm Ltd.)
Study to evaluate the effectiveness of a mechanised rack system for Pacific oyster seed production (Othniel Shellfish Ltd)
Alternative to a land-based nursery for *Pecten maximus* (Loch Fyne Seafarms Ltd)
Subsea wave tank modelling project (Subsea Shellfish Ltd)
Scallop cocoon system (Oakes Marine Ltd)
Autonomous shellfish harvesting platform (ASHP) (QinetiQ)
Studentship/Bursary
Characterisation of *Vibrio* sp in marine culture (Dr Kim Thompson, IOA, University of Stirling)
Strategies to determine and alleviate the impact of faecal contamination on shellfish aquaculture (Dr Graham Underwood, University of Essex)
Collaborative Projects
Vaccine performance/efficacy in gadoids measured by cell mediated immune response (Prof Chris Secombes, University of Aberdeen)
Lipids, egg and larval quality in cod (Dr William Roy, Marine Environmental Research Laboratory)
Algal mediated turbidity and larval performance in marine fish (SAMS/Ardtoe Ltd)
Targeted approaches towards controlling the microbial gut flora in first feeding fish larvae (Prof Harry Birkbeck, University of Glasgow)

MAERL: ITS VALUE AS A NURSERY HABITAT FOR COMMERCIAL SPECIES

Nicholas A. Kamenos, P. Geoffrey Moore, Jason M. Hall-Spencer and David Donnan

The term ‘maerl’ covers several species of free-living red seaweeds that are capable of incorporating calcium carbonate (chalk) into their skeletal structure. Maerl grows as unattached twig-like nodules on the seabed and, where conditions are favourable, can form extensive beds. These beds will typically have a thin layer of pink, living maerl overlying an accumulation of white (dead) fragments, which may be several metres deep.

Maerl beds form a very fragile habitat, a delicate three-dimensional structure that requires specific conditions in which to grow. Beds are often found in shallow, sheltered areas where there is some water flow, overlying a substratum of sand, mud or gravel. Such situations are found in the narrows and rapids of sea lochs, or the straits and sounds between islands. Water movement is important as it helps

prevent the settlement of silt on the maerl that may lead to smothering. Maerl is very slow growing and some of the dead material at the base of the beds that accumulates beneath the top living layer may have been there since the end of the last ice age, 8000 years ago!

Maerl grounds are an important habitat, comparable to sea-grass beds and even coral reefs in terms of the wide range of species found in them, including the juveniles of species of commercial importance. For this reason, a study funded by UMBSM and Scottish Natural Heritage has recently investigated the role of maerl as a nursery ground for scallops.

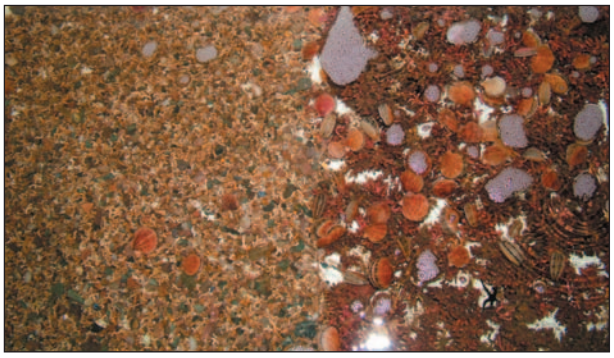
Maerl grounds impacted by towed demersal fishing gears were observed to have significantly lower three dimensional structure than pristine, un-impacted maerl grounds, and this reduces the diversity and quality of these habitats.

Pristine live maerl was observed to fulfil key nursery areas requirements for juvenile invertebrates and gadoid fishes. Densities of juvenile queen scallops (*Aequipecten opercularis*), soft clams (*Mya* sp.), sea urchins (*Psammechinus miliaris* and *Echinus esculentus*) and the common starfish (*Asterias rubens*) on the West coast of Scotland were significantly higher than those on impacted dead maerl and other common substrata. Additionally, undamaged maerl was observed to increase the carrying capacity of shallow inshore nursery areas for juvenile cod, saithe and pollack probably by providing a high biomass of juvenile food, importantly maerl was preferred as a foraging ground over gravel which has been historically assumed to be an optimal foraging ground for juvenile gadoids.

Juvenile queen scallops appear to be attracted to undamaged maerl following their initial settlement from the plankton. Results also suggested that undamaged maerl provides a unique combination of protection from predation coupled with high growth rates, a combination rarely seen in other nursery habitats which tend to offer a compromise between refuge and food availability.

Until recently the role of maerl as a nursery habitat has been largely overlooked. Yet maerl grounds are subject to an increasing range of pressures that diminish the quality of this habitat and, in turn, adversely affect recruitment to populations of commercial species in the surrounding area. We therefore hope that the results of this study will increase understanding of the importance of maerl grounds, and the fact that the conservation of maerl is not just an 'environmental' issue but of fundamental importance to sustainable fisheries.

A juvenile queen scallop on maerl (Photo: Nick Kamenos)



When given the choice of live maerl or dead maerl gravel, juvenile scallops show a distinct preference (Photo: David Donnan/SNH)

Further information

N.A. Kamenos, University Marine Biological Station Millport, Marine Parade, Isle of Cumbrae, KA28 0EG
Tel.: 01475-530581;
email: nick.kamenos@millport.gla.ac.uk

C- MAR WORKSHOP CELEBRATES A DECADE OF SUCCESS

Report by Dr Eric Edwards OBE, chairman of the C-Mar Advisory Board and a Visiting Professor at Queen's University, Belfast.

The Centre for Marine Resources and Mariculture (C-Mar) at Portaferry, Northern Ireland, celebrated its first decade with its seventh annual Aquaculture Workshop. C- Mar was set up in June 1994 by Queen's University, Belfast at their Marine Laboratory, Portaferry to further research, technology and education in marine fisheries and aquaculture.

This year's annual Workshop was held at the Exploris Aquarium, Portaferry, on 2nd and 3rd September and it attracted over 80 delegates, including commercial shellfish producers. The sessions included "Developments in bottom mussel cultivation, seed supply and management", "Seaweed Aquaculture and industrial applications" and "General Aquaculture". The event also looked back on the ten years of R&D on oysters, mussels, scallops, edible seaweeds and other species, under the direction of Dr Dai Roberts of Queen's University and C-Mar's current manager, Dr Niall McDonough.

One of the C-Mar Workshop sessions

Speakers from Holland, Germany, Ireland and Wales spoke about the importance of mussel cultivation and how the scarcity of the wild seed needed to replenish the culture plots is becoming a serious problem.

Predation by starfish, crabs, fish and seabirds and the destruction of seedbeds by gales and strong tides causes huge natural losses. Human interference by nature conservationists, who have an antagonistic view of fishing, adds to the problem.

Dr Mark Verdegem, a Dutch researcher from Yerseke, spoke about the challenges the Dutch mussel industry faces. European Union Directives – aimed at saving inter-tidal seed mussel beds for the birds - make it difficult for Dutch mussel growers to continue their traditional ways of bottom culture. As a result, instead of reaching the 100,000 tonnes a season needed for their huge markets, the Dutch are now producing only half this amount.

James Wilson of Deepdock Ltd, North Wales, gave a UK view on mussel farming in the Menai Strait. He explained the importance of seed as the raw material upon which is based a very valuable mussel cultivation industry. He told the delegates that mussel growers had to rely on an unpredictable and haphazard seed supply and the future could see some supplies coming from hatcheries.

Dr Gavin Burnell and his team from the National University of Ireland described a major study to understand the biology and ecology of mussel seedbeds in the Irish Sea. The expanding Irish bottom culture industry needs more seed and Dr Burnell explained that this project aimed to assess the abundance and sustainability of the existing seed mussel beds and draft a plan for their managed exploitation.

Other speakers in this session included Dr Uwe Walter from Germany, who spoke about collecting mussel seed on longlines (see following article) and Professor Ray Seed from the School of Ocean Sciences, University of Wales, who described the ecology of mussels and their benefits to the ecosystem.

Dr Niall McDonough (C-Mar) reported that the mussel industry in Northern Ireland was now producing about 4,000 tonnes of mussels, mainly for export. To ensure that this production is sustainable, the Fisheries Department (DARD) has a project under Dr Matt Service to evaluate the carrying capacity of the sea Loughs for shellfish cultivation.

Martin Pyke of Seafish concluded the mussel session with a lively talk on the use of standard depuration systems to purify shellfish. The optimum condition needed to remove both coliform bacteria and viruses were described.

The event also included the official launch of C-Mar's new boat – the RV SeaMar, which was christened by Dr Pat Boaden, a retired Queen's University lecturer and one of the original founders of the unit.

Launch of the RV SeaMar with, from left to right: Dai Robert; the author; Dr Pat Boaden; Niall McDonough

FIRST LONG-LINE EXPERIENCES AT THE GERMAN NORTH SEA COAST

Uwe Walter, Mytilamar - Aquaculture ● Research ● Consulting, Friedenstrasse 33,
D-26386 Wilhelmshaven - Germany

Introduction

On the German North Sea coast, culture of blue mussels (*Mytilus edulis*) is traditionally based on gathering seed mussels of around 1 to 4 cm length from natural beds and transplanting them to permanently water-covered bottom plots. The supply of mussel seed is a major constraint that affects the productivity of the mussel industry. Spatfall on natural inter-tidal mussel beds is not a regular or reliable occurrence. Therefore a research project was developed (2000 - 2004) in the Jade (Figure 1) to investigate whether long-line culture could be used successfully as a supplementary source for seed mussels.

Learning the hard way

Our first experimental long-lines were textbook in design with headropes, floats, mooring lines and anchor systems (one ton concrete block at each end). The first lesson we learned was that what works in one place may not work somewhere else, an experience that probably everyone suffers when starting out. Our first trial long line was dragged away from its initial position in the Wadden Sea after just 3 months as a result of the growth of mussels and other biota which led to a considerable increase in the hydrodynamic resistance.

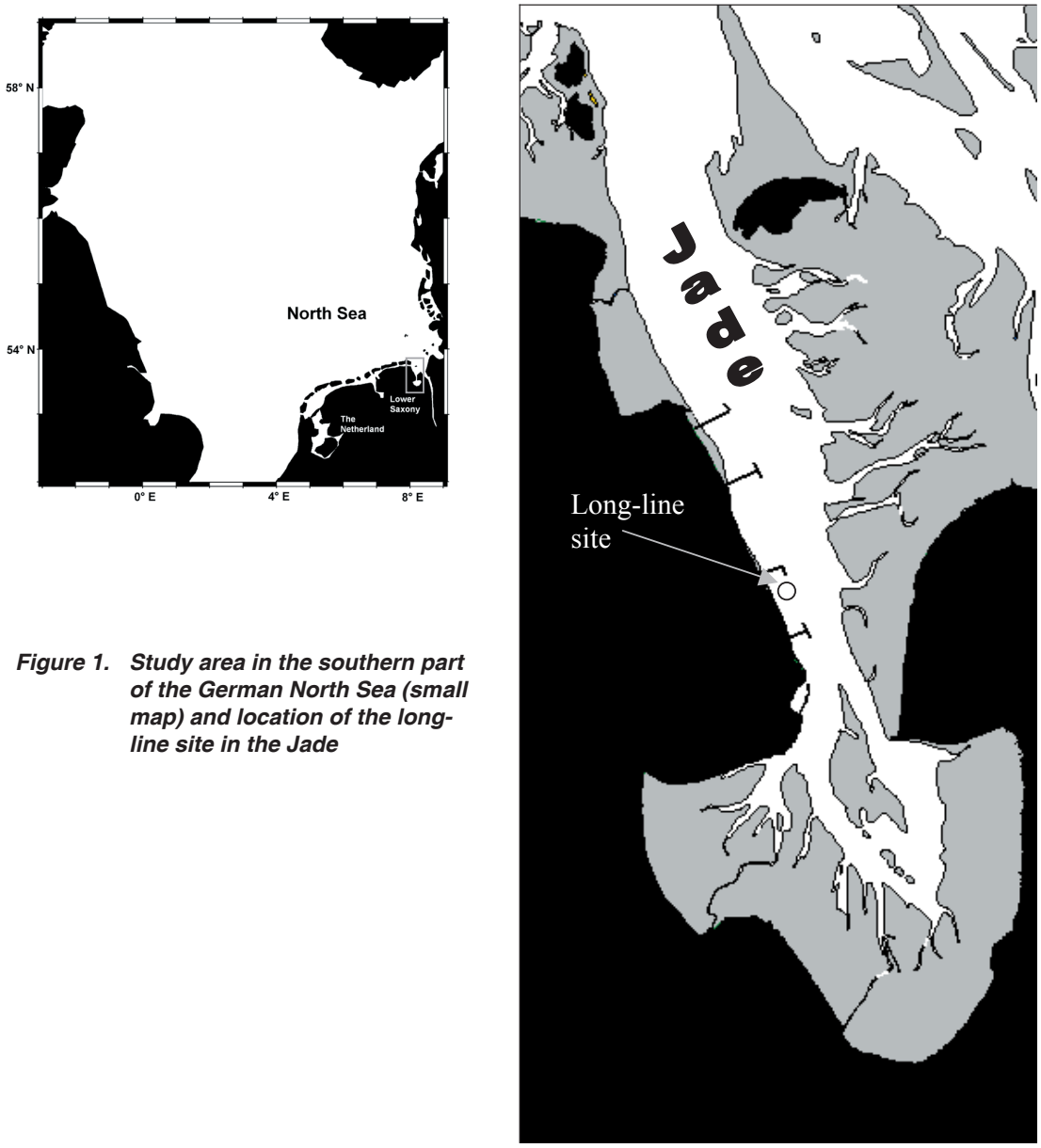


Figure 1. Study area in the southern part of the German North Sea (small map) and location of the long-line site in the Jade

As the mean tidal range is 3.9 m in the Jade and mean current speeds of 2-3 knots (maximum >5 knots) were recorded in 2002 we had to take additional safety factors into account. For the next trial, we applied a sophisticated mooring-anchor system with a 6 m-rail, three concrete blocks in a row (one ton each) and a 500 kg Danforth anchor (Figure 2a). This kept a surface long-line system of two paired horizontal backbone lines following a Swedish example in place. Each paired backbone line of 50 m length supported 50 vertical growing ropes (collectors) measuring 2.5 m in length.

In 2003 an anchor system of only two concrete blocks (each of two tons of weight) kept a single 50 m paired backbone line in place (Figure 2b). This construction can support 75 growing ropes. It proved successful and was easier to handle.

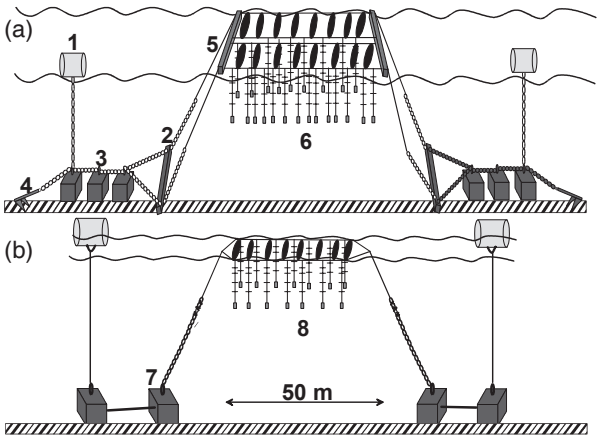


Figure 2. Longline setup: 1: marker buoy, 2: 6 m rail, 3: three concrete blocks (each 1 ton), 4: Danforth-anchor (500 kg), 5: wooden spreader, 6: two paired horizontal backbone lines, 7: two concrete blocks (each 2 ton), 8: single paired backbone line

Collecting spat

Mussel larvae and settlement occur all year round in the study area, even in winter. Although a marked seasonal peak of mussel larval abundance and settlement was observed regularly in May of each year. Highest monthly mean spat densities of tens of thousands of individuals per metre collector were recorded. Earlier experiments showed that, depending on the collector type, a mean of 3,000 to 14,000 mussel individuals m^{-1} (of collector) was recorded within 12 months after settlement.

The complete harvest of 73 collectors from the 2003 test long-line yielded more than 2,000 kg mussels.

Figure 3. The author with a densely settled mussel collector (8 kg m^{-1})

Within less than four months of settlement in May a mean of 10 kg mussel m^{-1} collector were harvested (Figure 3). The applied collector type of recycled net material with pegs was produced in Spain. Even at high mean mussel densities of 15,000 ± 6,000 individuals m^{-1} (number of collectors = 45) the mussels showed intensive growth. Between May and August 2003 the mean shell length increased to nearly 16 mm. This proves the feasibility of suspended culture to produce seed mussels for aquaculture even under the exposed conditions in the Wadden Sea.

Rope mussels suitable for relaying?

Some people argue that seed mussels originating from suspended ropes are not suitable for relaying on bottom cultures, due to their thinner shells. On closer inspection a comparison of mussels with shell lengths <30 mm from different habitats (sub-tidal, inter-tidal and suspended cultures) showed no difference in total wet weight and in shell dry weight (Figure 4).

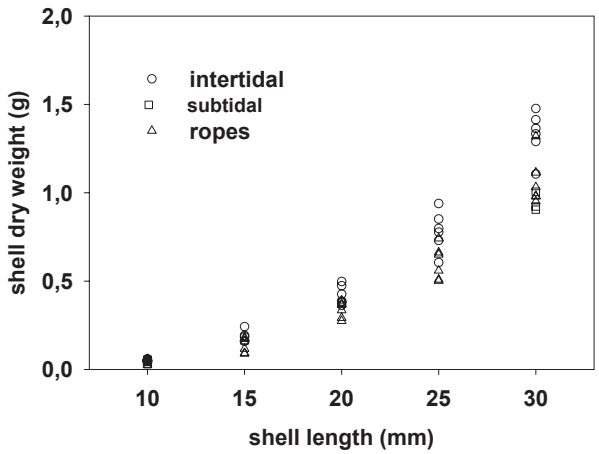


Figure 4. Comparison of shell weight (g) of mussels from three different habitats

Relaying seed mussels

Over the study period different relaying experiments were carried out with volumes ranging from 0.6 to 2.0 tons of mussel. A range of densities (based on the mean size of the mussels), times of the year and tidal position (sub-tidal or lower inter-tidal) were tested on small areas (100 - 800 m^2) of normal bottom culture plots. Wind and wave action spread the mussel seed beyond the experimental plot limits, making it impossible to trace or track the mussels originally from the trial site. In short, in all cases we lost the majority of the re-laid mussels in a short period. They drifted downwards into deeper parts of the tidal creeks or were decimated by green crabs (*Carcinus maenas*) and starfish (*Asterias rubens*). The latter was observed with a maximum density of 60 individuals m^{-2}. Thus, until now the transfer of 'rope' mussels to the bottom culture plots has not proved successful. One suggested solution to this problem, which will be the focus of a follow up study due to start this year, is to produce and relay commercial volumes of rope cultured seed on the bottom cultivation plots.

In conclusion this project has shown that it is possible to collect large quantities of mussel seed from suspended culture rigs in the Lower Saxonian Wadden Sea and has highlighted the problems associated with the transfer of this seed to bottom cultivation plots.

Acknowledgements

The author acknowledges the support of the Federal German Foundation for Environment (DBU), and the assistance of the Association of the Mussel Fishers of Lower Saxony. He is also grateful to Dr. Nuala McQuaid for helpful corrections of the manuscript.

Further information

For further information, please contact
Dr. Uwe Walter,
MYTILAMAR - Aquaculture ● Research ● Consulting,
Friedenstrasse 33, D-26386 Wilhelmshaven – Germany;
uwe.walter@terramare.de

FRENCH OYSTER AND MUSSEL TRADE SHOW

The annual trade show at Trinité-sur-Mer took place between 11th to 13th September 2004. Martin Syvret of Seafish Aquaculture reviews the show and looks at the developments that are taking place in French l'Ostréiculture.

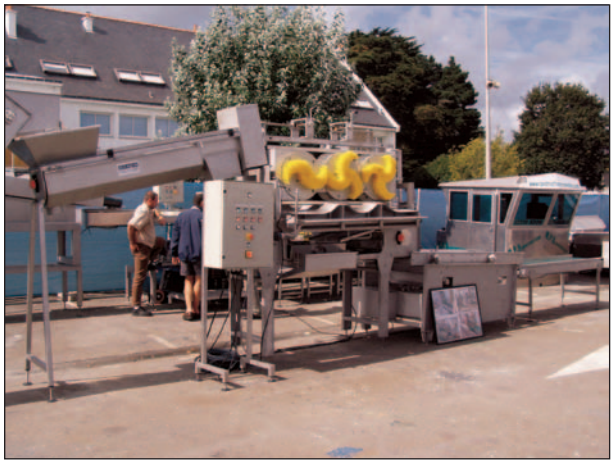
This year saw the 20th anniversary of the Brittany oyster and mussel culture trade show at Trinité-sur-Mer. The show, with over 80 exhibitors present this year, provides an opportunity for industry members from France and abroad to get together to discuss the season; the ups and downs of the year; prices and market trends. Seafish attended this year's show together with Peter Hoare, UK agent for the Australian Aquapurse oyster cylinders, and Ross Birbeck of Tradewinds mussel growers.

