Report on the 9th Annual C-Mar Aquaculture Workshop (2006) at Portaferry, Co. Down.

Attendance list and abstracts of papers presented are attached.

The workshop was arranged in 4 sessions – Sustainable Shellfish Aquaculture; Crustaceans, Aquaculture and Fisheries, The Environment and Fisheries; Seaweed Aquaculture.

1. Sustainable Shellfish Aquaculture.

Adele Cromie from Queen's presented an overview of razor clam hatchery research. There is a need for a hatchery to replenish natural stocks. The talk that covered 4 areas – hatchery and nursery production (larval rearing, nursery systems etc.) – Population genetics (developing molecular markers) – Fishing impacts – Transport to markets. The C-Mar research covers gametogenesis broodstock spawning, spawning induction, nursery rearing experiments (e.g. single vs. mixed algal diets (the latter were best). Future research will include intermediate culture, broodstock conditioning, gametogenetic investigations. It was concluded that the current fishery is unsustainable, creating a major environmental impact with a lot of mortality and shell damage. There is an urgent need for nursery and hatchery technology to be developed.

Edward Fahy highlighted how vulnerable a razor clam fishery can be to over-fishing and environmental disturbance. He used the example of previously active fishery (2-400 t/yr in 1998/9) off the east coast of Ireland. The fishery was replaced with otter clam and is now doing well.

Andy Brand reviewed the scallop industry in the Isle of Man. (Great scallops since 1937 and Queen Scallops since 1969). The fishing had gradually weakened over time and was having a huge impact on benthic communities. Scallops were not recruiting well, so the decision was made to shut it down and start rotational closure on a partial basis. They also investigated direct seeding (with 2-3yr old scallops) and this worked OK – they tend to dispense out of the area. The overall conclusion was that, currently this, the most valuable fishery in the IOM was unsustainable (largely through boats coming in from outside) and closed area and stock enhancement are the two ways ahead though this needs to be carefully planned, monitored and enforced.

Gavin Burnell (UCC) gave an overview of the potential for sea Urchin cultivation in Ireland. With diminishing wild stocks, commercial, land-based aquaculture with roe produced from natural stock would (i) alleviate pressure on wild stocks and (ii) be the basis for a new aquaculture industry. World production is currently 120,000 tons (value $600 m). The value is decreasing as worldwide quality is slowly declining. Chile delivers 60% of world production (in 2002). In Ireland production is by diving (1-5 t/year) but there is a growing world demand for quality Urchins. UCC are working with a commercial company (Dunmanus Seafoods) to develop a novel growing system (UP system and Redibind) based on land-based, stocked plastic modular units using natural or artificial feed. There are 3 applications:

1. Aquaculture (hatchery → market).
2. Ranching/Restocking – and release to the wild.
3. Roe enhancement of wild/ranched stocks (based on gonad enhancement).

1. Growth rates for test diameters are 1 mm/month (i.e. 14 –18 mm over 4 months) at 18°C fed on *Laminaria digitata*.
2. Growth was not density dependent. Production rates are: - 5 – 6 g of dry food produce. 1 g of gonad and 1.5 - 2mm of test diameter growth/g of food.
3. Roe enhancement in wild urchins. Using a novel type of feed based on binder (Redibind ™ Feeds) they can increase gonad production 15-16%. This is the first application of such binders for marine animals. There are applications for Urchins and Abalones. This UP system (cage culture) is a proven concept giving high growth rates 1 - 1.2 mm test/month; enhanced roe; low mortality at high stocking densities (80 – 120 kg/m^2).

It will also enable out-of–season production. This is seen as the only way ahead for the Irish industry and has huge potential for other aquaculture such as abalone which feed on cultured seaweed. Seaweed is only good food value for 3 months/yr but this binder can enhance its shelf life. They are developing a pilot scale demonstration of the system – contact g.burnell@acc.ie
Comments from the floor were to follow the South African model – 20 tonnes of seaweed produce 1 tonne of Urchins.

Session 2. Crustaceans, Aquaculture and Fisheries.
Paulo Prodohl talked about micro-satellite profiling of the European Lobster. V-notching of tails of females by fishermen to prevent removal and allow spawning is largely working. Fishermen get compensation to participate. Paulo has been collecting these notches (which contain enough DNA material) to compare protected and un-protected areas to see if there is scientific proof of success. They (at the Fish Genetics and Molecular Ecology Lab at QUB) have developed a 'barcode' profile for lobsters. Detailed population genetic screening (using 12 microsatellites) is being carried out. The technology has been developed and the project is now well under way.

