EPSILON
AQUACULTURE LIMITED

SEAFISH

The Suspended Mussel Hyperbook®

(Courtesy of FRM Ltd)

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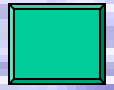
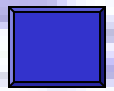
HOW TO USE THIS HYPERBOOK

Navigating around this Hyperbook is easy:

- **If you just want to proceed to the next page (or backwards), simply "left click" on the appropriate arrow key at the foot of each page (a pointing finger symbol will appear)**
- **If you want to use a "hyperlink" to jump to another part of the book, position your cursor over the appropriate button or text (a pointing finger symbol will appear), and left click**
- **You can practice this here**  **(and you can watch a video)**
- **Try clicking on this button** 
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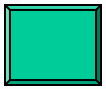
Click on this button to return 

Do you want to watch the Seafish Shellfish Video ?

- Single left-click on the icon below – the video will launch in a Windows Media Player window
- When you have finished watching it, close that window by clicking on the extreme upper-right x box – you should be returned right here
- TIP – the video looks better in a small window – set Media Player to “view” in “skin mode”

MAIN MENU

THE MAIN SECTIONS OF THE HYPERBOOK

(Press the appropriate action button)

- Introduction to mussel cultivation
- The markets
- The production process
- The technologies and equipment employed
- Site selection
- Legal and administrative issues
- Suppliers
- Business planning - including ECONOMIC MODEL

Useful internet links

NOTE: This is the “Main” home page you can return here from anywhere by pressing the blue house symbol

USEFUL INTERNET LINKS PAGE

This Hyperbook contains several "pages" which have links to useful or interesting web-sites. These are mainly located in the LEGISLATIVE and SUPPLIERS sections.

They are easily identified :  ***(Example icon only – do not click on this***

You can access these links as appropriate while you are working with the Hyperbook, provided you are "on line" when you start the Hyperbook session

Back to Main Menu

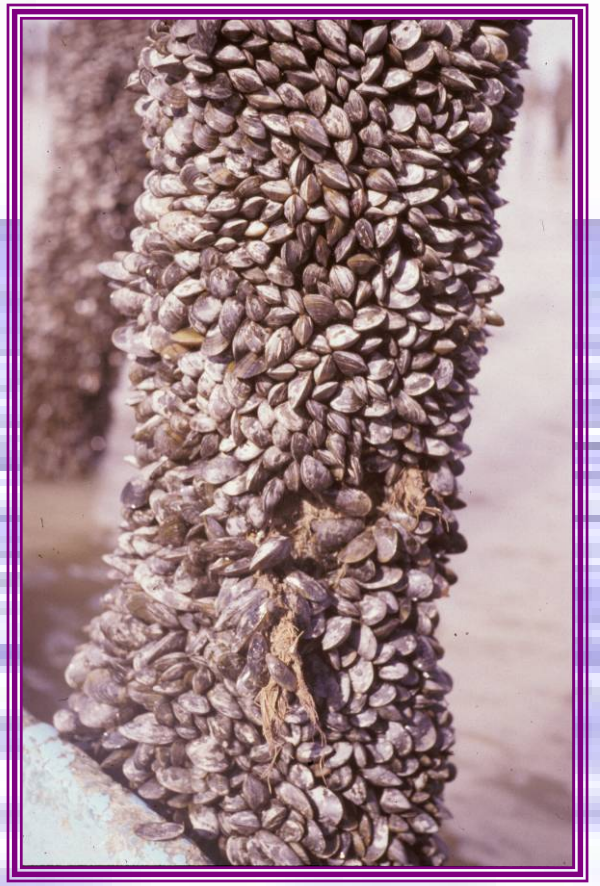
INTRODUCTION TO MUSSEL CULTIVATION

The common or blue mussel (scientific name = *Mytilus edulis*) is a bivalve mollusc that is widely distributed in the northern hemisphere. Mussels can be found all around the UK in inshore coastal waters and estuaries. They can occur high on the foreshore attached to rocks and man-made structures such as piers and jetties. At these more exposed locations close to high water mark, they tend to remain very small and have thick shells. They grow more slowly here because they are exposed for long periods and cannot feed. At the other extreme, they are found continually submerged in sub-littoral areas where their distribution is controlled by predators and local hydrographic conditions.

INTRODUCTION TO MUSSEL CULTIVATION - Continued

In the wild, mussels can form extensive dense beds especially in lower littoral and shallow sub-littoral areas. They comprise an important part of the ecosystem. Not only do the more permanent, stable beds provide us with food and a source of bait, but they also provide an essential source of food for wildlife including populations of shore birds that are protected through UK and European conservation legislation.

Cultivation of mussels on ropes or other material *suspended* from surface rafts or longlines makes use of their ability to attach firmly to such substrates. In the UK, the rope-grown mussel industry is centred in the west and north of Scotland where the deep, sheltered sea lochs provide ideal growing conditions.



Mussels on upright wooden post - 'bouchot' cultivation

INTRODUCTION TO MUSSEL CULTIVATION - Continued

SUSPENDED MUSSEL CULTIVATION

Rafts (in background) and buoyed, double longlines (foreground) as used for suspended mussel cultivation.

(Courtesy of FRM Ltd)

Cultivation of mussels on ropes or other material suspended from surface rafts or longlines makes use of their ability to attach firmly to such substrates.

In the UK, the rope-grown mussel industry is centred in the west and north of Scotland where the deep, sheltered sea lochs provide ideal growing conditions.

In 2001, around 2000 t of mussels were produced in Scotland by this method. Interest in suspended mussel cultivation is beginning to develop in a few of the more sheltered estuaries of England and Wales.

INTRODUCTION TO MUSSEL CULTIVATION - Continued

The Mediterranean mussel (scientific name = *Mytilus galloprovincialis*) is visually similar to the blue mussel. While many authorities consider that only the blue mussel occurs in British waters, extensive surveys have shown that *M. galloprovincialis* is present and has hybridised with the native mussel in areas of south-west England and Wales.

The life history is similar to that of *M. edulis* but peak spawning seems to occur later in the year, in August, and faster shell growth rates have been reported. It has also been suggested that the hybrid may exhibit faster growth rates than the parent stocks.

As yet, no known dedicated fishery or aquaculture operation exists for the Mediterranean mussel in the UK. In southern Europe it is extensively cultivated, particularly in suspended culture in the rias of north-west Spain.

The successful cultivation of this species in Atlantic waters of southern Europe suggests that it may have potential for cultivation in the UK. However, many studies have shown that growth differences in mussel populations are related more to environmental conditions than to genetic factors. Indeed, the Mediterranean mussel grows faster in Spain (up to 11 mm per month) than it does in the UK. Therefore, there may be limited additional growth benefits over those of the blue mussel. The one potential advantage is that the Mediterranean mussel could fill the gap in the market in late spring when the post-spawning meat condition of blue mussels is generally too low to make harvesting worthwhile.

INTRODUCTION TO MUSSEL CULTIVATION - Continued

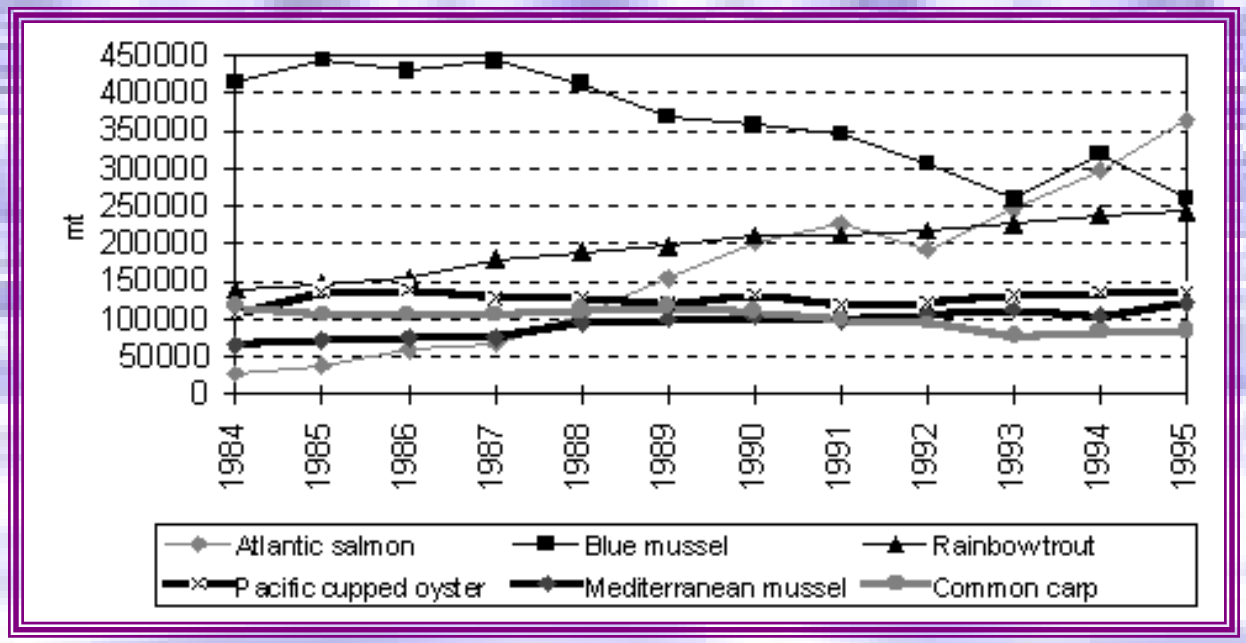
The FAO reported on the major aquaculture species groups which were cultured in Europe in 1995 - Fin fish (779,000 mt) and molluscs (626,000 mt), with only a very limited production of aquatic plants (5,000 mt) and crustaceans (2,000 mt)

In marked contrast to finfish production, the production of molluscs has remained relatively static, growing at an average annual rate of only 0.3% by weight since 1984 (5.7% by value) and production decreasing by 4.2% since 1994 (although value increased by 7.2% over this period). The main mollusc species cultivated within the region are mussels (61.2% of the total, with the main species being the blue mussel (*Mytilus edulis)* and Mediterranean mussel (*M. galloprovincialis*)), oysters (25.5%; main species being the Pacific cupped oyster (*Crassostrea gigas)*) and clams (13.1%; main species being carpet shells, *Tapes* spp.). The main mollusc-producing countries within the region in 1995 were France (34.3% total molluscs), Italy (25.7%), Spain (17.1%), and the Netherlands (12.9%). The total value of mollusc production in 1995 was US$907 million or 24.0% of total aquaculture production within the region.

The world's leading producer of mussels is Spain who use a suspended raft method of cultivation. Another large world producer of mussels is the Netherlands where mussels are grown extensively on the seabed. This is the method that has been used in the UK, mainly in the Menai Strait where mussel production increased during the 1990's from around 3,000 t per year to a maximum of 10,000 tonnes. The availability of wild seed is the main constraining factor for further increases in production.

INTRODUCTION TO MUSSEL CULTIVATION - Continued

The FAO commented upon decreased mollusc production within southern European countries due to the increasing occurrence of toxic red tides and consequent incidence of diarrhetic and paralytic shellfish poisoning, and to a lesser extent due to the increasing occurrence of parasitic diseases. For example, shellfish poisoning caused by red tides was responsible for the drastic drop in mussel production in Spain, from a high of 247,000 mt in 1986 to 90,000 mt in 1993.



Source: FAO

INTRODUCTION TO MUSSEL CULTIVATION - Continued

The cultivation of mussels does not rely on hatchery production of seed, for two main reasons:

- Wild spatfalls are usually of sufficient quantity and reliability
- The economics of mussel cultivation could probably not support hatcheries

Nevertheless, mussel production is constrained by other things. We have already heard about the problems of red tides, but there are other constraints which are more subtle:

- Rope mussel cultivation is not inconspicuous in sheltered sea lochs, and there can be objections to farms on these grounds
- Large scale mussel farms are as much of an impediment to navigation and recreational boat moorings as fin fish farms
- There are other aspects of carrying capacity - a recent Dutch report commented:

"The mussel culture is under pressure from conservationist quarters: the question is whether Dutch society will continue to give permission to fish for shellfish in the shallows. Politically, providing more room for farming in the shallows or in the Oosterschelde is not a matter of discussion. And apart from the non-enclosed areas that are currently used, no other suitable locations are available. Although the quota system has led to greater efficiency, it seems necessary to establish innovations in production methods, catching, sowing and transportation techniques to make better use of seed mussels. Serious thought should be given to farming improvements. Research in the Netherlands has not been designed to answer those questions: they are seen as marginal problems, in view of high natural stock fluctuations. The industry seems to be innovative in processing and distribution, but not in improving production."

INTRODUCTION TO MUSSEL CULTIVATION - Continued

Despite the reservations expressed in some quarters, rope-grown mussel cultivation is enjoying a period of sustained growth and production continues to expand. As the industry 'matures' consolidation is taking place. Established larger growers are taking interests in or buying-out other producers. Production is being split between locations, partly to overcome constraints on expanding existing leases, but also to minimise the potential detrimental effects of site closures due to the accumulation of algal toxins. Those seeking to enter the industry are treating it less as a 'lifestyle choice' and more as a serious business venture, although there is still room for the smaller, artisanal niche producer. Larger businesses require greater investment. The industry can now demonstrate a proven 'track record' and financial institutions are more willing to lend against it. Consequently, capital can be easier to obtain - but it is still highly dependant on having a sound business plan to back the projections. However, many factors, especially some affecting the stock in particular, cannot be controlled totally by the grower and risks remain. Rope-grown mussel culture is not a certain success and each year some of the newer and, occasionally, even established businesses cease to trade. This can lead some lenders to regard the investment as 'high risk' and this may be reflected in the interest rates attached to any loans. Nonetheless, with proper planning and forethought the chances of success can be maximised and a thriving business built.

INTRODUCTION TO MUSSEL CULTIVATION - Continued

FUTURE CONSIDERATIONS

The major threat to the shellfish cultivation sectors and their operations in the UK is not that they fail to be sustainable or environmentally friendly but that nature conservation designations do not always recognise their economic and social significance within the coastal environment.

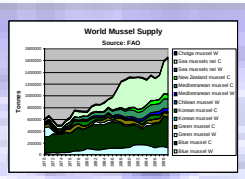
The designation of sites in the UK on the basis of the perceived need for wildlife conservation under national and European obligations is an ongoing process. Businesses and shellfish cultivation operations that are within the vicinity of conservation areas are likely to come under increasing scrutiny with respect to their activities on the site's conservation value.

It will become increasingly important that the industry is well placed to address any concerns through the maintenance of high environmental standards and active involvement with the groups and bodies charged with the managing the conservation areas.

THE MARKETS FOR MUSSELS

The global and regional "market" for mussels is presently defined by the availability of *supply* from the wild fishery plus the cultivation sector. The world total supply of one species or other of mussels was 1.6 billion tonnes in 1999 - of which 86% was cultivated and 14% was wild harvest.

