EPSILON
AQUACULTURE LIMITED

SEAFISH

The Scallop Hyperbook®

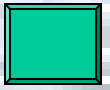
Just press "Esc" on your keyboard at any time if you want to leave this Hyperbook show

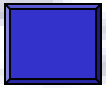
PRESS FOR NEXT PAGE

HOW TO USE THIS HYPERBOOK

Navigating around this Hyperbook is easy:

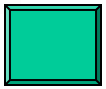
- **If you just want to proceed to the next page (or backwards), simply "left click" on the appropriate arrow key at the foor of each page (a pointing finger symbol will appear)**
- **If you want to use a "hyperlink" to jump to another part of the book, position your cursor over the appropriate button or text (a pointing finger symbol will appear), and left click**

- **You can practice this here** 

- **Try clicking on this button** 

- **When you are ready, proceed to the Main Menu page (click on this button)**

You have completed your first “hyper-jump”

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 scallop cultivation
- The markets
- The production process
- The technologies and equipment employed
- Site selection
- Legal and administrative issues
- Suppliers
- Business planning

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 SCALLOP CULTIVATION

King scallop Courtesy C Burton

Queen scallop Courtesy C Burton

King scallops (scientific name = *Pecten maximus*) and queen scallops (scientific name = *Aequipecten opercularis*) are the two species cultivated in the UK. They are mainly found at depths of 18-46 m, preferring substrates of clean firm sand, fine gravel or sandy gravel. King scallops recess into the sediment to a level with the upper shell; sometimes they are partially covered. Queen scallops are found in similar sediments although they can also go on to firmer ground because they do not recess.

INTRODUCTION TO SCALLOP CULTIVATION - Continued

GLOBAL HISTORY

As early as 1934, scallop larvae were collected on scallop shells hung from rafts in Japan. The juveniles (spat) were later released onto favourable rearing grounds. By 1941, this was being carried out commercially. However, bottom conditions during summer in Japan can be unfavourable, sometimes resulting in mortality rates above 99%. This problem soon stimulated a trend toward extending the suspended culture phase for longer periods of time. By the late 1950s, collected larvae were routinely reared in hanging cages or holding ponds until the scallops exceeded 3 cm shell length (after about seven months) and were then released. Subsequently, increasing quantities of scallops were raised to market size in aquaculture systems. Although successful hatchery-spawning techniques have been developed for the species in question *(Patinopecten yessoensis)*, the dependable and abundant set in certain bays has so far precluded the necessity for hatchery seed production in Japan.

Later studies in the Irish Sea found that collectors essentially identical to those developed by the Japanese were suitable for king and queen scallops.

INTRODUCTION TO SCALLOP CULTIVATION - Continued

Like other bivalve molluscs, scallops 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.

A filtering scallop

Courtesy C Burton

INTRODUCTION TO SCALLOP CULTIVATION - Continued

Most of the UK cultivation of scallops takes place along the west coast of Scotland although there is an increasing interest in cultivating King scallops in England and Wales. Sites should be located in sheltered bays and lochs.

Scallops on the seabed

Courtesy C Burton

THE MARKETS FOR SCALLOPS

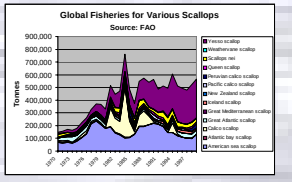
The global and regional "market" for scallops is presently defined by the availability of supply from the wild fishery plus the cultivation sector.

COMBINED SUPPLY - GLOBAL

The combined total of wild and cultivated scallops was almost 1.5 million tonnes in 1999.

WILD SUPPLY - GLOBAL

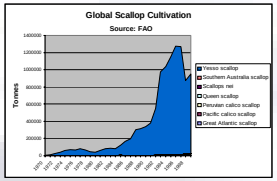
The world total wild-caught supply of one species or other of scallops was 567,000 tonnes in 1999. Note the fairly stable recent supply