Carly Daniels is carrying out a PhD on the use of prebiotics (Bio-Mos®) on lobsters. These immunostimulants have been used e.g. in poultry to help improve digestion and reduce disease. She found an optimum level of these prebiotics had potentially the same beneficial effects on lobsters. She is trying combinations of other pre-and pro-biotic immunostimulants as they appear to have potential for crustacean growth.

Other work at Portaferry (QUB) on stress responses to declawing in the editable crab showed that conventional 'pulling off' of claws definitely stressed (and often killed) crabs. Cutting at the correct place is less harmful.

Session 4. Seaweed aquaculture.
Matt Dring gave an overview of seaweed research at QUB. Mark Norman gave a critical overview of seaweed aquaculture in Ireland – we can grow it but why can't we

use it? Why no commercial farms in Ireland? A model route exists for other aquaculture – The Irish Aquaculture Development Model (Technology Transfer of existing technology to demonstration/Pilot Farms) – why not use the same route for seaweeds. No European model exists. It is unacceptable to import exotic seaweeds and then is a fast-growing market as existing stocks are (a) polluted (b) more protected (c) less accessible. He reviewed all the potential and markets and 'scored them' on

potential - Food (Palmeria)**
Aquaculture food (abalone/urchins) ***
Alginates
Active foods/Health *
Cosmetics **
Industrial (bio-remediation) *

Unique products can be extracted from indigeneous species. Quality, traceability, reliability and sustainability of cultivated seaweeds are big issues. A proper pilot farm demonstration site is needed to evaluate environmental impact. This would demonstrate viability, low impact and gain experience of engineering. How will this be resourced? Current prices paid in Ireland are €100 per wet tonne as abalone feed. 50 tonnes of wet weed equals one tonne of Abalone product. One environmental benefit is as a 'soft' solution to coastal erosion.

As I have reported earlier, seaweed aquaculture developments in Ireland are at an early stage and would represent a good model for the Falklands to follow in terms of identifying markets, production methods and marketing. Alan Critchely (now based with Acadian Seaplants in Nova Scotia) still feels there is huge potential from the Falklands.

At Portaferry they have developed rope cultivation of high-value red seaweeds (Dulse-Palmeria) to an advanced level. The EC has approved a seaweed farm in Strangford Lough (Maeve Edwards reported) based on 2 x 8m nets (10 cm width) on 100m lengths. She presented costs etc. for a production unit based on 40 nets/longline, seeded in Dec-April on 4 longlines. It takes 4 - 5 months to read 170 cm (harvestable size) and she compared with one annual or multiple harvests (removing plants as they grow to size – can take up to 4 harvests). The unit is profitable with 4 x 100 m longlines and 2 multiple harvests. Harvesting the same nets 3-4 times increased yield and is economically viable. Longline rope cultivation would work well in the Falklands for high value reds (e.g. *Gigartina*) was a comment from the floor.

Paul McCartan working for Cyber Colloids Ltd and is interesting in developing a market in Ireland. He gave a good review of world marine plant production for food. Seaweeds have multiple nutritional products and are of high value. Irish Universities are doing a fair bit of work on nutritional value of seaweeds at the minute. Seaweeds are high in fibre, many of these not digested therefore of low GI value and are therefore a good way to get fibre into food. They make a good contribution to a balanced mineral diet. Good levels of vitamins (especially A and B12) and lipids. Other uses include DDT removal from soil, horticultural and grass-growing properties in clothing and cosmetics.

The Irish Seaweed Industry is worth €15m per annum based on approx 32,000 wet tonnes harvested, employing 300 FT and 320 PT jobs. Current prices of Laminaria in France is €40 wet tonne. Dulse (edible red seaweed) sells at €15/kilo dry. There is a lot of future potential – Martin Walsh of the BIM is the Seaweed Industry Development Officer. There is a lot of valuable experience for the Falklands if they want to try seaweed aquaculture.

Alan Critchley, the leading international authority (now with Acadian Seaplants in Nova Scotia) is very familiar with and interested in the prospects of developing an industry in the Falklands. His previous company (Degussa – a French Seafood Producer) would be interested in testing samples from the Falklands. The Canadian harvest is based on *Ascophyllum*. They have good information on *sustainable harvesting* in Canada. They manage 74,000 acres of seabed in sections (given on 20 year leases) assuring 17% of the biomass is available for harvest. They cut (usually by hand) rather than tear plants. The whole operation is profitable – the seaweed market is growing worldwide.