Exhibitors

Organised by the Auray growers co-operative the show had exhibitors demonstrating equipment ranging from basic culture requirements such as oyster bags, seed (triploid and diploid), containers, clothing, etc. through to work boats and chalands (flat-bottomed work barges), processing equipment, labelling/weighing

The main hall

Peter Hoare and Ross Birbeck inspect grading equipment on the Cochon stand



Mussel processing equipment (modular design)

machinery and even vivier display tanks for oyster sales. In addition to these, there were also exhibitors covering finance/banking, insurance, consultancy services as well as industry support and research organisations such as Ifremer and producer support/ promotion agencies such as Huîtres de Bretagne.

Quality Standards and Industry Promotion

In terms of Seafish's role in industry promotion and development the closest equivalent organisation at the show was the Huîtres de Bretagne organisation. They seek to develop co-operation between growers, improve quality standards and promote the industry to the public. The quality issue is particularly important in the French oyster production industry at present. Recent statistics have shown a drop in oyster sales in the French market for the first time. Producers are therefore increasingly, if slowly, looking to improve the quality of the product that they supply. This change in emphasis in production towards a higher quality product has seen a marked increase in sales in this sector of the market.

The change towards growing a quality product was reflected in the range of new oyster growing systems that were being demonstrated at the show. In total, three different Australian systems were in evidence.

Overall the show provided an excellent opportunity to see at first-hand the latest developments in growing, harvesting and processing equipment as well providing the chance to assess the current trends in production and marketing in the French industry. The next show of this type will take place from the 16th to the 19th April 2005 in La Tremblade. For information contact Salon de la Tremblade, B.P. 8. – Place Faure Marchand, 17 390 LA TREMBLADE, Tel/Fax: France 05 46 47 22 57

Further Information

The Seafish Aquaculture Development Team currently have available a series of CD-ROM Hyperbooks covering the cultivation of 8 marine species. There are Hyperbooks for both mussel (rope grown and relayed) and oyster cultivation. These Hyperbooks are a good source of information regarding the cultivation of these species and also act as an aid to help assess the likely economic viability of any proposed project (via the Economic Model contained in the Hyperbook). More information about the Hyperbooks can be found on the Seafish Website http://www.seafish.org/sea/aquaculture.asp?p=ec286

For any further information regarding shellfish farming in England and Wales contact Martin Syvret of Seafish on m_syvret@seafish.co.uk

APPLICATION OF LIQUID CHROMATOGRAPHY-MASS SPECTROMETRY (LC-MS) TO DETECT LIPOPHILIC SHELLFISH TOXINS

Elizabeth Smith and Lesley Stobo
Fisheries Research Services (FRS) Marine Laboratory, PO Box 101, 375 Victoria Road, Aberdeen AB11 9DB

The Scottish Marine Biotoxin Monitoring Programme

In 1990, FRS established a monitoring and surveillance programme for the detection of marine biotoxins in shellfish around the Scottish coasts. From 1 April 2000 the Food Standards Agency Scotland (FSAS), as Central Competent Authority, assumed responsibility for this monitoring programme and currently contracts FRS to carry out analytical aspects of the monitoring.

This programme now monitors live bivalve molluscs for paralytic, amnesic and diarrhetic shellfish poisoning (PSP, ASP, and DSP) toxins at 102 inshore sampling sites, together with up to 104 offshore areas important for scallop fisheries. Additional water sampling, at coastal and offshore sites, is used to identify key phytoplankton species associated with toxic events.

Fishing, farming and processing shellfish industries are important contributors to the economics of many coastal communities around Scotland. The monitoring carried out by FRS, on behalf of FSAS, ensures compliance with Official Controls as required by European Union (EU) Directive 91/492 EEC and helps to ensure the safety of Scottish shellfish that are placed on the market, and hence helps sustain safe and successful Scottish fisheries.

Detection of Diarrhetic Shellfish Poisoning (DSP) Toxins

The monitoring programme for DSP toxins in shellfish from Scottish waters uses a mouse bioassay. This assay is the EU reference method. However, as with any bioassay, the method used can be susceptible to matrix interference and with the technological advances that have been made over the last few years, there is now opportunity to develop alternative assays.

Since monitoring began at FRS, it has become apparent that contamination of shellfish by DSP toxins is a complex phenomenon and recent discoveries within the EU have shown that several naturally occurring chemicals may give a positive test result when using the DSP mouse bioassay (Stobo *et al.*, 2003). This has resulted in changes to EU legislation (Commission Decision 2002/225/EC) governing the commercial production of shellfish for human consumption.

Advances in research mean the DSP toxin complex is now divided into the traditional DSP toxins (okadaic acid (OA) and dinophysistoxins (DTXs)), pectenotoxins (PTXs), yessotoxins (YTXs) and azaspiracids (AZAs). These groups of compounds are sometimes referred to as 'lipophilic toxins', which refers to their chemical characteristics rather than their toxic effect. Decision 2002/225/EC sets statutory concentrations for these compounds and provides for scientifically validated 'alternative or complementary methods' to the mouse bioassay to be used, for the detection of these toxins, if they provide an equivalent level of protection to the consumer, compared to the mouse bioassay.

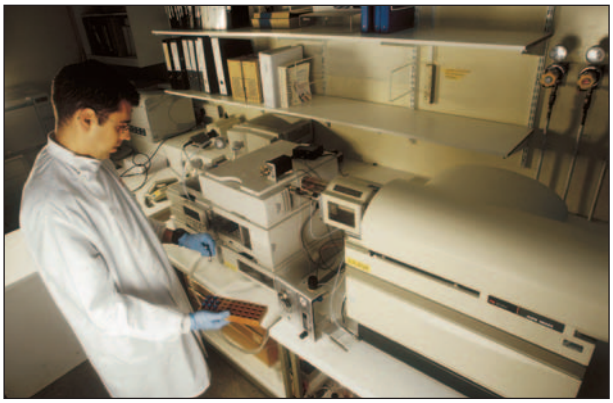
Developing a New Toxin Detection Method

In the last few years, developments in the use of a technique called liquid chromatography-mass spectrometry (LC-MS) for the detection of marine biotoxins in shellfish have progressed rapidly. An increasing number of scientists consider that LC-MS may be an effective and viable alternative to the mouse bioassay for the detection of lipophilic toxins in shellfish. However, the quantitative use of this method has been slowed down by a lack of adequate calibration standards and reference materials to ensure the accuracy of these analytical methods.

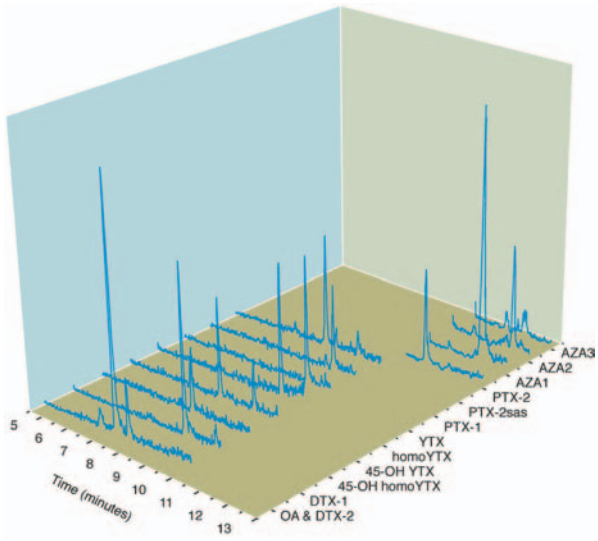
The Canadian National Research Council, in association with FRS and other expert laboratories, has developed certified calibration standards and reference materials for the analysis of some of the lipophilic toxins listed in the Decision. Using these standards and contaminated shellfish extracts, FRS has developed a new multi-toxin LC-MS qualitative screening method for the determination of OA, DTXs, YTXs, PTXs, and AZAs in shellfish as part of a FSA UK funded research project. The use of the new LC-MS method offers identification of the individual toxins present within a sample and has great potential as a screening technique.

Implications of the New Detection Method for Scotland

Using LC-MS, OA and some DTX compounds have been found in shellfish from Scottish waters, but as yet, little is known about the prevalence of other lipophilic



Testing for marine biotoxins using LC-MS



Output (chromatogram) using the multi-toxin LC-MS method. Peaks indicate the presence of a toxin

toxins. Preliminary work by FRS has indicated that YTXs, AZAs and PTXs are present, and a species of phytoplankton (*Protoceratium reticulatum*) obtained from UK waters has been identified as producing YTX.

Future Validation of the New Method

It is essential that the new multi-toxin LC-MS testing method is carefully validated and accepted by the international markets of shellfish harvested in Scotland. In conjunction with other shellfish monitoring laboratories within the UK (and the UK National Reference Laboratory for Marine Biotoxins), FRS aims to progress the application of this method to assist in protecting public health, to manage commercial shellfish harvesting and to help the Scottish industries pursue a successful future.

Further information

L. Stobo, L. Webster and S. Gallacher, 2003. Occurrence of azaspiracids, spirolides, yessotoxins, pectenotoxins and free fatty acids in plankton and shellfish. FRS report 08/03.

TOOTHPASTE FROM SHRIMP SHELLS (CONTINUED)

Frank Jeal, Zoology Department, Trinity College, Dublin 2

The article on the use of crustacean shells as a toothpaste component (Shellfish News 17, May 2004) reminded me that in Ireland crab and lobster claws were at one time used as 'teething rings' for babies. I tracked down the original reference to this practice in John Rutt's 'An Essay towards a Natural History of the county of Dublin' published in Dublin in 1772.

He writes (Volume 1, pp.371/372)

'Lobsters, Crayfish, Crabs, Shrimps, and probably all crustaceous fishes cast their shells from time to time, and probably with not less regularity than Deers (sic) do their Horns, and Horses, Cows and Dogs their hairs in Spring and Birds their feathers.

It hath been lately observed that if the claws of Lobsters or Crabs be destroyed, they will be reproduced even as the parts of the Polypes, Starfish, etc. This is one of those Wonders in Nature, the discovery of which does honour to the present age.

The claws are sometimes hung about Children's necks as Coral, to rub their gums in breeding their teeth.'

In view of the reported antibacterial properties of chitosan this may have been a less unhygienic practice that would appear at first sight!

SEAFOOD CAN HELP TOMATOES GROW

Fish and shellfish can help tomato and barley plants grow according to a new study by Seafish that suggests seafood waste is an ideal basis for producing compost.

Seafood processing businesses carry heavy costs for waste disposal despite the fact that seafood by-products – including heads, shells, bones and tails – are a potential resource, rich in valuable minerals, pigments and flavours.

A previous Seafish report considered various options for seafood waste and identified the production of compost as a promising idea.

The latest study looked at the effectiveness of seafood compost and concluded that seafood compost has potential in certain land-based applications. Successful trials used pot-grown tomato and barley plants.

"As the waste from seafood processing is so rich in minerals it can be extremely good material for composting," says Seafish technologist Michaela Archer.

"This study has shown that this is a safe, practical and cost-effective solution for the seafood industry. We produced a compost suitable for agricultural markets. With extra care we hope it is possible to develop a quality product for the horticultural and domestic markets."

"This project is just part of a major programme of Seafish work on seafood waste handling and disposal," says Michaela Archer.

"The ultimate aim is to encourage the commercial uptake of a range of seafood waste derived products. This can be achieved by developing links between the seafood industry, the developers of waste utilisation technology and the markets for the products. We would like to hear from anyone interested in being involved in the process."

Seafish will carry out further work on the commercial feasibility of seafood by-product composting by developing a small number of commercial demonstration projects in areas that are struggling to find alternative waste management outlets.

FRESHWATER PRAWN FARMING IN BANGLADESH: HOW CULTIVATION IS FINANCED

Dr Nesar Ahmed, Department of Fisheries Management, Bangladesh Agricultural University

Introduction

In Bangladesh, freshwater prawn (*Macrobrachium rosenbergii*) farming is currently one of the most important sectors of the national economy and during the last two decades its development has attracted considerable attention for its export potential. The freshwater prawn is a highly valued product for international markets, earning considerable amounts of foreign currency. Almost all prawns are therefore exported, particularly to the USA, Japan and Europe. The freshwater prawn is mainly cultivated in the southwestern part of Bangladesh, where thousands of farmers have converted their paddy fields to '*ghers*' to accommodate a profitable prawn culture practice. The Bangla term '*gher*' is an enclosure made for prawn cultivation by modifying rice fields and/or water bodies through building relatively higher dikes and excavating a canal several feet deep inside the periphery of the dikes to retain water during the dry season. During the rainy season the whole water body is used for the cultivation of prawn and fish. However, when the weather is dry then only the trenches are used for fish and rice is planted in the central plot. The *ghers* are generally situated in low-lying area of the floodplain, which are irregular in shape and may be up to 100 ha in area.

Costs for prawn production

According to the prawn farmers, investment in prawn cultivation within gher systems is quite large, averaging Tk 69,825 or US$ 1,204 ha^{-1} $year^{-1}$ (excluding *gher* construction cost). The first year of prawn farming is the period in which large amounts of money are needed due to *gher* construction. The dry months of February to April are the peak season for *gher* construction. The average *gher* construction cost was reported at Tk 55,646 (US$ 959) ha^{-1}. Construction cost is mainly associated with labour cost, where the normal wage rate is Tk 80 to 120 (US$ 1.4 to 2.1) day^{-1}, but this depends on *gher* size, location, number of labourers required, and season. The size, shape and depth of the *gher* also affect the cost of construction. The peak labour demand, during February to April, coincides with rice weeding and later harvesting. However, during the early monsoon months of June to August when little work is available, the normal wage rate drops to Tk 40 to 50 (US$ 0.7 to 0.9) day^{-1}.

Costs of prawn cultivation have increased significantly in recent years as a result of increased costs of inputs like prawn stock and feed. Farmers noted that the shortage of wild fry and their high price to be one of the biggest constraints. The prawn industry depends on catches of wild fry, and farmers begin stocking their *ghers* as soon as fry become available, typically in April, and continue adding fry up until about July.

Freshwater prawn production costs

Cost item	US $ per ha
Seed (prawn and fish)	467 (39%)
Feed	392 (33%)
Fertiliser	14 (1.2%)
Labour	18 (1.5%)
Harvesting and marketing	11 (0.8%)
Rice cultivation	95 (8%)
Miscellaneous	13 (1%)
Total Variable Cost (TVC)	*1,012 (84.5%)*
Management staff salary	60 (5%)
Interest	98 (8%)
Depreciation	34 (2.5%)
Total Fixed Cost (TFC)	*192 (15.5%)*
Total Cost (TC)	**1,204 (100%)**

Successful commercial farming of freshwater prawns must involve supplementary feeding. The preferred feed is the freshwater snail *Pila globosa*. The snail

Gher construction by labourers

population has declined in prawn farming areas due to excessive harvesting, and they are now harvested from neighboring districts. The supply of snail is not regular, and therefore farmers also use home made feed made by mixing cooked rice, rice bran, oil cake, and fishmeal. However, the prices of feed have increased significantly since prawn farming has become widespread.

Financing of prawn farming

According to a survey from 100 farmers, it was found that 68% of farmers used their own money for prawn farming, while the rest (32%) received loans. Farmers use a wide variety of strategies to develop prawn farming. Small farmers entering prawn operation typically employ an incremental strategy in which they begin with small *ghers* on only part of their land and stock and feed them at minimal level. The finance comes mainly from a broad mix of personal and informal sources. Farmers primarily finance their prawn farming operations through disposing of household assets. Some have their own capital, either savings or proceeds from sales of personal assets, especially cows, gold jewellery or timber, some sell land. Although actual sale of land to finance *gher* construction now appears to be extremely rare, leasing out a portion of one's land for gher development as a means to finance the building of one's own gher is common. Cattle were the most common assets to be sold for developing a *gher* and the most commonly reported. They are a common store of value for paddy farming households, and so most households had a pair. If the family is serious about becoming *gher* operators, they may no longer need their cows for ploughing. The number of cattle has therefore decreased significantly since *ghers* have become widespread. Farmers interviewed stated that they had decided against re-investing in cattle with their profits from prawn farming. A few farmers (5%) noted that they would not like to raise cattle due to decreased grazing land as a result of its conversion into *ghers*. Moreover these farmers stated that cattle are less profitable then investing money in prawn farming.

Access to credit (institutional and non-institutional) is considered to be one of the important factors influencing prawn production. However, only 32% have received a formal and informal credit for prawn farming. More than 80% of farmers are poor and unable to finance their prawn farming. They are therefore looking for credit from various sources. Over recent years several institutions for providing credit to the farmers have been developed, chief of which have been banks, non-government organisations (NGOs), prawn traders and local moneylenders. The most common source of credit is through moneylenders, who appear to be the preferred source of borrowed capital for prawn farming. Local moneylenders appear to behave in the customary way, with no noticeable changes to suit the particular needs of prawn farming. Actual interest paid is from 10% a month in most cases, though borrowers are sometimes quoted a higher rate (15 to 20%).

Some farmers noted that they were able to pay their loans to the moneylenders and become financially self-sufficient within the first one to two years. However, others sometimes have harvest failures due to flood, outbreak of disease or other unavoidable reasons, and as a result they can fall into continuing cycle of debt. If this does not recover, moneylenders may take the land of *gher* owners who default on their loan. The numbers of farmers who defaulted on their loans and lost land has increased during the last few years.

Ghers for profitable prawn farming

Local branches of national banks provide credit to the prawn farmers secured against land at a 12-18% yearly interest rate.

The prawn traders are also a major supplier of capital to the prawn farmers by '*dadon*' credit, which is widely practised in prawn producing areas. *Dadon* is a system of tied credit through which the prawn traders advance money to the prawn farmers in exchange for the assured sale of prawns. Usually, the prawn traders will receive their *dadon* advance towards the beginning of the buying season from processing companies. These companies buy prawns, grade and freeze them, and export them to the international market. Companies

Prawns being harvested by farmers

contact with commission (or purchasing) agencies who pay suppliers for their prawns on behalf of the companies in return for a commission.

The average amount of credit received by a farmer was estimated at Tk 16,135 (US$ 278) year[1], which is very low considering prawn farming. According to the farmers who received loans, 40% obtained these from prawn traders as *dadon* credit, 32% from moneylenders, 17% from NGOs, and only 11% from banks. Farmers who got loan from sources other than banks were asked why they had not obtained a bank loan. Farmers mentioned that they would not like to go to a bank due to a lack of education, too much official and paper work, and too small loans.

Harvested prawns, which are exported to the international market

Conclusions

As an economic point of view, freshwater prawn farming in *gher* systems is profitable. However, most of the poor farmers have been facing a number of constraints for its development due to lack of money and high rate of interest loan. As a result, farmers could not produce more prawn due to financial constraints. Thus, adequate bank credit with low interest needs to be ensured to the farmers for profitable prawn production.

Acknowledgements

The author would like to acknowledge DFID (Department for International Development, UK) for funding this research. The author is grateful to Professor James F. Muir, Institute of Aquaculture, University of Stirling, UK, for his help and generous advice throughout the study period.

Further Information

Dr Nesar Ahmed, Assistant Professor,
Department of Fisheries Management,
Bangladesh Agricultural University,
Mymensingh-2202, Bangladesh
E-mail: nesar@royalten.net

ANNOUNCEMENTS

UK MICROBIOLOGICAL LABORATORIES UNDERTAKING SHELLFISH TESTING

Resolutions of Eighth Meeting: June 8th 2004

A periodic meeting of laboratories undertaking microbiological testing of bivalve shellfish was held at Nobel House, London on June 8th 2004. The group comprised representatives from CEFAS Weymouth (the National Reference Laboratory), the Health Protection Agency, Hospital Trust Laboratories in England, National Public Health Service for Wales, the FRS Marine Laboratory Aberdeen and the Northern Ireland Public Health Laboratory.

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 developed administrations, of the views of testing laboratories as outlined above.
4. To enable CEFAS Weymouth, as the UK National Reference Laboratory (NRL), to represent the views of UK testing laboratories in the European Laboratory Framework specified in Council decisions 1999/313 and to co-ordinate with UK laboratories initiatives arising at the European level.

The group agreed the following regulations:

1. The group agreed that further standardisation was required at the homogenisation step prior to testing bivalve molluscs for *E. coli*. A proposal would be drafted and, after agreement, forwarded to the CRL.