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

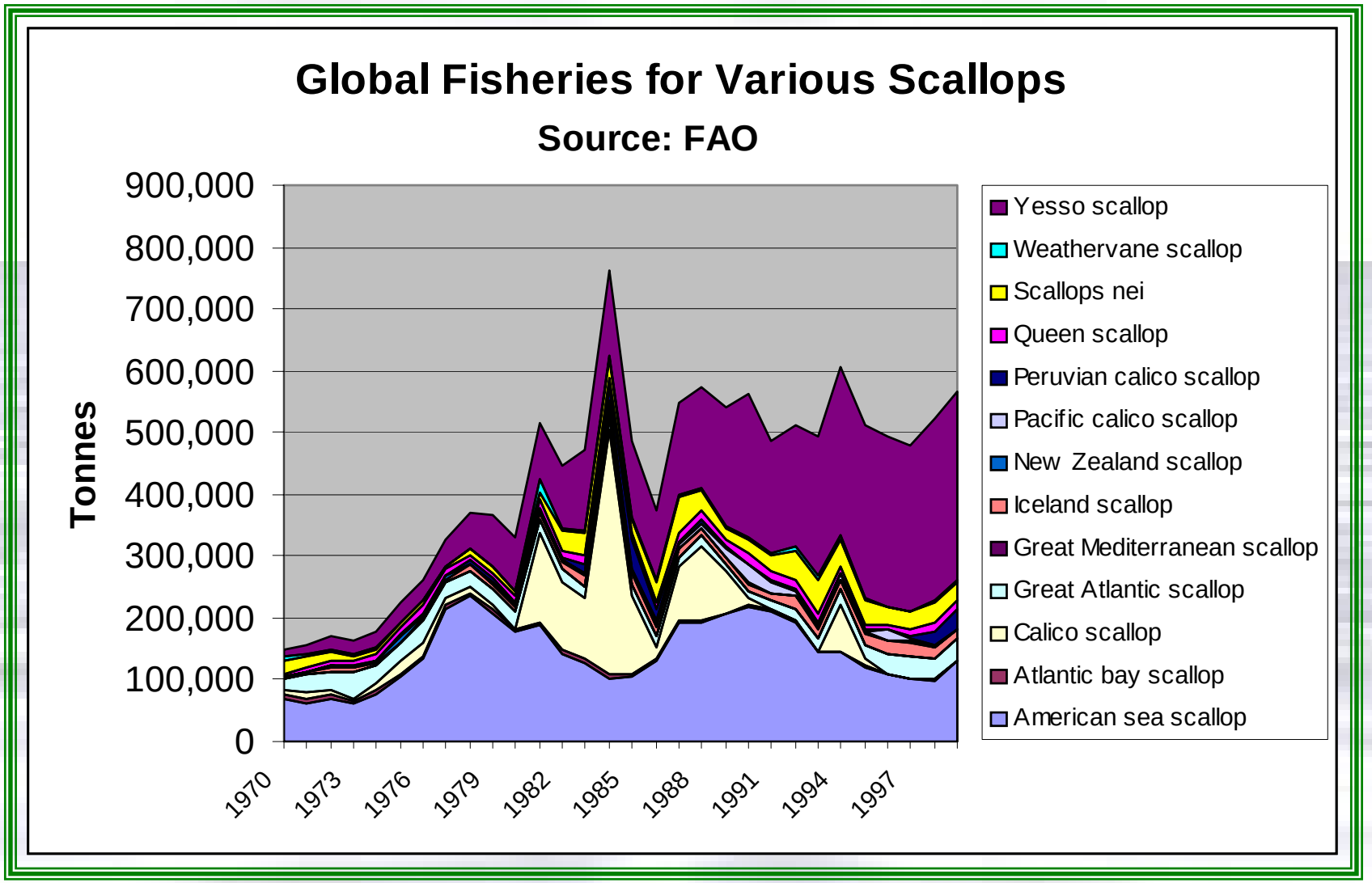
CULTIVATED SUPPLY - GLOBAL

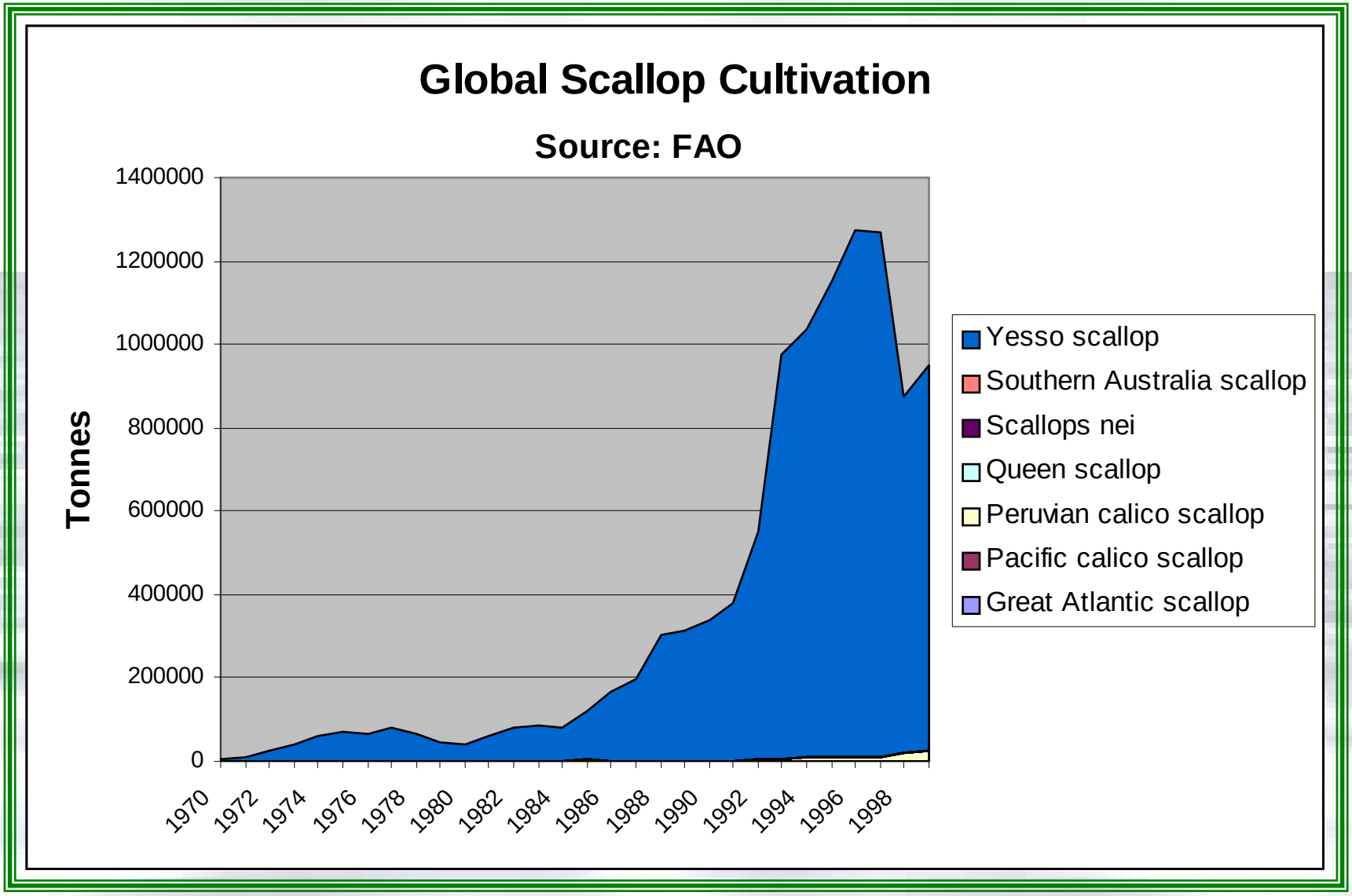
Cultivated scallop production has grown significantly over the last two decades - 950,000 tonnes in 1999. It is mainly one species that is produced - the Yesso scallop (*P. yessoensis*). Cultivated world production is dominated by China (76%), Japan (22%) and Chile (2%).