There were two final papers on seaweed for bio remediation of coastal areas subject to intensive agriculture and of other nitrate pollution.

Overall, there was a lot from the workshop of relevance to the Falklands. There are good contacts there, a lot of people are now familiar with the Falklands situation (I have been presenting the case on many occasions) and would offer assistance should seaweed aquaculture be considered. The Irish Model is a good one to follow. The industry is relatively new and developing (we could learn from their mistakes) and the scale of operation is not too dissimilar from what be proposed in the Falklands.

The C-Mar/QUB people would be happy to meet with Brendan when he is over. Early November would be best and once dates are known I can set this up. Both QUB and C-Mar were interested in proposed National Aquaculture Strategy Reports. They were forwarded to them and could be discussed at the meeting in November. This might provide an opportunity to discuss scientific support/backup/collaboration etc. Craig Burton of Seafish was also present and would be keen to meet Brendan in the UK.

Jim McAdam UKFIT

C-Mar

9th Annual Aquaculture Workshop
14th-15th September 2006
Exploris Aquarium, Portaferry, Northern Ireland

THURSDAY 14th SEPTEMBER

Session 1: Sustainable shellfish aquaculture

Chair: Dr Dai Roberts (C-Mar / QUB)		
09.50	Welcome: Dai Roberts (C-Mar / QUB)	
10.00	Adele Cromie (C-Mar)	Razor clam *(Ensis siliqua)* hatchery research at C-Mar
10.15	Edward Fahy (Marine Institute)	Recent research on an exploited razor clam bed at Gormanston, Co. Meath
10.40	Andy Brand (Port Erin Marine Laboratory)	The use of closed areas for sustainable scallop fisheries in the Isle of Man
11.05	Gavin Burnell (UCC)	The UP System for sea urchin cultivation
11.30	**COFFEE**	
Session 2: Crustaceans- Aquaculture and Fisheries Chair: Dr Paulo Prodohl (QUB)		
11.50	Paulo Prodohl (QUB)	Microsatellite profiling of the European lobster
12.00	Carly Daniels (National Lobster Hatchery)	The use of prebiotics in lobster culture
12.25	Lynsey Patterson (QUB)	Stress responses to declawing in the edible crab
12.50	**Lunch - Exploris Cafe**	
Session 3: The Environment and Fisheries Chair: Dr Niall McDonough (C-Mar)		
2.00	Sheila Rodgers (EHS)	The UK Marine Bill
2.25	Ken Bradley/ Alan Hamilton (DoENI)	Towards an Integrated Coastal Zone Management (ICZM) strategy for N.I.
2.50	Paddy Campbell (DARDNI)	The DARD review of inshore fisheries in N.I.
3.15	Dave Garforth (IFQC Ltd.)	Seafish Work Book for Live Bivalve Shellfish Handling
3.40	**Coffee**	
4.00	**C-Mar Advisory Board Meeting (QUB Marine Laboratory)**	
7.30	**Conference Dinner (Portaferry Hotel)**	

FRIDAY 15th SEPTEMBER

Session 4: Seaweed aquaculture and industrial applications Chair: Professor Matthew Dring, QUB		
10.00	Welcome: Matt Dring (QUB)	
10.10	Mark Norman (Taighde Mara Teoranta)	Opportunities and constraints for seaweed farming in Ireland
10.35	Maeve Edwards	New developments in the cultivation of dulse (*Palmaria palmata)*
10.50	Paul MacArtain (Cybercolloids Ltd.)	Seaweed commercialisation in Ireland and around the world
11.10	**Coffee**	
11.40	Alan Critchley (Acadian Seaplants Ltd. Canada), Raul Ugarte and J-P Deveau.	Sustainable harvesting of seaweed.
12.10	Amanda Guy (QUB)	The use of seaweeds in the bioremediation of agricultural effluents.
12.25	Claire Campbell (QUB)	Seaweed as biomonitors of nutrient pollution
12.40	**Discussion & Close**	
1.00	**Optional lunch in Exploris Cafe**	

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Registration Form

(Please complete and return the registration form to the address shown below or email to l.browne@qub.ac.uk)

Name: _____

Address: _____

_____

_____

Tel: _____

Fax: _____

E-mail: _____

I will be attending the C-Mar Aquaculture Workshop

Full Workshop (1½ days) : £60/ €90 _____(please tick)