2. The group agreed that the issue of the use of inappropriate *E. coli* methods by some end-product testing laboratories should be raised with the FSA and UKAS.
3. The group agreed that further feedback should be given to end-product-testing laboratories using inappropriate methods in order to encourage them to change to methods regarded as acceptable.
4. The group supported the development towards European wide standardisation of sampling protocols, sample transport and testing of bivalve mollusc harvesting areas for *E.coli.* Support should be given to relevant research to provide a sound base for such standardised protocols.

THE 3RD WORKSHOP OF MICROBIOLOGICAL NATIONAL REFERENCE LABORATORIES, ISS ROME, APRIL 2004

A workshop of the European National Reference Laboratories for monitoring bacteriological and viral contamination of bivalve molluscs was held at the Istituto Superiore di Sanità, Rome, Italy, on 30th March to 1st April 2004. The workshop was hosted by ISS and the attendees comprised representatives from the European Commission (DG Sanco and the Food and Veterinary Office), the European Community Reference Laboratory (CRL - CEFAS, Weymouth, UK) and National Reference Laboratories (NRLs) from Austria, Belgium & Luxembourg, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, and United Kingdom.

The workshop produced 49 resolutions and these can be viewed on the CRL website (www.crlcefas.org).

The next meeting will be hosted by IFREMER and held in Nantes, France on 15th to 17th March 2005

NEW GROUP SET UP TO ADVISE ON FOOD SAFETY

A group bringing together consumers, the food industry, retailers and farmers is being created to help make food safer.

The Advisory Group on the Food Chain and Animal and Plant Health will meet at least twice a year and consist of up to 45 members from EU-level associations, according to a statement from the EU. Reflecting the Commission's "farm to fork" approach to food safety, the group will be consulted on a wide range of food policy matters. Additionally, the Commission intends to create an Internet based consultative forum on food safety open to all European organisations with an interest in this area of policy.

The new Advisory Group is likely to meet for the first time towards the end of this year.

David Byrne, the European Commissioner for Health and Consumer Protection, said "Debate and dialogue with stakeholders helps strengthen the quality of our policy making and is an essential component of good governance. Over the past few years the EU has put in place a world-class system of food safety regulation. It is appropriate that today we also modernise our system for consulting on food safety."

European level associations representing food producers, food processors, retailers and consumers are being invited to apply for membership to the Advisory Group on the Food Chain and Animal and Plant Health. The new Advisory Group replaces five existing consultative bodies – the Advisory Committee on Foodstuffs, plus the standing groups on veterinary matters, plant health, animal welfare and feedstuffs previously attached to the Advisory Committee on Agricultural Product Health and Safety.

NEW ORGANISATION ESTABLISHED TO DEVELOP AQUACULTURE RESEARCH IN SCOTLAND

A new independent charity, Scottish Aquaculture Research Forum (SARF), has been formed to promote, encourage, and support research and development in the farming of fish and shellfish. In the first year SARF will receive £100k from both the Scottish Executive and the Crown Estate and is likely to raise a further £300k through collaborative funding from its members. Over time this research budget is expected to grow.

Established by representatives from the aquaculture industry, government, wild fish groups and environmental Non-Government Organisations (NGOs), SARF will tackle research in the fields of environmental impacts, technical and biological cultivation, health and welfare science, and related activities. It is also intended to enhance public understanding of aquaculture through the dissemination of research results in the public domain. This will include online publication of investigations and results.

Deputy Environment and Rural Development Minister Allan Wilson said:

"We are committed to supporting an aquaculture industry that is sustainable, diverse and competitive. The work of SARF will play a key role in delivering this objective.

"The establishment of the forum reflects the widely recognised need for more research to be carried out, not only in areas that are impacted upon by aquaculture, but also in areas that impact upon aquaculture.

"I hope that the forum's independent status, coupled with a balance of different interests will ensure that the research outcomes benefit both industry and the environment."

Professor Bill Ritchie of University of Aberdeen will head up a board of SARF directors from organisations such as Scottish Environment Link, Scottish Environment Protection Agency, Scottish Quality Salmon, British Trout Association, Crown Estate, Scottish Natural Heritage and the Sea Fish Industry Authority.

Bill Ritchie emphasised the independence of the newly formed charity and said: "SARF is the first opportunity for environmental groups, the aquaculture industry and regulatory bodies to come together in Scotland with a budget that will enable research to take place that will benefit the whole industry, the environment and local communities."

Jon Harman, Development Director of Sea Fish Industry Authority said: "This is a great opportunity for this sector of the seafood industry. It will enable the funding of research focussed on renewable resources that will help to achieve a successful future for aquaculture businesses across Scotland."

Becky Boyd, representing Scottish Environment LINK said: "LINK looks forward to SARF playing a key role in building an aquaculture industry that supports and is supported by a healthy and productive marine environment, meeting the needs of Scotland's coastal communities."

The creation of SARF was a key priority in the Framework for Scottish Aquaculture, published by the Scottish Executive in March 2003.

Further information

SARF, c/o FRM Ltd.,
Coillie Bhrochain,
Bonskeid, Pitlochry, Perthshire PH16 5NP.
Tel:/Fax: +44 (0)1796 474473;
Email : info@sarf.org.uk,
web: http://www.sarf.org.uk/index.html

INTEGRATED RESEARCH TO IMPROVE AQUACULTURE ACROSS EUROPE

As stocks of wild fish suffer through overfishing, attention is increasingly turning to fish farming as an alternative way of meeting the world's appetite for fish and seafood. Although commercial fish farms are successfully supplying large amounts of salmon, trout, sea bream and other species, the rapid growth of this new industry is generating concerns about the long-term sustainability of production methods.

A new initiative to create an integrated programme of research across five countries on the western seaboard of Europe is set to address this problem. Aquaculturists

at the renowned School of Ocean Sciences at the University of Wales, Bangor are to head a Europe-wide project to coordinate research on reducing the environmental impacts of commercial fish farming. The group will also be looking at how the industry can develop in a sustainable manner by increasing the range of species that can be successfully farmed.

The School put forward a winning proposal to the European Union's European Regional Development Fund for the formation of the Atlantic Arc Aquaculture Group. Comprising researchers in Wales, Scotland, Ireland, Spain and France, the group will coordinate research efforts to develop an aquaculture industry that is both sustainable and ecologically sound.

"The consequences of aquaculture are not constrained by national boundaries so it certainly makes sense to collaborate internationally to reduce negative impacts and to identify future options for sustainable production" said Daniel Lee, the project coordinator.

As well as looking at ways of improving current aquaculture techniques, the group will also be researching new fish and shellfish species that could be successfully reared. Candidates include Arctic charr and sea urchins. Sea urchins are a highly prized food, particularly in the Far East, but farming methods are poorly developed. Improvements in aquaculture techniques clearly have the potential to supply adventurous consumers with all kinds of new fish and shellfish.

Running for three years, the Atlantic Arc Aquaculture Group will bring additional posts and equipment to further enhance the School of Ocean Sciences' expertise in this important area of commercial fisheries.

The group will be working closely with industry. Indeed the project has a special remit to foster links with small and medium-sized enterprises - often the key innovators that give rise to whole new branches of aquaculture. Projects are already underway with Llyn Aquaculture, Pwllheli, a leader in the field of low-impact, high-yield recirculation technology, with the aim of producing secondary crops using surplus nutrients from fish culture.

A NEW FUND TO SUPPORT SUSTAINABLE FISHERIES AND DIVERSIFICATION

Background

The European Commission has tabled a proposal for a European Fisheries Fund (EFF) for the period 2007-2013, to help implement measures aimed at securing sustainable fisheries and diversifying economic activities in fishing areas. The proposed overall budget for EFF for the seven year-programming period 2007 to 2013 amounts to € 4.963 billion. Three-quarters of this budget will be allocated to the regions lagging behind, most of which are located in the new Member States.

On average, € 700 million will be made available per year. This EFF will succeed the current Financial Instrument for Fisheries Guidance (FIFG). EFF measures are adapted to the changing needs of both the fisheries and aquaculture sector and the coastal fishing areas concerned. The approach is based on helping to reduce fishing pressure to allow the recovery of fish stocks and encourage the use of more environmentally friendly equipment and practices in fishing and aquaculture and in processing and marketing of fisheries products. EFF will also provide aid for fishing regions most affected by job losses to help them diversify and strengthen their economic base. Collective initiatives and those that encourage equal opportunities will also be eligible for EFF aid. It is up to Member States to decide which mix of measures suits their regions best. As decided under the 2002 Common Fisheries Policy reform, aid to renew the fleet, export vessels or create joint enterprises will no longer be eligible under the new rules.

Aquaculture, processing and marketing

EFF will continue to support the sustainable development of European aquaculture. Shellfish farmers, temporarily unable to harvest their production due to unforeseen circumstances, will be eligible for aid. The development and application of methods and practices that lessen the impact of aquaculture on the environment, the implementation of measures to promote hygiene and protect public health as well as initiatives to enhance marketing conditions of aquaculture products will be eligible for EFF aid. Priority will be given in these areas to projects that boost employment without encouraging over-investment. The focus will be on support for small enterprises. These objectives will also guide funding to the processing and marketing of fisheries and aquaculture products.

NEW PROTECTION FOR GALLOWAY SHELLFISH STOCKS

In June, the Scottish Executive took steps to help conserve shellfish stocks in the south-west of Scotland.

An order that was laid in the Parliament and expected to come into force on July 5, 2004 introduced a maximum length of 12 metres for vessels using creels in Luce Bay and Wigtown Bay.

This new measure will aid continuing efforts to conserve crab, whelk, lobster and other shellfish stocks in Scotland's inshore waters and help local fishermen who are dependent on the stocks.

Environment and Rural Development Minister Ross Finnie said:

"In managing Scotland's inshore fisheries, the Scottish Executive is determined to balance economic and environmental interests. Our aim is to achieve sustainable inshore fisheries.

"The measure that we are introducing today will contribute to the conservation of Galloway's important shellfish stocks. It will also help safeguard the jobs of local fishermen whose livelihoods depend on those stocks."

The new measure prohibits fishing with creels from vessels longer than 12m in Luce Bay and in Wigtown Bay, and is intended to stabilise effort on the shellfish stocks in these areas. Vessels fishing with mobile gear are not affected by this measure.

An Order, under the Inshore Fishing (Scotland) Act 1984, has been laid in the Scottish Parliament to come into force on July 5, 2004. The Order also consolidates the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989.

LANTRA RECEIVES FIVE-YEAR 'LICENCE TO SKILL' UK'S AQUACULTURE INDUSTRY

The UK's aquaculture industry received a boost last June, when Sector Skills Council, Lantra, was awarded a five-year licence from the Secretary of State for Education and Skills, Rt Hon Charles Clarke MP. This significant achievement acknowledges the hard work that employers, trade associations and Lantra staff have put in to developing Lantra as a Sector Skills Council. The licence will enable Lantra to continue leading the drive to increase skills across the aquaculture industry. Aquaculture employer, Doug McLeod, joined other representatives from the 17 environmental and land-based industries that Lantra represents, to celebrate Lantra's achievement at a VIP reception and skills debate at the House of Commons on Tuesday 29 June.

TV presenter Nick Ross hosts skills debate

The award of the licence was marked by a skills debate hosted by TV presenter Nick Ross, which gave employers and industry representatives the opportunity to have their say on the skills issues affecting the sector. An interactive voting system meant some fast answers to inform the debate and to guide the Lantra management on what the sector expects of them. The debate covered many key issues relating to the needs of micro-businesses and sole traders, which predominate in the sector. In particular, the need to upskill employers and improve management skills were discussed.

Rt Hon Charles Clarke MP presents Lantra Chairman, Dr Gordon McGlone, with Lantra's five-year licence

Employers show support

Doug McLeod of Glenelg Shellfish, Isle of Skye, attended the event. "I found the skills debate both interesting and useful", he said. "The Holy Grail remains that of how to stimulate interest and commitment in training across the aquaculture industry, from multi-nationals to SMEs and micro enterprises". "The five year licence will give Lantra a stability of purpose and allow it to develop and expand its Industry Group based activities, with which I hope to play an active role, promoting the wider interests of training in the aquaculture sector".

Lantra's Aquaculture Industry Group, chaired by Doug McLeod, has played a key role in shaping and forming Lantra's strategic direction to meet the needs of the industry and the sector as a whole. The group comprises employers and representatives from across the aquaculture industry.

Doug McLeod of Glenelg Shellfish, Isle of Skye, joins discussions with Lantra Chairman Dr Gordon McGlone and Lantra Industry Partnership Manager Sally Beel

Ministerial backing for the industry

Rt Hon Charles Clarke MP acknowledged the hard work and commitment from employers, industry representatives and Lantra: "I really congratulate Lantra and all that have worked with you to reach this tremendous moment - the establishment of Lantra as a full Sector Skills Council." Recognising many of the challenges facing businesses in the sector, he continued: "I think the commitment to the skills agenda is tremendously important as a method of controlling the process of change, influencing it and making change happen to benefit communities, rather than simply being victims of it."

Continuing employer commitment

A message emerging from the whole event was the continuing need for employers to voice their skills needs so that Lantra continues to be an effective employer led organisation. Chairman Gordon McGlone said: "We are at the beginning of a new era in which the voices of employers working in the sector are heard louder than ever - and not just heard, but taken notice of."

To find out more about Lantra and its work for the aquaculture industry, visit www.lantra.co.uk/aquaculture.

Launch in Wales

Jane Davidson AM, Education and Lifelong Learning Minister, joined employers and industry representatives from Wales' environmental and land-based industries at the Millennium Stadium in September to celebrate the awarding of the new five-year Sector Skills Council licence to Lantra.

Jane Davidson said: "I am delighted that Lantra has received this licence as the Sector Skills Council for the environmental and land-based sector in Wales. This represents another important step towards establishing the Skills for Business network of Sector Skills Councils across the UK and in particular Wales. It is through forming real partnerships and working collaboratively that we will raise our game, and be responsive to the needs of employers. This is the only way we can hope to achieve our goals of a strong, economically and socially secure Wales."

She continued: "Land-based industries such as aquaculture are predicting growth, and these will require new entrants with high quality skills. Existing workers will need to be supported to develop new skills."

Speaking at the event, Lantra Chief Executive, Peter Martin, said: "Lantra is a member of the strategy group for aquaculture and fisheries, which has been facilitated by the WDA. As part of the work of this group, Lantra was invited to review current and future training needs, the results of which are now starting to shape learning provision in Wales."

Raising management skills in Scotland through free ILM course places

As part of efforts to improve business and management skills in Scotland's land-based industries, Lantra is working in partnership with the Institute of Leadership and Management (ILM) to offer free places on the ILM's Introductory Certificate in First Line Management. Funding from the Scottish Executive's Scottish Skills Fund means that 30 places on the course – a short, flexible management qualification ideal for managers with little or no formal training – are available to land-based businesses for free. The offer is open to those working in agriculture, aquaculture, trees and timber and production horticulture businesses based in Scotland. For more information contact Morag Holdsworth on 01738 553311 or email morag.holdsworth@lantra.co.uk.

Further information

To find out how you can get involved with Lantra's Aquaculture Industry Group, contact Tricia Bloomfield, email tricia.bloomfield@lantra.co.uk, or visit www.lantra.co.uk/aquaculture.
For further information on Lantra's work in Wales, visit www.lantra.co.uk/wales or contact the team in Wales on 01982 552646, email wales@lantra.co.uk.

SEAFISH MARINE FARMING UNIT BECOMES SAMS ARDTOE

In the presence of a small group of invited guests, the former Marine Farming Unit at Ardtoe on the west coast of Scotland, was recently officially handed over by Seafish to the Scottish Association of Marine Sciences (SAMS).

The hand-over ceremony took place on Saturday July 3rd. It was addressed by Graham Shimmield, the director of SAMS and John Rutherford, the chief executive of Seafish as well as local politicians, Michael Foxley and Fergus Ewing.

Graham Shimmield said: "We believe in the science that has been going on at Ardtoe - both in the history under Seafish and the skills of staff here. It was clear to the governing body of SAMS that this was a fundamental opportunity, which, if missed, we would never regain.

"We're really pleased that we have been able to retain 10 staff here, all of whom have stayed with the objectives of SAMS Ardtoe. The next step will be firming up of operational structures – we are looking for a new director of research. Strategically, aquaculture research will depend on the Scottish Aquaculture Research Forum, despite the slow start to this programme."

John Rutherford said it was important to stress that staff had made their own decision to come over to SAMS, indicating that they are totally committed to the new structure. He said: "I am very proud that you have asked me to stay on the steering committee. Seafish is now the biggest single aquaculture research funder in the UK and has been able to lever further funding from industry. I expect SAMS Ardtoe to be bidding for these funds"

LOBSTER NOTCHING PROGRAMME

Ingrid Iredale, Research Assistant, NWNWSFC

The North Western and North Wales Sea Fisheries Committee was awarded an EC FIFG grant of £196,020 in July 2003 to implement a lobster conservation programme in the Objective One Area of North Wales, which covers Anglesey, Ceredigion, Conwy and Gwynedd. Berried female lobsters (those carrying eggs underneath their abdomen) are marked with a notch in the tail and returned to sea. Whilst the notch remains in the tail the lobster is protected under SFC byelaws and legislation of the National Assembly for Wales, so that it can reproduce freely, boosting egg production and recruitment of juveniles to the fishery. The notch becomes smaller with each subsequent moult and disappears completely after 2 to 3 years. The lobster may then be caught and legally retained.

The programme is a positive and non-intrusive way of protecting the breeding females in their natural environment without undue inconvenience to the fishermen. Fishermen receive the full market price for each of their lobsters that is notched by NWNWSFC Officers and returned to sea.

The scheme is going well and so far 52 potting vessels have returned around 6,000 lobsters.

The NWNWSFC are also running some lobster studies alongside the notching programme to learn more about the mechanisms of the lobster fishery. Catch Per Unit Effort data is being collected at sea to help monitor the progress of the scheme and a qualitative movement study hopes to identify simple migratory patterns. Lobsters are tagged with two coloured rubber bands that are placed over a claw of the lobster, and which are coloured according to the area of release. Anyone finding such a lobster can learn where it was banded from a colour map, and see roughly how far it has moved since. This study, although only qualitative, has attracted much interest from local fishermen.

ADDENDUM

The following acknowledgement should have appeared at the end of the article 'Spat collection in native oyster ponds' in the May 2004 Issue of Shellfish News (Number 17, Page 6):

"This work was carried out with funding as part of the EU CRAFT Project "*Bonamia ostreae* Life Cycle Investigations" Contract No. Q5CR-2002-72338"

NEWS FROM SEAFISH

Seafood Awards Gather Pace

Enquiries have been flooding in following the announcement by the Sea Fish Industry Authority (Seafish) of a major new awards venture aimed at raising standards and recognising excellence throughout the seafood sector.

Seafish works across all sectors of the UK seafood industry promoting good quality and sustainable seafood, with research and various projects all committed to raising standards, improving efficiency and ensuring that the industry develops in a viable way.

The Seafood Awards will be presented at a gala dinner at the Royal Lancaster Hotel London in March 2005. They will encompass the whole industry with eleven categories including Technical Innovation, Trainee of the Year, Best New Product as well as a special, Aquaculture producers award.

Entry information for The Seafood Industry Awards can be obtained from Grant Collier, Divisional Marketing and Events Manager, Highbury Business on 01322 660070 or by contacting Alison.Levick@nexusmedia.com.

Other news

The articles:
SEAFISH PROVIDE FUNDING SUPPORT FOR AQUACULTURE RESEARCH AND DEVELOPMENT
FRENCH OYSTER & MUSSEL TRADE SHOW
SEAFOOD CAN HELP TOMATOES GROW
to be found elsewhere in this issue of Shellfish News were contributed by Seafish.

NEWS FROM THE TRADE ASSOCIATIONS

SHELLFISH ASSOCIATION OF GREAT BRITAIN (SAGB)

Shellfish in the healthy diet

This year's annual Bordeaux Aquaculture Conference included a whole day devoted to the role of seafood in a healthy diet. The value of oily fish, which are especially rich in long chain n-3 polyunsaturated fatty acids (PUFAs), is well publicised, but in Britain the fact that shellfish also contain good levels of these beneficial compounds is much less well known. Earlier this year a group at the Marine Laboratory in Aberdeen showed that mussels, oysters and queen scallops contain the same essential fatty acids (EPA and DHA) which are now recognised as being the basis of many of the health benefits. In France, of course, shellfish, especially bivalves, are a much more important part of the everyday diet, so there is much interest in their beneficial value.