Click on the thumbnail to see the total global wild + cultivated supply data

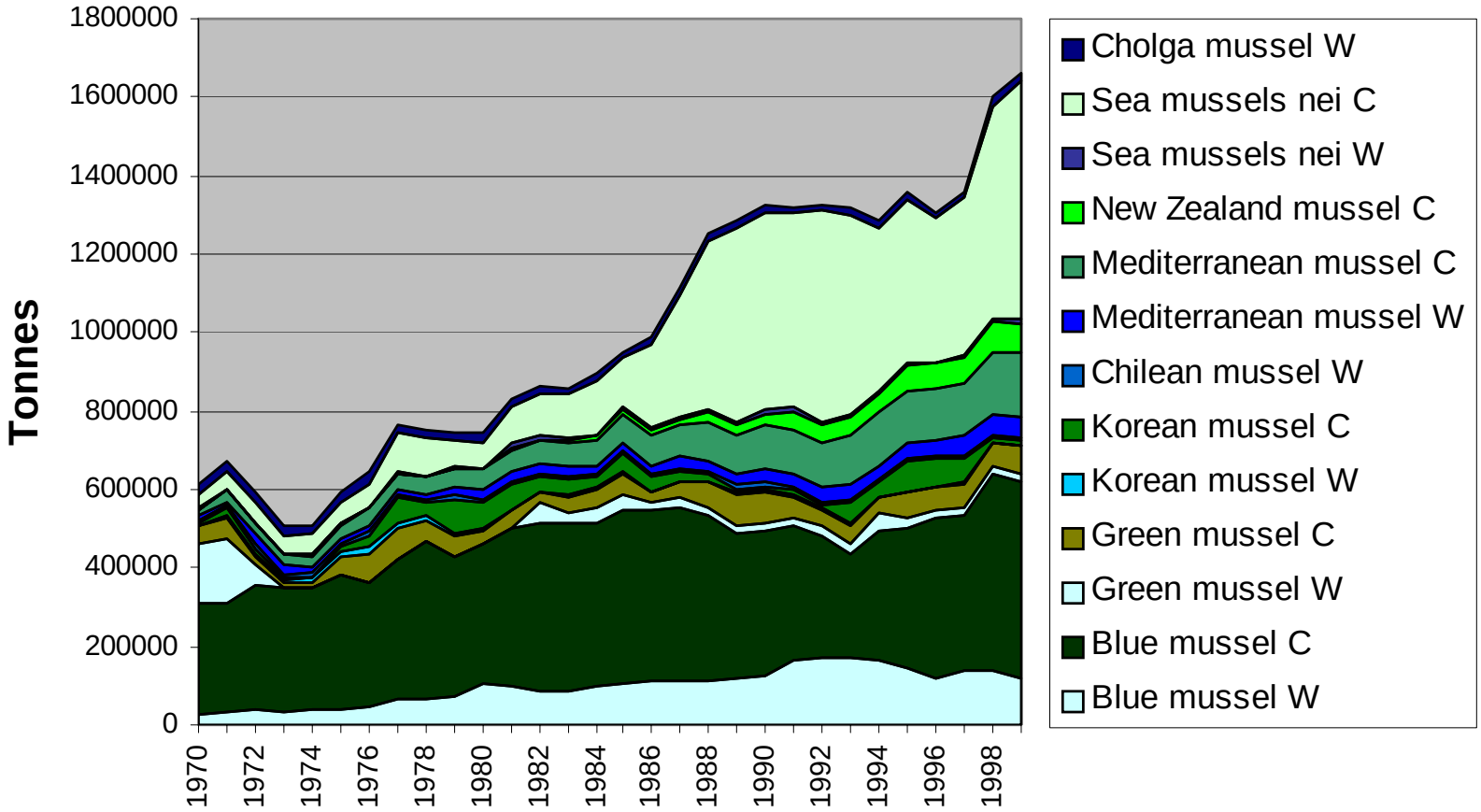


This trend - around 80-85% of world total supply from cultivation - was established during the mid 1970's, and has been relatively stable since then. Total supply has increased from 0.6 billion tonnes in 1975 to the current 1.6 billion tonnes + per annum. Effectively, whilst cultivated mussels have dominated the increasing world supplies, the wild sector has also benefited from increased production.

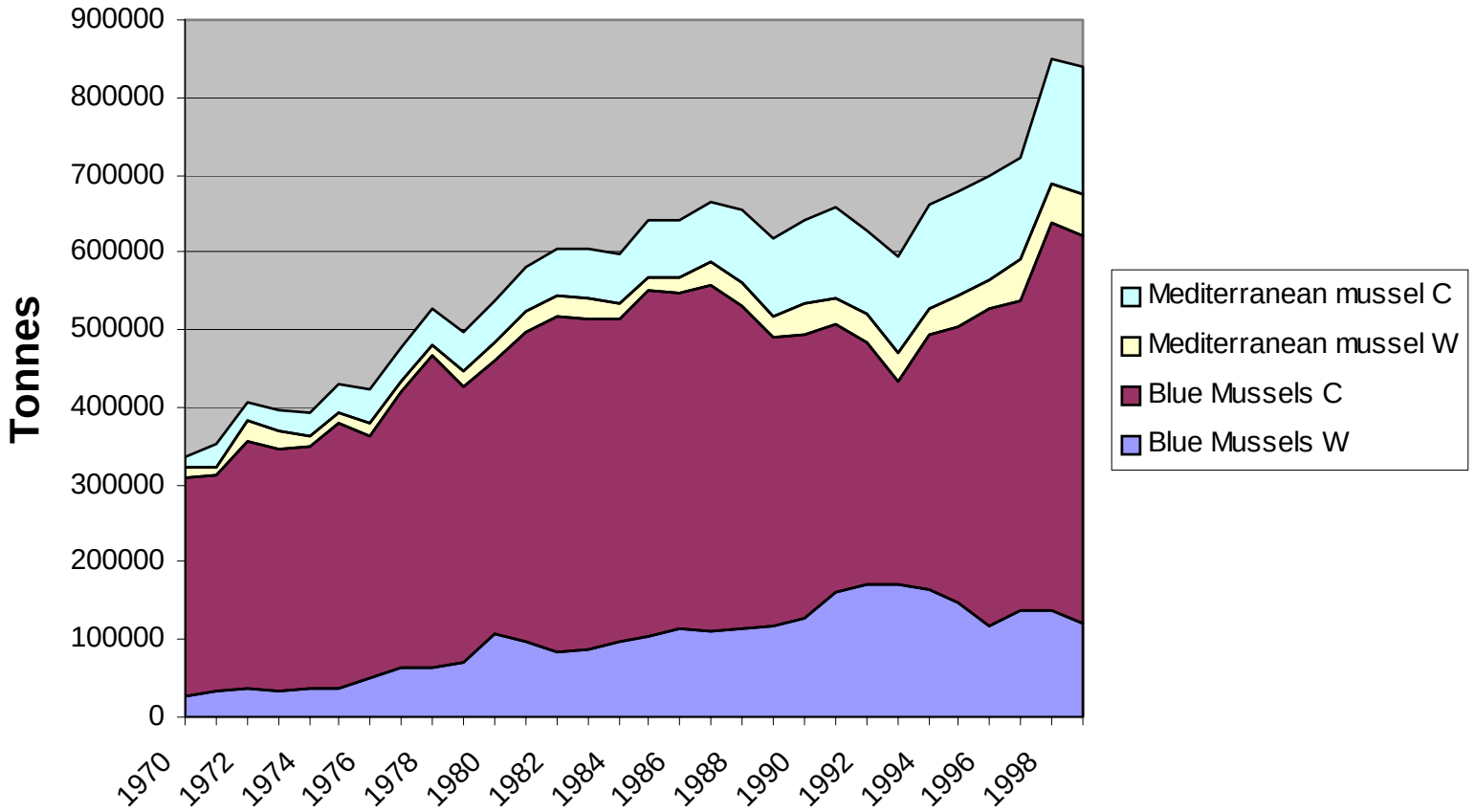
The other important point to note about global supply is that the increases in the last 15 years have been dominated by Chinese cultivation of "sea mussels" - but there has also been a significant increase in cultivated Mediterranean mussels in Europe, and New Zealand green shell mussels

World Mussel Supply

Source: FAO



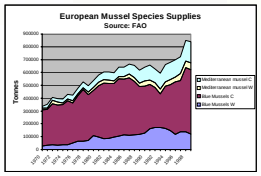
NOTE: W = Wild harvest, C = Cultivated

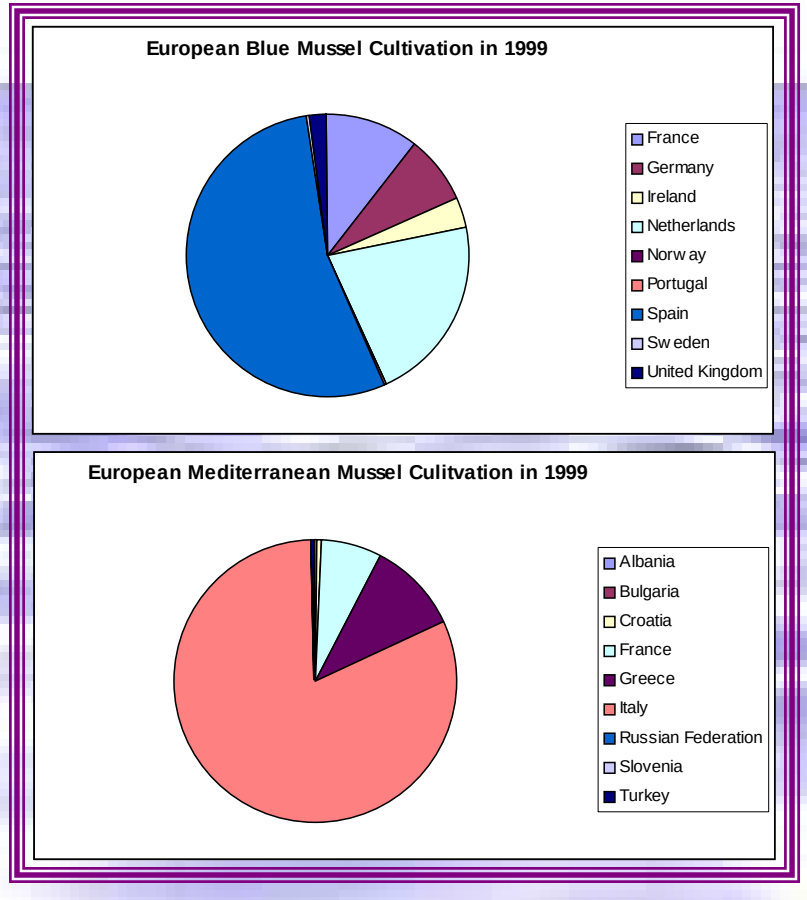


NOTE: W = Wild harvest, C = Cultivated

THE MARKETS FOR MUSSELS - Continued

European species supplies are of more interest to Scottish producers - click on the thumbnail for more detail





The European supply would appear to be:

- **600,000 tonnes of blue mussels in 1999**
- **215,000 tonnes of Mediterranean mussels in 1999**

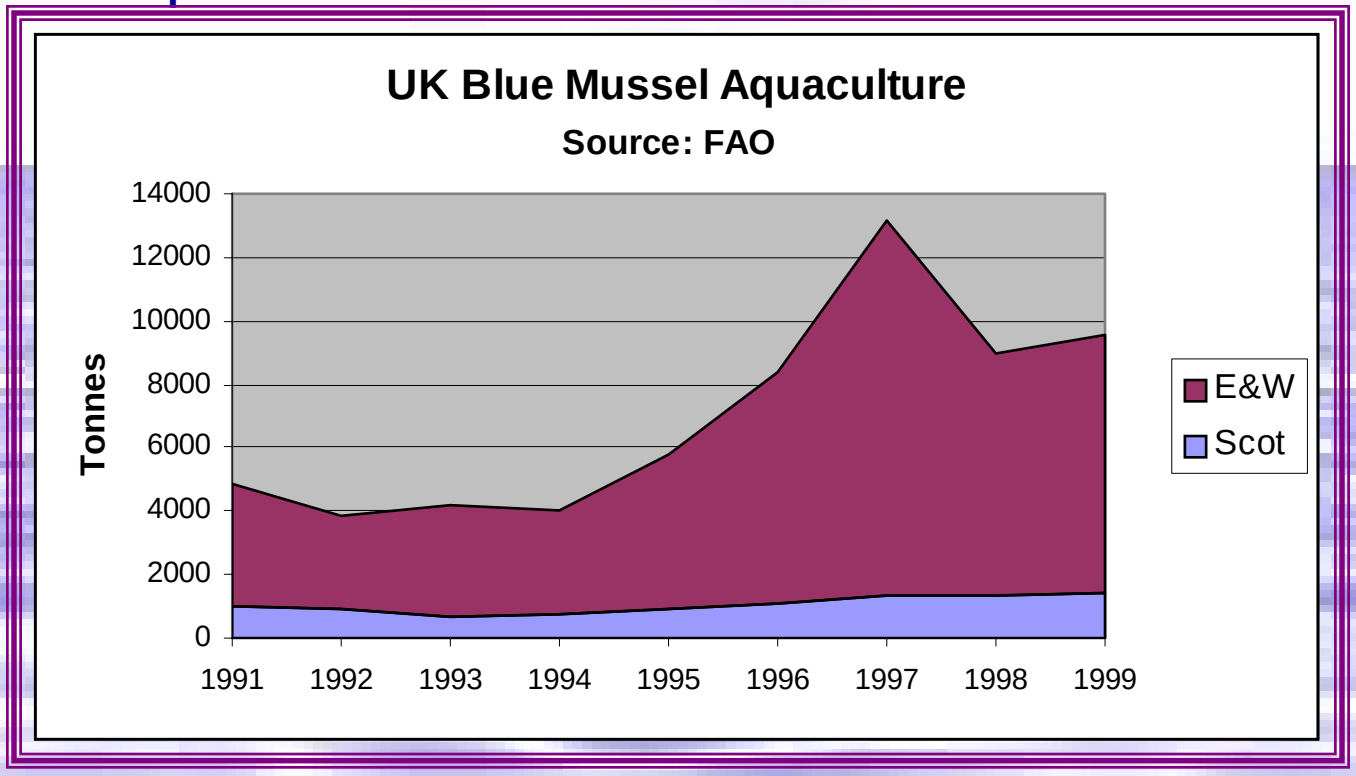
The main producing nations for both species are shown in the figure left

Spain and the Netherlands dominate blue mussel production

Italy dominates Mediterranean mussel production

THE MARKETS FOR MUSSELS - Continued

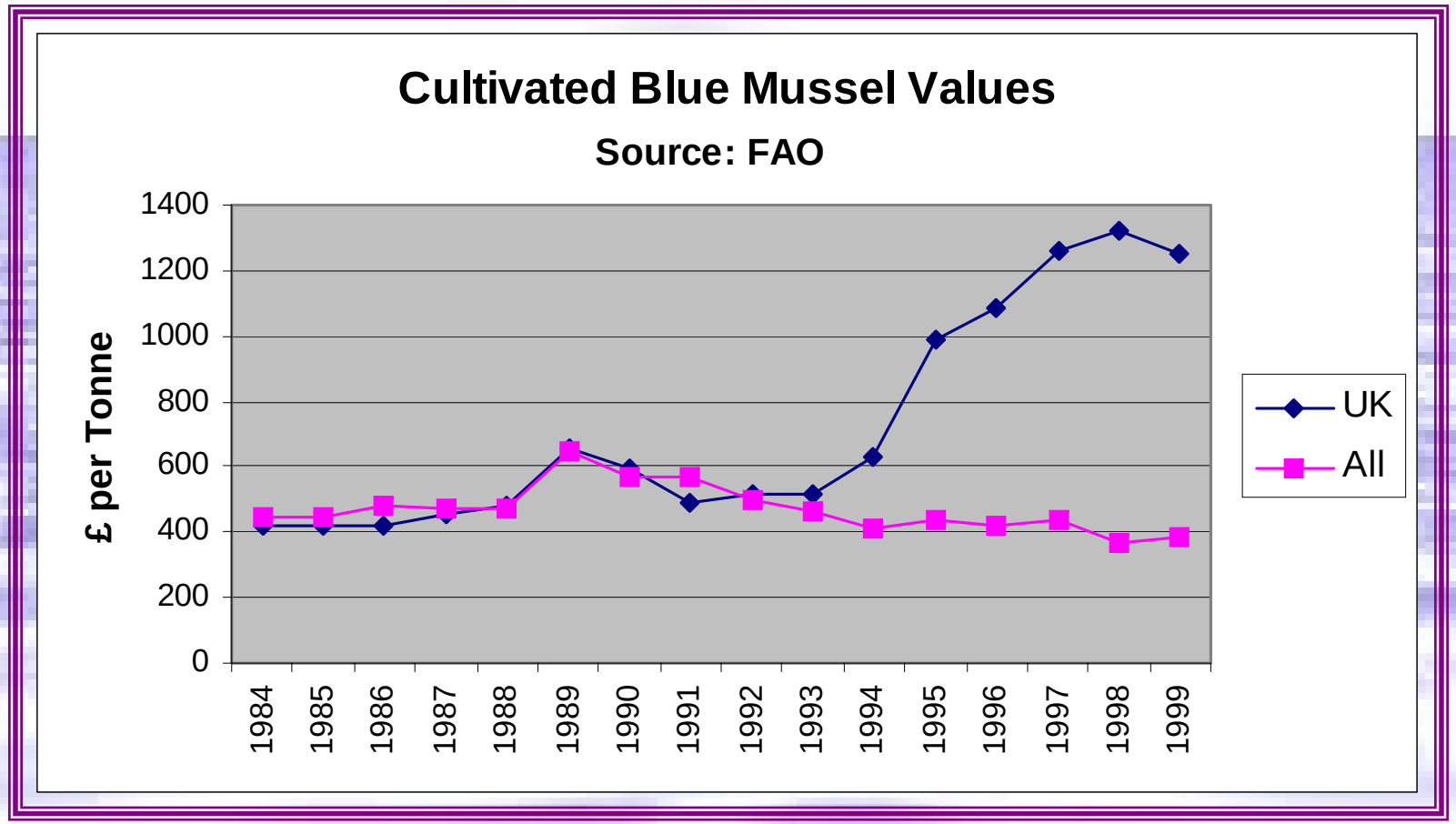
Against this background of 600,000 tonnes of blue mussels entering the European market, it is interesting to track the history of UK and Scottish aquaculture production in this sector.