Half-day only : £20/ €30 _____(please tick)

I will be attending the conference dinner (£40/ €60 per person) _____(please tick)
(8pm, Thursday 14 September, Portaferry Hotel)

I enclose a cheque for: £ / €_____
(Please make cheques payable to The Queen's University of Belfast)

Receipt required? _____(please tick)

(NB. It will be possible to pay the registration fee on arrival at the workshop but you should either return this form or call us if you wish to attend)

Centre for Marine Resources and Mariculture
QUB Marine Laboratory, 12 The Strand, Portaferry,
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Tel: 028 42729648
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URL: www.c-mar.eu

Session 1:

Thursday 14th September 2006, 9.50 am to 11.30 am.

Developing optimal diets for razor clam postlarvae

Adele Cromie, Astrid Werner and Niall McDonough
Centre for Marine Resources and Mariculture

An investigation on the effects of diet on growth rates of *Ensis siliqua* spat (postlarvae) was initiated in July 2006. Broodstock adults were collected from the wild and held in open water tanks (no sediment) suspended on plastic rods. The adults were induced to spawn and fertilised eggs were collected on 40*µ*m-mesh sieves. Larvae were then reared in 90-litre bins on a single species diet of *Isochrysis galbana* until settlement (around 16- 21 days).

When 50% of the larvae had developed a foot, they were transferred to a 150*µ*m sieve which was then placed back inside the 90L white bin. When all the larvae had developed into postlarvae and had begun to show the elongated shape characteristic of *Ensis* species (approximately 1 month), they were counted and divided into six groups. Each group, of approximately 3,000 *E. siliqua* postlarvae, was then placed in a 150*µ*m mesh sieve containing a thin layer of sand and placed in a 90L white bin containing UV-sterilised, filtered seawater. Three of the tanks are supplied with a fixed daily single-species micro-algal diet of *Isochrysis galbana*. The other three tanks are supplied a mixed diet of *Isochrysis galbana, Tetraselmis suecica* and *Chaetoceros calcitrans* in a 1:1:1 ratio. The seawater in each tank is changed three times a week.

The experiment is being run for a period of 2-3 months. During this time, samples of approximately 20 postlarvae are being removed from each tank on a weekly basis and retained for measurement to enable comparison of growth rates. Preliminary results indicate that growth is better in the postlarvae being supplied with the mixed algal diet. Once systems that promote optimal growth rates of *E. siliqua* spat have been established, the focus of the research will shift to transferring juvenile clams to open water sites for intermediate cultivation.

A razor clam bed at Gormanston, Co Meath: a cautionary tale.

Edward Fahy and Jim Carroll
Marine Institute, Abbotstown, Dublin

To understand what occurred, it is necessary to know something about the biology of razor clams. They are k (as opposed to r) strategy species: slow growing, late maturing and long lived. Most of the biomass resides in the older year classes which are well adapted to their environment. Recruitment is very slow. Razor clams also have a type 1 survivorship curve, rather like humans; they live for a long time then die off over a short period. These characteristics are apparent in the statistics of capture and in the biology of the Gormanston bed.

Since 1981 razor clam landings were dominated for a period by Spain and then Portugal whose contributions were considerably reduced when the virgin biomass was exhausted. Between 1999 and 2001 Ireland landed more than half of all the razor clams produced in Europe and most of these came from the Gormanston bed.

The northwest Irish Sea is divided into a number of administrative "boxes" in which dredging for clams is allowed. Water quality is the only criterion on which decisions to fish are taken; there is no other regulation of the fishery. When originally described by us the bed was 21 km² in extent. Hydraulic (fluidised bed) dredging was the method of extraction. It is highly destructive and possibly 60% of commercial sized animals were damaged and rejected in the process.

We have sampled at Gormanston for 8 years and 7 of these are reported here. To sample it is necessary to penetrate the substratum, which is very firm, to 30 cm. Samples were obtained from the dredge fishery. Ensis siliqua, the pod razor, the species at Gormanston, occurs in very fine sediment which is also very cohesive. It was possible to obtain sediment samples and small invertebrates (maximum dimension <1 cm) from dredge contents. Tidal currents in the northwest Irish Sea are weak and are likely to have favoured the deposition of fine sediment in this area. Repeated dredging has increased the sorting coefficient and may have resulted in the loss of some of the fines from the substratum.