The notion that seafoods carry an element of risk, which needs to be offset against the benefits, is now established. In the UK, the Food Standards Agency recently produced a very detailed and well argued report on the benefits and risks of fish consumption, particularly aimed at assessing this balance in relation to risks from PCBs in oily fish. This concluded that pregnant and breastfeeding women can safely eat two portions of oily fish per week, and men and boys, together with women not planning babies can eat up to four portions per week. What became clear at the Bordeaux conference is that the benefits of a diet high in PUFAs are remarkably diverse and do not just apply to reduction in risks of heart disease.

Professor Catherine Bennetau-Pelissero spoke about the development of the idea of preventive nutrition in the context of both ageing processes and health problems such as obesity, diabetes and cardio-vascular diseases. In a diet dominated by processed foods, dietary imbalances become more important than simple deficiency problems. Molluscan shellfish meet most of

the deficiencies which the adult population of France would otherwise be exposed to.

Shellfish are low in calories, for example oysters have about 70 Kcal per 100g (1/2 doz medium oysters) compared with steak at 200 Kcal and chicken at 225 Kcal per 100 g. They are high in protein but low in fat, because their energy reserves are stored as glycogen, but even so, at around 5 g/100 g this is not excessive.

The fat levels in molluscs are low; about one tenth of the level in steak, but even more important is that it is largely made up of poly-unsaturated fatty acids, such as DHA, which is essential to brain development. These same essential fatty acids can slow the onset of senile dementia and even Alzheimer's, as well as reducing the risks of heart disease, both through preventing plaque formation in arteries and through easing heart rhythm faults.

The current debate, especially in the UK, concerning salt levels in food is the only thing against recommending shellfish for those with high blood pressure. One piece of advice is to pour off the seawater within the shell when eating oysters. An interesting point from another paper at the conference by Barbara Demeneix on the need for dietary iodine, especially by pregnant and breastfeeding women, is that people imagine that sea-salt is extra beneficial for health. However, salt is also our main source of iodine and sea-salt is surprisingly low in iodine, certainly insufficient to provide those women or even children with their daily iodine needs. It contains only 1 mg/Kg iodine, compared with 50-100 mg/Kg in iodised salt. She also pointed out that few western countries now require salt to be iodised by law and she raised the spectre of an unwitting return to seeing symptoms of iodine deficiency, such as goitre and mental retardation if people were not aware of this. She suggested a helping of oysters as the quickest cure!

Catherine Bennetau-Pelissero summed up by saying that there is no doubt that molluscan shellfish are beneficial in the diet. These include some vitamins and minerals for which the French Food Standards Agency (AFSSA) considers there to be risk of deficiency in their nutritional advice (Apports Nutritionnels Conseillés-ANC). These include vitamin B6, zinc, copper, iodine and manganese. Periwinkles are top of the list for vitamin B6, together with whelks for manganese and oysters for iodine and zinc, so a diverse diet is their best recommendation.

Shellfish were seen as the best way of redressing today's problems of a diet too rich in fats and proteins. With all the precautions in place to assure freedom from microbial and chemical contamination and algal toxins, they have everything to recommend them. Japanese seafood consumption at about 70 Kg per capita per year is about three times as high as Europe. French and Italian shellfish consumption is about 10 Kg per capita p.a. whilst Spain manages to consume 45-55 Kg seafood per head per year, of which 15-20 Kg is shellfish.

Bouchots on the move

Confidence in the public health measures that now apply to bivalves has been shown in France by the large-scale move of the mussel growing area in the Bay of Cancale, where the prime French mussels are produced on bouchot poles. Some 275,000 poles have been moved eastwards towards Mont St. Michel, into predominantly Class B growing water. The bouchots are now worked mainly from amphibious boats, each fitted with a special tool hanging from a hydraulic crane to strip the mussels when ready for market. The mussels are purified in aerated seawater tanks before grading and packing in various forms depending on customers needs. The French supermarkets are increasingly taking mussels in sealed packs, chilled

There are now 55 of the amphibious boats working in the Bay of Cancale

and with an oxygen rich modified atmosphere to extend shelf life. This all helps to put fresh, live shellfish into the weekly shopping basket of French households, making it easier to serve traditional meals and to maintain a diet which is increasingly seen as healthy.

Further information

The Shellfish Association of Great Britain,
Fishmonger's Hall, London Bridge, London, EC4R 9EL
Tel. 020 7283 8305 Fax. 020 7929 1389
email: SAGB@shellfish.org.uk

ASSOCIATION OF SCOTTISH SHELLFISH GROWERS (ASSG)

VIEWS FROM THE ASSG

Spring AGM

Spring was, as usual, the season for the ASSG AGM – this year the meeting enjoyed a stimulating presentation from Keynote Speaker John Rutherford, Chief Executive of SFIA, which reflected his trademark breadth of knowledge and infectious enthusiasm! The formal AGM exposed the financially fragile state of the ASSG, reflecting a combination of a drop in income during 2003 (which had been forecast at the previous AGM) and an even more frenetic scale of activity in terms of attendance at meetings, Working Groups (several spawned by the Scottish Executive 'Strategic Framework' for the aquaculture sector), consultations, etc. However, I remain confident that we will see out this period of financial difficulty, with an increase in revenue (from European projects) plus the (unfortunate) reining back of participation by ASSG representatives at meetings.

Shellfish Safety Conference

I spent the best part of a week in June at the '5th International Conference on Molluscan Shellfish Safety' in Galway, enjoying multiple sessions of discussions over viruses, bacteria and biotoxins – how they act, how to detect them, how to safeguard public health, etc. And one major issue, the use of bacteriophage as an indicator for depuration efficiency was high on the agenda. Here I am pleased to report that the Commission have acknowledged the problems that we saw in this proposal and have, in essence, withdrawn it and are now seeking alternative methods to protect public health. The ASSG had been negotiating both directly with DG Sanco and multilaterally through the European Association to achieve this positive outcome.

In addition, DG Sanco clearly stated their wish to move away from the mouse bioassay as quickly as possible, reflecting the general desire amongst the scientific and regulatory community at the Conference.

SARF

Closer to home, the 'Scottish Aquaculture Research Forum' (SARF), has now come into being, to form the main focus for funding research into problems affecting the sector in Scotland. So if you want to press for specific projects, or even to raise broad areas of concern for future funding, SARF should be one of your first ports of call. I am a member of the SARF Board, so any proposals can be rapidly channelled to this new funding forum.

Code of Practice

Summer has been another busy season for the Association, with many positive highlights, including a brief visit to Washington DC by your Chairman for a discussion with a group of interested parties from around the planet - scientists, regulators and industry representatives, including from as far afield as New Zealand - the potential for including cultivated molluscs in a portfolio of internationally accredited products. This proposed certification scheme - not an organic standard (a concept that was fairly comprehensively shot down) – is intended to focus on sustainability of

Sharing experience on a Code of Practice

operation, from a foundation of an environmentally robust Code of Practice for industry.

Now it just so happens that the ASSG is in the middle of preparing a Code of Practice for our sector (funded through the HiMARCs scheme and the Crown Estate), so this initiative, under the auspices of WWF US, has appeared at a very opportune moment. And the meeting was helpful, as it enabled discussions with industry representatives from Associations that have already prepared such Codes, thus enabling us to avoid or minimise 'reinvention of wheels'! Full consultation on our Code, and discussions across the membership, will take place later this year.

In a further example of life's serendipity, Seafish has recently launched 'The Seafood Awards', and one category is the 'Aquaculture Producers' Award'. The criteria for this Award reflect many of the elements that I expect to be leading aspects of the ASSG Code of Practice. These include "quality and consistency of product, development of quality control and full traceability, as well as production techniques that are sustainable, improve efficiency and demonstrate concern for the environment". So it's satisfying to know that, again, the ASSG's instincts are ahead of the curve!

EMPA

Among the many other meetings I attended was one of the Board sessions of the 'European Mollusc Producers Association', in Cancale, Brittany, where we discussed future efforts to ensure that the on-going 'recast' of food hygiene legislation in Brussels did not negatively impact on the industry. And having enjoyed success in lobbying against the introduction of a bacteriophage standard there is confidence that we can propose and argue strongly for an industry friendly approach to pollution and contamination whilst maintaining high standards of human health protection.

The industry in France

I always find it a somewhat sobering experience visiting French shellfish production sites, and the scale of operations in Cancale was no exception to this historic rule. However, it was the marketing end of the business that even more so, and also as usual, gave greatest pause for thought – the promenade overlooking the growing area had an area set aside for the sale of local cultivated oysters and mussels, doing a roaring trade from early morning until dusk. It is that consumer-related element that we have still to get right in Scotland; the direct promotion of our products to the end-consumer at the point of production, the promotion of the overall experience (see, smell, taste).

Cultivation in Cancale

Shellfish on sale

Not that life is a breeze for anyone in our sector, even in France; the mussel growers in the western Mediterranean area have been suffering attacks on their open-sea longlines from Daurade (Sea Bream). The depredations of the shoals of fish have been so great that producers have been forced to import mussels from Greece in order to fulfil local summer season demand. But now, in September, workers are being laid off, and the entire future of the industry in this stretch of the Mediterranean is in doubt. This reflects similar 'attacks' by Daurade two to three years ago, further east along the coast, at Sete, where the growers resorted to arc lights and, reportedly, the occasional stick of dynamite, to attempt to dissuade the huge shoals from attacking the mussel laden droppers. A shellfish grower's life is never easy, no matter where!!

Native oysters

But as far as native oysters are concerned, a belated initiative is finally taking place, with discussions taking place about a future campaign to protect the limited stocks involving ASSG, Crown Estate, SNH and

(initially) the Strathclyde police force. This is a welcome positive move, following several years of depredation of the few remaining beds by irresponsible fishermen.

Other aspects of this summer's efforts have included:
- Responding to consultations on Developing a Strategic Framework for the Marine Environment;
- Maintaining a watching brief on the slowly evolving consolidation of food hygiene legislation, and similarly maintaining a close relationship with the development of new testing methods (especially biotoxins);
- Considering the proposal for a 'European Fisheries Fund' (to replace FIFG in 2007);
- Opening discussions with the Crown Estate over the seabed lease rental review;
- Discussing the future investment programme for Designated Shellfish Growing Waters (and proposals for new Designations);
- Reviewing proposals for R&D at CARD and SARF meetings (and later);
- Considering the report of the consultant commissioned to analyse and recommend structures for aquaculture representation in Scotland (headline conclusion : a re-branded SQS as 'front office' of an '*Aquaculture Associations' Development Council*');
- There was also development in the training area, with Lantra, the UHI, and further work on the SPA in Aquaculture, which is being launched in secondary schools in Shetland and Argyll this academic year. And I suggest anyone with an interest in improving their management skills should read the Lantra piece in 'The Grower', offering a FREE course!

Finally, a plea from SEERAD concerning expenditure under the FIFG programme:

"Recent monitoring visits to projects in Shetland and Argyll have given rise to some concern regarding our ability to meet the FIFG expenditure targets for the area. A number of projects are either proceeding more slowly than planned or are on hold until there is more business confidence in the planned investment. Similar situations exist in Lowland Scotland. We are therefore ***actively encouraging recipients of awards to submit claims sooner rather than later***." By maximising claims we minimise de-commitment and avoid a number of potentially damaging consequences. It would be ironic if de-commitment occurred in the Highlands and Islands where demand and competition for resources is strong.

We appreciate that it takes time for businesses to prepare claims, but while individual businesses may be in no particular hurry to complete projects you will appreciate that from the strategic perspective that their delays may limit opportunities for applicants in the latter stages of the programmes."

Further information

Doug McLeod, ASSG.
Tel/Fax: 01471 844324;
email: DouglasMcLeod@aol.com;
Mobile: 07831 383826.

MONITORING REPORTS

THE MARINE BIOTOXIN MONITORING PROGRAMME FOR ENGLAND AND WALES: APRIL 2003 – MARCH 2004

Summary

This report on the results of the marine biotoxin monitoring programme for England and Wales covers the period from 1st April 2003 to 31st March 2004. During this period, 388 water samples were analysed from 23 harvesting areas, and 1326 shellfish samples were analysed from 126 sites in 66 harvesting areas.

PSP toxins were found in 1 sample, from Salcombe Estuary in South Devon. It is the second consecutive year that PSP toxicity has been recorded in shellfish from this area.

DSP tests were positive in 148 samples from 15 areas, 145 of these results were atypical positive, and only 3 results were classic DSP positive. The most significant areas affected were again: The Thames estuary (including River Swale and Pegwell Bay), Burry Inlet and The Wash. The Thames was affected by closures in several areas from April 2003 through to October 2003. Positive DSP samples were recorded in samples from The Burry Inlet between April 2003 and October 2003. Samples from The Wash were also found to be positive between the months of April 2003 and October 2003. The other affected areas were the River Dee, River Dart, Ravenglass, Holy Island, Silloth, Taw/Torridge, Plymouth, Yealm, Solent and Langstone Harbour.

ASP toxins (domoic and epi-domoic acid) were found in 11 samples from 7 areas: Holy Island, The Fleet, Colne, Plymouth, Lune, Falmouth Bay and

Butley Creek. None of these samples were above the Maximum Permitted Level (20 µg/g), the highest level (3.88 µg/g) being found in a sample of scallops from EC20 on 16th September 2003.

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 phytoplankton in production and relaying areas, and biotoxins in live bivalve molluscs.

Within England and Wales monitoring for algal biotoxins is divided into two programmes, the flesh monitoring programme, where samples of shellfish from designated sites are tested, and the water monitoring programme, where fixed water samples are collected from selected harvesting areas. 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 2003 - 2004 was based on each classified shellfish harvesting area, and includes all areas in England and Wales where commercial harvesting takes place. Samples are collected on a monthly basis, except in areas with a history of algal biotoxin or toxic algae, where samples were collected fortnightly during weeks 14 - 39 (April to September). Where positives occur, the affected sites continue to be tested on a weekly basis at least seven days apart between samples, until two consecutive negatives are obtained.

The water monitoring programme for 2003 - 2004 continued as a rolling programme, where samples were collected from selected shellfish harvesting areas and these included all sites with a history of algal toxicity.

The Food Standards Agency (FSA) as the competent authority has overall responsibility for ensuring that this monitoring programme is effectively carried out, and the CEFAS Weymouth Laboratory is responsible for identifying the sample areas and co-ordinating the programme. The local Food Authorities are responsible for collecting the water and shellfish samples from the designated sites, which are then sent to the relevant testing laboratory. For the period covered in this report, these were the CEFAS Weymouth laboratory for flesh analysis for PSP, DSP and ASP, and the CEFAS Lowestoft laboratory for the water sample analysis.

Results of the 2003/2004 sampling programme

Shellfish Collection and Analysis

For the monitoring year commencing 1 April 2003, 66 harvesting areas were included in the primary shellfish testing programme, and 23 harvesting areas in the primary water testing programme. Additionally, there were 2 ports where samples of scallops were obtained. In total, shellfish from 126 sampling locations were tested in the 66 harvesting areas. During the period covered in this report, a total of 388 water samples were tested for the presence of potentially toxic algae as part of the water testing programme. The flesh testing programme analysed 1326 shellfish samples, carrying out 873 flesh tests for Paralytic Shellfish Poison (PSP) 1128 flesh tests for Diarrhetic Shellfish Poison (DSP) and 818 flesh tests for Amnesic Shellfish Poison (ASP). This gives a total of 2819 test results for shellfish samples in the third 12 months of the programme, a decrease of 406 from the previous year.

PSP Results

A total of 873 tests for PSP have been carried out during the monitoring year. PSP toxicity was detected in 1 sample of shellfish from the Salcombe estuary in South Devon. This is the second recorded event of toxicity in shellfish from Salcombe in consecutive years. The level detected was 52.48 µgSTX/100 g in a sample of Pacific oysters collected in June from the Salcombe Estuary. *Alexandrium* spp were detected at a concentration of over 1.4 million cells per litre in a water sample taken 1 week prior to the positive shellfish sample from this site. *Alexandrium* spp. were found in an additional 12 water samples during the year, but there was no correlation with toxicity in shellfish from these areas.

DSP Results

A total of 1128 tests for DSP were carried out this monitoring year. Toxicity was detected in 148 samples from 15 areas, showing a decrease in prevalence over the previous year, the earliest detection occurred in April, and continued until October. The majority of positives were in cockles, and these tests showed atypical signs as reported since June 2001 (the tests that have been undertaken on samples from these positive areas have been unusual in that positives have occurred very quickly, often within 5 minutes of the test beginning).

Again over the last year, the majority of atypical positives occurred in three areas in particular: The Burry Inlet, The Thames estuary and The Wash.

The number of samples detected with 'classic' DSP was low again this year, with three areas being affected. The areas affected were; Box EC63 off Plymouth during August, Haslar Wall (The Solent) and Main Channel (Langstone Harbour). Both of these sites were positive for one week during July.

ASP Results

A total of 818 tests for ASP have been carried out during this monitoring. Toxicity was detected in 11 samples from 7 areas (Holy Island, The Fleet, Colne, Plymouth, Lune, Butley Creek and Falmouth Bay). However, none of the samples exceeded the action level for ASP. The highest level recorded was 3.88 µg/g and was in whole scallops from EC20 (off the SW coast) landed at Plymouth. Again, the majority of samples where ASP was detected were whole scallop samples (45% of ASP positives). Cells of *Pseudonitzschia* spp., the organism responsible for ASP, were only found in 18 water samples. Again, no correlation was found between these results and toxicity in shellfish.

Discussion and Conclusions

PSP incidence, was extremely low this monitoring year, with only one area affected, the Salcombe Estuary in South Devon. The saxitoxin equivalent in this sample was calculated as 52.48 µg per 100g of shellfish flesh. This result was below the maximum permitted level of 80 µg/100g. Whilst there has not been a major PSP toxic event in England and Wales in recent years, this single result represents a significant decrease in the number of positive episodes, compared with previous years.

Atypical DSP positives, continued to occur in samples (predominantly cockles) submitted for testing between the months of April and October.

Between November 2003 and March 2004, no samples tested positive for DSP (atypical or classic). Whilst the occurrence of atypical DSP appears to have diminished, CEFAS are continuing research into this phenomenon both independently, and in collaboration with other statutory and research organisations.

As in previous years, the occurrence of shellfish samples contaminated with compounds associated with classic DSP poisoning was low.

As highlighted in previous monitoring programme reviews, the trend of relatively high incidence of ASP positives in scallops samples, in proportion to the number of samples received has continued during the 2003-2004 monitoring programme. This year however, there were even fewer scallops samples provided by the local authorities (15 samples compared with 21 the previous year).

Acknowledgements

Finally, we would once more like to thank all the sampling authorities that have collected the shellfish and water samples for analysis during the past year, particularly the authorities who have collected additional material for research on our behalf. The success of the biotoxin monitoring programme relies upon the co-operation between the sampling agencies and the testing laboratories, and the Food Authorities and their agents have been unfailingly helpful often at considerable cost in terms of both staff time and expense.

SHELLFISH PRODUCTION

SHELLFISH PRODUCTION IN THE UK IN 2003

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

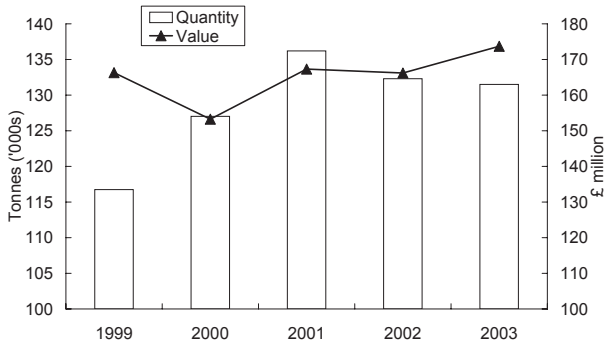
1. Shellfish landings

Source: Defra, UK Sea Fisheries Statistics 2003, HMSO, London.
Web: http://statistics.defra.gov.uk/esg/publications/fishstat/default.asp

The total quantity of all fish, including shellfish, landed by the UK fleet into the UK has decreased steadily since 1999 and fell from 466 thousand tonnes in 2002 to 429 thousand tonnes in 2003. The value of landings fell from £415 million to £392 million. Of landings into the UK by the UK fleet, demersal species represented 32% of total landings by the UK fleet in terms of quantity and 43% in terms of value. Pelagic species accounted for 39% of landings by quantity but only 14% by value, and shellfish for 29% quantity and 44% value.

Just less than 132,000 tonnes of shellfish were landed in the UK in 2003, representing a decrease of about 0.6% compared with the previous year. This is the second successive year showing a small decline but the 2003 figure still represents an increase of about 12% over production in 1999. Shellfish landings were worth over £173 million in 2003, which is a 4.2% increase, compared with 2002. The English and Welsh fleet land 56% of all recorded shellfish landings, the Scottish fleet 37% and the Northern Irish fleet 5%. Islands fleet with departments of administration in Jersey, Guernsey and Isle of Man are responsible for landing 2% of shellfish landings into the UK and abroad. Weight and value of shellfish landings in the UK over the last 5 years are shown on the figure, above right.