Total UK production was around 10,000 tonnes in 1999 - compared to around 500,000 tonnes of *cultivated* blue mussels on a global basis in the same year. Scottish production is mainly rope-grown, production in England and Wales is predominantly from bottom dredging

THE MARKETS FOR MUSSELS - Continued

The UK production of cultivated mussels may be small, but it does achieve a high first sale value compared with the average value of the total global production, as the figure below illustrates. This trend seems to have started at a very discrete point in 1994



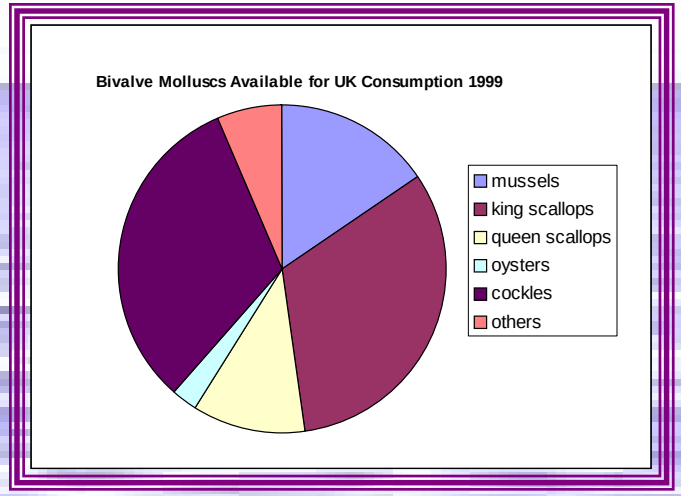
THE MARKETS FOR MUSSELS - Continued

The market for mussels in the UK and several other European countries was extensively studied by Seafish in 2001

You can find this report as a Word document "Shellfish Market Report" inside the main Hyperbook folder. Click "exit" to leave this show, if you want to see the report now

A summary for the UK market situation for bivalve molluscs would suggest:

- **40,406 tonnes of bivalve molluscs were available to UK consumers in 1999**
- **Reporting of landings (official statistics) are poor. Other data sources suggest this total could be in excess of 80,000 tonnes**
- **First sale value of UK landings was around £38 million in 1999**
- **Exports in 1999 were 20,675 tonnes**
- **Imports in 1999 were 8,380 tonnes**
- **Aquaculture production was 10,646 tonnes in 1999**
- **Main aquaculture growth has been in mussels – by dredging and suspension**
- **Per capita consumption of all shellfish has risen steadily from 1 to 7 g/head/week between the years 1971 and 1996 – a higher rate of growth than all seafood combined (146 to 154 g/head/week)**



On the next two pages we will look at the overall seafood market in the UK

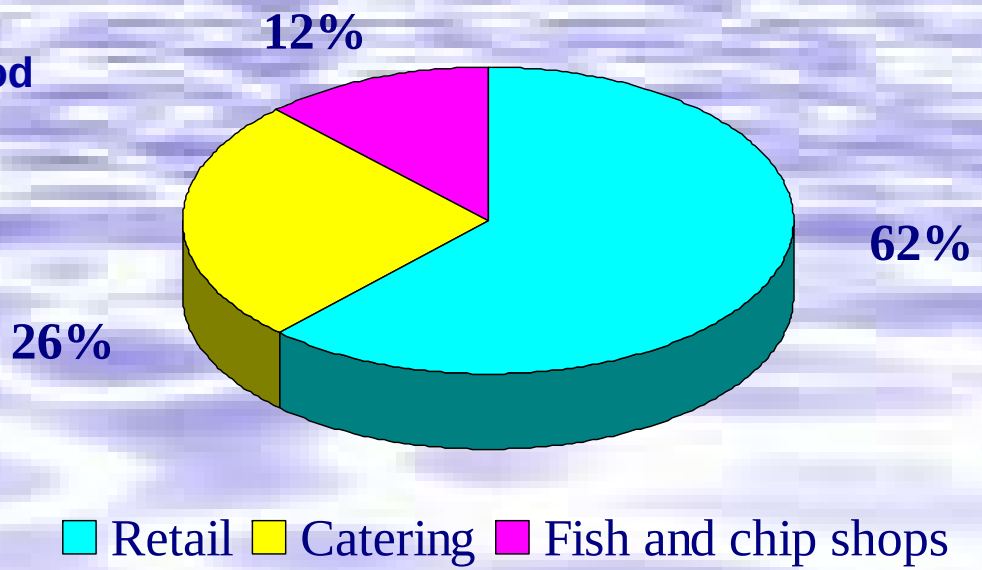
THE MARKETS FOR MUSSELS - Continued

Seafood is purchased in two broad categories by consumers:

- ***Retail - where it has to be prepared for eating at home***
- ***Foodservice - where it is purchased in a ready-to-eat form***

There are overlaps where shops and petrol stations sell ready-prepared meals, and sub-categories such as take-away foodservice. The main distinction between the two broad categories is that the consumer pays more per unit piece of protein in foodservice than he/she does in retail.

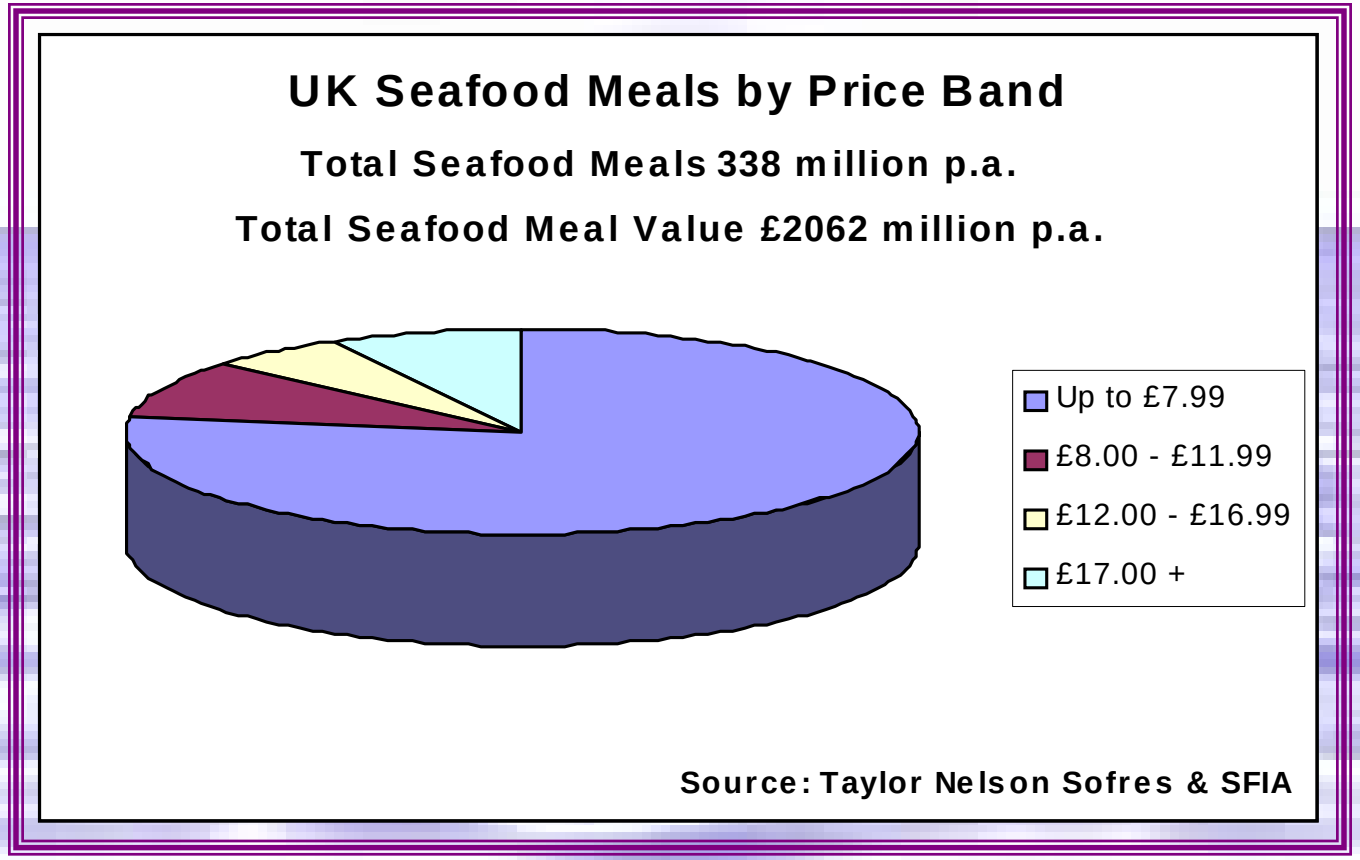
The balance between seafood retail and foodservice



Source: SFIA, Foodservice Intelligence & Superpanel

THE MARKETS FOR MUSSELS - Continued

UK seafood consumption in foodservice - in terms of number of meals and their values - is interesting:



- 338 Million seafood meals per annum
- 25% of them costing more than £8 per meal

THE MARKETS FOR MUSSELS - Continued

The "Farm to Fork" concept is a way of understanding how aquaculture products are valued by consumers - and how the value of the product works backwards through the supply chain to the aquaculturist at the edge of his farm.

One example might be a typical moule mariniere-type dish, which as a main course would probably have at least 500g of whole mussels, and which might sell to the consumer for around £8.00. In foodservice we can follow a well-researched "chain" of value through the catering outlet:

Price of the meal		£8.00
Less VAT @ 17.5%	(£1.19)	£6.81
Less restaurants "margin" of 66%		£2.27
Less cost of other ingredients (c.£0.50)		£1.77

In effect we are suggesting that a restaurateur offering such a dish would not be able to pay any more than £3.54 per kg for whole mussels "delivered to his back door".

This still appears to leave a reasonable margin for the foodservice companies, wholesalers, transporters etc – farmed mussels achieve between £0.40 and £1.00 per kg depending upon source and quality.

Note that the calculation above is speculative in so far as product weight per meal, actual meal price on the menu, and cost of other ingredients are concerned. However, the principle behind this method of assessing cost of protein ingredients into catering outlets has been well tested – readers of this report can substitute their own values and quantities. The restaurant "margin" may vary from outlet to outlet, and even from product to product. However, the level of around 66% is probably close to an industry standard.

THE MARKETS FOR MUSSELS - Continued

With an apparent national availability of some 7,772 tonnes per annum, mussels represent around 16% of availability of all bivalve molluscs to UK consumers. They are widely seen as being one of the growth areas in terms of consumption:

- They are the only bivalve mollusc which is routinely presented in a chilled ready meal format in the chill cabinets of retail multiples – 500g packs of "mussels in garlic butter", retailing for £2.99 per pack at time of writing.
- They are commonly available "loose" on retail multiple and independent mongers wet fish counters
- They are increasingly being offered in a more appealing pre-packed form (see Section 4.5)
- There are specialised seafood restaurants opening in major cities, whose raw materials feature mussels rather heavily
- There are other foodservice outlets which routinely offer mussels

The bulk of UK consumption of mussels could, in theory, be provided by domestic production – from wild harvesting, managed fisheries and suspended culture. In practice we export a reasonable amount of mussels, and import a large amount. The supposition is some of the mussel imports in the fresh/chilled/frozen categories (3010 tonnes in 1999) are in an added-value form which UK consumers want to purchase. This element must be a target for domestic producers and processors. The general conclusion of the recent study was that there are good prospects for growth (with innovation) in the UK mussel aquaculture sector, both in terms of the domestic market and export market.

THE MARKETS FOR MUSSELS - Conclusion

The main mussel market messages from this section are:

- Mussels and scallops dominate recorded fresh/chilled mollusc sales in UK retail – with 1.6% of all fresh/chilled seafood by volume and 1.2% by value. There is some evidence of growth in this area
- Growth areas in retail are:
  - Defined chilled mussels (18% growth by volume 2000-2001)
  - Pre-packed fresh mussels (72% growth by volume 2000-2001)
- UK consumers are tending to seek innovation and novelty in food, and some respondents feel there is a move to "trendiness" of molluscs
- UK retail customers want convenient, safe pre-packed products
- The general feeling about market opportunities is more upbeat when companies are closer to the consumer
- Dredge mussels are a type of "managed fishery" - the production cost is lower than suspended mussels, but the product moves in volume (largely un-depurated) to European markets

Some mussel recipes
(click on the buttons to view)

Back to Markets Section

Moules Mariniere

2kg (4lbs 7oz) fresh mussels, washed, debearded and scrubbed
30g (1oz) butter or margarine
1 onion, finely chopped
1 clove garlic, crushed
300ml (10fl oz) dry white wine, or stock
2 x 15ml spoon (2 tablespoons) lemon juice
3 bay leaves
salt and black pepper
3 x 15ml spoon (3 tablespoons) fresh chopped parsley

Melt the butter or margarine in a large saucepan and lightly fry the onion and garlic, until onions are soft and transparent.

Add the liquids, bay leaves and seasonings and bring to the boil. Add the mussels all at once, cover and cook over a high heat, shaking the pan occasionally to ensure even cooking.

When all the mussels have opened (discard any that remain closed) transfer to a heated serving dish, reserving the liquid.

Return the liquid to the heat and boil rapidly until reduced by half, stir in the parsley and season to taste.

Pour the sauce over the mussels, before serving with French bread.

Serves 4

NUTRITIONAL VALUES PER PORTION (APPROX) 261Kilocalories;
23g Protein; 10g Fat; 8g Carbohydrate; 1g Fibre.