The list of macro invertebrate species in the community is short and generally distributed throughout these razor clam "boxes". The pod razor accounted for >90% of biomass in samples when exploitation began in 1998. The Shannon-Wiener index of diversity increased as exploitation progressed (most fishing activity has the opposite effect, reducing diversity to monoculture). The biomass of the pod razor has since declined to about 50% of total biomass. Other suspension feeders have replaced it. The biomass of carnivores and scavengers increased as exploitation progressed as did the biomass of deposit feeders. Two bivalve species, *Lutraria lutraria* (the otter clam) and *Pharus legumen* (the pen knife) have increased their biomass and the otter clam appears to be taking over from the razors. The populations of both species appear to have developed largely from a single spatfall in 1998 and that was the only year in which a good razor spatfall was also recorded. Since 2000 the razor clam population at Gormanston is no longer dominated by older year classes such as are found in virgin stocks. At the same time, there is no evidence of compensatory juvenile recruitment. It is suggested that continued exploitation of this clam bed will fundamentally alter its species composition.

The use of closed areas for sustainable fisheries in the Isle of Man

Andy Brand
Port Erin Marine Laboratory, University of Liverpool, Port Erin, Isle of Man,
arbrand@liverpool.ac.uk

Scallops have been commercially fished around the Isle of Man since 1937 and queens since 1969. From the start these fisheries have been of major economic importance to the Isle of Man: together they generally account for some 80-90% of the value of fish landed in the Island.

Fishing effort on scallops increased greatly in the late 1950s and 1960s and stocks declined. There was some respite for scallops in the 1970s following the start of the queen fishery but over the last twenty years stocks of both species have come under increasing pressure. As a result the age and size structures of scallop populations on all grounds have declined and the fisheries have become highly dependent on the strength of annual recruitment.

Following the closure of a small area (approximately 2 km x 2 km) off Port Erin to mobile fishing gear in 1989, scallop stocks inside the area have increased substantially. Scallop densities inside the area are now x5 times greater than those in the fished areas outside, while total scallop biomass is x9 and reproductive biomass is x15 greater. There is now increasing evidence that this small closed area acts as a spawning refuge, supplying larvae and juvenile scallops to the surrounding fished areas. In 2003 another adjacent small area was closed to fishing for a period of 3 years in order to investigate the potential of rotational closures as a way of managing scallop fisheries, with or without enhancement with reseeded juvenile scallops. Some results of this study will be presented.

Sea Urchins – an UP and coming species in UCC

Gavin Burnell and Gerry Mouzakitis
Aquaculture and Fisheries Development Centre University College Cork

The Purple Sea Urchin, *Paracentrotus lividus*, was effectively fished out of Irish coastal waters in the 1980s by divers. During the 1990s a number of projects coordinated by UCC's Aquaculture and Fisheries Development Centre (AFDC) showed its potential for culture. As a result in 1994 a commercial company (Dunmanus Seafoods) started up in West Cork and has developed a successful hatchery and extensive ranching operation. World sea urchin production peaked in 1995 at just over 115,000 metric tonnes valued at US$600 million. This has since dropped to about 100,000 tonnes per annum as wild stocks have been under pressure. The resultant strong market demand has encouraged the AFDC, in association with Dunmanus Seafoods, to initiate a new research programme to develop novel ongrowing technologies for urchin culture. So far five grants from the Marine Institute and Enterprise Ireland have led to two patents (UP System and Redibind) and a complete farm to fork ongrowing protocol.

Session 2:

Thursday 14th September 2006, 11.30 am to 12.50 pm

Microsatellite DNA profiling in the European lobster

Paulo Prödohl
Queen's University Belfast

The practice of V-notching, where female lobsters carrying eggs are marked by fisherman with a small triangular notch, is being increasingly accepted as a viable and positive procedure aimed at the protection of natural lobster stocks. Irrespective of their size, V-notched females are returned to the sea to ensure that they are able to spawn. This approach promotes higher egg production by allowing more females to reproduce before they become vulnerable to fisheries, and thus contributes to the maintenance of sustainable stocks. The main difficulty with the V-notching scheme is the need for appropriate controls to ensure that V-notched individuals are being returned to the wild in the particular area that they were caught. In the past, these controls have involved holding of berried females in cages while waiting for V-notching. This is known to cause substantial egg loss, undue stress, and even the death of individuals. Another problem is that the real impact of this procedure has yet to be properly quantified.