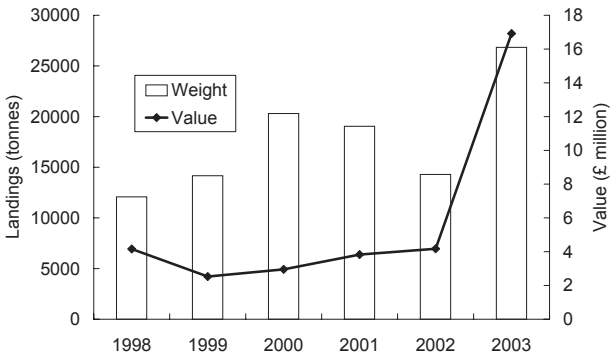
A detailed species breakdown of shellfish landings in the UK can be found in the Table overleaf. Traditionally, the two main species of shellfish landed by the UK fleet are crabs and nephrops, each accounting for 20% of landings by weight in 2003 and together accounting for approximately half of total shellfish value. Landings of crabs and nephrops have



Weight and value of shellfish landings in the UK (1999-2003)

remained relatively stable over the past five years. Of the 28 thousand tonnes of crab landed by the UK fleet at home and abroad in 2003, the largest proportion (36%) were caught in the North Sea, 23% were caught in the West of Scotland and a further 25% were caught in the English Channel. Of the 28 thousand tonnes of nephrops landed by the UK fleet in 2003, 44% were caught in the North Sea, 38% in the West of Scotland area and 17% were caught in Irish Sea.

In 2003 there was a substantial (1.87 times) increase in cockle landings, compared with the previous year. Most of the 12,000 tonnes of additional landings are accounted for by increased exploitation of stocks in Morecambe Bay. The value of this catch increased four-fold, due to a more than doubling of the unit price (see figure below).



Cockle landings increased substantially in 2003

Scallops are also an important species. They accounted for 16% of the total shellfish catch and 18% of the total value in 2003.

Lobsters were once again the most valuable species on a per weight basis, although the price per tonne fell slightly so that it was less than £10,000 per tonne for the first time in four years.

Reported mussel landings appear to be relatively very low compared with data for previous years. However, a more accurate assessment of the quantity of mussels harvested in the UK and the value of this industry can be obtained from the farmed and Fishery Order figures presented later.

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

Total Shellfish landings in the UK in 2003

Type	Tonnes	Value (£'millions)	Unit Value (£ per tonne)
Cockles	26,832	16.92	631
Crabs	23,984	25.71	1,072
Lobsters	1,309	12.18	9,792
Mussels	3,131	0.77	247
Nephrops	27,747	64.22	2,314
Periwinkles	288	0.25	876
Queen Scallops	7,358	2.86	388
Scallops	20,753	31.64	1,525
Shrimps	658	1.09	1,662
Squid	3,065	6.85	2,236
Other Shellfish	16,330	10.57	
Total Shellfish	**131,454**	**173.70**	

2. Farmed Shellfish Production

A summary table of farmed shellfish production in the UK in 2003 is given below. The total value of the shellfish produced for the table was an estimated £18 million, from over 27,000 tonnes. The table does not include production or value of native oysters from the Solent Several and Regulated grounds. These appear in the Fishery Order table in Section 3, below. These oysters are 'cultivated' in the sense that the grounds are managed, including the relaying of cultch. The figures also do not include hatchery/nursery seed production, for on-growing, much of which is exported.

There was a substantial increase in production of mussels and a small increase in production of Pacific oysters in 2003. Production of other species of farmed shellfish for the table was relatively low and broadly similar to that in previous years. The estimated value of production in 2003 increased by about 38% compared with 2002.

A. England and Wales

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

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

In 2003 there were 125 registered farm sites in England, a net increase of 14 on the previous year. These sites belonged to 98 businesses, an increase of 10 businesses, there were 12 new businesses registered, while two ceased trading. The equivalent figures for Wales are 10 farms belonging to 9 businesses, with one new farm being registered in 2003. The English shellfish farm businesses employed 268 people (169 Full time, 93 Part time and 6 Casual) in 2003. This represents an increase of 24% in total employment, compared with 2002. The Welsh employment total was 32 (25 Full time and 7 Part time workers). This represents an annual increase of 20% in full-time employees.

Production (tonnes) of farmed shellfish in the UK in 2003

	Scotland	England	Wales	Northern Ireland	UK Total
Pacific oyster	279	446	8	335	1,068
Native (flat) oyster	13	119	-	5	137
Scallops	22	0	-	-	22
Queens	45	-	-	-	45
Mussels	3,632	2,230	15,230	4,776	25,868
Clams	-	43	-	18	61
Cockles	-	24	-	-	24
Estimated Value (£ million)	**5.0**	**2.87**	**6.86**	**3.3**	**18.03**

Farmed shellfish (table) production in England and Wales 1998-2003 (in tonnes)

	Native oysters	Pacific oysters	Mussels	Manila clams	Hard clams	Palourdes	Cockles
1998	106	330	9,295	19	0	12	43
1999	93	386	8,009	17	0	12	43
2000	115	313	11,224	25	0	3	147
2001	127	225	13,367	29	4	1	105
2002	116	392	12,386	37	4	1	147
2003	**119**	**471**	**17,919**	**35**	**2**	**6**	**24**

Farmed production of native oysters was broadly similar to that in 2002. Most (79%) native oyster farming is carried out at sites in East Anglia, although the total amount is small compared with oyster production from the managed fisheries in the south and southwest of England (see Fishery Order production, below).

Pacific oyster production increased by 20% over the amount farmed in 2002. About half of this production takes place in the South West of England, with a further 31% from farm sites in East Anglia.

Total shellfish production, by weight, continues to be dominated by mussels. There was a substantial (44%) increase in production of mussels in 2003 over the previous year. The vast majority of these mussels (88%) are produced at farm sites in Wales.

Hatchery seed production of Pacific oysters increased compared with 2002, and was only slightly less than the exceptionally high level of 2001. Large numbers of Manila clam seed were reared for export, together with small quantities of native oysters, some of which were produced in support of studies associated with the Native Oyster Species Action Plan (NOSAP).

Farmed juvenile (seed) shellfish production in England and Wales 1998 -2003 in thousands (1000's)

	Native oysters	Pacific oysters	Manila clams	Palourdes	Hard Clams	Scallops
1998	2,200	110,035	20,000	4,010	0	50
1999	2,270	125,500	20,000	4,000	0	0
2000	2,000	63,230	19,200	2,100	0	0
2001	600	318,211	50,000	30,000	62,000	0
2002	0	178,142	163,000	0	0	0
2003	**132**	**265,000**	**342,000**	**0**	**0**	**0**

B. Scotland

Source: "Scottish Shellfish Farm Production Survey 2003" (ISBN : 1363-5867), available from Fisheries Research Services, Marine Laboratory, PO Box 101, Victoria Road, Aberdeen, AB9 8DB (Editors D.J. Pendrey & D.I. Fraser).
Web: http://www.marlab.ac.uk/FRS.Web/Delivery/Information_Resources/information_resources_view_document.aspx?contentid=1305

Introduction

This report is based on the returns of an annual survey questionnaire sent to all registered Scottish shellfish farming companies. The cooperation of the shellfish farming industry is gratefully acknowledged. Movement and production forms were sent to 178 companies registered as active before the survey. All returns were received. One 'wild' mussel fishery registered as a shellfish farm has been excluded from this report. During 2003, twelve new companies registered; two de-registered.

Activity

The survey shows that 103 companies (58%) produced shellfish for sale, both for the table and for on-growing. The remaining 75 continued in operation, but had no

sales during 2003. The number of active companies continued to decrease from a peak of 229 in 1990, to 178 at the end of 2003. These companies farmed 302 active sites, of which 141 (47%), placed shellfish on the market.

The industry employed 146 full-time and 218 part-time workers during 2003, an overall increase of 5% on the previous year. This reflects the on-going trend in the development of new sites and businesses particularly for mussel production.

The number of companies registered as active has decreased by 3% since 2002, and the number of active sites has increased by 5% over the same period. This trend reflects the development of new sites, particularly for mussel production. Many unproductive sites held stock not yet ready for market, others were fallow, and some were positioned in remote areas where the cost-effective production and marketing of shellfish proved difficult.

Historically, production data have been collected by company. However, since 2002, data have been collected by both company and site, enabling us to provide more accurate site information. One hundred and forty-one sites were shown to have produced shellfish for sale, an increase of 4% since 2002.

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

The number of companies producing more than 100 tonnes of mussels has increased from 9 to 13 since 2002. Those 13 companies produced 66% of the total mussel production in Scotland. The number of companies producing Pacific oysters did not alter significantly in 2003, although their scale of production has increased by 12% since 2002. The eleven companies producing over 100,000 Pacific oysters produced 89% of the Scottish total.

Production

Total production was dominated by mussels (3,632 tonnes) and Pacific oysters (3.5 million shells, 279 tonnes). Small volumes of queens (45 tonnes), scallops (22 tonnes) and native oysters (13 tonnes) were also produced. There continued to be an upward trend in the production of mussels and Pacific oysters. The increase in production of queens bucked the downward trend experienced since 1998. Production of both scallops and native oysters decreased and scale of production remained low. Mussel production increased by 12%, as markets were developed, and prices remained high. The greatest increase in regional production was in Shetland, by 25% to 1,552 tonnes. Strathclyde produced 1,388 tonnes, which, combined with the amount for Shetland accounted for 81% of the Scottish total. Pacific oyster production increased by 12%, whilst markets were maintained and demand remained high. Over 85% of Pacific oysters were produced in the Strathclyde region, where the scale of production amongst larger companies decreased. Queen production increased by over 100% through annual variation in natural settlement. Native oyster production decreased by 16%. This accounts for a small percentage of total oyster production, targeting a niche market. Production of farmed scallops decreased by almost 50%, and production was again affected by environmental influences causing area closures, which prevented sales for human consumption. Nine Several Orders have been granted for scallop fisheries, eight for commercial companies and one for research and development. Reports from industry indicated a strong market for scallops and queens throughout the year. Prices of farmed shellfish fluctuated throughout the year; however, the value at first sale of the species cultivated was estimated. The price of Pacific oysters varied between 15 and 25 pence per shell; native oysters 35 pence per shell; scallops and queens 50-60 and five pence per shell respectively; and mussels between £800-£1,300 per tonne.

Environmental and Health issues

Approved Zone status for the notifiable diseases Bonamia and Marteilia was maintained in 2003 (in accordance with EC Directive 91/67) after testing confirmed the absence of these diseases in Scottish waters. Samples were taken from eight sites holding native oysters, a species known to be susceptible to these shellfish diseases. Approved Zone status continued to protect the health of both wild and farmed native oyster stocks in Scottish waters. EC Council Directive 95/70 maintains that minimum Community measures for the control of certain diseases affecting bivalve molluscs are in place. A third of all shellfish sites are visited annually by the Fisheries Research Services (FRS) Fish Health Inspectorate in accordance with the requirements of the Directive. On these visits facilities, stock health, movement records and registration details are checked. It is the responsibility of farmers to inform FRS of any abnormal or unexplained shellfish mortality on their sites. Mortalities were reported to be the result of predation by eider ducks, crabs, starfish and oystercatchers. Losses were also reported due to storm damage, warm weather and mechanical grading. Tubeworm infestation caused marketing difficulties for one company.

Summary

The 2003 survey has shown:

- Mussels and Pacific oysters are the main species produced in terms of value and tonnage, both species continued an upward trend in increased production;
- A substantial increase in the production of queens, bucking a downward trend experienced since 1998,

whilst scale of production remained low;
- A substantial decrease in the production of scallops, whilst scale of production remained low;
- A decrease in the production of native oysters, whilst scale of production remained low;
- There was little change in the number of active and producing companies;
- That employment increased by 5%;
- Environmental influences affected scallop sales during the year;
- That Approved Zone status for the diseases Bonamia and Marteilia was maintained during the year;
- For shellfish health purposes, at least a third of all shellfish sites were inspected by FRS Fish Health Inspectorate during 2003;
- That the industry continued to be dominated by small producers, although there was a continued trend toward large companies contributing significantly to the annual production of all species.

The market for all species was buoyant and prices remained stable throughout the year. It is predicted that annual production of all species will continue to increase steadily.

C. Northern Ireland

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

Shellfish production statistics for Northern Ireland in 2003 are included in the summary table, above. The industry currently employs 63 full time and 85 part time personnel. This represents an annual increase in employment of 21% and 35% respectively for these groups and follows on increases in 2002 of, respectively, 30% and 24%. Production of oysters was similar to that in 2002, but production of mussels increased significantly, from 728 tonnes in 2002 to over 4.5 thousand tonnes in 2003. The Department, since 1998, has licensed a number of new sites for mussel cultivation and many of these are now coming into production.

3. Shellfish Production from Several and Regulated Fisheries

Source: Annual Returns
In England and Wales there are currently 18 Several Fisheries, 7 Regulated Fisheries and 2 Hybrid Order Fisheries. Hybrid Orders are Regulating Orders where the grantee has the power to assign Several plots within the fishery. Scotland has 9 Several Fisheries, primarily for scallops and one Regulated Fishery, covering most shellfish species, around the Shetland Islands. Farmed shellfish production from the Scottish sites is included in the report above.

For England and Wales, information was obtained from 23 Fishery Orders, and is included in the table. It is considered that there will have been very little if any production at the four Several Order sites for which no response was obtained. There was shellfish production at 12 of the 14 responding Several Fishery sites. There was also production at six of the Regulated Fisheries and both of the Hybrid Order Fisheries. The other Regulated Fishery is operated for supplying significant quantities of seed mussels. Various levels of other cultivation activity took place at many of the productive sites, for example relaying of cultch and or stock.

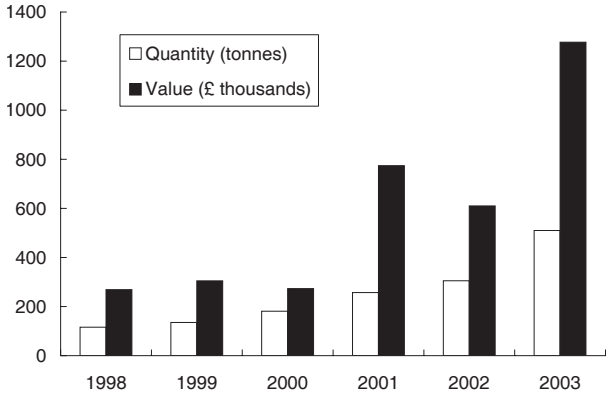
The table shows an estimated total value of production from the Fishery Orders in 2003 of just over £18 million. This is a substantial (42%) increase on the estimated value for 2002 (£12.64 million), and follows year on year increases in which the total value of production from Fishery Orders is over double that of three years ago.

Mussel production was a record 18,064 tonnes and, despite the large increase in cockle production in 2003, the weight of mussel landings exceeded that for cockles for the second year running. The estimated value of mussel production contributed 43% of the total value of production from Fishery Orders. Welsh Fisheries contributed almost 89% of Fishery Order production for this species. All of the mussel production from Fishery Orders is also recorded as coming from registered farms, with the majority of mussel farming taking place within Fishery orders.

The total production of cockles increased substantially, with 24% more being produced in 2003 compared with 2002, when production was just less than 14,000 tonnes. Almost all cockle production is from managed fisheries. A significant increase in the unit price for cockles, from £253/tonne in 2002 to £412/tonne in 2003 has raised the value of this crop to over £7 million, a record figure. The previous highest reported value for cockle production from fishery orders was £4 million in 2001.

Production of clams from Fishery Orders continues to increase, as shown in the figure overleaf. Over 500 tonnes were produced in 2003, compared with 305 tonnes in 2002. The estimated value of these clams more than doubled in the same period, to a record value of over £1.2 million, with the unit price increasing by about 25%. Almost all clam production is from managed fisheries.

There was a small (5%) decrease in production of flat oysters compared with 2002, Care must be taken in interpreting year on year differences in production, however, as the figures are invariably estimated from incomplete information. The estimated total value of



Clam production from Fishery Orders 1998-2003

these oysters increased, by about 16%, to over £1.6 million. Various initiatives to improve stocks, in connection with the UK Native Oyster Species Action Plan, have been carried out or are in progress and it is hoped to report on some of these in the next (May 2005) issue of Shellfish News.

Production/Landings (tonnes) of shellfish from Fishery Orders in England and Wales in 2003

Type	Several	Regulated	Hybrid	Total	Estimated Value (£,000s)
Pacific oyster	20	3	121	282	355
Native (flat) oyster	52	1,050	19	1,120	1,680
Clams	-	5	505	510	1,277
Mussels	15,912	393	1,759	18,064	7,922
Cockles	-	13,301	4,112	17,413	7,179

The level of production of Pacific oysters from Fishery Orders in 2003 was six times greater than in the previous year. This increase has raised the proportion of this species produced in Fishery Orders to 60% of the total farmed production in England and Wales. All Pacific oyster production in England and Wales is from registered shellfish farms (and is included in the farmed production figures).

WORLD SHELLFISH PRODUCTION

Overview

Each year, the Food and Agriculture Organisation of the United Nations (FAO) publishes data on the status of global fisheries and aquaculture. The figures for 2002 are now available.

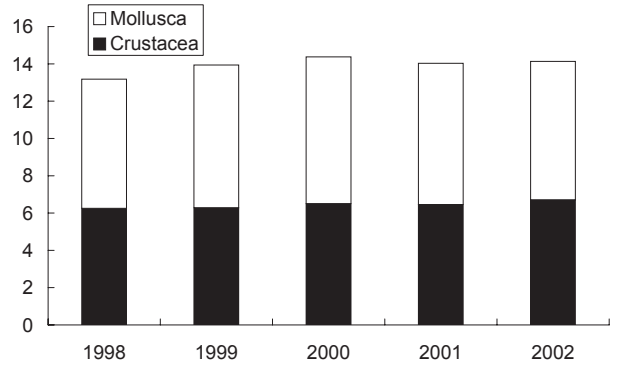
Landings

Total world landings of shellfish in 2002 were very similar to those in 2001, at just over 14 million (metric) tonnes. This yield has been fairly constant over the last five years (see figure, top right). In comparison, total finfish landings are about 78.5 million tonnes, a total that has also been fairly static for the last five years. Crustaceans make up 44% of the shellfish total with almost half of this from landings of shrimps and prawns.

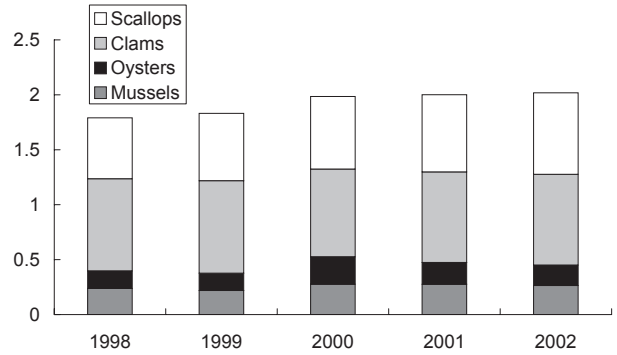
World landings of scallops, oysters, mussels and clams over the last 5 years are shown on the figure, bottom right. There has been an increase of only 2% in the quantity of these mollusc species landed over the last two years.

Cultivation

World shellfish aquaculture production continues to grow, with the annual increase of about 6% of the previous two years being maintained in 2002. Molluscs



World shellfish landings (million metric tonnes)



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

account for about 42% of the total world marine or brackish water aquaculture production of just over 28 million metric tonnes. Crustaceans account for just five and a half percent of this weight. Total production is also made up of marine fish as well as aquatic plants (mainly seaweed), together with relatively very small quantities of other invertebrates, amphibians and reptiles.

Although molluscs dominate shellfish production by weight, the greater unit value of crustaceans gives them nearly equal value. In 2002, the reported figures were 8.5 and 10.5 billion US dollars for crustaceans and molluscs respectively. The increase in the total value of these cultivated shellfish in 2002 was small, the total being similar to that in 2001, but this is still 23% greater than that of four years ago. European shellfish production is worth just under 0.8 billion US dollars, almost all of this due to mollusc production.

Around 91% of all shellfish production is from Asia, although Europe contributes about 6% (by weight) of total world mollusc production.

The Pacific oyster (*Crassostrea gigas*) is by far the most important individual species, making up over 35% of total mollusc production. Production of this species exceeds 4 million metric tonnes globally, and has increased by 22% in the last five years. Only 2.7% of this production is in Europe, with France by far the major producer.