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

Note: "Great Atlantic Scallop" = King Scallop


Global Fisheries for Various Scallops
Source: FAO
Tonnes
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
Yesso scallop
Weathervane scallop
Scallops nei
Queen scallop
Peruvian calico scallop
Pacific calico scallop
New Zealand scallop
Iceland scallop
Great Mediterranean scallop
Great Atlantic scallop
Calico scallop
Atlantic bay scallop
American sea scallop


Global Scallop Cultivation
Source: FAO
Tonnes
1400000
1200000
1000000
800000
600000
400000
200000
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
Yesso scallop
Southern Australia scallop
Scallops nei
Queen scallop
Peruvian calico scallop
Pacific calico scallop
Great Atlantic scallop

THE MARKETS FOR SCALLOPS - Continued

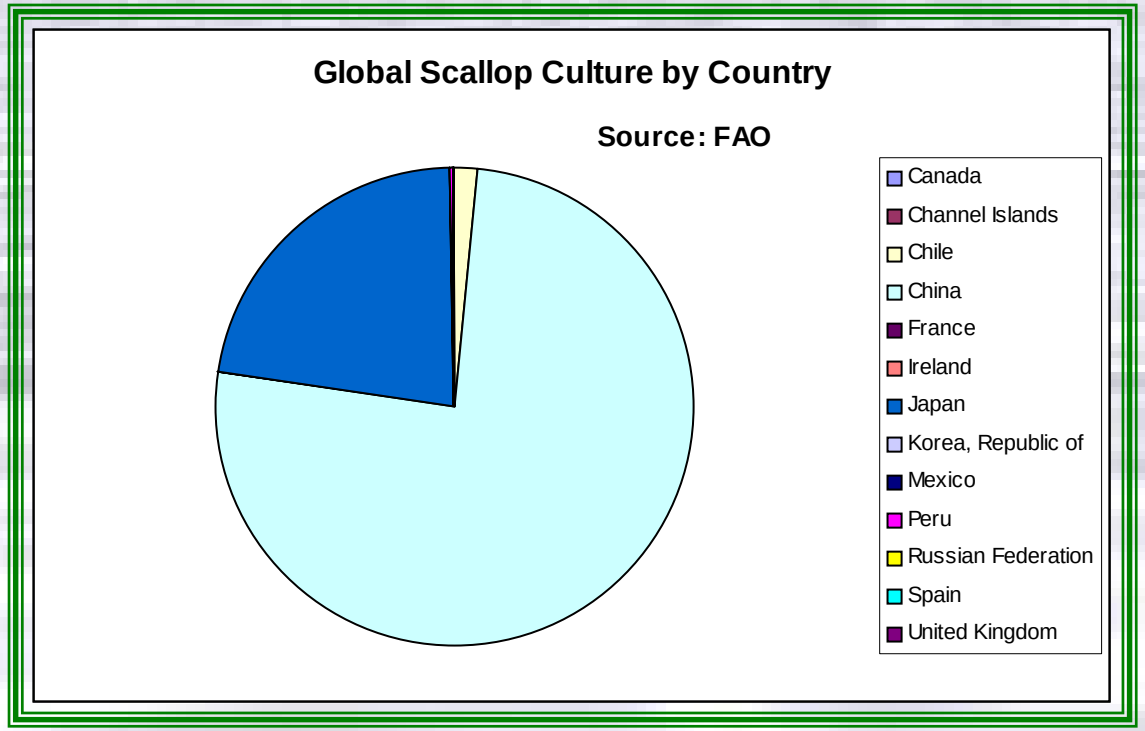
COMBINED SUPPLY - GLOBAL

The combined total of wild and cultivated scallops was almost 1.5 million tonnes in 1999

CULTIVATED SUPPLY

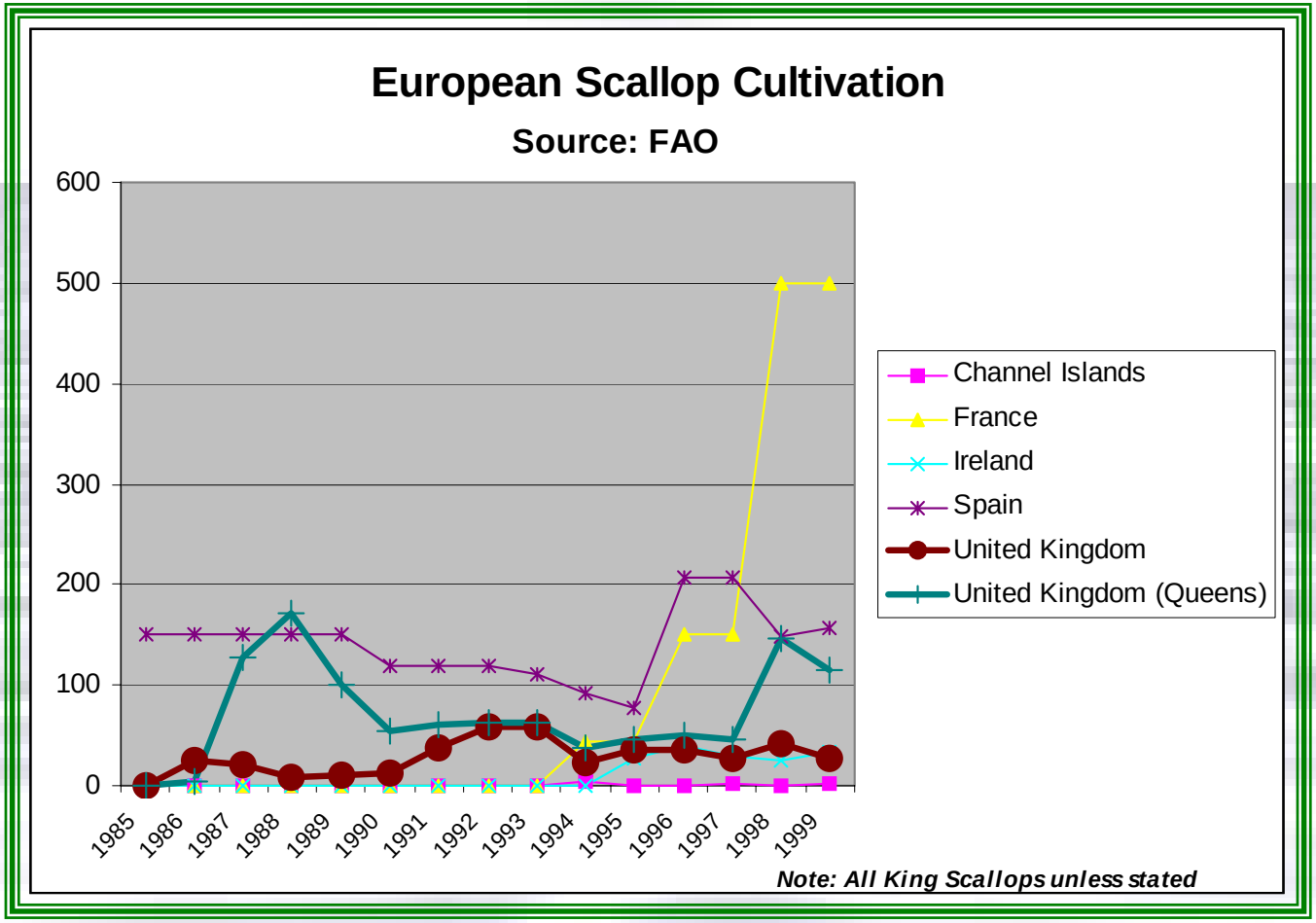
The world's cultivated production is dominated by China (76%), Japan (22%), and Chile (2%)