See a picture

Back to Markets Section

Moules Mariniere

Next recipe

Back to Markets Section

Pesto Moules

2kg (4lb 7oz) fresh mussels, washed and scrubbed and debearded
30g (1oz) butter
2 shallots, finely chopped
300ml (10fl oz) white wine
2 x 15ml spoon (2 tablespoons) lime juice
2 x 15ml spoon (2 tablespoons) pesto sauce
fresh chopped basil, to garnish

Melt the butter in a large saucepan and cook the shallots, until soft and transparent.

Add the wine, lime juice and pesto sauce and bring to the boil. Add the mussels all at once, cover and cook over a high heat for 4-5 minutes, shaking the pan occasionally to ensure even cooking.

When all the mussels have opened (discard any that remain closed) transfer to a heated serving dish, reserving the liquid.

Reduce the liquid by boiling rapidly for 3-4 minutes.

Pour the liquid over the mussels, garnish and serve with French bread.

Serves 4

NUTRITIONAL VALUE PER PORTION (APPROX) 545 Kilocalories;
63g Protein; 21g Fat; 14g Carbohydrate; 0g Fibre.

See a picture

Back to Markets Section

Pesto Moules

Next recipe

Back to Markets Section

Mussel and Saffron Pilaff

455g (1lb) fresh mussels, cleaned and debearded
1 large pinch saffron threads,
2 x 15ml spoon (2 tablespoons) olive oil
1 small onion, peeled and finely chopped
1 clove garlic, finely chopped
125g (4 and a half oz) long grained rice
300ml (10 fl oz) vegetable or fish stock
1 bay leaf
salt and black pepper
30g (1oz) dried currants or sultanas
lemon wedges, to garnish

Preheat the oven to 190ºC/375ºF,Gas Mark 5

Soak the saffron threads in 3 x 15ml spoon (3 tablespoons) boiling water for 15 minutes.

Heat the oil in an ovenproof casserole dish and add the onion and garlic. Cook until soft.

Stir in the rice. Add the stock, saffron with liquid and bay leaf. Season and bring to the boil. Cook in the oven for 15-20 minutes.

Add the mussels, cover and return to the oven. Cook for a further 10 minutes until the mussels are opened. Discard any mussels that remain closed after cooking. Stir in the dried currants or sultanas.

Garnish with lemon wedges and serve.

Serves 2

See a picture

Back to Markets Section

Mussel and Saffron Pilaff

THE PRODUCTION PROCESS

Introduction

Click here to see a description of the life cycle

This Hyperbook will focus on the main life cycle stages for cultivation of blue mussels: getting started, spat settlement, ongrowing and harvesting

The Hyperbook can not provide every detail, and it is recommended you visit some of the resources listed in the Legal & Administration and Suppliers sections

Life Cycle

An increase in water temperature, change in salinity or wave action, desiccation, or increases in phytoplankton concentrations can trigger spawning in blue mussels. Sexes are separate with maturation typically occurring during the first year. When ripe, male mussels are recognised by their creamy white colour when opened whereas the females have an orange roe. The main spawning season is in spring but some areas may have less intense spawnings during the year. Eggs and sperm are released through the exhalent siphon into the water column, at a ratio of 10,000:1 spermatozoa to egg, and sperm are released first, stimulating the release of eggs. The eggs are spherical with diameters of approximately 0.07 millimetres. The larval period ranges from 15 to 35 days depending on environmental conditions, and is marked by development of the shell valves, umbo, photosensitive eyespots and elongated foot. The larvae then settle on to hard substrates, fix their locations via byssus threads, and metamorphose into plantigrades (0.25-0.4 mm). They remain in this juvenile state until they reach 1 to 1.5 millimetres in length. Following this growth period, the plantigrades detach from the substrate and move with the currents into an adult blue mussel bed. Here they secrete new byssus threads and attach to the substrate or other mussels. Sexual maturity occurs in one to two years, and adult blue mussels grow to approximately 100 millimetres and live up to 20 years (Newell 1989).

Generally, mussels have a life span of only four to five years due to natural predation. However, those living high up the foreshore have a possible life span of up to 17 years or more.

Introduction - 1

MUSSEL BEDS

In the wild, mussels often form extensive dense beds in the intertidal and shallow sub-littoral areas. The more permanent, stable beds provide us with food and a source of bait. These beds also comprise an important part of the ecosystem because:

- they provide an important benthic habitat that supports numerous other benthic species,
- they provide an essential source of food for wildlife including populations of shore birds that are protected through UK and European conservation legislation,
- they probably have an important effect on coastal hydrology and chemistry, e.g. by stabilising sediments and by playing a key role in organic production/breakdown cycles.

Cultivation of mussels on ropes or other material suspended from surface rafts or longlines makes use of their ability to attach firmly to such substrates. In the UK, the rope-grown mussel industry is centred in the west and north of Scotland where the deep, sheltered sea lochs provide ideal growing conditions.

Introduction - 2

Like other bivalve molluscs, mussels are filter feeders removing natural phytoplankton (microscopic algae or plant cells) and organic particles from sea water as it passes over the gills. The gills have the dual function of respiration and feeding. They act like fine, intricate nets that trap food particles from the water. The quantity of water filtered by a mussel (filtration rate) depends on a number of factors including animal size, water temperature and the concentration of suspended particles. In good conditions, adult mussels can filter up to 60 litres of water an hour.

In exposed situations, mussels tend to have poor growth performance compared to those in more submerged conditions. In part this is due to their reduced ability to filter in the heavy surf and the higher likelihood of being detached from the rocks.

Getting Started - 1

The main spawning season for mussels is the early spring. Ripe, male mussels are recognised by their creamy white colour when opened whereas the females have an orange roe. Eggs and sperm are released into the sea and the resulting larvae drift in the plankton for 3 - 5 weeks, feeding on microscopic algae.

When mature, the larvae sink out of the plankton, attach to filamentous algae and hydroids and develop into the first 'immature' adult stage (called spat) which are 0.25 - 0.4 mm shell length.

The spat grow to 0.9 - 1.5 mm, then detach and drift again in the plankton before finally re-attaching on to harder surfaces by their byssal threads. These threads can be easily seen in mature mussels and are commonly called 'the beard'.

Recruitment can be very variable from year to year but larger spatfalls often coincide with colder winters.

Basic Techniques to Apply

Rope-grown mussels are cultivated on ropes hung either from rafts or surface longlines. The capacity of the raft or the length of a longline can be varied to suit the location, but typically a raft would have a capacity of approximately 30 tonnes and a longline would be approximately 200 m long (capacity approximately 20 tonnes). The production ropes are spaced at between approximately 0.5 m and 1 m intervals to minimise the chances of tangling.

On a small scale (up to approximately 100 tonnes per year) the grower can operate using adapted small boats, but as production increases it is necessary to invest in purpose designed vessels to service the lines and handle the volume of stock.

See Technologies Section for more details of equipment:

Obtaining Seed Mussels

Spat is collected from the plankton by suspending the production ropes in the top 2 – 3 m of the water column. There are various designs of rope in use. The simplest is a rope that has been roughened to make it 'hairy'. Plastic pegs or discs are inserted between the strands of the rope at between 0.3 – 1 m intervals to provide extra support for the spat.

The production ropes are usually between 6 – 10 m in length and are coiled to keep them at the target collection depth.

Some areas have little or no natural spat-fall and growers purchase ropes with spat attached from areas of high settlement. There are growers who specialise in providing spatted ropes to others.

Mussel spat attached to a collector rope

Ongrowing - 1

Once the spat are firmly attached to the ropes, they are lowered to their full extent. The animals are then left to filter feed suspended in the water column. As the mussels grow, extra buoyancy has to be added to the longlines in order to prevent the line from sinking and the production ropes touching the seabed.

As the animals grow, the density of the mussels on the ropes may also be reduced, a process known as 'thinning'. This is carried out in order to prevent overcrowding and promote optimum growth and productivity. The mussels are gently removed from their original rope, sorted and enclosed in a mesh 'sock' around a fresh production rope. The mesh 'sock' supports the mussels whilst they re-attach to the rope with a new bysuss. The 'sock' can be made from a variety of materials, but some of the most widely used are cotton based and designed to gradually rot away after the animals are firmly attached. Plastic mesh 'socking' is increasingly used in some areas. This is process is also often referred to as 'retubing'.

Mussels filtering

Production can be as high as 20 kg per metre of rope dropper, but 10 – 15 kg m^{-1} is more usual.

Ongrowing - 2

Retubed mussel ‘thinnings’ enclosed in a mesh ‘sock’ being lowered in to the water for further on-growing

Predators - 1

The common starfish (*Asterias rubens*), is the main predator of rope-grown mussels. They can get on to the ropes by settling out from the plankton as juveniles or as a result of the ropes coming in to contact with the seabed. If they are not removed losses can be significant. Raising the ropes from the water, on a suitable day, and allowing them to dry in the shade can be a very successful control method without damaging the mussels.

Mussels and starfish

Predators - 2

In certain areas, particularly on the west coast of Scotland, eider ducks (*Somateria mollissima*) are a problem. More than 60% of the diet of adult ducks is mussels in the size range 10-25 mm, but they feed on mussels of up to 50 mm. They generally dive down to a maximum of 10 metres to feed. Eiders are found in Scotland year-round, but generally the ducks are more abundant in spring and autumn which results in peak predation at those times of year. A large flock can rapidly strip a line of its mussels. Losses result from both direct predation and from dislodgement of other mussels from the lines. A variety of methods to deter eider ducks have been tried, one of the most successful is continual chasing with a boat. Conservation bodies publish advice on how to minimise the impact of the birds.

In certain areas, predation by goldeneye ducks (*Bucephala clagula*) has been encountered.

Control advice leaflet

Male Eider Duck

Courtesy of M Bleasdale

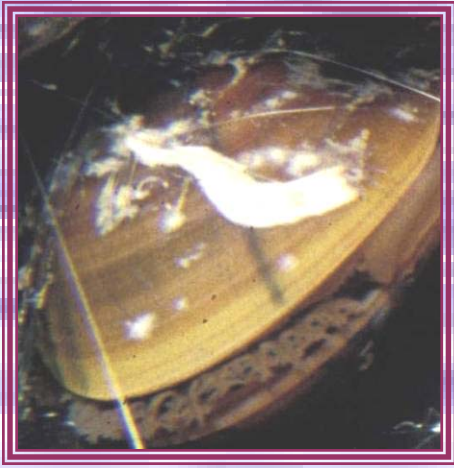
Competitors and Fouling Organisms - 1

Pea crabs (*Pinnotheres pisum*) are very small, males have a maximum size around 6 mm carapace width, whilst females are larger, maximum carapace width approximately 13 mm. They are seldom photographed. Line drawings show their shape, but do not do them justice. Colour drawings are often to be seen in sea shore life identification guides. Pea crabs are almost circular, with the males being a pale yellow-grey colour whilst the females are translucent. They occur all around UK coasts and live in the mantle cavity of mussels and clams. Sometimes they can be found inside blue mussels, but they are generally rare in this species as it is not their preferred host. However, when they do occur their presence can adversely affect cultivated mussel production. Small pea crabs (i.e. all males + immature females) are mobile and their effects on the host mussel are intermittent and reversible. However, mature females (>6mm) are trapped within their host, this adversely affects the mussel's physiology, causing them to loose condition and decreasing the meat yield. These effects can be exacerbated by the presence of additional environmental stressors.

Competitors and Fouling Organisms - 2

Fouling organisms such as barnacles and tube worms can attach and grow on mussel shells. Heavy infestations can make the shell look unattractive and may affect their marketability. Little can be done to remove such fouling and the best strategy is one of avoidance where this is possible.

Heavy barnacle fouling on a mussel



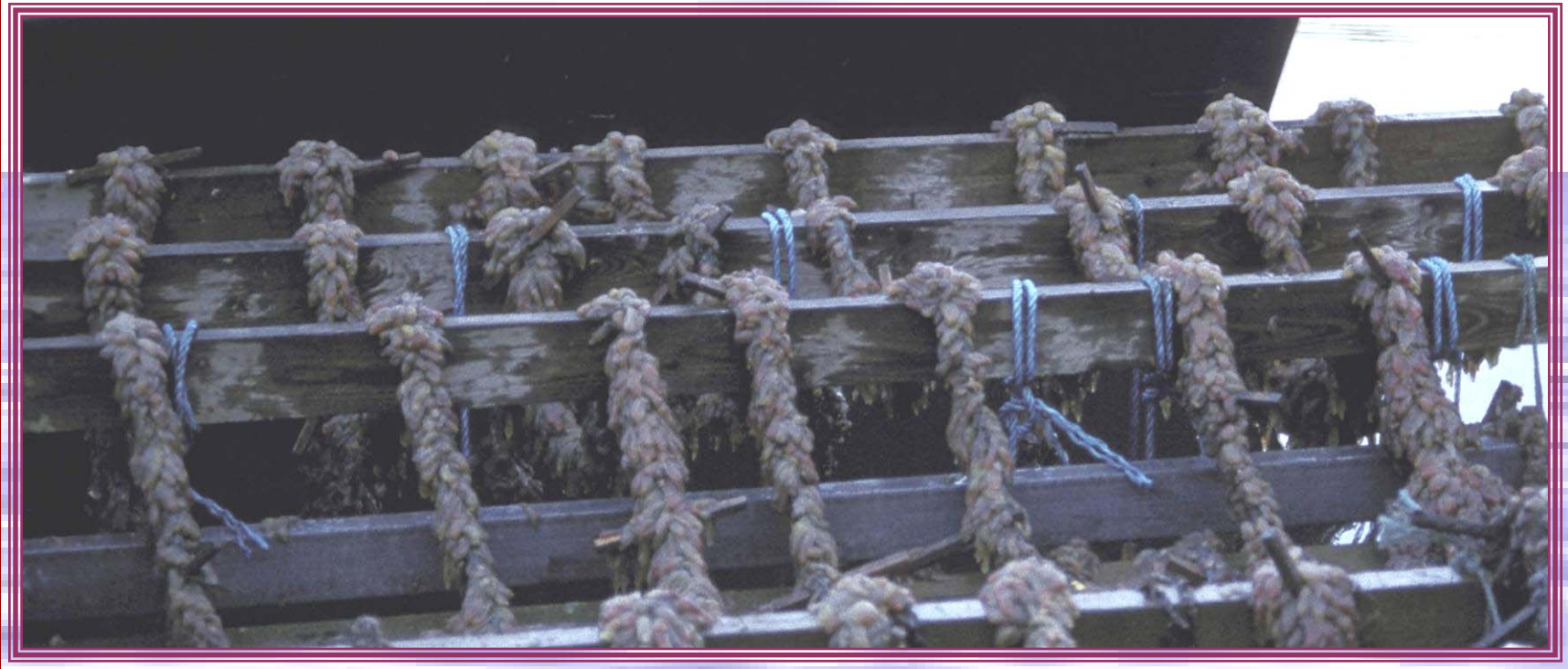
Tubeworm on mussel

Competitors and Fouling Organisms - 3

Sea squirts (tunicates), sponges, anemones and macro-algae can also attach to the shells or the lines. The animals compete for food and space and all increase the weight of the ropes in the water, necessitating the addition of extra buoyancy. Raising the ropes from the water, as for starfish control, can help to reduce such fouling.

Mussel lines underwater showing fouling by sea squirts, sponges, anemones and hydroids.

Competitors and Fouling Organisms - 4



Drying mussel lines heavily covered with sea squirts to remove fouling

Environmental Issues

The UK shellfish cultivation industry to-date has an extremely good environmental track record and it is generally recognised that in order to function, it requires access to clean, unpolluted and naturally productive waters. Indeed, the successful operation of the industry is widely acknowledged to act as an environmental indicator with respect to water quality and pollution levels.