Manila clams contribute a further 20% of the total world aquaculture production of molluscs. Globally, production of this species has increased by 60% over the last five years. In Europe, production takes place predominately in Italy, where, although 41,000 tonnes is the reported production for 2002, this is a significant (25%) decrease from the figure of 55,000 tonnes for 2001.

Mussels make up only about 4.5% of total world mollusc production. Spain produced 201,000 tonnes of mussels in 2002; this is about 40% of all cultivated mussels in Europe. The yield of mussels in Spain has fallen by 18% compared with production in 2001 of almost 246,000 tonnes. Other major European producers are Italy (18%, 92,000 tonnes) and France (15%, 73,000 tonnes).

SHELLFISH PRODUCTION IN JERSEY IN 2003

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

The table below shows the areas farmed and the production of shellfish from 1999-2003. There has been a steady increase in shellfish production over the last 5 years. In 2003 there was a 17% increase in production compared with the previous year. This follows a 16% increase in that year. There has been no increase in farming areas this year but greater work on marketing into France has proved successful for some enterprises. The sub-tidal fish farm sector has still not developed substantially mainly due to the difficulties of seed acquisition.

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

	1999	2000	2001	2002	2003
Intertidal area (hectares)	57.1	46.6	53.6	54.5	54.5
Subtidal areas (hectares)	150	166	166	100	100
Pacific Oysters (kg)	188,482	240,692	389,775	475,643	560,200
Scallops (kg)	1,887	1,949	1,914	1,544	1,351
Mussels (kg)	7,500	57,500	78,000	96,370	108,300
Total (kg)	**197,869**	**300,141**	**469,689**	**573,557**	**669,851**

SHELLFISH PRODUCTION IN IRELAND IN 2003

Source: BIM

Total Irish shellfish production in 2003 was over 40,000 tonnes with a first sale value of almost €40 million.

Bottom culture production is up 7.5% in 2 years to 24,500 tonnes, increasing in value from €12.6 million to €17 million. Rope grown mussels increased production by 20% over 2002-2003 to 9,100 tonnes and the value increased from €4.2 million to almost €6.5million.

Irish oyster production in the same period grew by almost 25% to 6,100 tonnes and its value in the last two years has nearly doubled from €8 million to €13 million.

UK SHELLFISH IMPORTS AND EXPORTS IN 2003

Source: H M Customs and Excise. Data prepared by Trade statistics, Food Chain Analysis 3, Defra.

The UK is a net exporter of shellfish, with over 100,000 tonnes leaving the country in 2003, compared with imports of just over 60,000 tonnes. Exports rose by over 12,000 tonnes compared with the previous year, whereas imports were relatively static. Half of this increase in trade surplus was mainly due to a substantial (56%) increase in exports of mussels from the UK.

The vast majority (over 96%) of shellfish exports are to other EU member states, whereas over 70% of imports are from outside the EU.

Trade in selected shellfish species, together with the totals for crustaceans and molluscs are shown in the table.

UK trade in selected shellfish in 2003 (tonnes)

	Exports	Imports
Crabs	14,618	1,086
Lobsters	1,152	1,471
Shrimps and Prawns	25,783	43,984
Crustaceans Total	**59,681**	**48,272**
Mussels	17,360	4,035
Oysters	997	364
Scallops	8,464	1,128
Cuttlefish	5,058	370
Squid	4,999	3,311
Molluscs Total	**42,880**	**11,934**

Crustaceans account for the majority of trade, making up 58% of total exports and 80% of the imports. Much of the export trade recorded as shrimps and prawns will be of Nephrops, also known as Dublin Bay Prawns or Norway Lobster, together with some brown shrimp. There may also be some imported species, processed in the UK for export, included in this figure. Imported shrimps and prawns are predominantly frozen product of tropical species, with over half the total coming from India, Bangladesh and Indonesia. Most of the crabs exported from the UK go to Spain and France, with further significant quantities going to Portugal. These three countries are also the main consumers of exported lobsters. Virtually all imported lobsters are live animals, coming from Canada (82%) and the USA (18%).

The Netherlands are the major importer of UK mussels, taking over 10,000 tonnes in 2003, and accounting for over 57% of the total. Exports to France fell slightly in 2003, but together with the Netherlands and Ireland they still take over 93% of UK mussel exports. About 75% of imported mussels come in frozen, or possibly preserved in some other way, with slightly less than 1,000 tonnes imported from New Zealand. The UK also imported over 1,000 tonnes of mussels from the Irish Republic in 2003. Over 97% of UK oyster exports are sent to France (557 tonnes), Spain (353 tonnes) and the Irish Republic (60 tonnes). Most (79%, 288 tonnes) of UK oyster imports come from Ireland. Just over half (58%) of the scallops exported are as a frozen, or otherwise preserved product, with 84% of these going to Italy, Spain and France. France is the major importer of UK live/fresh or chilled scallops, taking 2,652 tonnes, or 73% of the total. Over 70% of cuttlefish exports are as a live product, with Italy, The Netherlands and Spain importing 90% of these.

RESEARCH NEWS

Research News includes abstracts of recent work that may be of interest to the shellfish industries. These abstracts can be 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. Critical stages in Pacific oyster larvae development

A biochemical-based model was developed to simulate the growth, development, and metamorphosis of larvae of the Pacific oyster, *Crassostrea gigas*. The model defines larvae in terms of their protein, lipid, carbohydrate, and ash content and includes variation in growth efficiency and egg quality to better simulate cohort population dynamics. Changes in tissue composition occur as the larva grows and in response to the biochemical composition of the food. The premise behind this modelling study was that certain periods of larval life are more critical than others with respect to the availability of food and that food quality is as important as food quantity.

The results of the simulations indicate that critical periods do exist, but that the period of larval life that is critical depends upon the composition of the available food supply and how it varies over time. Overall, the most critical time is late in larval life, near the time of metamorphosis. At this point, some variations in food quality are particularly efficacious, others particularly disastrous. But, under certain circumstances, events early or midway in larval life also dramatically change cohort survival. Simulations show that cohort survival varies in a relatively predictable way when salinity or food quantity varies. Both control time-integrated food supply to the larva by varying the amount of food ingested. Reduction of time-integrated ingestion reduces survival. Larvae with high growth efficiency are more successful, as are larvae coming from large eggs.

The simple effect of time-integrated food presents a stark contrast to the complexity introduced by varying food quality. Simulations indicate that it is late in larval life when larvae are most sensitive to changes in food quality. Increased protein at this time always improves survival. Increased lipid is most efficacious midway in larval life, but also exerts a positive impact late in larval life. Variations in carbohydrate are relatively inconsequential in affecting larval survival.

Simulations in which food quantity and food quality vary independently show that cohort survival is sensitive to the exact timing and type of environmental change. Transient changes in food quantity influence survival primarily by varying the length of larval life. Transient changes in food quality, on the other hand, can produce large changes in survivorship by restricting the range of genotypes in the cohort that can survive, as well as by varying larval life span. The simulations support the adaptive advantage of larval cohorts with a relatively wide range of genotypes and suggest the important influence of variations in food quality in maintaining genetic variability.

Reference

Powell, E.N. (eric@hsrl.rutgers.edu), Bochenek, E.A., Klinck, J.M., Hofmann, E.E., 2004. Influence of short-term variations in food on survival of *Crassostrea gigas* larvae: A modelling study. Journal of Marine Research Vol 62, pp 117-152.

---

2. Pacific oyster larvae survival

Previous studies of energy metabolism in larvae have described a developmental 'point of no return' (PNR), a time by which larvae of planktotrophic marine species must feed in order to survive and grow. This study investigated the effects of long-term food deprivation on developing larvae of the oyster *Crassostrea gigas* with the goal of providing a biochemical and metabolic description of larvae at the PNR in this species. Mortality of unfed larvae was low for the first 14 days without the addition of phytoplankton foods. Even after 33 days without food, larvae were still swimming. Unfed larvae did not lose their ability to capture and digest algal cells when provided with food after 33 days. Growth, metabolic rate and biochemical constituents all increased at the same or greater rates in larvae whose feeding was delayed for 5, 8, 11, 14 or 17 days compared to larvae fed at 2 days old. These results show that larvae of *C. gigas* can survive long feeding delays while maintaining a constant rate of metabolism. These results suggest that oyster larvae have the capacity to survive 'starvation' using alternative sources of energy. If there is a "point of no return" beyond which larvae of *C. gigas* must feed on microalgae to survive, our findings suggest this point may be set by the availability of detritus or dissolved organic carbon that can fuel maintenance metabolism for extended periods equivalent to over four times the predicted lifespan.

Reference

Moran, A.L., Manahan D.T., 2004. Physiological recovery from prolonged 'starvation' in larvae of the Pacific oyster *Crassostrea gigas*. Journal of Experimental Marine Biology and Ecology Vol 306, pp 17-36.

---

3. Vibrio infection in Pacific oysters (1)

In an attempt to develop a reproducible experimental model of bacterial infection in *Crassostrea gigas*, oysters taken from very localised sub-populations suffering outbreaks of natural mortality were used in cohabitation trials under laboratory conditions. From these trials, a collection of *Vibrio* strains was isolated from moribund and healthy oysters. In a second step, strains were experimentally tested for virulence by means of injection into healthy oysters. This screening revealed a span of virulence among isolated strains from none to medium. When pooling injected strains, results suggest increased virulence. *Vibrio* strains may have additive/synergistic action leading to higher *C. gigas* mortality rates in experimental challenges. Although the study initially aimed to develop a simple experimental model, a complex of interactions emerged between several bacterial strains during the pathogenic process in their molluscan host.

Reference

Gay, M., Berthe, F.C.J., Le Roux, F. (fleroux@ifremer.fr), 2004. Screening of *Vibrio* isolates to develop an experimental infection model in the Pacific oyster *Crassostrea gigas*. Diseases of Aquatic Organisms Vol 59, pp 49-56.

---

4. Vibrio infection in Pacific oysters (2)

Bacterial diseases are a major cause of larval mortality in shellfish hatcheries. Even with proper sanitation, bacterial pathogens cannot be eliminated in all cases. The pathogenicity of bacteria isolated from Pacific Northwest shellfish hatcheries to Pacific oyster larvae was investigated. We found three highly pathogenic strains and one mildly pathogenic strain among 33 isolates tested. These strains appear to be members of the genus *Vibrio*.

Although there have been many studies of bivalve bacterial pathogens, a standard method to assess bacterial pathogenicity in bivalve larvae is needed. Thus, we developed two methods using either 15 ml conical tubes or tissue culture plates that were employed for rapidly screening bacterial strains for pathogenicity to Pacific oyster larvae. The tissue culture plates worked well for screening both mildly pathogenic strains and LD50 (lethal dose) assays. This method allowed for non-intrusive and non-destructive observation of the oyster larvae with a dissecting microscope. The LD50 for the three highly pathogenic strains ranged between 1.6 and 3.6 x 10^4 colony forming units (CFU) per ml after 24 h and between 3.2 x 10^2 and 1.9 x 10^3 CFU per ml after 48 h.

Reference

Estes, R.M., Friedman, C.S., Elston, R.A., Herwig, R.P. (herwig@u.washington.edu), 2004. Pathogenicity testing of shellfish hatchery bacterial isolates on Pacific oyster *Crassostrea gigas* larvae. Diseases of Aquatic Organisms Vol 58, pp 223-230.

———————————

5. Detecting oyster herpes virus

In 1994, some of the high mortality episodes that affected oysters cultured in France were associated with herpes virus infections. Through histology analysis, however, viral presence could only be suspected and confirmation of histological diagnosis by transmission electron microscopy was performed in only a few cases. Subsequently, the characterisation and genome sequencing of Ostreid herpesvirus 1 (OsHV-1) made possible the development of specific molecular detection (PCR and *in situ* hybridisation (ISH)). Using both molecular tools, attempts were made to screen for OsHV-1 a number of fixed, paraffin-embedded oyster samples collected and processed in 1994. The aim was to compare these techniques and to estimate the accuracy of histology-based indication of viral infection.

Existing DNA extraction protocols were adapted for oyster samples and two pairs of specific primers targeting small fragments (less than 200 bp) were designed (C-9/C-10 and B-4/B-3). The poor consistency observed between the results of PCR with both primer pairs was confirmed by statistical analysis. C-9/C-10, which targets a repeated region of the OsHV-1 genome, appears to be the primer of choice for viral detection in archival samples. In situ hybridisation may furnish complementary information concerning the localisation of viral foci. Under certain conditions, retrospective examination of archival samples by molecular techniques may therefore provide valuable epidemiological data.

Reference

Barbosa-Solomieu, V., Miossec, L., Vazquez-Juarez, R., Ascencio-Valle, F., Renault, T. (trenault@ifremer.fr), 2004. Diagnosis of Ostreid herpesvirus 1 in fixed paraffin-embedded archival samples using PCR and in situ hybridisation. Journal of Virological Methods Vol 119, pp 65-72.

———————————

6. Artificial diet for abalones

Stott's Abalone Postlarval Production System (SAPPS) was developed to replace live food as the primary means of settling and growing out abalone seed. Culture plates are initially sprayed with microalgal powder/agar gel solution to induce larval settlement. Abalone seed are then raised on an artificial diet/agar gel solution, which is sprayed directly onto the culture plates. This study was conducted to test SAPPS on a commercial scale against the diatom biofilm method and two further trials were conducted to investigate the optimum feeding frequency and agar concentration for SAPPS.

A total of 100,000 larval abalone *Haliotis diversicolor aquatilis* were induced to settle onto 90 mucus conditioned commercial rearing plates (5 racks, each with 18 plates) in 1500-l tanks to test two treatments; diatom biofilm method and SAPPS. The trial was conducted over a 6-week period and the temperature averaged 24.2±1.0°C.

Settlement, at around 17,500 spat, was similar on all plates in the two treatments. The postlarval growth rate on the SAPPS plates was over 50% higher than the growth rate on the diatom plates. The final length of postlarvae was significantly higher on SAPPS plates (3,281±573 micron) than on diatom biofilm plates (2,231±314 micron). Furthermore, the survival of postlarvae was also five times higher on SAPPS (51.7%) compared with diatom biofilm (10.6%). SAPPS plates were heavily colonized by marine bacteria, which may have acted as a food source for early postlarvae and assisted in the breakdown of polysaccharides. The whole body protein of juveniles was 17.2% in SAPPS compared to 13.3% in diatom biofilm, which may suggest that the artificial diet was a more balanced and complete nutrient source than diatom biofilm. Smaller scale trials were conducted over 25 days to determine optimum concentration of agar (2.5, 5.0, 7.5 and 10.0

mg/ml) and also to determine specific feed frequency (daily, every second day and every third day). There was no significant difference in survival rate in both trials. However, the growth rate of postlarvae at 2.5 mg/ml agar was significantly lower than the other treatments and the leaching rate (% weight loss of food) was double that of agar concentrations 5.0–10.0 mg/ml. Growth rate was highest in the feed frequency experiment for postlarvae fed daily and lowest for those fed every third day.

The results therefore suggest that agar concentration is optimal at between 5.0 and 10.0 mg/ml with plates being sprayed daily. SAPPS has the potential to be used in industry depending on the development of a mechanized, cost-efficient system for spraying the plates.

Reference

Stott, A.E., Takeuchiand, T., Koike, Y., 2004. An alternative culture system for the hatchery production of abalone without using livefood. Aquaculture Vol 235, pp 341-360.

———————————

7. Triploid advantage in mussels

Triploid shellfish are sterile and retain product quality during and after the spawning period. Field evaluations of diploid and triploid mussels (*Mytilus edulis*) demonstrated that triploids had a greater growth rate than diploids. The growth difference was evident in the first growing year after deployment in a high growth site. This difference was not detectable in a low growth site until the second year after deployment, suggesting possible differential growth of triploids versus diploids, related to environment. Diploid mussels in the low growth site were notably less sexually mature in the first year; therefore, the differential performance of triploids between test sites may have been related to spawning. After 11 months in the field, triploids had a mean shell length 1.05% larger than diploids in the low growth site and 8.09% larger in the high growth site. Triploids examined after a spawning event showed no histological evidence of spawning, while 71% of diploids showed some evidence of spawning. Shell length, relative soft tissue weight, and condition index were all higher in triploids. This resulted in a maximum observed increase in dry tissue weight of 62.82% and a mean shell length increase of 10.95% when triploids were compared to diploids after the local spawning event. A highly skewed sex ratio in triploid mussels, in favour of males was observed. This confirmed a similar observation in triploid *Mytilus galloprovincialis*.

Reference

Brake, J., Davidson, J. (davidson@upei.ca), Davis, J., 2004. Field observations on growth, gametogenesis, and sex ratio of triplold and diploid *Mytilus edulis*. Aquaculture Vol 236, pp 179-191.

———————————

8. Mussel hybrids

The mussels *Mytilus edulis* and *Mytilus galloprovincialis* hybridise naturally in the wild along the Atlantic coast of Europe producing a patchwork of mixed pure species and hybrid populations. Individuals of both species were spawned in the laboratory and were hybridised in a series of reciprocal crosses. After 72 h, the proportion of eggs that developed into larvae (%yield) and the proportion of those larvae that had normal veliger morphology (%normality) were estimated and compared between pure species and hybrid families. There were no significant differences in %yield or %normality between pure species and hybrids, but significant differences were evident between the offspring from different parents irrespective of whether they were hybrids or pure species. Therefore confirmation of hybrid heterosis in laboratory studies should not be based on a single, or a few reciprocal crosses.

Hybrid and pure species veliger larvae were grown for approximately 4 weeks at 10, 14 or 20 degrees C. In all trials, pure *M. galloprovincialis* larvae grew significantly faster at 20 degrees C than either reciprocal hybrid or pure *M. edulis* larvae. Irrespective of temperature, in general, hybrid larvae grew slower than larvae of either pure species. Increased exposure to planktonic predation due to slow growth can be interpreted as selection against hybrids and this may play a role in the structure and distribution of mixed pure species and hybrid populations.

Reference

Beaumont, A.R. (a.r.beaumont@bangor.ac.uk), Turner, G., Wood, AR., Skibinski, D.O.F., 2004. Hybridisations between *Mytilus edulis* and *Mytilus galloprovincialis* and performance of pure species and hybrid veliger larvae at different temperatures. Journal of Experimental Marine Biology and Ecology Vol 302, pp 177-188.

———————————

9. Mussels feed on zooplankton

In a 10-week microcosm experiment, it was demonstrated that the mussel *Mytilus edulis* could feed and grow upon zooplankton (rotifers), phytoplankton (*Tetraselmis*) and a mixture of both. The group supplied with the mixture showed the highest shell growth rate, faecal production rate and largest size of faecal pellets.

Reference

Wong, W.H. (dwong@lumcon.edu), Levinton, J.S., 2004. Culture of the blue mussel *Mytilus edulis* (Linnaeus, 1758) fed both phytoplankton and zooplankton: a microcosm experiment. Aquaculture Research Vol 35, pp 965-969.

———————————

10. Ingestion of larvae by mussels

Ingestion of bivalve larvae by *Mytilus edulis* was investigated. Laboratory experiments revealed that about 90% of bivalve larvae offered to mussels were ingested and apparently fully digested. The shell of the bivalve larvae offered no protection against digestive processes, resulting in high larval mortality once inside the stomach. Stomach content analysis carried out from September 2001 to January 2003 showed that farmed mussels ingested bivalve larvae year-round, with one exception, in March 2002. Numbers of ingested larvae were highest in October 2001 and May 2002, which coincides with known spawning times of farmed mussels in Ireland. Mussels ingested a large size-range of bivalve larvae, suggesting that all stages of the bivalve life cycle are vulnerable to predation. It is suggested that adult bivalves routinely filter larvae from the surrounding water and that, given the high biomass of mussels present in mussel farms, filtration by adult bivalves significantly reduces numbers of bivalve larvae in nearby waters.

Reference

Lehane, C. (c.lehane@ucc.ie), Davenport, J., 2004. Ingestion of bivalve larvae by *Mytilus edulis*: experimental and field demonstrations of larviphagy in farmed blue mussels. Marine Biology Vol 145, pp 101-107.

---

11. Ingestion of slipper limpet larvae

The slipper shell snail *Crepidula fornicata* forms dense assemblages along much of the European coast, where it co-occurs with oysters. We examined the susceptibility of slipper shell larvae to predation by suspension-feeders, including adults of their own species. In particular, we compared filtration rates on phytoplankton with those on larvae, and determined the extent to which consumption of larvae varied with adult size, larval size, and with the presence of alternative food (phytoplankton). We also examined the ability of competent larvae to metamorphose successfully in the presence of feeding adults.