Until recently, the only evidence for the success for the V-notching program was derived from fishing data. Comparison of landing from areas where V-notched females are protected versus unprotected areas allows for a crude estimation of the success of the procedure. However, it is widely recognised that such an approach, given uncertainties related to fishing methods/effort, may not be appropriate to obtain reliable estimates. Microsatellite DNA profiling allows for the unambiguous identification of individuals and families and hence provides an ideal tool for accessing the impact of V-notching on local stocks. Here we describe a successful ongoing project/monitoring scheme involving a partnership between the North-East Lobster Fishermen's Co-operative Ltd. (NELCO) and QUB. NELCO lobster fishermen are preserving both the female V-notch as well as a few of her fertilised eggs for DNA work. There is no need to hold individuals in cages. DNA analysis allows for unambiguous identification of individuals. The advantages of this scheme are briefly outlined.

The use of prebiotics in Homarid Lobster culture

Carly Daniels, Colin Wells, Dom Boothroyd
National Lobster Hatchery, Padstow, Cornwall
www.nationallobsterhatchery.co.uk

Trials using Bio-Mos®, supplied by Alltech, were carried out at the National Lobster Hatchery in Cornwall, UK. Bio-Mos® (Mannan Oligosaccharide) has been shown to enhance the growth and survival of animals such as poultry, as well as acting as an immunostimulant. This could potentially reduce bacterial diseases in *Homarus gammarus*, which cause low survivability in lobster hatcheries.

Previous work has identified the addition of Bio-Mos® to Selco™ (HUFA) enriched *Artemia* as significantly decreasing the mortality rate of lobster larvae, thus giving a higher success rate to stage IV. The aim of this study was to identify the optimum concentration of Bio-Mos® for increasing larval survival rates.

Juvenile *H. gammarus* lobster larvae were fed Selco™ enriched *Artemia* supplemented with Bio-Mos® at four feeding regimes (Bio-Mos concentrations; 0ppt (control), 2ppt, 20ppt, 200ppt), from hatching through metamorphosis to stage IV. Initially the survival and bacterial conditions in the culture medium of *Artemia* were recorded at the four different feeding regimes. No detrimental effects of Bio-Mos® were determined so all feeding regimes could be employed. The results will be compared by quantifying the mean number of larvae to reach stage IV from each Bio-Mos® concentration and control diet (Selco™ enriched *Artemia*).

Furthur research is being carried out to determine what effect, if any, the larval feeding of Bio-Mos® has on the on growth and survival of post-larval lobsters growing from juvenile stages IV to VIII.

Gut histology at stage IV and VIII will be conducted to establish what effect Bio-Mos® has on the morphology of the digestive tract and to increase understanding of the role of Bio-Mos®. In addition, larval microscopy photographs at each stage of growth (I-IV) will be analysed to compare the four feeding regimes to determine what effect if any Bio-Mos concentration has on larval development.

The use of Bio-Mos® is new in aquaculture and may have the potential to increase larval and juvenile survival, and therefore hatchery output of lobsters. The rearing environment may also play a major role in juvenile survival. This study therefore also aims to determine the success of a circulation multistacking tray system in reducing rearing efforts, and mortalities from stage IV-VIII.

Stress responses to declawing in the edible crab

Lynsey Patterson
Queen's University Belfast

Crustaceans exhibit stress responses similar to other animals when their normal physiological limits are surpassed such that the release of the Crustacean Hyperglycemic Hormone alters typical glucose, glycogen and lactate levels. Here the effect of the commercial fishing practise of declawing crabs was investigated using physiological measures. If claw removal is stressful we expect to find higher glucose and lactate levels, with a consequent reduction in glycogen levels. We also calculated a mobilisation ratio to ascertain if elevated glucose concentrations could be attributed to the utilisation of storage glycogen.

We show that removing one claw of the edible crab causes a significant stress response in the short term, with significantly higher glucose and lactate concentrations in the claw removed animals within 10 min. This is supported with similar findings in a long term investigation (24hr). There was also a significantly increased effect, if another similar sized, intact conspecific was present, on the stress response induced, which has implications when holding facilities are considered. Finally, comparing the act of declawing to the natural process of autotomy, it was clear declawing was more stressful with significantly higher glucose, lactate and mobilisation rates, and significantly lower glycogen concentrations. In addition, some mortalities occurred in the declawed animals and this occurred when the wound size was large. Clearly, declawing is stressful to the animals, even more so than the process of autotomy as evident in the physiological responses reported. Thus, the practise may not be justified on the basis of this phenomenon. In addition, it is conceivable that the further stress imposed through regular processes such as feeding/ aggressive encounters raises important questions with regards their survival on return to the sea.