Potential environmental issues can arise in relation to mussel culture. The impacts (positive as well as negative) will be related to the scale of cultivation. Most of the issues that are likely to arise will need to be addressed at a local level with the regulatory authorities and with other users of the coastal zone. These are some of the points that you might like to consider.

Both rafts and longlines are visible at all times, but in many areas the visual impact of cultivation is minimal. However, at high densities or in some particularly 'visually sensitive' locations their presence can be an issue. In most areas, the use of grey buoyancy floats and unobtrusive siting is required. The marker buoys used to identify the site to shipping are yellow and have to be clearly visible, but with careful consideration their impact can be minimised whilst safety is maintained. Submersible cultivation systems are also under development.

Some methods used to deter eider ducks, such as automatic scarers, can give rise to noise disturbance. This can be of concern if the site is close to habitation.

The mussel ropes may cause localised changes to water circulation which can lead to the deposition of sediments. Siting them where there is good water flow will reduce this as well as ensure that the mussels receive adequate levels of food.

Environmental Issues 2

Longlines in a sea loch can be difficult to spot, particularly when light levels are low

Environmental Issues 3

The same longline array viewed from directly above the site

Harvesting 1

Rope-grown mussels take approximately 2 years to reach marketable size (45 mm shell length or above). The exact time is dependent on the location and productivity of the cultivation site and the destination market. Some countries prefer larger mussels than others.

The normal harvesting season is from late August/September through to April. Mussels are harvested at around 20g live weight with the meat representing from 30% to 50% of the total weight depending on the productivity of the site and the time of year. Meat quality and yield is at its lowest after spawning.

Harvesting 2

The degree of mechanisation employed is dependent upon the scale of the operation. At its simplest, the ropes may be raised and the mussels stripped and graded by hand. However, this can only be done at a very low level of production and above approximately 10 t per annum varying degrees of automation are required. At its most sophisticated, the ropes are raised by hoist, passed through an automatic stripper to remove the mussels, which then go through a declumping machine to separate them. From here, they are graded, washed and proceed to a weighing/bagging machine or bulk harvest container. The entire process can take place on board the harvesting vessel. Mussels too small to market are often retubed and rehung on the line for further growth.

Harvest yield is commonly between 5 - 7 kg of marketable mussels per metre of dropper.

Mussels being harvested

Harvesting 3

Once ashore, bulk mussels are weighed and bagged. Usually, all stock is stored briefly in large seawater tanks before dispatch to market. If required, purification takes place at this time.

Purification or depuration of shellfish means holding them in sterilised sea water for 48 hours under conditions that allow them to filter normally. This removes any bacteria accumulated in the gut. The sea water can be sterilised by ozone or ultra-violet light although the latter is the most common method used. The design and operation of purification systems must be carefully controlled and have to be approved for commercial use.

A typical large scale depuration unit

The Product

Individual bags of high quality rope-grown mussels awaiting dispatch to the retail outlet

Health & Safety Issues

The health and safety aspects of any cultivation enterprise are extremely important and can be quite diverse. Working practices and safety standards should be reviewed on a regular basis.

Areas for consideration will include:

A responsibility for personnel working on the site, ensuring that they are working under safe conditions and with gear and equipment that is appropriate and adequate for the job. All staff should have received the necessary training and/or guidance when using equipment that could be dangerous or when working on boats or out in isolated or dangerous conditions such as tidal waters or during the hours of darkness or poor light.

Divers may be required at certain stages of cultivation e.g. fitting moorings etc and this will require additional consideration including using a registered contractor and having an appropriate number of divers for the job with the relevant diving qualifications and equipment.

All gear on the foreshore or in the water should be marked clearly so that they are not a hazard to navigation or to other users of the area.

Boats, vehicles and large machinery should comply with any statutory safety requirements.

For more information refer to the Legal and Administrative Section.

THE TECHNOLOGIES AND EQUIPMENT EMPLOYED

Introduction

This section of the Hyperbook will “mirror” the previous section (PRODUCTION PROCESS), but will focus on the hardware and systems aspects of suspended mussel production

Mussel Growing Locations

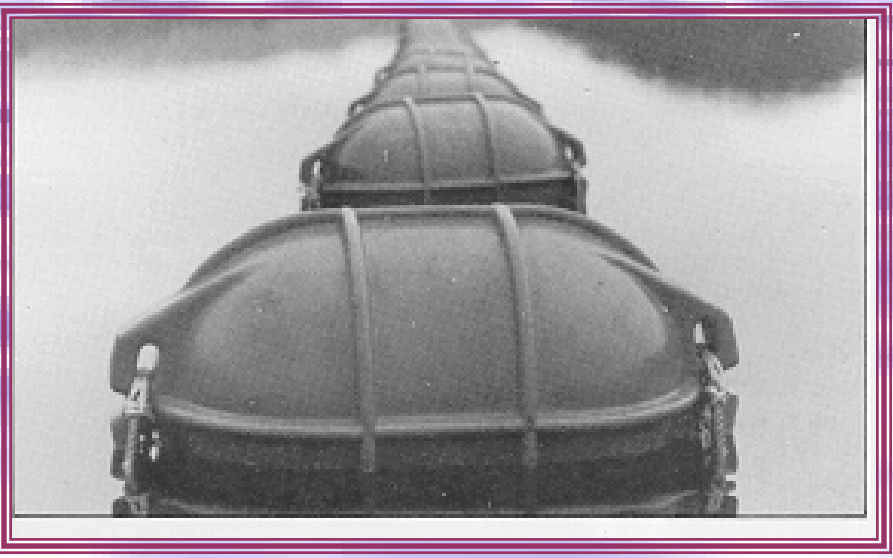
A “typical” mussel farming location (and see also Site Selection) - Loch Etive

Courtesy of FRM Ltd

Long Lines - 1

Longlines supported by individual floats are probably the main suspension system employed in Scotland (and Ireland). A “typical” longline would be:

- 200 m of twin 18 - 32 mm headropes
- Supported by grey plastic floats of 150 - 400 l capacity, positioned approximately every 3 meters
- Droppers would be 6 -10 m long, and positioned every 1 m along both head ropes
- Droppers would be made of 12 mm rope
- Plastic pegs or discs would be inserted through the rope droppers every 0.3 - 1 m
- The entire structure would be moored at either end - either from the shore or by way of a mooring block - typically 9 tonnes at each end.



Mussel floats in action Courtesy of C G Paxton

Longlines 2

Longlines and mussel rafts in a Scottish loch

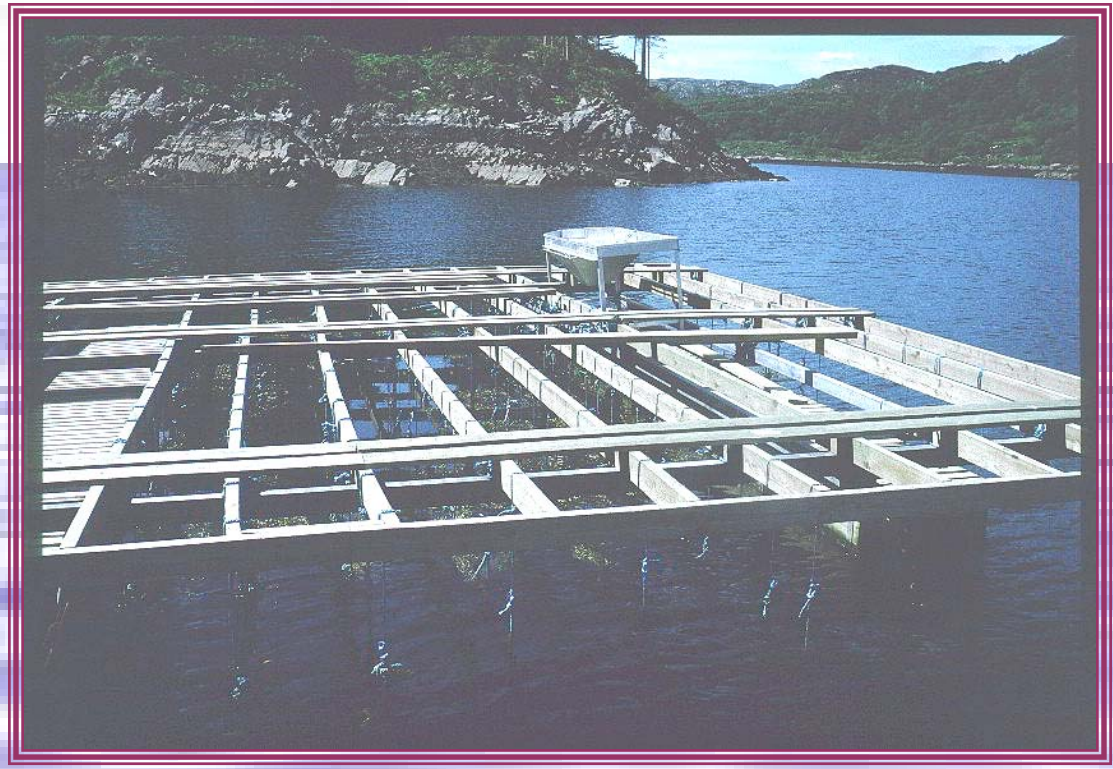
Courtesy of FRM Ltd

Rafts 1

The other way to support droppers in the water is from rigid floating rafts:

Typically a mussel raft in Scotland would be:

- Approximately 30 T production capacity
- Approximately 10 m square
- Metal or plastic floatation pontoons
- Wooden cross-beams
- 10 m long droppers of 12mm rope with pegs every 0.3 - 1 m (as longlines)
- Droppers are spaced approximately every 0.5 m
- Moorings approximately 6 T in each corner



A mussel raft

Rafts 2

Large rafts - traditionally called “bateas” - are the most common form of mussel cultivation system in Galicia, Spain. Modern bateas are made of eucalyptus wood, and have large metal flotation drums

Bouchot Culture

In France, mussel production can commonly be based on rigid poles, driven into the seabed and wrapped around by the mussel attachment ropes.

This so-called "bouchot" system clearly does not rely on flotation and moorings, and might therefore be considered more secure. However, the mussels on parts of the vertical piles are exposed to air with the rise and fall of the tide.

Bouchot cultivation requires quite specialised locations, and is not generally practiced in Scotland or the UK.

Typical bouchot operations taking place

Materials

Apart from the rope, floats and moorings, the other main materials used in suspended mussel cultivation are different types of mesh material to "sock" or "retube" small mussels as they re-attach to the main production ropes after 'thinning'.

Typical mesh materials - from cotton-based to all plastic

Materials 2

Pegs or discs are used to prevent the mussels sliding off the ropes under their own weight. Traditionally, the pegs were made of wood, but it is now more common to use plastic ones. Actual designs vary between manufacturers.

Traditional wooden pegs inserted in a mussel rope

Plastic pegs used instead of wooden pegs

Other Equipment

A mussel farmer will need an assortment of smaller pieces of equipment and safety clothing - plus some specialised items

Examples of the equipment required include:

- First Aid Kit
- Lifejackets / Buoyancy Aids
- Gloves
- Knives
- Bespoke tools for cleaning fouling from the lines or taking manual samples of the stock
- Measuring and weighing instruments
- Brushes and brooms
- Hoses and fittings
- Mobile phone/radio

Plastic calipers can be useful for measuring samples of the stock

BOATS

Specialised boats are now available for mussel cultivation operations - and offer many advantages in terms of handling efficiency.

An example of a modern boat designed to service longlines used for rope-mussel cultivation

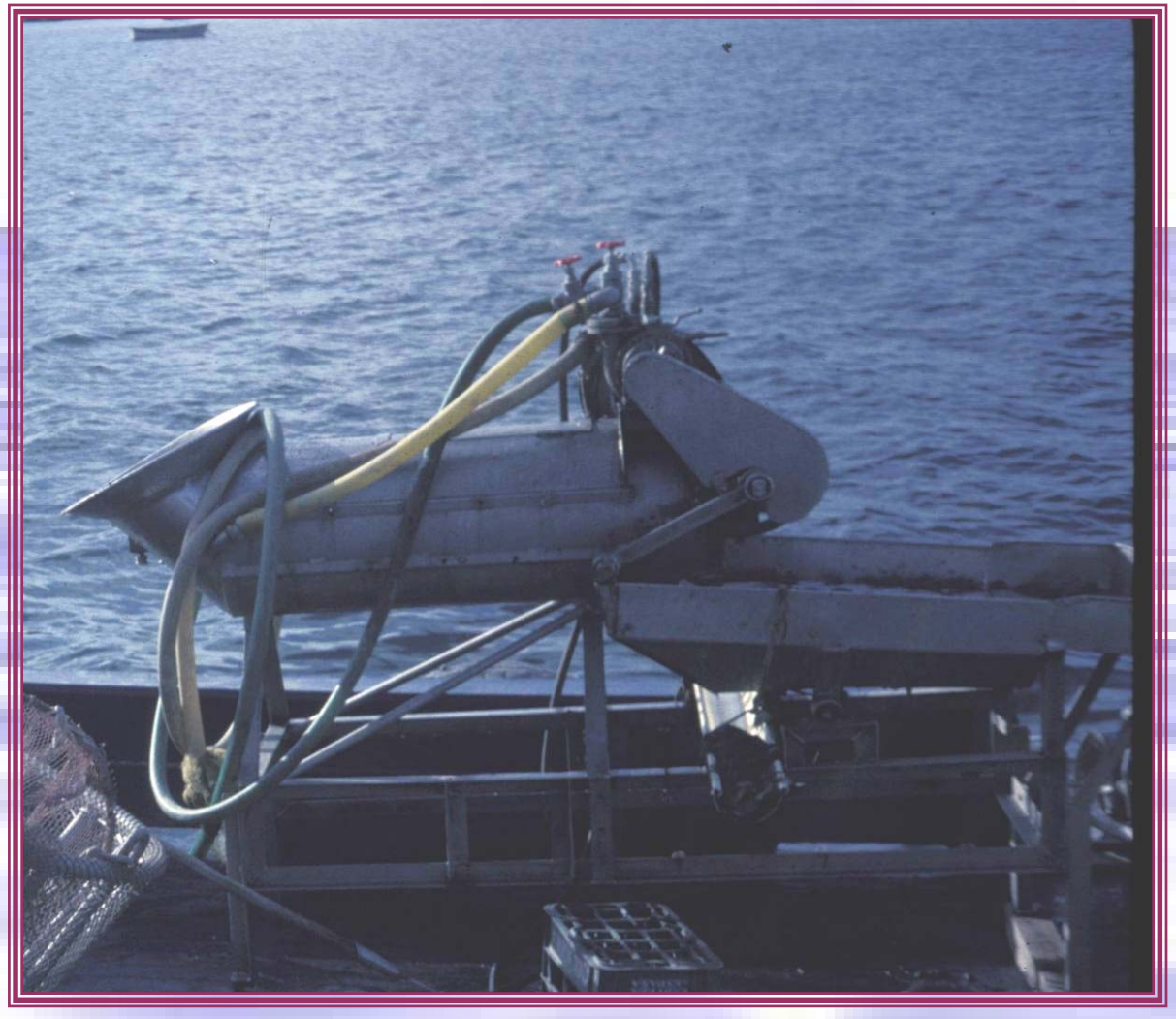
Handling Equipment 1

Lifting gear is becoming essential for raising ropes laden with mussels

Cranes or lifting arms can be mounted on service rafts or boats

Handling Equipment 2

After harvest, the mussel clumps must be separated using a ‘declumping’ machine.