For each experiment, adults were held in plastic jars with seawater or phytoplankton suspension and allowed to graze on larvae (101 larvae per jar) for 4–6 h at room temperature (21–23°C). Larvae were kept in circulation with gentle aeration.

Adults of *C. fornicata* ingested substantial numbers of larvae over the complete range of sizes tested, about 450–850 micron shell length. Ingestion rates were reduced by 43–50% in the presence of phytoplankton, and were not correlated with adult shell length. The rates at which larvae were removed by adult slipper shells were generally lower than predicted from the rates at which the same adults ingested phytoplankton, suggesting either some ability of larvae to avoid capture or some difficulty of adults in consuming larvae entrained into their feeding currents. Slipper shell larvae were also readily consumed by adult oysters (*Ostrea edulis* and *Crassostrea gigas*), and indeed oysters consumed larvae at faster rates than predicted from their phytoplankton ingestion rates. Nevertheless, substantial numbers of competent larvae managed to metamorphose successfully during the test periods, either on the sides of the jars they were in or on the adults' shells, suggesting that recruitment probably continues in the field even when suspension-feeding adults are at high concentrations in the benthos.

Reference

Pechenik, J.A., Blanchard, M., Rotjan, R., 2004. Susceptibility of larval *Crepidula fornicata* to predation by suspension-feeding adults. Journal of Experimental Marine Biology and Ecology Vol. 306, pp 75-94.

---

12. Mussel cultivation – comparison of methods

Growth of the mussel, *Mytilus edulis*, was compared for the first time under three culture regimes, longline located in open sea, pole and on-bottom both situated on an inter-tidal flat, in the Pertuis Breton, on the Atlantic coastline of France. Mussel sampling was performed on a monthly basis over 1 year while monitoring of hydrobiological parameters was conducted on a bi-weekly basis.

Fluctuation of environmental parameters showed a similar pattern on both sea and shore locations with generally higher concentration levels for the inter-tidal area compared with the open sea, i.e. 4.07 and 3.17 mg per 1 for particulate organic matter, 3.16 and 2 µg per 1 for chlorophyll-a, 58.43 and 38.72 mg per 1 for inorganic-N, respectively.

A clear seasonal growth pattern was observed, being similar for all three cultural conditions. A gradient of length and weight growth appeared as a function of the culture type. Longline mussels exhibited the highest performance while bottom-type culture showed the lowest. An emersion time of approximately 26% was estimated from the temperature record of the Pole station during the period of maximal growth. This could partly explain the reduced growth in length on Pole compared to Longline. While growth was faster in Longline culture and condition index were better for Pole culture, further data on the carrying capacity of the area are needed for the establishment of a mussel culture extension policy.

Reference

Garen, P. (pgaren@ifremer.fr), Robert, S., Bougrier, S., 2004. Comparison of growth of mussel, *Mytilus edulis*, on longline, pole and bottom culture sites in the Pertuis Breton, France. Aquaculture Vol 232, pp 511-524.

---

13. Impact of mussel cultivation

At a site of commercial seabed mussel cultivation, we determined the effect of mussels on the infaunal community of an inter-tidal mudflat at different spatial scales and under different stocking strategies.

Mussels were laid at four different densities (2, 3, 5 and 7.5 kg per sq m on 400 sq m plots in a 4 x 4 Latin square). Benthic samples were collected within and 10 to 100 m distant from the cultivation area about 7 months prior to and 18 months after seeding the plots with blue mussels. Benthic community characteristics were related to initial seeding density and to the actual surface area of mussels associated with each set of samples collected within replicate plots.

The presence of mussels significantly changed the occurrence of some species of the infaunal community within the cultivated area. The infaunal communities supported fewer individuals and species than control treatments at all but the lowest mussel cover. Species richness and the abundance of individuals per unit area also declined with increased area of mussel cover. The abundance of cirratulids and amphipods declined strongly with increasing mussel surface area. Although the species composition and abundance of individual invertebrate species were altered by the presence of mussels, the distribution of individuals among species remained relatively unchanged.

Overall, mussel beds changed the infaunal community, but the effects were localized (0-10 m) and not detectable at larger scales (10-100 m). Changes in benthic community composition could be reduced (but not eliminated) by lowering the stocking density of mussels to either 2 or 3 kg per sq m. Given the small edge effects associated with cultivated mussel beds, the use of larger mussel beds would be preferable to many smaller mussel beds.

Reference

BEADMAN, H.A., KAISER, M.J. (michel.kaiser@bangor.ac.uk), GALANIDI, M., SHUCKSMITH, R., WILLOWS, R.I., 2004. Changes in species richness with stocking density of marine bivalves. Journal of Applied Ecology. Vol 41, pp 464-475.

———————————

14. Post-harvest stress in mussels

The neutral red assay (NRA) was evaluated and used as a biochemical indicator of stress response in cultured mussels that were subjected to various post-harvest processing and storage conditions. The NRA, which measures retention time of neutral red dye in the hemocyte organelle, the lysosome, can be correlated to the condition of mussels under various circumstances. Shelf life also provides an index of mussel condition and quality. The objectives of this study were to evaluate mussel stress response in relation to post-harvest conditions of (1) handling, (2) processing, and (3) storage practices.

Neutral red retention was altered in mussels that underwent washing and de-clumping compared to unprocessed mussels. The process of de-byssing substantially decreased neutral red retention in mussels. Mussels held under chilled or iced storage conditions displayed decreased neutral red retention compared to those held under wet storage.

The results demonstrated that NRA was a useful index of physiological stress response in mussels subjected to conditions under various culture practices. The implications of this study for growers are that the practice of re-immersion of mussels for 24 h, especially after de-byssing, and storage of mussels in water or on ice can reduce stress response and provide a better quality product with longer shelf life.

Reference

HARDING, J.M. (jomharding@hotmail.com), COUTURIER, C., PARSONS, G.J., ROSS, N.W., 2004. Evaluation of the neutral red assay as a stress response indicator in cultivated mussels (*Mytilus* spp.) in relation to post-harvest processing activities and storage conditions. Aquaculture Vol 231, pp 315-326.

———————————

15. Mussel glue

Mussels can affix themselves to nearly any surface, including Teflon, the substance used to make non-stick coatings for frying pans. An understanding of the glue that they use to adhere to surfaces and its biological origin could make it useful in many different areas. Mussels stick to objects such as rocks, pilings and each other. They do so by attaching dozens of tiny filaments to a stationary object with a dab of glue. This glue hardens on contact and secures the mussels in position. Recent research has revealed that iron is a critical component in bringing about the final hardening of the adhesive. Mussels obtain this iron by filtering it directly from the surrounding water. This is the first time that a transition metal has been found to be essential for the formation of an amorphous biological material.

Further investigation could also reveal a less environmentally damaging way to keep barnacles and mussels from attaching themselves to ship hulls, where they increase drag and reduce sailing speeds. Copper-based paints are often used on ship bottoms to kill barnacles in their larval state and prevent them from attaching. However, copper-based antifouling paints are known to have the potential to harm marine ecosystems.

The adhesive itself, however, could have many uses. It may be possible to use parts of this glue to make materials that have controlled electronic, magnetic or optical properties. The glue could be modified for use

in wound closure, nerve reconstruction, or in providing a scaffold upon which to grow cells and build new tissue. Another potential application for this adhesive could be in rustproof coatings, often used in outdoor settings such as the exteriors of buildings and cars.

Reference

ANONYMOUS, 2004. Mussel glue may be the adhesive of the future. Marine Pollution Bulletin Vol 48, pp 207-207.

---

16. Mussel parasite in France

Steinhausia mytilovum is a globally distributed microsporidian parasite that infects the oocytes of the blue mussels *Mytilus edulis* and *M. galloprovincialis*. Despite the intensive monitoring effort made on mussel populations, the parasite has not previously been reported in France.

Here we report on the occurrence of *S. mytilovum* in *Mytilus* sp. from one cultured and two natural populations on the northern coast of France, thus extending the parasite's known distribution northwards. We also report on the observation in 1989 of *S. mytilovum* in *M. galloprovincialis* from the Golfe de Fos area in the Mediterranean Sea (South of France), *S. mytilovum* was observed in the European hybrid zone between *M. edulis* and *M. galloprovincialis*, which therefore renders the exact taxonomic status of the infected hosts unknown, The prevalence of the parasite was low, which suggests that its effect on mussel populations was probably limited.

Reference

COMTET, T. (comtet@sb-roscoff.fr), GARCIA, C., LE COGUIC, Y., JOLY, J.P., 2004. First record of the microsporidian parasite *Steinhausia mytilovum* in *Mytilus* sp (Bivalvia: Mytilidae) from France. Diseases of Aquatic Organisms Vol 58, pp 261-264.

---

17. New flat oyster parasite

A new species, *Perkinsus mediterraneus*, a protistan parasite of the European oyster *Ostrea edulis*, farmed along the coast of the Balearic Islands, Mediterranean Sea, is described. Morphological examinations with light and transmission electron microscopy, DNA sequence-analysis and enlargement in Ray's fluid thioglycollate medium (RFTM) confirmed that this parasite belongs to the genus *Perkinsus*. Specific morphological and genetic characteristics indicated that it should be considered a new species in the genus.

Reference

CASAS, S.M., GRAU, A., REECE, K.S., APAKUPAKU, K., AZEVEDO, C., VILLALBA, A. (villalba@cimacoron.org), 2004. *Perkinsus mediterraneus* n. sp., a protistan parasite of the European flat oyster *Ostrea edulis* from the Balearic Islands, Mediterranean Sea. Diseases of Aquatic Organisms Vol 58, pp 231-244.

---

18. Bonamia-resistant native oysters

The study investigated the susceptibility of a number of European populations of *Ostrea edulis* to the protistan parasite *Bonamia ostreae*. The study was carried out at oyster-growing regions in three European countries where *Bonamia* is endemic. The oyster populations screened during the trial were either: naive populations, which had never previously been exposed to the parasite; populations of oysters, which had been exposed to the parasite for a number of years and where no management of the population to try to reduce infection had occurred; and an infected population, where selective breeding has taken place to try to reduce susceptibility to the parasite. Results of the study indicated that this latter population 'Rossmore' performed significantly better in some trials than the other populations in terms of prevalence and intensity of infection. Another population from Lake Grevelingen performed best in one trial when cumulative mortality rates were compared.

Reference

CULLOTY, S.C. (s.culloty@ucc.ie), CRONIN, M.A., MULCAHY, M.F., 2004. Potential resistance of a number of populations of the oyster *Ostrea edulis* to the parasite *Bonamia ostreae*. Aquaculture Vol 237, pp 41-58.

---

19. Spread of alien oyster drill in France

Dispersal ability is the key to the spreading of exotic species to new areas. Here, we look at the spread along the French Atlantic coast of an exotic marine gastropod, *Ocinebrellus inornatus*, first detected in the Marennes-Oleron Bay in 1995. Unlike many aquatic invaders, *O. inornatus* lacks a swimming larval stage. This feature may reduce its ability to expand within the area of introduction unless counterbalanced by human-mediated spreading. By analyzing the genetic diversity at 7 allozyme markers, we compared the genetic diversity and structure of 9 French, 3 American and 5 Asian (native) populations. The genetic differentiation between populations within each area was low and of similar magnitude. A genetic isolation by coastline distances was detected in Asia only. We draw two main conclusions from these results. First, the settlement of new populations along the French Atlantic coast is not associated with drastic founder events. Second, expansion along the French coast is enhanced by oyster-farming activities.

Reference

MARTEL, C., VIARD, F., BOURGUET, D., GARCIA-MEUNIER, P. (pgarciam@univ-lr.fr), 2004. Invasion by the marine gastropod *Ocinebrellus inornatus* in France. II. Expansion along the Atlantic coast. Marine Ecology-Progress Series Vol 273, pp 163-172.

---

20. Impact of oyster cultivation

We used a carbon-based food web model to investigate the effects of oyster cultivation on the ecosystem of an inter-tidal mudflat. A previously published food web model of a mudflat in Marennes-Oleron Bay, France, was updated with revised parameters, including a realistic surface area and density of existing oyster cultures on the mudflat. We developed two hypothetical scenarios to estimate the impact of oyster cultivation on the food web structure of the ecosystem: one with no oysters, the other with the area devoted to cultivated oysters in the bay increased twofold. Oysters are direct competitors of other filter feeders, and their presence modifies benthic-pelagic coupling by forcing a shift from pelagic consumers to benthic consumers. Increasing the surface area of cultivated oysters caused secondary production to increase, providing food for top predators (in particular juvenile nekton), reinforcing the nursery role of the mudflat in the ecosystem, and altering the species composition available to the top predators.

Reference

LEGUERRIER, D., NIQUIL, N. (nniquil@univ-lr.fr), PETIAU, A., BODOY, A., 2004. Modeling the impact of oyster culture on a mudflat food web in Marennes-Oleron Bay (France). Marine Ecology-Progress Series Vol 273, pp 147-161.

---

21. Sustainable harvesting of oyster reefs

A major cause of the steep declines of American oyster (*Crassostrea virginica*) fisheries is the loss of oyster habitat through the use of dredges that have mined the reef substrata during a century of intense harvest. Experiments comparing the efficiency and habitat impacts of three alternative gears for harvesting oysters revealed differences among gear types that might be used to help improve the sustainability of commercial oyster fisheries.

Hand harvesting by divers produced 25-32% more oysters per unit of time of fishing than traditional dredging and tonging (hand raking), although the dive operation required two fishermen, rather than one. Per capita returns for dive operations may nonetheless be competitive with returns for other gears even in the short term if one person culling on deck can serve two or three divers. Dredging reduced the height of reef habitat by 34%, significantly more than the 23% reduction caused by tonging, both of which were greater than the 6% reduction induced by diver hand-harvesting.

Thus, conservation of the essential habitat and sustainability of the sub-tidal oyster fishery can be enhanced by switching to diver hand-harvesting. Management schemes must intervene to drive the change in harvest methods because fishermen will face relatively high costs in making the switch and will not necessarily realize the long-term ecological benefits.

Reference

LENIHAN, H.S. (Lenihan@bren.ucsb.edu), PETERSON, C.H., 2004. Conserving oyster reef habitat by switching from dredging and tonging to diver-harvesting. Fishery Bulletin Vol 102, pp 298-305.

---

22. A use for waste oyster shells

Oyster shells are a waste product from mariculture that presents a major disposal problem in coastal regions such as southeast Korea. It was found in the present study that pyrolysis of waste oyster shells under defined conditions (750 degrees C for 1 h under a nitrogen atmosphere) transforms this material into a sustainable reagent for efficient (up to 98%) removal of phosphates from wastewater. In comparison, raw oyster shells removed almost no phosphate from water, whereas oyster shells heated to 750 degrees C under an air atmosphere removed a moderate proportion (up to 68%) of phosphates from water. X-ray diffraction (XRD) analysis of pyrolyzed oyster shells showed peaks that were characteristic of calcium oxide, whereas analysis of raw oyster shells showed peaks that were characteristic of calcium carbonate. Surface morphology of pyrolyzed oyster shells also differed from that of raw oyster shells. Preliminary economic feasibility analysis indicates that cost of activated oyster shell is competitive with other wastewater treatment chemicals.

Reference

KWON, H.B., LEE, C.W. (water@kyungnam.ac.kr), JUN, B.S., YUN, J.D., WEON, S.Y., KOOPMAN, B., 2004. Recycling waste oyster shells for eutrophication control. Resources Conservation and Recycling Vol 41, pp 75-82.

---

23. Maerl – effects of dredging

A short-term experiment to assess the ecological impact of a hydraulic blade dredge on a maerl community was carried out during November 2001 in the Clyde Sea area on the west coast of Scotland. A fluorescent sediment tracer was used to label dead maerl, which was then spread out on the surface of sediment to act as a proxy for living maerl. The fauna collected by the dredge was dominated by the bivalves *Dosinia exoleta* and *Tapes rhomboides*, which were found to be intact. The target razor clams *Ensis* spp. were caught in low numbers, which reflected the low abundance of this genus within the maerl habitat. The hydraulic dredge removed, dispersed and buried the fluorescent maerl at a rate of 5.2 kg per sq m and suspended a large cloud of sediment into the water column, which settled out and blanketed the seabed to a distance of at least 8 m either side of the dredge

track. The likely ecological consequences of hydraulic dredging on maerl grounds are discussed, and a case is made for protecting all maerl grounds from hydraulic dredging and establishing them as reservoirs to allow for the recruitment of commercial bivalve populations at adjacent fished sites.

Reference

HAUTON, C. (ch40@st-andrews.ac.uk), HALL-SPENCER, J.M., MOORE, P.G., 2003. An experimental study of the ecological impacts of hydraulic bivalve dredging on maerl. ICES Journal of Marine Science Vol 60, pp 381-392.

———————————

24. Maerl beds as nursery grounds (1)

Juvenile queen scallops (*Aequipecten opercularis*) not previously acclimated to a substratum were released in equal numbers onto pristine live maerl (PLM), impacted dead maerl (IDM), gravel and sand in choice chambers. Their habitat selection was monitored over a 4-day period in control and predator treatments (utilising starfish and shore crabs). Microhabitat use of PLM by juvenile queen scallops and the presence of cues in live maerl were also investigated.

In control and predator treatments juvenile queen scallops were observed to attach preferentially to PLM than IDM, gravel or sand. Juvenile queen scallops were observed to maintain a more exposed attachment site in the absence of predators but sought refuge within and between maerl nodules in the presence of both predators. Smaller queen scallops (less than 18 mm shell height) were more efficient at utilising maerl thalli as a refuge. Juvenile *A. opercularis* showed hierarchical cue responses mediated by predator presence, i.e. responding favourably to a factor associated with live maerl presence irrespective of heterogeneity in the absence of predators but favourably to higher maerl heterogeneity in their presence. If they also preferentially attach to PLM in the field, at some sites where PLM grounds cover large areas, they may thus be considered to constitute 'nursery areas'. Habitat attachment preference appears to be predetermined and not a result of localised predator avoidance; however, habitat usage changes in the presence of predators. Scallop dredging in Scotland easily damages Maerl beds and if such nursery areas are being destroyed extensively in the field, this could damage recruitment to localised adult populations.

Reference

KAMENOS, N.A. (nick.kamenos@millport.gla.ac.uk), MOORE, P.G., HALL-SPENCER, J.M., 2004. Attachment of the juvenile queen scallop (*Aequipecten opercularis* (L.)) to Maerl in mesocosm conditions; juvenile habitat selection. Journal of Experimental Marine Biology and Ecology Vol 306, pp 139-155.

———————————

25. Maerl beds as nursery grounds (2)

The services provided by coastal ecosystems such as mangrove forests and sea-grass beds are becoming increasingly recognised, yet the functional role of maerl beds has not been addressed. Maerl forms highly biodiverse habitats composed of loose-lying coralline red algae, which build up over thousands of years. These carbonate-rich deposits occur in waters that are penetrated by sufficient sunlight for photosynthesis in areas with strong water movement. They have a widespread global distribution yet remain one of the most overlooked shallow-water marine habitats, with little known about the ecosystem services maerl may provide. Our diving research in Scotland has shown that pristine live maerl (PLM) grounds fulfil nursery area prerequisites for commercial populations of queen scallops *Aequipecten opercularis* and other invertebrates, such as the soft clam *Mya arenaria*, the sea urchins *Psammechinus miliaris* and *Echinus esculentus*, and the starfish *Asterias rubens*, more effectively than impacted dead maerl and other common substrata, The complex architecture of maerl beds attracts high densities of these juvenile invertebrates, which use PLM grounds as nursery areas in preference to adjacent substrata. Considering its global distribution, it is highly likely that ecosystem services provided by maerl are considerable. Maerl is easily damaged and killed by a variety of human activities, yet its protection would maintain vital nursery area function, benefiting commercial fishery yields and, pivotally, regional biodiversity.

Reference

KAMENOS, N.A. (nick.kamenos@millport.gla.ac.uk), MOORE, P.G., HALL-SPENCER, J.M., 2004. Nursery-area function of maerl grounds for juvenile queen scallops *Aequipecten opercularis* and other invertebrates. Marine Ecology-Progress Series Vol. 274, pp 183-189.

———————————

26. A new ASP diatom in Scottish waters

In 1999, a 49,000 sq km area in western Scottish waters was closed to shellfish harvesting due to the amnesic shellfish poisoning (ASP) toxin domoic acid (DA). The toxin has appeared every year since and has led to more harvesting closures.

The only previously confirmed DA producer identified had been *Pseudo-nitzschia australis*. We isolated and cultured two strains of another species, P*seudo-nitzschia seriata f. seriata* from western Scottish waters in 2001 and 2002. They were identified using TEM analysis of their morphological fine structure and rDNA sequencing.