(*Data is average for 1997-1999*)



THE MARKETS FOR SCALLOPS - Continued

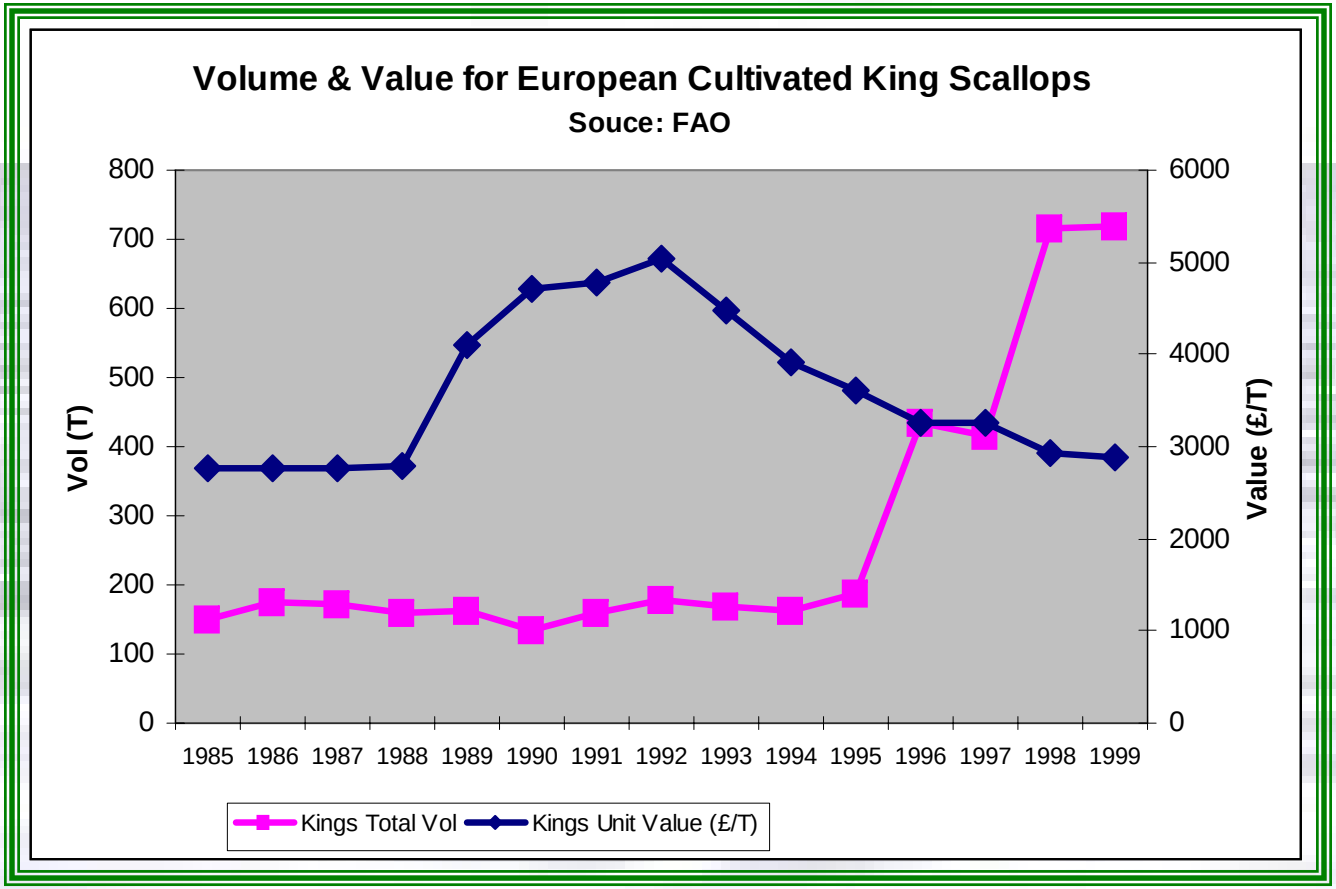
European production is dominated by France (500tonnes) - but is miniscule compared with China (722 00 tonnes), Japan (209 000 tonnes) & Chile (19 000 tonnes).