A small ‘declumping’ machine

Handling Equipment 3

After 'declumping', the mussels are then graded for size. On a small scale this can be done by hand, but as production increases mechanised systems are necessary.

Mussels being 'declumped' and graded by hand

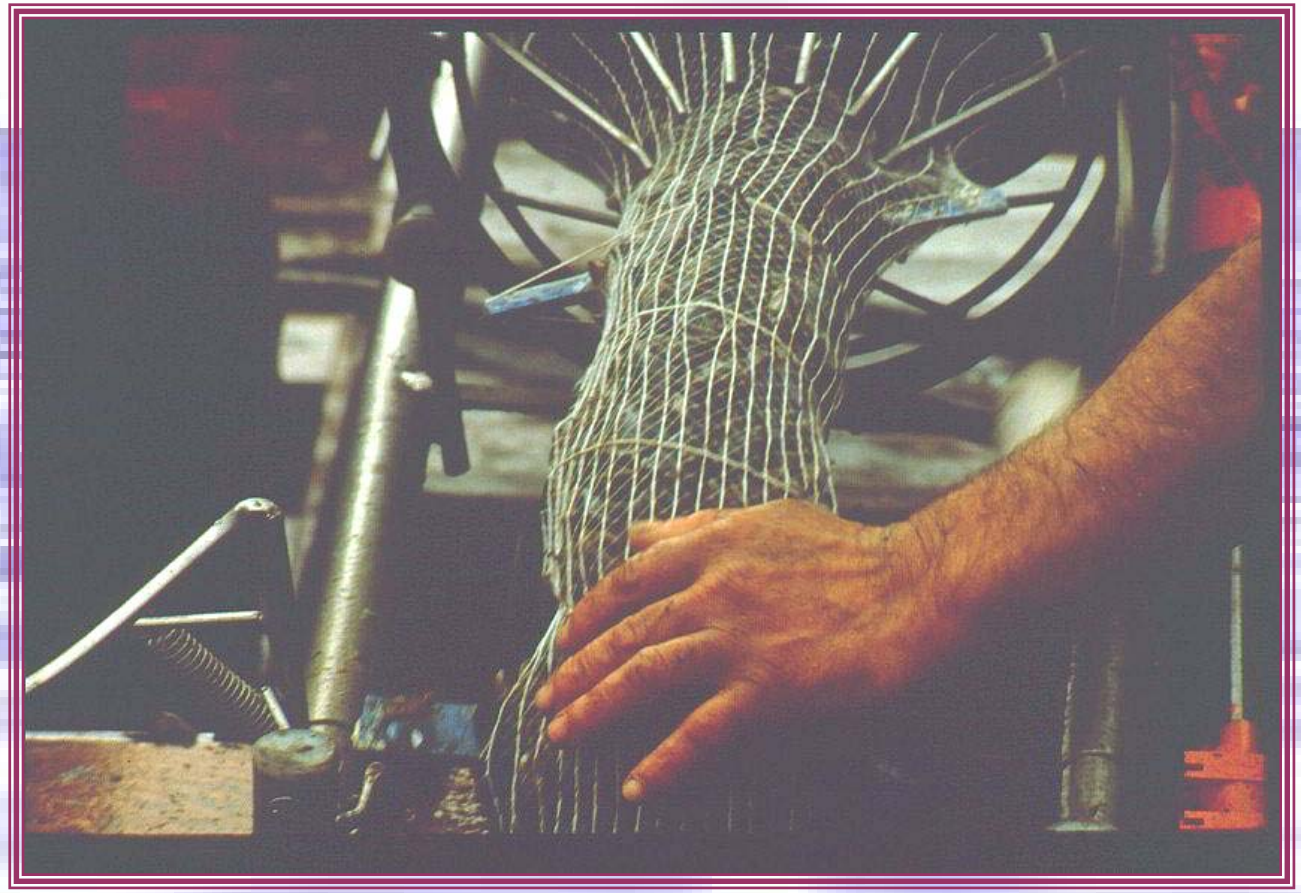
Handling Equipment 4

A mechanised processing line for stripping the mussels from the production ropes, declumping, washing and grading them can be accommodated aboard a modern mussel cultivation vessel.

A mechanised processing line on a dedicated mussel cultivation vessel

Handling Equipment 5

Small mussels are usually “re-socked” and put back into the water to continue growing. A re-socking machine is a useful tool for the larger grower. There are manual equivalents for the smaller producer.



Mussels being retubed using a Spanish designed ‘socking’ machine

Handling Equipment 6

Bulk storage facilities are often required. Bagged mussels can be stored for a short time in bulk bins or on pallets before dispatch.

Bagged mussels awaiting dispatch

Handling Equipment 7

Handling large volumes of mussels necessitates using as much mechanised assistance as possible, from pallet trucks to forklifts.

Using a forklift truck to load palletised mussels in to a chilled transport trailer

Handling Equipment 8

Chilled transport to market or main dispatch centre is a necessity. On a small scale this may provided by the grower, but as volumes increase dedicated lorry trailers are used. These may be hired by the grower, or provided by the merchant.

A consignment of mussels in a chilled transport trailer on its way to a merchant

Depuration

Purifying or “depurating” mussels is almost obligatory for Scottish producers hoping to sell into major buyer chains - irrespective of their water’s classification

A small depurating unit

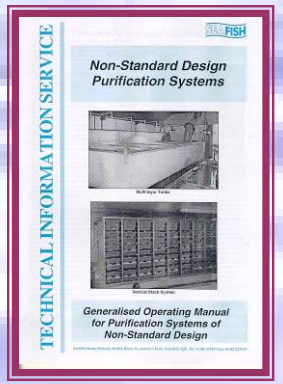
Depuration generally involves holding mussels in clean water for 48 Hours, and letting their systems flush out any pseudofaeces which might contain harmful human pathogenic bacteria

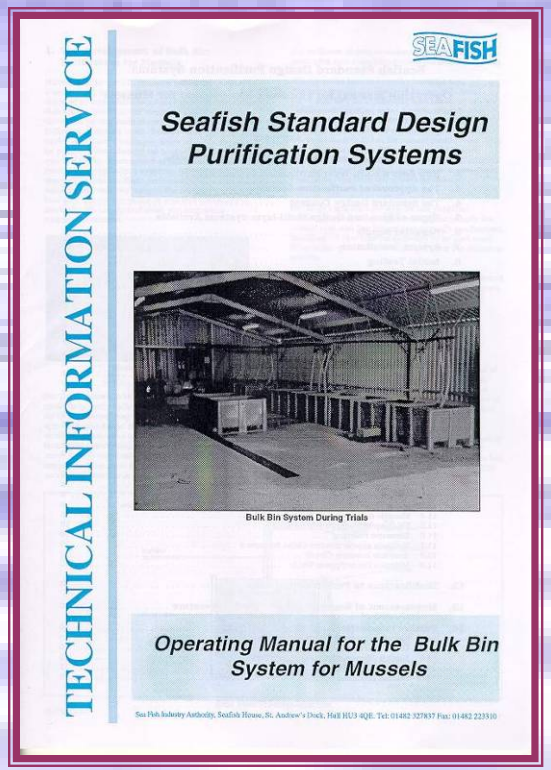
The process often uses recirculated water systems, with simple UV sterilisation of the water on each pass

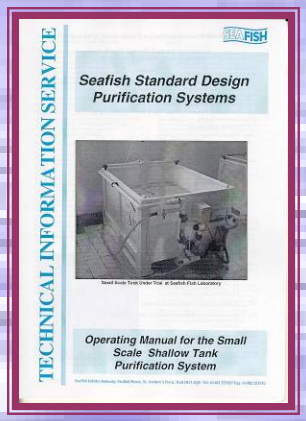
Depuration 2

The grower may choose to install their own depuration unit or to purchase the service from a dedicated facility. This may be operated by the merchant who buys their stock.

Advice on different scales of depuration facility design, installation and operation are available from Seafish.







SITE SELECTION

Introduction

This section of the Hyperbook will consider how locations for suspended mussel cultivation projects might or should be chosen. Good site selection is critical to the success of any aquaculture venture, and there are some obvious considerations:

- **Choosing a location with the wrong ambient seawater temperature, exposure to rough weather or lacking in natural foodstuffs for the species may mean that they grow too slowly - or may risk storm damage**
- **Sites near industrial facilities, with the risk of water pollution incidents, should be avoided**
- **Sites without reasonable access for staff, euipment and supplies are clearly impractical - although the cost of providing access can always be considered in the outline business plan**
- **Sites have to be "feasible" from the point of view of the regulatory and planning authorities who have statutory obligations in the area - but this issue is discussed in the Legal and Administrative section**

Site selection

Introduction

Selecting a site that is suitable for suspended mussel cultivation is clearly of fundamental importance. It requires careful consideration of a range of different factors and these are examined in detail in this section.

If at all possible, it is advisable to monitor the conditions at any prospective site for at least a year before any commercial culture begins. Growth differences between sites usually reflect differences in conditions that may be fairly specific to the sites, but you should also be aware that these could vary between years.

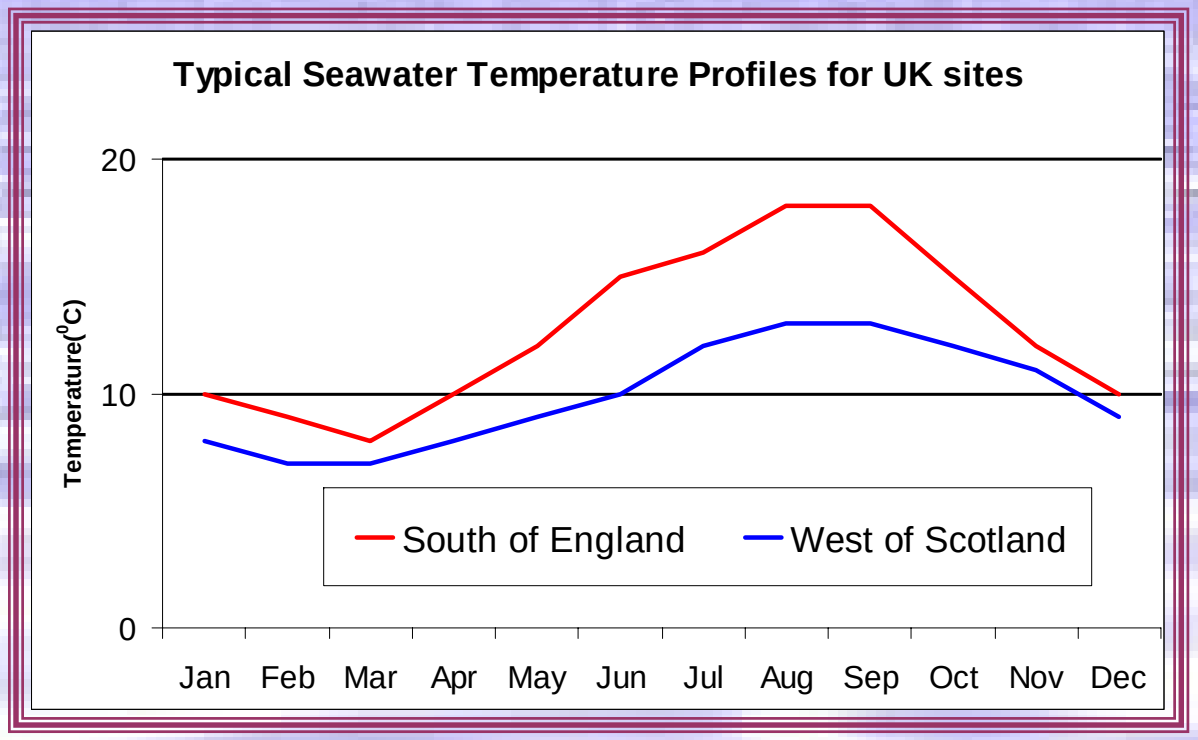
Key issues include:

- Shelter from strong wind & wave action
- Local plankton productivity
- Abundance of predators
- Good site access
- Favourable local planning attitude
- Convenience for market

SITE SELECTION

Seawater Temperature Profile - 1

In the UK, mussels start to grow in the spring when sea water temperatures reach 8-9 ºC. Growth rate reaches a maximum in July or August when water temperature peaks (usually 16-18 ºC) and then falls off again as the temperature drops to below 8-9 ºC in November or December. Mussels are usually found in estuarine and coastal sites where salinity > 20 ppt. When exposed to the air, they close tightly to prevent desiccation of the internal tissues.



The figure shows the ambient seawater temperature cycle in different parts of UK

Algal Situation

The selection of a suitable site is crucial to the success or failure of a mussel farm. Growth and survival of suspended mussels are influenced by a range of physical, biological and chemical factors including sea water temperature and salinity, water flow rate and phytoplankton content, predators, competitors and fouling organisms, dissolved nutrients, oxygen and pollutants. Many of these are subject to seasonal and annual variation and it is advisable to monitor the conditions at your prospective site for at least a year before any commercial culture begins and carry out a pilot study to see how well mussels grow and survive.

Most coastal sites have sufficient quantities of algae in the water to support cultivation. However, some species of algae can cause shellfish to accumulate biotoxins in their flesh. Routine testing is carried out to monitor biotoxin levels and once they exceed permitted values shellfish beds are closed (statutory or voluntary) and stock can no longer be harvested or offered for sale. The beds remain closed until two consecutive samples return values below the threshold levels. Such closures can adversely affect a business so this factor should be considered when selecting a site. Unfortunately, past track record (where available) can only offer limited guidance, it can not guarantee that a problem will not occur in the future.

Site access and ownership

Any cultivation site should be readily accessible for bringing gear on to the site and for transporting harvested clams away to market. Ownership of the area and its availability are important considerations in the initial site selection.

Many shellfish cultivation operations directly co-exist beside and even within designated environmentally sensitive areas including statutory sites such as Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs), Special Protected Areas (SPAs) and Ramsar sites, as well as local voluntary sites. It is the co-existence with such sites that industry operations possibly face the greatest challenge. The Habitats Directive 92/43/EEC and the Birds Directive 79/409/EEC make provision for the conservation of wildlife habitats and of birds through the designation of SACs and SPAs respectively. Designated areas can, and are encouraged, to include estuaries, shallow bays and coastal waters. Within such areas, cultivation practices are likely to be subject to local management plans.

As legislation on these and other aspects can be changed, it is wise to consult the appropriate regulating bodies for the most recent information.

Classifications

Water quality - bacteria and viruses

Mussels can thrive in more turbid environments than some other bivalve species because they can preferentially select organic material from suspended particulates in the water. Like other bivalve molluscs, the mussel is a filter feeder removing natural phytoplankton (microscopic algae) and organic detritus from the sea water. They also take in other small particles, such as organic detritus, bacteria and viruses. Some of these bacteria and viruses, especially those originating from man-made sources, can cause illnesses in consumers if they remain in the bivalve when it is eaten.

Shellfish beds are classified according to the faecal coliform (or *Escherichia coli*) levels recorded in the bivalve flesh and the animals are treated, where appropriate, to remove this contamination. Grounds which are close to, or likely to be affected by the flow from, outfalls discharging significant amounts of untreated effluent or sewage are generally not suitable for shellfish production as they are likely to give a 'C' or 'Prohibited' classification and they should be avoided. Consult your local Environmental or Port Health Authority if in any doubt. While it is possible to relay mussels from an area with a 'C' classification to cleaner areas this is unlikely to be economically viable, even if such grounds are available.