Session 3:

Thursday 14th September 2005, 1.30pm to 3.50 pm

The UK Marine Bill

Sheila Rodgers

Department of the Environment, Environmental Policy Division

The UK Government manifesto in 2005 gave a commitment to a Marine Bill which will introduce mechanisms for integrated planning, management and protection of the marine environment, and the creation of a new fit for purpose framework founded on the principles of sustainable development, good regulation and modern government. The aim of the proposed UK Marine Bill is to introduce a new framework for the marine environment that will work towards delivering clean, healthy, safe, productive and biologically diverse oceans and seas.

The Department for Environment, Food and Rural Affairs (Defra), in liaison with Northern Ireland and the other devolved administrations, is currently developing policy in five key areas that will lead to new legislation affecting the way we manage the marine environment. The five policy areas are: marine spatial planning, marine licensing, marine nature conservation, fisheries management and a Marine Management Organisation.

The UK-wide consultation package on the strategic direction of the policy proposals for the Bill commenced on 29 March. The consultation period closed on 23 June and responses, which will inform the development of the final policies, are now being considered. There will be a further round of consultation, later this year or early next, on detailed legislative proposals, with the aim of legislating in 2008.

Towards an Integrated Coastal Zone Management (ICZM) strategy for Northern Ireland

Ken Bradley

Department of the Environment, Environmental Policy Division

The presentation will include a general explanation of what Integrated Coastal Zone management (ICZM) is all about and the potential benefits which a properly integrated management system could achieve for Northern Ireland. It is intended to highlight the large number of diverse activities and management bodies which exist in the marine and coastal area and the fact that such a large percentage of the NI population either live, work or visit this relatively small area. We set out the reasons for developing an ICZM strategy and the EU dimension to coastal management. Finally the steps which DOE has taken on ICZM and the current position of setting up a Coastal and Marine Forum to oversee the implementation of the Strategy's objectives, and to take a strategic view of policies affecting the coastal/marine area, will be discussed.

A Review of Inshore Fisheries Management in Northern Ireland

Patrick Campbell

Sea Fisheries Policy Branch, Fisheries Division, DARDNI

The “Net Benefits” report on the UK fishing industry carried out in 2004 identified the increasing importance and potential of inshore fisheries and the need for UK Fisheries Administrations to provide more focus on this area. As part of the Government’s response to this report DARD initiated a review of inshore fisheries management in Northern Ireland at the end of 2005. A stakeholder advisory group was established, drawing representatives from a diverse range of bodies with an interest in inshore fisheries, with the aim of producing recommendations for sustainable development and management. This presentation explains the need for the review and progress to - date.

Seafish workbook for live bivalve shellfish handling

David Garforth

IFQC Ltd.

With the introduction of the new Hygiene Regulations on the 1st January 2006 (852/2004, 853/2004 and 854/2004), referred to as the 'Hygiene Pack' getting clear and simple advise to support compliance and best practice has always been high on the industry agenda.

To support this, Seafish are about to launch a new Work Book supported by Seafood Scotland FIFG funding for the Live Bivalve Shellfish Industry. The Work Book will give clear and easy-to-understand interpretation of the new legislation and also advise on good manufacturing practice. The initiative has been spearheaded by Martin Pyke of Seafish and has been developed in consultation with IFQC Ltd, contracted to develop the theme and manage the project. The Work Book is intended to assist live bivalve shellfish operators produce a high quality, safer live bivalve in compliance with legal obligations. It will be published in a durable, highly visual and waterproof format so that it can be used in the production environment, either onboard the vessel or harvesting raft, or in the dispatch and purification facility.

It is intended that operators will use the work book as an every day guide for:

- Good manufacturing practice and legal compliance
- On the job and induction training
- Reference information on good work practices

Session 4:

Friday 15th September 2005, 10.00 am to 12.45 pm.

Opportunities and constraints for seaweed farming in Ireland

Mark Norman
Taighde Mara Teoranta

No abstract available.