UK production has been variable over the last 15 years

THE MARKETS FOR SCALLOPS - Continued

European scallop production has been rising only slowly in comparison with the global total. First sale value peaked in the early 1990's, but has been steadily declining as production volumes have increased



Note: The value of UK farmed Queen scallops has been £1418 per tonne on average for the 5 years 1995-1999

THE MARKETS FOR SCALLOPS - Continued

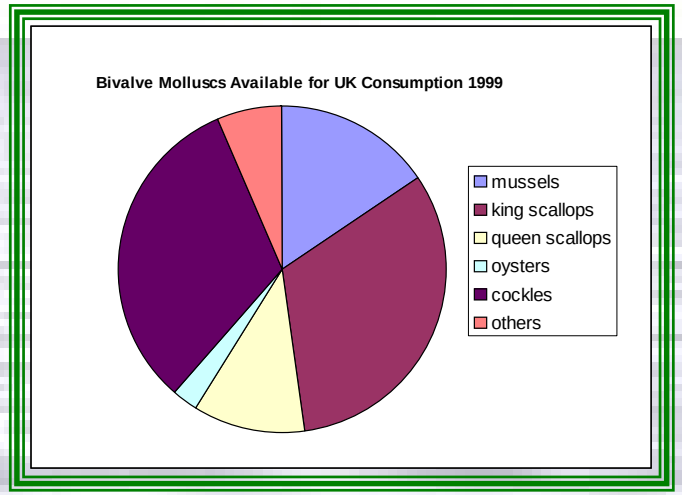
The market for scallops in the UK and several other European countries was extensively studied by Seafish in 2001

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

Scallops are a major part of the UK bivalve mollusc sector, and quite popular with consumers – but very limited supplies of scallops come from aquaculture. The market is probably suitable for increased scallop cultivation in terms of volume, and *perhaps* value. The issues are cultivation methods, and production economics to meet the realistic value points in the market. Increasing competition from imports (South America) can cause some concern about prices in the market.

It is estimated that the UK consumes around 20-21,000 tonnes of scallops each year. Some of the UK production is exported, but much is retained. The majority of UK scallop production comes from wild-capture - around 19,000 tonnes per annum of King scallops, and 5,000 tonnes per annum of Queen scallops

(*Data from Seafish, DEFRA & UK Customs & Excise*)



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

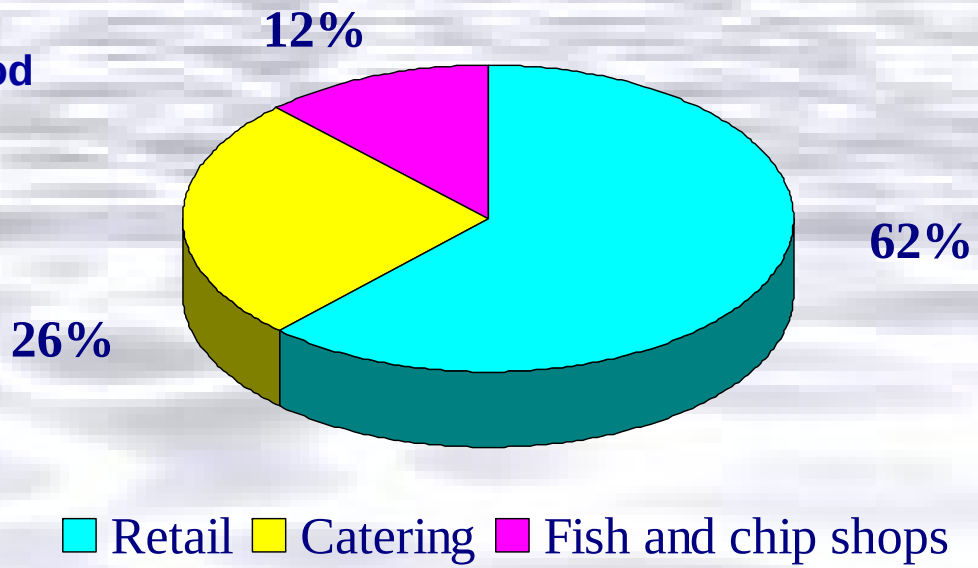
THE MARKETS FOR SCALLOPS - Continued

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.

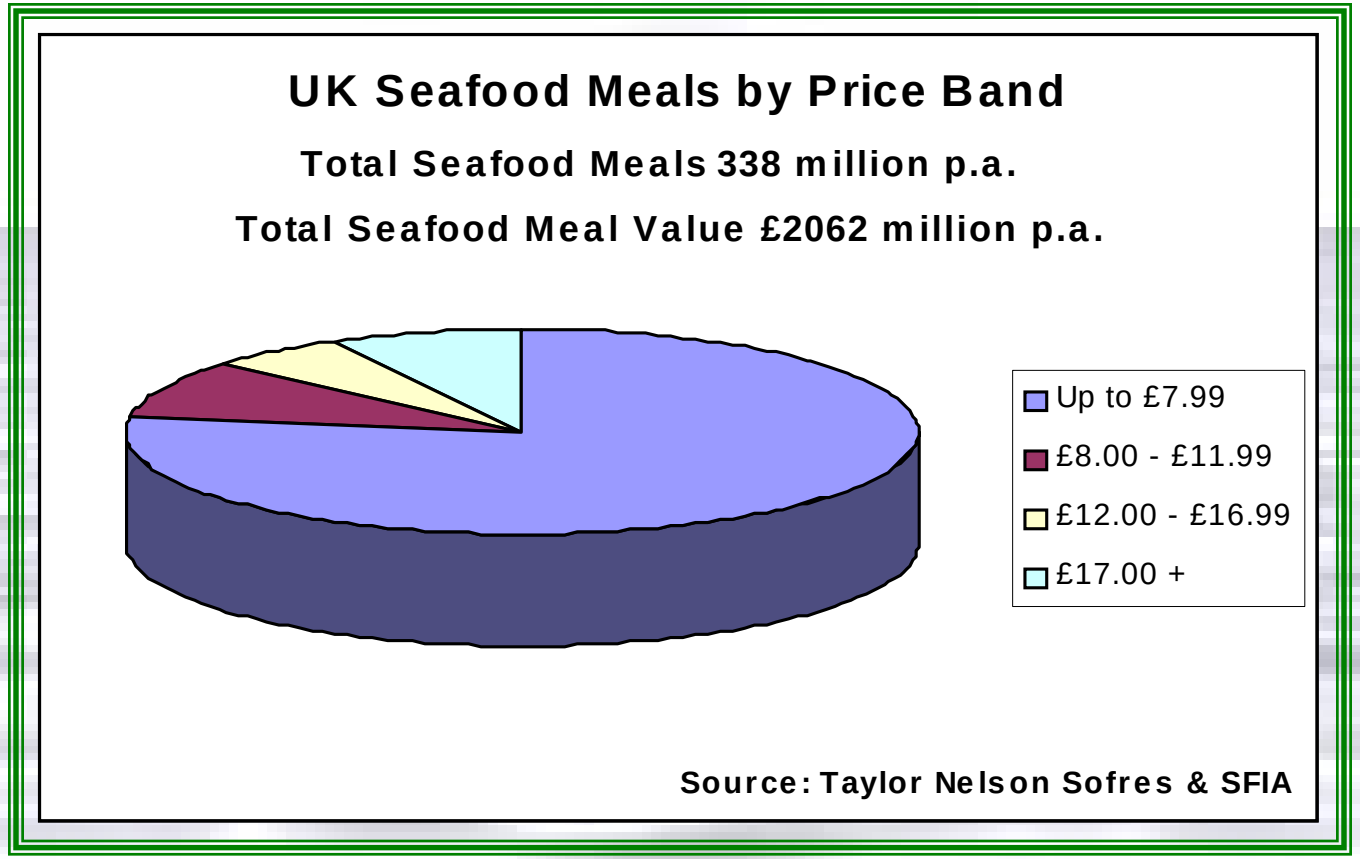
The balance between seafood retail and foodservice