Press the button to see the classification table

Shellfish Waters Classifications

As of Sep 2002 – users of the Hyperbook are urged to contact the relevant authority in order to update this information

Classifications of shellfish harvesting areas under the Shellfish Hygiene Directive 91/492/EEC

Classification	Treatment required
A	Shellfish can go direct for human consumption.
B	Shellfish can go for human consumption after purification in an approved plant, or after an EU approved heat treatment process, or after relaying in an approved relaying area (whether or not combined with purification).
C	Shellfish can go for human consumption only after relaying for at least 2 months in an approved relaying area followed, where necessary by treatment in a purification centre or after an EU approved heat treatment process.
Prohibited (D)	Shellfish from these areas must not be subject to production or be collected.

Correct at Sep 2002 – see DEFRA or CEFAS websites for any updates

LEGAL AND ADMINISTRATIVE ISSUES

Introduction

To set up a suspended mussel operation, the minimum a grower needs is to own or lease an area of the seabed and have the right of access to that site. There are national and local variations to legislation on this, therefore it is always advisable to contact the Local and Regional Authorities in the first instance. In England and Wales the regional Sea Fisheries Committee may also be able to offer advice. If structures are to be placed in the sea, they may be hazardous to navigation so the Harbour Authority and/or Maritime & Coastguard Agency should be notified.

Many areas of the coastal zone have been designated for their conservation value so it is also advisable to contact the appropriate conservation agency. These are English Nature; Countryside Council for Wales; Scottish Natural Heritage; Environment and Heritage Service (Northern Ireland).

Legislative Controls - 1

There are various regulations specific to shellfish farming that must be followed when cultivating mussels. These are summarised below, with links to pages with further information.

1. A shellfish farmer must *register* a farm. This should usually be done within two months of commencing operation.

2. The shellfish area must be *classified* for hygiene purposes.

3. Samples may be collected for monitoring of *algal toxins*.

4. *Movements* of shellfish, including *imports and exports*, may be controlled

Legislative Controls - 2

1. Registration

The Fish Farming and Shellfish Farming Business Order, 1985 (or equivalent legislation) obliges a shellfish farmer to register his or her business with the Department for the Environment, Food and Rural Affairs, the Welsh Assembly Government, or the Scottish Executive. The Fish Culture Licence fulfils a similar function for the Department of Agriculture and Rural Development in Northern Ireland.

The purpose of registration is to assist the departments in dealing with outbreaks of disease if these should occur. Registered businesses are required to keep a record of the stock movements on and off site and to submit a simple summary of movements each year.

It is necessary to register the shellfish farm within two months of commencing operations.

Legislative Controls - 3

1. Registration - continued

Applications for registration are made to:

In England and Wales:
The Fish Health Inspectorate, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, England, DT4 8UB
Tel: 01305 20 6673 / 6674
Fax: 01305 206602
E-mail: Fish.Health.Inspectorate@cefas.co.uk

In Scotland:
Fisheries Research Services, Marine Labroatory, PO BOX 101, Victoria Road, Aberdeen, AB11 9DB
Tel: 01224 295645
Fax: 01224 295620
E-mail: fishhealth@marlab.ac.uk

In Northern Ireland:
Department of Agriculture and Rural Development, Fisheries Division, Annex 5, Castle Grounds, Stormont, Belfast. BT4 3PW
Tel: 028 9052 0100
Fax: 028 9052 3121

Further information on shellfish farm registration can be found on:
http://www.cefas.co.uk/fhi/farm%20registration.htm

2. Harvesting Area Classification

It is a statutory requirement [Food Safety (Live Bivalve Molluscs and Other Shellfish) Regulations, 1992] that shellfish beds must be classified according to the faecal coliform (or *Escherichia coli*) levels of the bivalve flesh. Treatment of shellfish before marketing is dependent on that classification. In harvesting areas with a 'B' classification the shellfish must be purified of any faecal bacterial content in cleansing (depuration) tanks before sale for consumption.

The local Environmental Health Department (EHD) or Port Health Authority (PHA) may be able to provide you with information on shellfish hygiene and water classifications if the site is already a shellfish harvesting area.

New sites must be graded. You should collect samples of mussels from your selected area or place shellfish (contained in a tray) in the area for testing. If the EHD/PHA can be involved and the sampling is done every 2 weeks for 3 to 4 months according to strict protocols it may be possible to get a provisional classification almost immediately thereafter. If the sampling is done independently, the results will not count towards a provisional classification. Full classification may be achieved after a year of continuing sampling at monthly intervals. It may be possible to shorten the sampling period if additional information is available for the same species on nearby beds, from other species in the same area, of from historical monitoring.

Legislative Controls - 5

3. Algal toxins

The risks to consumers from shellfish poisoning due to the presence of algal toxins in the tissues are minimised by a statutory requirement for sampling. The monitoring programme for algal biotoxins is a requirement of the Shellfish Hygiene Directive 91/492/EEC, which is implemented in the UK by the Food Safety (Fishery Products and Live Shellfish Hygiene) Regulations 1998 as amended. The monitoring programmes are undertaken on behalf of the Food Standards Agency (FSA), FSA (Scotland) and FSA (Northern Ireland). You may be required to provide samples. If the amount of toxin exceeds a certain threshold, the collection of shellfish for consumption is prohibited until the amount falls to a safe level, giving a temporary closure of the fishery. Sampling frequency is increased if toxins are detected. Samples of seawater from selected sites are also examined routinely for the presence of the phytoplankton species that produce these toxins, as an early warning system.

Further information on the algal toxin monitoring programme, together with a list of the areas currently affected can be found on the following link:
http://www.foodstandards.gov.uk/foodindustry/shellfish/algaltoxin/

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

Press the button to see the toxins table

Algal toxins - Action limits and maximum permitted levels

As of Sep 2002 – users of the Hyperbook are urged to contact the relevant authority in order to update this information

WATER		SHELLFISH FLESH	
ALGAL GROUP	Action Limit (cells/l)	TOXIN	Maximum Permitted Levels
Alexandrium Spp.	Presence	PSP	80 µg per 100 g
Dinopysis / *Procentrum* Spp.	100	DSP	Presence
Pseudonitzschia Spp.	150 000	ASP	20 µg per g

Correct at Sep 2002 – see DEFRA or CEFAS websites for any updates

Legislative Controls - 6

4. Movement controls

There are certain restrictions on the deposit of bivalve molluscs around the coast of Great Britain, to prevent the introduction and spread of diseases.

The UK has now achieved Approved Zone status for most of the coastline for the oyster diseases Marteilia and Bonamia, except for three restricted areas where Bonamia is found. These areas are (1) from the Lizard to Start Point; (2) from Portland Bill to Selsey Bill and (3) from Shoeburyness to Felixstowe (Commission Decision 2002/300/EC of 18 April 2002).

Movements of mussels within the UK are controlled according to the health status of these areas. Anyone wishing to collect or relay seed taken from the controlled (restricted) areas listed above must apply for permission to the Fish Health Inspectorate (FHI) at the CEFAS Weymouth Laboratory (for England and Wales) or the Fisheries Research Services (FRS) at the Marine Laboratory, Aberdeen (in Scotland). It is advisable to check with DARD for the current position within Northern Ireland.

Approved zone status also enables the UK to operate import controls.

4a. Import and export controls

EU Imports

Import controls are aimed at preventing the introduction of shellfish diseases from elsewhere in the EU, where they are known to occur, or where no sampling and testing is carried out. Imports for the purpose of deposit into coastal waters are subject to controls based on the health status of shellfish growing areas in the region of origin. Each import must be accompanied by a *Movement Document* signed by the competent Veterinary Authority in the Member State of origin. The FHI (for England and Wales), FRS (for Scotland) and DARD (Northern Ireland) are responsible for ensuring that any shellfish imports are made in accordance with these rules. They should be consulted well in advance of any intended import if there is any doubt. In any case, at least 24 h notice is required before the arrival of any consignment.

Other imports

Musels from non-EU countries may only be deposited within the EU waters so long as they are certified free from disease by a testing programme as stringent as that which applies in the EU and comply with the other conditions of import. The FHI, FRS or DARD will have the latest information.

4a. Import and export controls - continued

Exports

If you wish to export mussels to another EU country you should contact the FHI, FRS or DARD to discuss what documents, if any, are required. Five working days notice is needed so that the documents can be produced by the intended export date. Anyone intending to export mussels to countries outside the EU should check the requirements of the destination country. If any health certification requirements exist you should contact the FHI, FRS or DARD to establish whether they can be met.

Further more detailed information on movements, imports and exports (in relation to disease control) can be found on:
http://www.cefas.co.uk/fhi/movements.htm#Shellfish

Rights of shellfish cultivators in the sea

At present, the cultivator has limited legal protection of the stock. Bivalves grown in containers, e.g. pearl or lantern nets, in public waters are protected by the *Theft Act, 1968* and the *Criminal Damage Act, 1971* (or equivalent legislation in Scotland and Northern Ireland).

Shellfish beds covered by private right of fishery or by Several Order are protected against theft or damage by the provision of *Section 7* of the *Sea Fisheries (Shellfish) Act, 1967* (or Northern Irish equivalent), provided that the beds are adequately marked.

Several Orders

A cultivator who wants to have additional protection for stock kept in public waters may apply for a right of Several fishery. These are granted in England by the Department for the Environment, Food and Rural Affairs, and in Wales and Scotland by the fisheries departments of the respective devolved governments. In Northern Ireland, the Shellfish Fishery Licence fulfils a similar function. They are granted for a fixed period, to an individual, a co-operative, or a responsible body, to enable the grantee to cultivate the sea bed within a designated area of water and to conserve, develop and enhance the specified stocks of shellfish thereon. The Several fishery concept is designed to give the lessee a much greater management control of the stocks. Several rights may also be granted to a Sea Fisheries Committee, which cannot cultivate stocks in its own right but may lease rights of Several fishery. The applicant must provide a management plan, and this must show that the fishery will benefit from cultivation. The Several fishery rights may be terminated if the grantee fails to meet the terms of the order.

Application for and granting of a Several fishery right can be a time-consuming process, which may take up to 3 years. If there are any objections to the application then this can force a public enquiry, the cost of which falls to the applicant. Subletting from a Several Order that is held by a Sea Fisheries Committee is often easier, where this is an option. However, areas already covered by Several Orders may only be suitable for cultivation of certain species of bivalve.

Guidance notes on applying for a Several Fishery (for England and Wales, but general principals apply elsewhere) can be found on:
http://www.defra.gov.uk/corporate/regulat/forms/fish/Fis3.pdf

Planning issues - 1

A focus on the the main agencies involved in the approval of an application for a new aquaculture site is provided in this section . Once an application has been granted, and aquaculture operations commence, the number of regulators with a significant ongoing operational concern reduces.

For a bivalve aquaculture site application, the following decision making bodies are involved:

- The Crown Estate (CEC). Effectively the "landlord" in terms of ownership of the seabed, the Crown grants a lease and issues development consent to the operator, and levies a "rent" which is based upon tonnage of production
- Local Authorities. Considers applications and issues opinions to the Crown (within England, Wales and Scotland and will eventually be the lead body in this regard). Also provide planning permission for any on-shore facilities
- Department of Agriculture and Rural Development (Northern Ireland) Administers all aspects of marine aquaculture applications in Northern Ireland.
- Foyle, Calingford and Irish Lights Commission For those waters in Northern Ireland
- National fishery advisory bodies- CEFAS and SEERAD
- Health and Safety Executive. Concerned with health and safety

Planning issues - 2

In addition, there are statutory consultees, who will pass their views on the local authority for consideration:

- Statutory Conservation Agencies- EN, CCW, SNH, EHS(NI). Have an interest in the natural environment
- Statutory Environmental Protection Agencies - EPA, SEPA etc. As above

Other groups and individual also have an opportunity to comment upon aquaculture applications:

- Maritime and Coastguard Agency
- Northern Lighthouse Board
- Local communities
- Private individuals
- Other groups e.g. FOE, WWF, RSPB, RYA, moorings associations etc

Once fish farms are up and running, they have to be concerned with ongoing interaction with some of the groups above - and with others such as:

- Food Standards Agency (FSA)
- Environmental Health Offices (EHO's)

Use of Divers

When divers are engaged in harvesting or other work all diving operations must be carried out in accordance with the relevant national legislation (Health and Safety at Work Act 1974 and Diving at Work Regulations 1997 or subsequent revisions) and the most appropriate Approved Code of Practice (ACoP). Depending upon the work to be undertaken this may be that for 'Commercial Shellfish Diving in Inshore Waters' or that for 'Commercial diving projects inland/inshore'. Compliance is checked by the Diving Inspectorate of the Health and Safety Executive (HSE)

Particular attention should be paid to preparation of the dive plan and risk assessment which, in turn, will indicate the minimum number of persons (usually 4) required in the dive team for the particular operation. Failure to fulfil these requirements is the most common complaint made by the HSE against those involved in shellfish diving. This can result in prosecution and those who contract-in divers are equally liable in these circumstances.

Useful Internet Links

Before proceeding any further with this Hyperbook, you could quickly review the current position of various organisations *vis-a-vis* aquaculture (*click on the blue buttons, and "close" your browser to return to this page*):

- **The Crown Estate (CEC)**
- **The Scottish Environmental Protection Agency (SEPA)**
- **Scottish Executive Environment and Rural Affairs Department (SEERAD)**
  - **Fisheries Research Service (FRS)**
- **Scottish Natural Heritage (SNH)**
- **Maritime and Coastguard Agency(MCA)**
- **Northern Lighthouse Board**
- **Health and Safety Executive (HSE)**
- **Food Standards Agency (FSA)**
  - **Specifically: for algal toxins**

Note that you should be "on-line" during this part of the Hyperbook session, if you want these internet links to function automatically. You may have to do some searching within each organisation's website to find material relevant to aquaculture - use their search engines and common sense about their site maps.

Useful Internet Links - Continued

Before proceeding any further with this Hyperbook, you could quickly review the current position of various organisations *vis-a-vis* aquaculture (*click on the blue buttons, and "exit" your browser to return to this page*):

- **The Centre for Environment, Fisheries and Aquaculture Science (CEFAS)**

DEFRA Specifically:

guidance notes on licences for dredging for mussel seed - www.defra.gov.uk/corporate/regulat/forms/fish

guidance notes on Several Orders - www.defra.gov.uk/corporate/regulat/forms/fish/Fis3.pdf

general information on aquaculture - www.defra.gov.uk/fish/aquacult.htm

Note that you should be "on-line" during this part of the Hyperbook session, if you want these internet links to function automatically. You may have to do some searching within each organisation's website to find material relevant to aquaculture - use their search engines and common sense about their site maps.

SUPPLIERS

Introduction

This section of the Hyperbook covers suppliers to the industry who might be able to support suspended mussel cultivation operations. The list is not exhaustive, nor does inclusion within the list denote any particular endorsement of the company in question by Seafish or Epsilon Aquaculture Ltd. Wherever possible the supplier's website address is the main reference - readers can access these sites directly from this Hyperbook if they are "on line" during the Hyperbook session.

This list includes only some of the companies that supply to the aquaculture industry. Reference to these companies should not be construed as an official endorsement of these companies, nor is any criticism implied of similar companies that have not been mentioned.

Suppliers of aquaculture equipment can be found advertising in the trade papers and journals. The annual 'Fish Industry Yearbook' contains an aquaculture supplier section. Suppliers can also be contacted at conferences and trade exhibitions, such as the biannual Aquaculture International exhibition in Glasgow.