The morphology of the Scottish *P. seriata f. seriata* strains differed slightly, for example, in the number of poroid rows, from descriptions in identification keys. The *P. seriata* strains grew successfully at 15 degrees C, suggesting that although generally considered to be a low-temperature species, it may also occur at higher water temperatures. All isolates produced DA in the stationary phase (measured on day 25): 0.16-0.23 pg DA per cell in *P. seriata* and 0.15-1.68 pg DA per cell in *P. australis*. This study is the first to identify *P. seriata f. seriata* as a DA producer in Scottish waters and indicates that at least it and *P. australis* can be responsible for ASP toxicity in that region.

Reference

Fehling, J. (johanna.fehling@sams.ac.uk), Green, D.H., Davidson, K., Bolch, C.J., Bates, S.S., 2004. Domoic acid production by *Pseudo-nitzschia seriata* (Bacillariophyceae) in Scottish waters. Journal of Phycology Vol. 40, pp 622-630.

---

27. ASP in scallops – the effect of processing

The king scallop, *Pecten maximus*, fishery is a valuable economic resource in the UK, and is reliant on supplying premium 'roe-on' processed scallops to the continental market. A considerable degree of variability is observed in domoic acid (DA) levels among individual *P. maximus* and their body components, which complicates the management of the fishery during amnesic shellfish poisoning (ASP) events. This study examined the impact of professional processing and three differing laboratory preparation techniques on final gonadal DA levels. DA analysis was conducted using a LC-MS/MS procedure.

The results demonstrate that different methods of preparation can significantly alter gonadal toxicities in scallops from the same site, and the extent to which DA within the digestive loop, which passes through the gonad, contributes to total gonadal DA.

Mean gonadal toxicity attributed to the digestive loop contents was estimated at 4.7-24.7 µg DA per g. Despite large individual variations in toxin levels; in scallops with elevated gonadal toxicities resulting from higher digestive loop content toxicity, the effect of flushing out the contents of the digestive loop significantly reduced the DA content of the tissue and lowered the frequency of individuals harbouring levels above the 20 µg DA per g statutory safety limit. Removal of the digestive loop contents can potentially result in an 87% decrease in gonadal DA burden. Furthermore, the method applied by professional processors effectively removed the contents of the digestive loop and reduced gonadal DA to levels comparable with the laboratory techniques. Deliberate contamination with scallop mucus did not increase gonadal DA levels. The extent of toxin variation resulting from differing gonad preparations demonstrates the need to standardize scallop tissue preparation techniques during ASP events. Consequently, detailed protocols aimed at minimizing the contamination of edible components should be developed and adhered to by both processing facilities and monitoring bodies.

Reference

Campbell, D.A., Kelly, M.S. (mke@dml.ac.uk), Busman, M., Wiggins, E., Fernandes, T.F., 2003. Impact of preparation method on gonad domoic acid levels in the scallop, *Pecten maximus* (L.). Harmful Algae Vol 2, pp 215-222.

---

28. PSP uptake by oysters

Several experiments were conducted to define the factors likely to influence the uptake of paralytic shellfish poison (PSP) by oysters in the Penze estuary (France, Brittany). Each 4-day experiment was carried out in a re-circulated sea water system using 15 Pacific oysters (*Crassostrea gigas*) separated from each other and supplied with unfiltered natural seawater containing alternatively toxic (*Alexandrium minutum*) or non-toxic (*Skeletonema costatum*) algal diets. The food supply and exposure times to toxic diets were determined according to field studies of the upstream and downstream movement of patches containing *A. minutum*. The experimental parameters corresponded roughly to the hydrological conditions generally observed in June when tidal coefficients are lowest and blooms occur. That is, *A. minutum* concentrations in sea water of 200, 5,000 and 10,000 cells per ml; inorganic matter consisting of 5 and 15 mg per L of calcinated muddy sediments; and low and high tide salinities of 25 and 35 parts per thousand, respectively.

Significant experimental contamination (greater than the 80 µg STX equiv. per 100 g sanitary threshold) occurred after 4 days of exposure for the monospecific *A. minutum* diet (20-200 cells per ml) and alternated *A. minutum* and *S. costatum* diets (5,000 and 20,000 cells per ml, respectively). Contamination levels were less than the sanitary threshold for alternated *A. minutum/ S. costatum* diets of 200 and 20,000 cells per ml, respectively, and for a monospecific *A. minutum* diet at concentrations of 1,000-10,000 cells per ml. In the last case, the accumulation rate was quite low; possibly because of inhibition of the filtration rate related to a lower biodeposit production rate and decreased feeding time activity. The addition of inorganic matter appeared to play a significant role in the observed increase of toxin uptake, whereas salinity was not a determining factor for toxin accumulation rates.

Reference

Lassus, P. (Patrick.Lassus@ifremer.fr), Baron, R., Garen, P., Truquet, P., Masselin, P., Bardouil, M., Leguay, D., Amzil, Z., 2004. Paralytic shellfish poison outbreaks in the Penze estuary: Environmental factors affecting toxin uptake in the oyster, *Crassostrea gigas*. Aquatic Living Resources Vol 17, pp 207-214.

---

29. Role of bacteria in PSP toxin production

Bacteria associated with toxic dinoflagellates have been implicated in the production of paralytic shellfish poisoning (PSP) toxins, but it has not been substantiated that bacteria are truly capable of autonomous PSP toxin synthesis or what role bacteria may play in shellfish toxification. In this study, different putatively PSP toxin producing bacteria originally isolated from toxic *Alexandrium* spp. were exposed to the blue mussel *Mytilus edulis*. Molecular genetic techniques were used to demonstrate that these bacteria accumulated in the digestive tract of the mussels. Results demonstrate that mussels will readily uptake and accumulate these bacteria in the hepatopancreas. However, the mussels were not rendered toxic by the ingestion of the bacteria as determined by HPLC with UV detection for PSP toxins and determination of sodium channel blocking activity using the mouse neuroblastoma assay. Thus, although the role that bacteria play in mussel toxification remains unclear, methods are now available which will aid in further investigation of this relatively unexplored area.

Reference

Tobe, K. (ktoebe@awi-bremerhaven.de), Smith, E.A., Gallacher, S., Medlin, L.K., 2004. Detection of bacteria originally isolated from *Alexandrium* spp. in the midgut diverticula of *Mytilus edulis* after water-borne exposure. Harmful Algae Vol 3, pp 61-69.

———————————

30. Shellfish in the diet in the USA

Fish and shellfish supply the human diet with complex nutrients including the omega-3 fatty acids, but can also contain highly toxic chemicals including methyl mercury. The purpose of this article is to provide information on the comparative distribution of these chemicals and nutrients to help groups formulating dietary recommendations. The dietary essential fatty acids are linoleic and a-linolenic acid. Two omega-3 fatty acids with longer carbon chains, eicosahexaenoic acid (EPA) and docosahexaenoic acid (DHA), can be synthesized in humans from a-linolenic precursors. Though not required in the diet per se, EPA and DHA have important roles in metabolism. The almost exclusive source of preformed dietary DHA is fish and shellfish. These foods are also an important source of EPA.

In marked contrast to the benefits of fish and shellfish as sources of preformed omega-3 fatty acids, fish and shellfish are almost exclusively the dietary source of methylmercury. Fortunately, these chemicals are not uniformly distributed across many species of fish and shellfish. The mollusc species looked at (clams, scallops, oysters) had very low levels of mercury (0.04 ug per g fresh weight or less). This compares with levels of 0.12 - 0.14 µg per g in cod and trout. Higher levels were found in lobsters (0.25 µg per g), similar to that detected in halibut.

Reference

Mahaffey, K.R. (mahaffey.kate@epa.gov), 2004. Fish and shellfish as dietary sources of methylmercury and the omega-3 fatty acids, eicosahexaenoic acid and docosahexaenoic acid: risks and benefits. Environmental Research Vol 95, pp 414-428.

———————————

31. Seafood allergy study in the USA

Seafood allergy is potentially severe, but the prevalence of this group of food allergies in the US population has not been determined. To estimate the prevalence of seafood (fish, shellfish) allergy in the United States we performed a nationwide, cross-sectional, random telephone survey by using a standardized questionnaire. Criteria were established in advance to define seafood allergy by report of convincing symptoms and physician evaluation.

A total of 5,529 households completed the survey (67.3% participation rate), representing a census of 14,948 individuals. Fish or shellfish allergy defined by established criteria was reported in 5.9% of households and among individuals as follows: 2.3% for any seafood allergy, 2% for shellfish, 0.4% for fish, and 0.2% for both types. Seafood allergy was more common in adults compared with children (2.8% and 0.6% respectively) and in women compared with men (3.6% and 2% respectively). Recurrent reactions were reported by 58%, dyspnea or throat tightness was reported by more than 50%, and 16% were treated with epinephrine. Despite this level of acuity, only 8.6% were prescribed self-injectable epinephrine. The rate of reactions to multiple fish among those with any fish allergy was 67%; for crustaceans the rate was 38%, and for molluscs the rate was 49%. Only 14% with crustacean allergy reported a mollusc allergy.
In conclusion, physician-diagnosed and/or convincing seafood allergy is reported by 2.3% of the general population, or approximately 6.6 million Americans. Affected individuals typically report recurrent and sometimes severe reactions, indicating that seafood allergy represents a significant health concern.

Reference

Sicherer, S.H. (scott.sicherer@mssm.edu), Munoz-Furlong, A., Sampson, H.A., 2004. Prevalence of seafood allergy in the United States determined by a random telephone survey. Journal of Allergy and Clinical Immunology Vol 114, pp 159-165.

———————————

32. PAH in Scottish mussels

Concentrations of polycyclic aromatic hydrocarbons (2- to 6-ring parent and branched PAH) from all actively producing commercial shellfish farms in Loch Leven,

Scotland, were found in excess of 4,000 ng per g wet weight tissue. These concentrations were considerably greater than had been recorded from mussels sampled elsewhere around the Scottish mainland. The PAH composition of the mussels from Loch Leven was dominated by the 5-ring, parent compounds; benzo[b]fluoranthene was the dominant compound. This data was consistent with the source being a discharge from an aluminium smelter. The individual compounds benz[a]anthracene, benzo[a]pyrene and dibenz[a,h]anthracene returned values of 304 ng per g, 446 ng per g and 39 ng per g respectively; these were well above the 15 ng per g pragmatic guideline limit. Over the two year monitoring period, the concentrations of these compounds in mussels from Loch Etive, a reference location, ranged between 'not detected' and 4 ng per g (for benz[a]anthracene). Mussels were transferred from a clean location to Loch Leven. This demonstrated that the rate of uptake of PAH was rapid. Following closure of the aluminium smelter, the PAH concentrations in mussels decreased. Differences between the two sites within Loch Leven were noted with the longer-term impact remaining greater for the mussels closer to the original point discharge.

Reference

McIntosh, A.D., Moffat, C.F., Packer, G., Webster, L., 2004. Polycyclic aromatic hydrocarbon (PAH) concentration and composition determined in farmed blue mussels (*Mytilus edulis*) in a sea loch pre- and post-closure of an aluminium smelter. Journal of Environmental Monitoring Vol 6, pp 209-218.

---

33. Mussel meat prepared to last

A processing method has been developed to prepare ready-to-eat mussel meat, retaining its natural texture and succulence. The product was vacuum-packed in an indigenously developed retortable pouch and processed in a still over-pressure retort. Time and temperature data was collected during heat processing. The heat penetration characteristics were determined using a formula method. These vacuum-packed retort-processed samples were rated excellent by the taste panel and remained in good condition even after storage for one year at room temperature.

Reference

Bindu, J. (bindujaganath@rediffmail.com), Gopal, T.K.S., Nair, T.S.U., 2004. Ready-to-eat mussel meat processed in retort pouches for the retail and export market. Packaging Technology and Science Vol 17, pp 113-117.

---

34. An alternative method for *E. coli* estimation

Impedance measurement is presented as a possible alternative to the MPN method for rapid quantitative estimation of *E. coli* in live bivalve shellfish. The impedance method reduces analysis-handling time considerably and is much easier to use than the MPN method. Moreover, results can be obtained within 5-10 h, allowing rapid intervention to ensure public health protection in case of shellfish contamination.

Reference

Dupont, J (jdupon@ifremer.fr), Dumont, F., Menanteau, C., Pommepuy, M., 2004. Calibration of the impedance method for rapid quantitative estimation of *Escherichia coli* in live marine bivalve molluscs. Journal of Applied Microbiology Vol 96, pp 894-902.

---

35. Norovirus detection

The aims of this investigation were to develop a quantitative RT-PCR for noroviruses and to evaluate it on environmental samples.

Noroviruses in environmental water samples were concentrated by adsorption/elution/flocculation. Sewage was processed by clarification and protein flocculation. Norovirus-specific cDNA produced by primer-directed reverse transcription of extracted RNA was amplified by LightCycler® and accumulation of product monitored by observation of fluorescence induced by the incorporation of SYBR Green. Absolute quantitation of product was achieved by construction of standard curves using quantitative standards produced by cloning a modified sequence of the 3'-region of the forward norovirus primer. Reaction specificity was confirmed by analysis of product melting curves.

Sewage was found to contain up to 1.8 million norovirus cDNA copies per 100 ml and effluent contained up to 1.7 million copies per 10 l. Marine bathing water and recreational river waters also contained noroviruses. Sample inhibition was detected to varying degrees in most sample types.

The study will enable quantitative comparisons be made of samples from different locations and treatment processes, and inform the debate on the revision of the EU Bathing Water Directive; it will have important implications for the analysis of samples derived from different aquatic matrices, and from foods.

Reference

Laverick, M.A., Wyn-Jones, A.P. (peter.wyn-jones@sunderland.ac.uk), Carter, M.J., 2004. Quantitative RT-PCR for the enumeration of noroviruses (Norwalk-like viruses) in water and sewage. Letters in Applied Microbiology Vol 39, pp 127-136.

---

36. Viruses in Norwegian shellfish

Common blue mussels (*Mytilus edulis*), horse mussels (*Modiolus modiolus*), and flat oysters (*Ostrea edulis*)

obtained from various harvesting and commercial production sites along the Norwegian coast were screened for the presence of norovirus by a real-time reverse transcription (RT)-nested PCR assay and for possible indicators of faecal contamination, i.e., for F-specific RNA bacteriophages (F-RNA phages) by plaque assay and for human adenoviruses and human circoviruses by nested PCR assay. The aims were to obtain relevant information for assessing the risk of transmission of enteric viruses by shellfish and to investigate the potential of various indicator viruses in routine screening.

Noroviruses were detected in 6.8% of the samples, and the indicators were detected in 23.8% (F-RNA phages), 18.6% (adenoviruses), and 8.0% (circoviruses) of the samples. A seasonal variation was observed, with the exception of circoviruses, with more positive samples in the winter. A positive correlation was found between F-RNA phages and noroviruses. However, F-RNA phages were present in only 43% of the norovirus-positive samples. The results show that mussels from the Norwegian coast can constitute a risk of infection with enteric viruses and that routine testing of samples may be justified. Advantages and disadvantages of various options for screening are discussed.

Reference

Myrmel, M. (Mette.Myrmel@veths.no), Berg, E.M.M., Rimstad, E., Grinde, B., 2004. Detection of enteric viruses in shellfish from the Norwegian coast. Applied and Environmental Microbiology Vol 70, pp 2678-2684.

---

37. *Vibrio parahaemolyticus* in France

The occurrence of the hemolysin genes, tdh and trh, in *Vibrio parahaemolyticus* strains isolated from environmental samples collected in two French coastal areas, clinical samples, and seafood products imported into France was studied. The results indicate that pathogenic *V. parahaemolyticus* isolates are present in French coastal areas and in seafood imported into France. Furthermore, they may also be present in French seafood products.

Reference

Robert-Pillot, A. (arp@pasteur.fr), Guenole, A., Lesne, J., Delesmont, R., Fournier, J.M., Quilici, M.L., 2004. Occurrence of the tdh and trh genes in *Vibrio parahaemolyticus* isolates from waters and raw shellfish collected in two French coastal areas and from seafood imported into France. International Journal of Food Microbiology Vol 91, pp 319-325.

---

38. Detecting viruses of animal origin

In this study, a molecular procedure for the detection of adenoviruses of animal origin was developed to evaluate the level of excretion of these viruses by swine and cattle and to design a test to facilitate the tracing of specific sources of environmental viral contamination. Two sets of oligonucleotides were designed, one to detect porcine adenoviruses and the other to detect bovine and ovine adenoviruses. The specificity of the assays was assessed in 31 faecal samples and 12 sewage samples that were collected monthly during a one-year period. The data also provided information on the environmental prevalence of animal adenoviruses. Porcine adenoviruses were detected in 17 of 24 (70%) pools of swine samples studied, with most isolates being closely related to serotype 3. Bovine adenoviruses were present in 6 of 8 (75%) pools studied, with strains belonging to the genera *Mastadenovirus* and *Atadenovirus* and being similar to bovine adenoviruses of types 2, 4, and 7. These sets of primers produced negative results in nested PCR assays when human adenovirus controls and urban-sewage samples were tested. Likewise, the sets of primers previously designed for detection of human adenovirus also produced negative results with animal adenoviruses. These results indicate the importance of further studies to evaluate the usefulness of these tests to trace the source of faecal contamination in water and food and for environmental studies.

Reference

de Motes, C.M., Clemente-Casares, P., Hundesa, A., Martin, M., Girones, R. (rgirones@ub.edu), 2004. Detection of bovine and porcine adenoviruses for tracing the source of faecal contamination. Applied and Environmental Microbiology Vol 70, pp 1448-1454.

Shellfish in the Press

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

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

INFORMATION FILE

WHERE CAN I GET HELP OR ADVICE?

Policy Matters

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

Several and Regulating Orders, shellfish farming -
Fisheries Division II, Room 110 10 Whitehall Place East,
(Tel. 020 7270 8227) (Fax. 020 7270 8827)

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

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

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

Grant Aid -
Fisheries Division 1B, Room 308,
10 Whitehall Place East,
(Tel. 020 7270 8045) (Fax. 020 7270 8019)

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

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

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

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

Welsh Assembly Government, Agricultural and Rural Affairs Department,
New Crown Buildings, Cathays Park, Cardiff CF1 3NQ
(Tel. 029 2082 3567) (Fax. 029 2082 3562)
(http://www.wales.gov.uk)

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

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

Shellfish Hygiene

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

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

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

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

Scientific and technical advice

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

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

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

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

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

SEAFISH - Aquaculture Development Officers:
For Scotland and Northern Ireland: Craig Burton,
PO Box 3, Acharacle, Argyll. PH36 4YF
(Tel/Fax: 01967 431 573; Mobile: 078 760 35771)
(email: c_burton@seafish.co.uk)

For England and Wales: Martin Syvret
c/o 62 Harrington Lane, Pinhoe, Exeter, EX4 8NS
(Tel/Fax. 01392 202043; Mobile: 078 760 35746)
(e-mail: m_syvret@seafish.co.uk)

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

You can also visit the SEAFISH website at http://www.seafish.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,
6, Ashmeadow Road, Arnside, Via Carnforth,
Lancashire, LA5 0AE
(Telephone and Fax: 01524 761616)
(email: asfc.office@btopenworld.com)

Co-ordinator for Defra - CARD R&D -
Dr. Mark James, Fisheries Resource Management Ltd.,
Coillie Bhrochain, Bonskeid, Pitlochry, Perthshire,
PH16 5NP
(Tel./Fax: 01796 474473)
(http://www.frmltd.com)

USEFUL PUBLICATIONS

CEFAS

A variety of booklets and leaflets are available, including:

- A Guide to Shellfish Health Controls
- The Fish Health Inspectorate and You - Service Standards and Code of Practice for Enforcement
- Bivalve cultivation: criteria for selecting a site
- Scallop cultivation in the UK: a guide to site selection
- Storage and care of live lobsters
- Research on Shellfish Cultivation (1990-2003)

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

A catalogue of CEFAS publications is available from the CEFAS Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk, NR33 0HT, (Tel no: 01502 562244; Fax no: 01502 513865). Electronic copies of many of these publications can be found on the CEFAS web site at *http://www.cefas.co.uk/publications/default.htm*

Back copies of issues 7-17 of Shellfish News can also be viewed and/or downloaded as .pdf files from the CEFAS web site *(http://www.cefas.co.uk/publications/shellfish_news.htm)*. Many of the illustrations are in full colour in the web edition.

Seafish Aquaculture

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

For further information contact the Aquaculture Development Officer for your area (see above for contact details, or *http://www.seafish.co.uk/aquaculture/development.htm* for further information).

A full list of Seafish publications can be found on the Seafish web site at *http://www.seafish.co.uk/publications/publications.htm*