Source: SFIA, Foodservice Intelligence & Superpanel

THE MARKETS FOR SCALLOPS - 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 SCALLOPS - 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. In the absence of any firm data for SCALLOPS in the UK, we must use MUSSELS to illustrate the concept:

THE MUSSEL "MEAL VALUE TRANSFER" EXAMPLE

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.

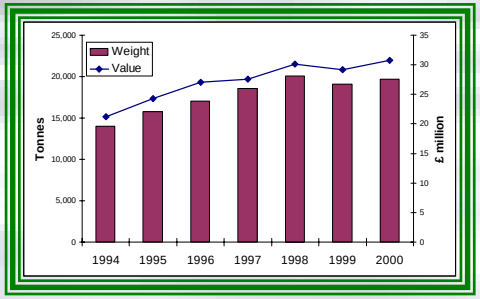
Note that the calculation above is speculative in so far as product weight per meal, actual meal price on the menu, and cost of other ingredients are concerned. However, the principle behind this method of assessing cost of protein ingredients into catering outlets has been well tested – readers of this 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 challenge for anyone interested in SCALLOP meals is to identify the key components, as shown above.

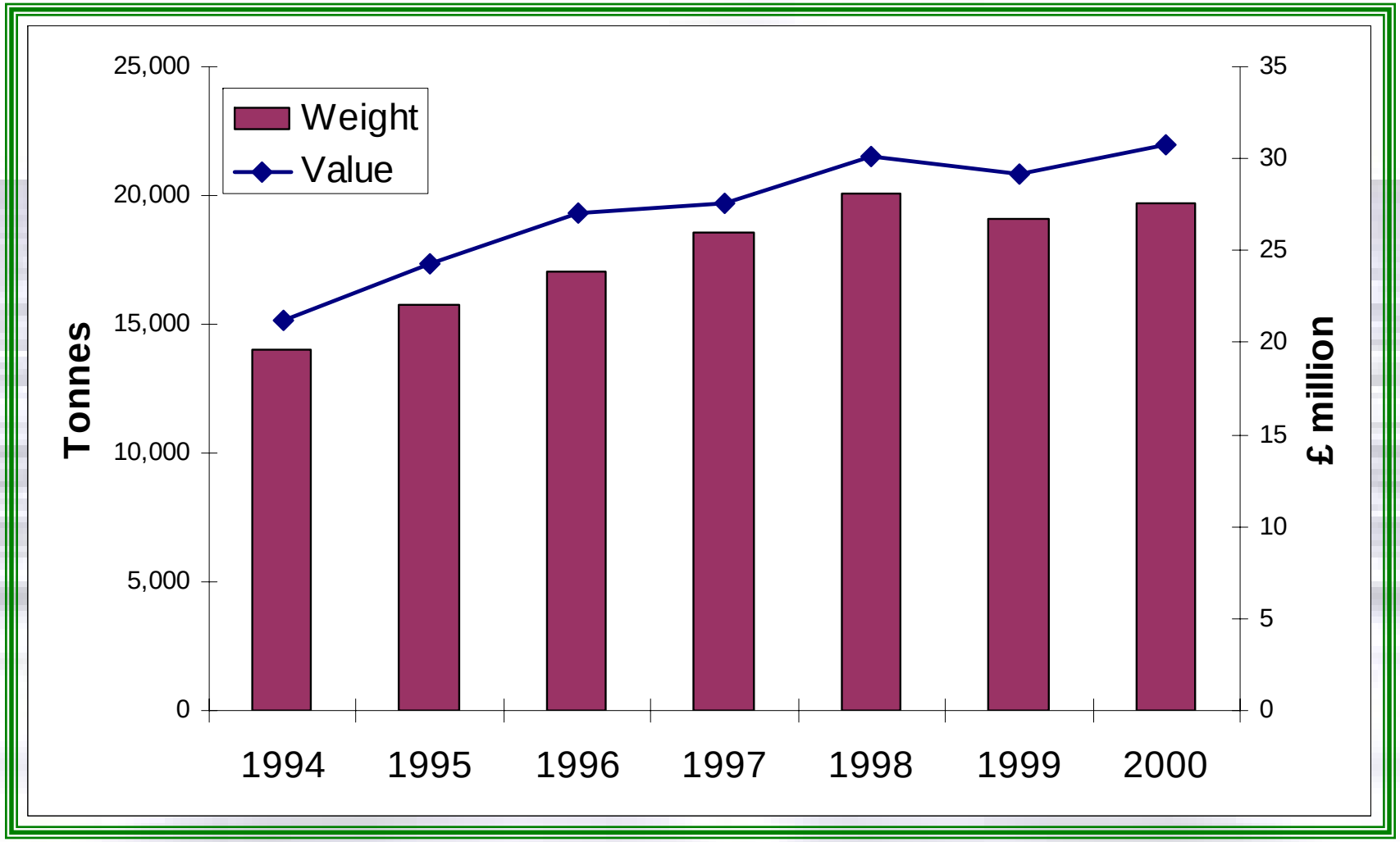
THE MARKETS FOR SCALLOPS - continued

King scallops are a valuable seafood product with large established markets both within Europe and world-wide. In the UK, the majority of king scallops (*Pecten maximus*) produced for the table market are fished from natural wild stocks. This fishery is extremely valuable, worth about £ 30 million per year from landings of just under 20 000 tonnes. However, the fishery seems to have reached a peak at this level. There remains a significant retail demand for high quality scallops. Any increase in production within Europe to satisfy this demand is likely to come from cultivation. To date, just 40 tonnes of scallops are produced in this way in the UK, mostly from the west coast of Scotland.