Suppliers are broadly grouped into:

- **Hardware suppliers (equipment)**
- **Services suppliers (advisors, utilities, financial)**

Hardware Suppliers

General

•Gael Force Marine, 136 Anderson Street, Thornbush, Inverness. IV3 8DH Tel: 01463 229400 Fax: 01463 229421 E-mail: sales@gaelforce.net

Complete systems

•Muckairn Mussels, West Cottage, Achnacloich, by Oban. Argyll. PA37 1PR Tel: 01631 710653 Fax: 01631 710748

•Xplora, Unit 2, Greenelms Trading Estate, Grays Road, Uddingston, Glasgow. G71 7ET Tel: 01698 818842 Fax: 01688 818032 E-mail: aqua@xploraproducts.com Web: www.xploraproducts.com

Boats

•Alexander Noble & Sons, Girvan, Ayrshire. KA26 9HL Tel: 01465 712223 Fax: 01465 715089 E-mail: nobel@boatbuilders.fsbusiness.co.uk

•Alnmaritec, Willowburn Industrial estate, Alnwick, Northumberland. NE66 2PQ. Tel: 01665 602917 Fax: 01665 605399 E-mail: sales@alnmaritec.demon.co.uk Web: www.alnmaritec.demon.co.uk

•Bow & Stern, Unit 7B4, Industrial Estate, Lisigary, Portree, Skye. IV51 9HD Tel/Fax: 01478 613334

•Malakoff & Wm Moore, North Ness, Lerwick. Shetland. ZE1 0LZ Tel: 01595 695544 Fax: 01595 695720 E-mail: enquiries@malakoff-moore.co.uk Web: www.malakoff-moore.co.uk

•Wood & Davidson, North Esplanade East, Aberdeen. AB11 5FR Tel: 01224 581221 Fax: 01224 584007 E-mail: info@wood-davidson.co.uk

•Corpach Boatbuilding Company, The Slipway, Annat Point, Corpach, Fort William. PH33 7NN Tel: 01397 772861 Fax: 01397 772765

Suppliers

Hardware Suppliers - continued

Longline Floats

• C G Paxton, 28 Carmyle Avenue, Glasgow. G32 8HF Tel: 0141 778 8676 Fax: 0141 778 3708 E-mail: mail@paxton.co.uk Web: www.paxton.co.uk

•Viking Ecosse, 4 Braeside, Irvine. KA11 1BX Tel: 01294 213716 Fax: 01294 212604 E-mail: vikingecosse@ndirect.co.uk Web: www.vikingecosse.ndiresct.co.uk

•Gem Plastics, Regaskin, Cavan, Co Cavan, Ireland. Tel: ++ 353 49 4331077 Fax: ++ 353 49 4361157 E-mail: sales@gemplastics.ie Web: www.gemplastics.net

•Xplora (see complete systems)

Rafts

•Muckairn mussels (see complete systems)

•Kames Fish Farming Equipment, Kilmelford, by Oban. Argyll. PA34 4XA Tel: 01852 200286 Fax: 01852 200312 E-mail: fish@kames.co.uk

•Viking Ecosse (see floats)

Head ropes

•Gael Force Marine (see general)

•Marlow Ropes, Diplocks Way, Hailsham, East Sussex. BN27 3JS Tel: 01323 2 847234 Fax: 01323 440093

Moorings

•F P M Henderson, Unit 27B, Whiteinch Business Centre, Jordan Street, Glasgow. G14 0RR Tel: 0141 950 1800 Fax: 0141 950 1777

•Gael Force Marine (see general)

•E Y E Co, The Gunshed, Levington, Ipswich. IP10 0LX Tel: 01473 659666 Fax: 01473 659995 E-mail: info@eyecochain.com Web: www.eyecochain.com

Suppliers

Hardware Suppliers - continued

Production ropes, socking, mesh, pegs

- J J Chicolino SL, Vilarino, s/n 15930, Boiro, La Coruna, Spain. Tel: ++ 34 981 84 99 00 Fax: ++ 34 981 84 57 00 E-mail: chico@chicolino.com Web: www.chicolino.com
- Murphy & O'Conner, The Quay, Bantry, Co Cork. Ireland. Tel: ++ 353 27 50024 Fax: ++ 353 27 50120
- Titterington Associates, (John Milner), Thaxton Barn, Quarmby Fold, Huddersfield. Yorkshire. HD3 4YT Tel: 01484 654625 E-mail: johnandpatsy.milner@virgin.net
- Intermas Nets SA, Ronda de Collsabadell 11, Poligono Industrial, 08450 Llinars del Valles, Barcelona. Spain. Tel: ++ 34 938 425 700 Fax: ++ 34 938 425 701 E-mail: info@intermas.com Web: www.intermas.com
- All in a Shell, Dooniskey, Lissarda, Co Cork, Ireland. Tel: ++ 353 26 42267 Fax: ++ 353 26 42645 E-mail: allinashell@tinet.ie
- Tilldenet, Hartcliffe Way, Bristol. BS3 5RJ. Tel: 0117 966 9684 Fax: 0117 923 1251 E-mail: enquiries@tildenet.co.uk Web: www.tildenet.co.uk

Mussel rope discs

- J Buchan Marine and Offshore Equipment, Reisk, Crimond, Fraserburgh. AB43 8QJ Tel: 01346 532119 Fax: 01346 532826
- Penn Cove Shellfish, PO Box 148, USA-98239 Coupeville, WA, USA. Tel: ++ 1 360 6784803 Fax: ++ 1 360 6780266 E-mail: shellfish@whidbey

Handling, declumping, grading, washing, retubing, packaging machinery

- J J Chicolino (see production ropes etc)
- Cochon, BP2, 17600 Le Gau. France. Tel: ++ 33 546 228214 Fax: ++ 33 546 228719
- Talleres Aguin SL, Ardia 178, O Grove, 36989 Pontevedra. Spain. Tel: ++ 34 986 731091 Fax: ++ 34 986 731380
- Norfab Products, Unit 17, Ben Nevis Industrial Estate, Fort William. PH33 6RU. Tel; 01397 703752 Fax: 01397 705977 E-mail: sales@norfab.co.uk Web: www.norfab.co..uk
- All in a Shell (see production ropes etc)

Suppliers

Hardware Suppliers - continued

Bulk handling containers

•Paxton (see floats)

•Mailbox International, Bayley Street, Stalybridge. Cheshire. SK15 1QQ Tel: 0161 330 5577 Fax: 0161 330 5576

Depuration systems

•Tropical Marine Centre, Solesbridge Lane, Chorleywood, Hertfordshire. WD3 5SX Tel: 01923 284151 Fax: 01923 285840 E-mail: tmc@tms-ltd.co.uk Web: www.tmc-ltd.co.uk

•Depur, Moneycarragh Fish Farm, 60 Dromara Road, Dundrum, Newcastle. Co Down. BT33 0NS Tel: 028 437 51860 Fax: 028 437 51940

•Shellfish Purification Systems, Unit 9, Tregoniggie Industrial Estate, Falmouth. Cornwall. TR11 4SN Tel: 01326 374748 Fax: 01326 377688

Website with a comprehensive page of links to other suppliers sites

•Web: www.stir.ac.uk/departments/naturalsciences/Aquaculture/fishing/fish/f_web.htm

Hardware Suppliers - continued

Clothing and safety

•ARCO, *for nearest regional supply centre contact:* Tel: 01482 222522 Fax: 01482 218536 E-mail: sales@arco.co.uk

•Gael Force Marine (see general)

•Crewsaver, Mumby Road, Gosport. PO12 1AQ Tel: 02392 528621 Fax: 02392 510905

•Cosalt (Scotland), Unit 1 & 2, Kessock Road Industrial Estate, Fraserburgh. AB43 5UE Tel: 01346 513721 Fax: 01346 515158

•Mullion Manufacturing, 44 North Farm Road,South Park Industrial Estate, Scunthorpe. DN17 2AY Tel: 01724 280077 Fax: 01724 280146

•Guy Cotton, BP538 29185 Concarneau Cedex, France. Tel: ++ 33 02 98 97 66 79 Fax: ++ 33 02 98 50 23 62 E-mail: info@guycotton.com Web: www.guy.cotton.com

•McMurdo, Silver Piont, Airport Service Road, Portsmouth. PO3 5PB Tel: 023 9262 3900 Fax: 023 9262 3998 Web: www.pwss.com Web: www.mcmurdo.co.uk

Navigation buoys and lights

•Hydrospehere UK, Units C&D, West End Centre, Colthouse Lane, Upper Froyle. Hampshire. GU34 4JR Tel: 01420 520374 Fax: 01420 520373 E-mail: sales@hydrosphere.co.uk Web: www.hydrosphere.co.uk

•Gael Force Marine (see general)

•EYE Co (see moorings)

Services Suppliers

Insurance

Aquaculture Risk(Management) Ltd., The Esplanade, Sunderland, SR2 7BQ. (Tel: 0191 5682000; Fax: 0191 5658625).

Aquarius Underwriting Agencies Ltd., 60 Mark Lane, London, EC3R 7ND.

Trade Associations

Association of Scottish Shellfish Growers (ASSG): Doug McLeod (Chairman), Mountview, Ardvasar, Isle of Skye, IV45 8RU. (Tel: 01481 844324; e-mail: DouglasMcLeod@aol.com).

Shellfish Association of Great Britain, (SAGB), Fishmonger's Hall, London Bridge, London, EC4R 9EL. (Tel: 0207 283 8305; www.shellfish.org)

Training

Scottish Aquaculture Training Association, Mountview, Ardvasar. Skye. IV45 8RU Tel/Fax: 01471 844324 E-mail: DouglasMcleod@cs.com

North Atlantic Fisheries College (see information next page)

Scottish Association for Marine Science (see information next page)

Inverness College, 3 Longman Road, Longman South, Inverness. IV1 1SA Tel: 01463 273000 Fax: 01463 273001 E-mail: admissions.officer@inverness.uhi.ac.uk Web: www.uhi.ac.uk/inverness

Services Suppliers - Continued

Information, technical advice etc

Sea Fish Industry Authority, Aquaculture Development Service, Marine Farming Unit, Ardtoe, Acharacle. Argyll. PH36 4LD Tel: 01397 875000 Fax: 01397 875001 E-mail: aquaculture@seafish.co.uk Web: www.seafish.co.uk

Sea Fish Industry Authority, Technology Division, Seafish House, St Andrew's Dock, Hull. HU3 4QS Tel: 01482 327837 Fax: 01482 223310 E-mail: technology@seafish.co.uk Web: www.seafish.co.uk

C-Mar, Centre for Marine Resources and Mariculture, Marine Biology Station. The Strand, Portaferry. Co Down. BT22 1PF Tel: 028 4272 9648 Fax: 028 4272 9672 or 8902

Cross-boarder Aquaculture Initiative Team, Unit 14-15, Gray's Lane, Park Street, Dundalk, Co Louth. Ireland. Tel: ++ 353 42 9385074 Fax: ++ 353 42 9352490 E-mail: cbait@oceanfree.net

North Atlantic Fisheries College, Port Arthur, Scalloway. Shetalnd. ZE1 0UN Tel: 01595 772000 Fax: 01595 772001 E-mail: admin@nafc.ac.uk Web: www.nafc.ac.uk

Scottish Association for Marine Science, Dunstaffnage Marine Laboratory, Oban. Argyll. PA34 4AD Tel: 01631 559000 Fax: 01631 559001 E-mail: marine.science@dml.ac.uk Web: www.sams.ac.uk

Marketing Associations

Scottish Shellfish Marketing Group, Suite 3, Block 20, The Motherwell Food Park, Bellshill. Lanarkshire. ML4 3NP Tel: 01698 844221 Fax; 01698 841723 E-mail: sales@ssmg.demon.co.uk Web: www.scottishshellfish.co.uk

Services Suppliers - Continued

Government Departments

Scottish Executive Environment and Rural Affairs Department, Fisheries Research Service, Marine Laboratory, PO box 101, Victoria Road, Aberdeen. AB11 9DB. Tel: 01224 876544 Fax: 01224 295511

Department of Agriculture and Rural Development, Fisheries Division, Annex 5, Castle Grounds, Stormont Estate, Belfast. BT4 3PW Tel: 028 9052 0100 Fax: 028 9052 3121 Web: www.dardni.gov.uk

National Assembly for Wales, Agriculture Department, Fisheries Division, New Crown Buildings, Cathays Park, Cardiff. CF10 3NQ Tel: 029 2082 5111 Fax: 029 2082 3562

Department for Environment, Food and Rural Affairs, Centre for Environment, Fisheries and Aquaculture Science, Weymouth Laboratory, Barrack Road, The Nothe, Weymouth. Dorset. DT4 8UB Tel: 01305 206600 Fax: 01305 206601 Web: www.cefas.co.uk

Development agencies

For access to a network of local development agencies in Scotland contact:

Highlands & Islands Enterprise, Cowan House, Inverness Retail & Business Park, Inverness. IV2 7GF Tel: 01463 234171 Fax: 01463 244469 E-mail: hie.general@hient.co.uk Web: www.hie.co.uk

Scottish Enterprise, 150 Broomielaw, Atlantic Quay, Glasgow G2 8LU Tel: 0141 248 2700 Fax: 0141 221 3217 Web: www.scottish-enterprise.com

For Northern Ireland:

Department of Agriculture and Rural Development, Northern Ireland (DARDNI) (see government departments)

For Wales:

Welsh Development Agency, Principality House, The Friary, Cardiff. CF10 3FE Tel: 08457 775577 Fax: 01443 845589

Additional local or regional development initiatives may be operational in your area. To check the current position consult the agencies above or local council development departments. Organisations providing technical advice and support may also be able to advise (see Information etc).

BUSINESS PLANNING

Introduction

This section of the Hyperbook covers the development of business plans to support mussel cultivation. The section will provide an overview of business planning, but mainly includes the Suspended Mussel Economic Model - a Microsoft Excel-based planning tool. The overview and the model must be seen as a starting point only - they do not replace the need for professional technical and financial planning, but might assist that process.

Seafish and Epsilon Aquaculture Ltd can take no responsibility for any business decision based upon this section (or other sections) of the Hyperbook, and readers are urged to seek professional and experienced assistance if they wish to proceed towards investment in this sector of aquaculture.

However, readers who are investigating initial scenarios within this sector might find the economic modelling tools within this section useful - they may serve to “scope” discussions with other professional advisors or suppliers.

General Principles

Readers should be clear at this point what their purpose is:

- To simply use this Hyperbook in order to improve their general understanding of mussel cultivation
- To use this Hyperbook to inform them about other people's plans concerning mussel cultivation
- To use this Hyperbook to help them plan an expansion or diversification of their existing business
- To use this Hyperbook to help them plan a new mussel cultivation project

Products which might arise from use of this Hyperbook will depend upon the purpose - but there are certain basic truisms about cultivation of any aquaculture species:

- Aquaculture is a business - it needs to make sufficient profit to continue to develop and to repay its shareholders or investors
- Any successful business needs a good initial plan - and whilst the reality of operations might diverge from that plan, a good business will continually review those operations in the context of the initial plan
- Aquaculture is considered to be a "high risk" business in financial terms - and the history of the spectacular failures within the industry over the last three decades confirm that judgement
- An aquaculture business plan needs to be robust:
    - any technical uncertainties must be highlighted and numerically quanitified
    - a realistic view of the short, medium and long term market prospects must be taken
    - the Management Team must demonstrate capability to carry the plan to fruition
- Raising new finance for aquaculture is not easy. The sector's profitability potential normally falls below the criteria for true Venture Capital, and therefore requires more conventional bank finance - which means the provision of full security for any debt capital. Aquaculture is probably more readily financed from industrial sectors (either other aquaculture or related businesses) than from any other source.

Readers are urged to contact their Local Enterprise company, a qualified consultant or their financial advisor for guidance in business plan preparation

ECONOMIC MODELS

The core Economic Model for Suspended Mussel Cultivation is contained within your SUSPENDED HYPERBOOK Folder. Access the READ ME FIRST file once again, just to remind yourself how to use the model.