New Developments in the cultivation of dulse (*Palmaria palmata*)

Maeve Edwards, Matt Dring and Lynn Browne
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It has been recognised for many years that algal cultivation has a vital role to play in sustaining the world's increasing population. The cultivation of the popular edible seaweed dulse (*Palmaria palmata*) has also received attention over the last five to ten years from a variety of institutes in Europe and Canada. The latest research from QUB includes work on most aspects of the growth of the species in preparation for commercial cultivation. For example, optimum laboratory conditions for both growth and cost efficiency of cultures have been determined, along with growth rates of plants throughout the year and advances in choice of substrate. An economic analysis of dulse production has also been created to highlight the culture requirements for a successful aquaculture business.

Seaweed commercialisation in Ireland and around the world

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The Irish Seaweed Industry Organisation represents a number of seaweed utilising companies in Ireland and promotes seaweeds and seaweed products through its website, www.isio.ie. The number of products worldwide that use seaweed are numerous and diverse. A brief overview of the types of products that use seaweeds as well as possible opportunities for commercial exploitation of seaweeds is presented. Research into seaweeds and seaweed uses in Ireland will be synopsised and ongoing projects and research will be outlined. Issues facing the seaweed industry in Ireland as well as how these issues have been addressed internationally will also be discussed.

Sustainable harvesting of seaweed.

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Raw material availability and sustainable supply are amongst the most important aspects of any commercial utilisation of seaweed/seaplants for food or processing.

Collection may include harvest from wild beds, but a founding premise must ensure due diligence, which comprises responsible stewardship and management of the natural resource to ensure a sustainable supply. We will outline the sustainable use of *Ascophyllum nodosum* in Eastern Canada, as a resource for the production of beneficial animal supplements and extracts for applications to plants. In addition, the socio-economic benefits of these activities to the local economy plus the properties of the various products derived from these seaplant resources will be summarised.

The use of seaweeds in the bioremediation of agricultural effluents

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Anthropogenic nutrient enrichment caused by elevated levels of nitrate and phosphate in freshwater discharge has been identified as being a primary cause of eutrophication in coastal ecosystems throughout the UK. Sources of such nutrient enrichment include the release of wastewater from domestic households, industrial processes and sewage treatment works and leachates released by agricultural practices. The Blackstaff River estuary, located between Portaferry and Kircubbin on the shores of Strangford Lough has been selected as an example of a coastal zone enriched by nutrients largely derived from agriculture. Excess nutrients are released into the system from one point source, namely the Blackstaff River, and several non-point sources including submarine and surface groundwater discharge, all of which are loaded with nutrients. This study aims to determine a method by which local species of macroalgae can be utilized *in-situ* to remove excess nutrients within the water column. In order to do so, species with a high tolerance to freshwater conditions and rapid nutrient uptake rates need to be identified. Species of interest include *Fucus ceranoides*, *F. vesiculosus*, *F. serratus, F. spiralis, Ulva lactuca* and *Sargassum muticum.* Suitable species of algae will be strategically located on the muddy shores of the estuary. This will involve establishing a substrate such as concrete blocks or ropes to which the algae can attach. An integrated monitoring system assessing sediment porewater nutrient concentrations and sediment-water nutrient fluxes will be used to provide an overall indication of any changes in the nutrient status of the system. Polyacrylamide gels probes will be used for this purpose.

Using seaweeds as integrating biomonitors of nitrate and phosphate pollution in coastal waters.

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This study investigates the potential for using seaweeds to monitor the extent and development of eutrophication by nitrate and phosphate in the coastal waters of Northern Ireland.

A batch culture experiment was carried out to determine the effect of ambient nutrient concentrations on nutrient concentration in tissues of *F. serratus* and *Ascophyllum nodosum* over time. There was no significant change in internal phosphate content of *F. serratus* under any nutrient treatment, but *A.nodosum* plants showed a significant increase in phosphate during the course of the experiment under all nutrient treatments. Both species showed an increase in internal nitrate.

Samples were gathered from five sites where sewage discharge had either been through waste water treatment works or released directly from retention tanks. This allowed comparison of sites with different nutrient loads.

Phosphate concentrations were found to be consistently high in all macroalgal species studied from Strangford Lough and the Irish Sea coast of the Ards Peninsula. This and previous data collected suggests that phosphate may not be a useful indicator of nutrient pollution.

A comparison of nitrate and nitrite from different sites shows higher nutrient concentrations at areas of high nutrient input than at less impacted sites. This indicates internal nitrate and nitrite concentrations may provide a more sensitive biomonitor of nutrient pollution and this will be the focus of future investigation.