Click on the thumbnail to see the UK market situation



Scallop landings in the UK 1994 - 2000



THE MARKETS FOR SCALLOPS - Continued

King scallops are the single most important bivalve mollusc in the UK market, in terms of volume and value. Unlike mussels, the majority of the product available to the market come from the wild fishery. One of the main regions for scallop fishing is the southwest of England. Most scallop processors are located near the main fishing grounds, and whilst some of them also handle a range of other seafood products, some companies are almost exclusively involved with scallops.

THE MARKETS FOR SCALLOPS - Conclusion

The general conclusion to the scallop section of the recent study is that the product is important to UK consumers. The majority of the (UK) product is wild-caught, but there is importation of competitively priced product from overseas. There is little doubt that aquaculture production of scallops will be able to slot into niches in the market – particularly at the “diver harvested” quality end. The main issue for the industry is one of production cost v. market value.

Some scallop recipes
(click on the buttons to view)

Back to Markets Section

Grilled Scallops with Basil and Lime Butter

9 king scallops, shucked and cleaned
salt and black pepper
Basil and Lime Butter
85g (3oz) butter, softened
2 x 15ml spoon (2 tablespoons) fresh chopped basil
juice and rind of 1 lime
Preheat the grill
Remove the coral (or roe) from each scallop and set aside. Slice the scallop in half and set aside.
In a small bowl mix the butter ingredients together and set aside.
Spread 40g (1 and one half oz) of the flavoured butter onto a grill pan.
Add the scallops to the grill pan 5cm (2") apart. Dot with the remaining butter and cook for 3-4 minutes, turning occasionally.
Transfer to a serving dish.
Spoon the juices from the pan over the scallops and serve with sliced new potatoes and salad leaves tossed in a little vinaigrette dressing.
Serves 3 as a starter
NUTRITIONAL VALUES PER PORTION (APPROX) 459 Kilocalories; 49g Protein; 7g Carbohydrate; 26g Fat; 0g Fibre.

See a picture

Back to Markets Section

Grilled Scallops with Basil and Lime Butter

Next recipe

Back to Markets Section

Barbecued Scallops Wrapped in Bacon and Sage

10 king scallops shucked, fresh or defrosted and without the roe
20 fresh basil or sage leaves
10 rashers streaky bacon, halved
150ml (5 fl oz) prepared flavoured oil, i.e. garlic or herb
Preheat grill or barbecue
Cut large scallops in half horizontally to make 2 rounds.
Place two basil or sage leaves on top of each scallop.
Stretch the bacon with the back of a knife and wrap each bacon strip around one scallop, then wrap a second if used across the first, to enclose the scallop.
Thread each scallop onto 2 pre-soaked wooden skewers, brush with the garlic or herb flavoured oil and place onto a prepared foil-lined barbecue or grill, or griddle pan placed directly onto the barbecue.
Cook for 1-2 minutes, turning once and serve immediately.
Makes 10, serves 4-5 as a starter

See a picture

Back to Markets Section

Barbecued Scallops Wrapped in Bacon and Sage

THE PRODUCTION PROCESS

Introduction

Click here to see a description of the King scallop life cycle

This Hyperbook will focus on the main life cycle stages for cultivation of King scallops:

Hatchery, ongrowing and harvesting

The Hyperbook is a planning guidance tool, but it can not provide every detail.
It is recommended you undertake your own research into scallop cultivation if you wish to proceed with a specific investment or project.

LIFE CYCLE OF KING SCALLOPS

Scallops spawn in the summer and they may spawn more than once in a season. They are hermaphrodite; the proximal white part of the gonad is the male testis, the distal part of the gonad is the ovary which is bright orange in ripe scallops. Sperm are released before the eggs and this helps to prevent self-fertilisation.

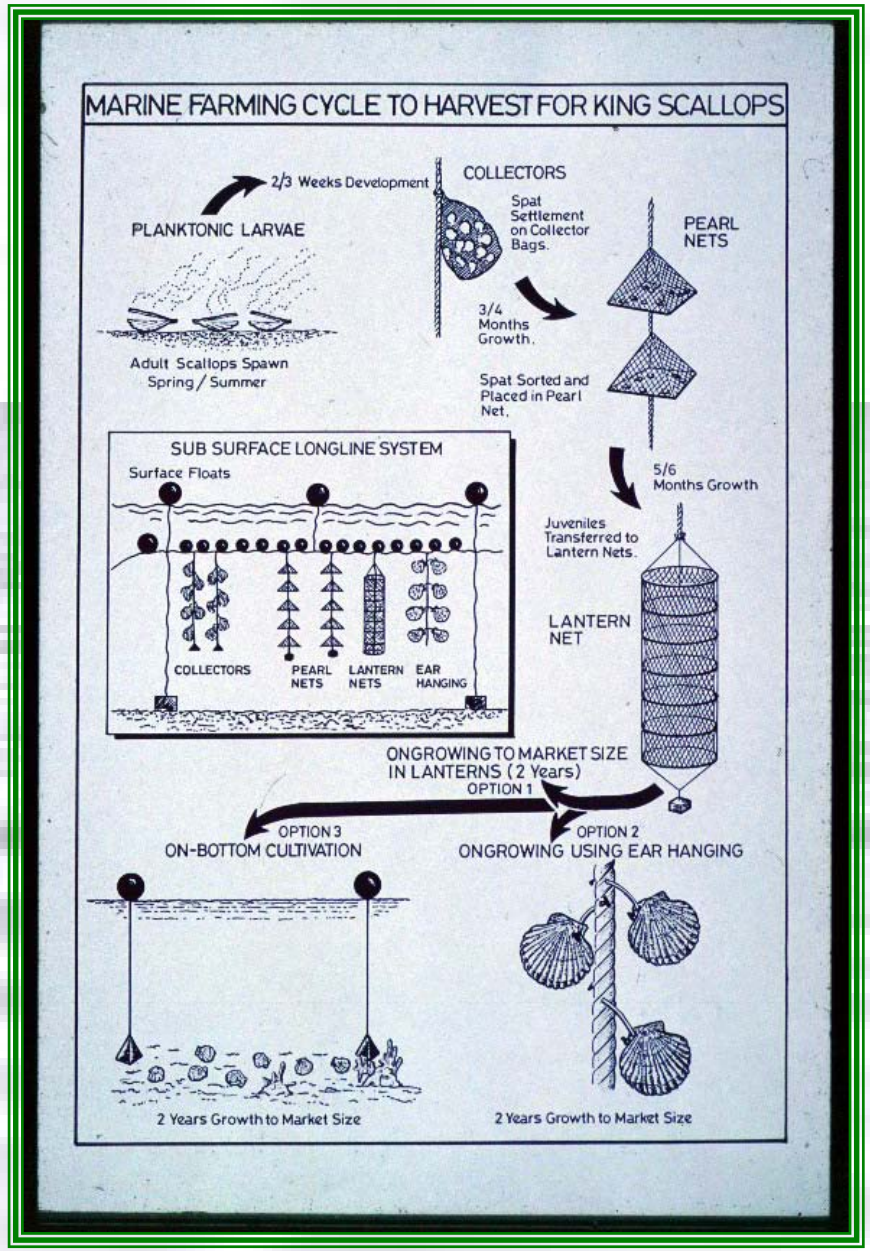
Fertilisation of the eggs takes place in the sea and the resulting larvae drift in the plankton for around 3 to 6 weeks (depending on whether in southern or northern parts of the UK), feeding on microscopic algae. When mature, the larvae sink out of the plankton, attach to stones, empty shells, bryozoans, filamentous algae and hydroids by their byssal threads and develop into the first 'immature' adult stage (called spat or seed) which are 0.25-0.4 mm shell length. Later, they detach again to live on the seabed. They remain mobile as adults and can swim short distances by clapping the shell.

Recruitment can be very variable from year to year and this has implications in the collection of spat from the wild for commercial cultivation.

Introduction - 2

The figure on the right provides an overview of the King scallop cultivation cycle.

Care should be exercised when considering the duration of the on-growing phase - it can vary from 4 years in the south of England to 5 or 6 years in Scotland.



Introduction - 3

Like other bivalve molluscs, scallops are filter feeders, removing natural phytoplankton (microscopic algae) and organic detritus from the sea water as it passes over the gills. The gills, which have a dual function of respiration and feeding, act like fine, intricate nets that trap the food particles from the water. Filtration rate depends on a number of factors including animal size, sea water temperature and the concentration of suspended particles in the water.

Scallops filtering on the seabed

Securing seed for production

Seed for on-growing is most commonly obtained by the collection of natural spat settlement from the wild (both King and Queen scallops). Alternatively, spat may also be obtained from hatchery production (King scallops only). Both approaches are discussed in the following sections.

The requirement for hatchery-produced scallop seed for the UK cultivation sector is not absolutely clear. Current levels of production are supported using wild-collected seed. However, hatchery produced spat may be cost effective in reducing the high labour requirement associated with wild collection and bring benefits in terms of quality and continuity of supply.

Currently there is no hatchery production of scallop seed in the UK, but initiatives are underway. The economic viability of such ventures has yet to be proven. When evaluating whether to invest in hatcheries, it may be appropriate to consider the following questions:

- If wild seed supply is sufficient, will on-growers purchase hatchery-reared seed?
- What scale of production is the scallop cultivation sector likely to reach?
- If the sector expanded significantly, a hatchery might be justified.

Hatchery Production - The Principles

General

The culture of scallop larvae and juveniles (or seed), either for research, commercial aquaculture or biotechnology, is dependent on a number of important factors. These include providing optimal technological and environmental conditions, adequate nutrition in terms of quantity and quality of the diet for larvae, juveniles and parent broodstock, disease control and other ecological, physiological and genetic factors.

The production of mollusc seed in commercial hatcheries is an important element of shellfish aquaculture worldwide. In the hatchery, environmental conditions can be carefully controlled during critical stages of the life cycle to meet the specific needs of the species being reared. This includes the conditioning and spawning of adult broodstock, the rearing of larvae through to metamorphosis and the containment of post-larval stages until they are large enough to be put into the natural environment. Commercial hatcheries are used primarily for the production of high market value species. Until recently the aquaculture of molluscs has generally been for food production but more novel applications, especially in the field of biotechnology, are the subject of an increasing number of research studies and may ultimately lead to commercial production for purposes other than food.

Hatchery Production - 2

History of hatchery production of bivalves in the UK

The hatchery production of bivalves began in the UK in the 1960s. Since that time the technological and biological requirements of a range of bivalve species including native European flat oysters (*Ostrea edulis*), Pacific oysters (*Crassostrea gigas*), Manila clams (*Tapes/Ruditapes philippinarum*), native palourde clams (*Tapes decussatus*) and American hard shell clams or quahogs (*Mercenaria mercenaria*) have been determined at a commercial scale.

Worldwide, techniques for the hatchery production of a range of scallop species have been established. These include the American bay scallop (*Argopecten irradians*) which has been introduced into China, the Japanese scallop (*Patinopecten yessoensis*) which is now reared in hatcheries in Canada and the Chilean scallop (*Argopecten purpuratus*) which sustains commercial production of the species in southern Chile. In France (in Brittany), up to 10 milllion King scallop (*Pecten maximus*) seed are produced per year to sustain a managed fishery in the Rade de Brest.

Norway also produces seed to support a developing scallop aquaculture industry. At present there is no commercial hatchery production of scallop seed in the UK but in spring 2002 QinetiQ set up a hatchery in Portland Harbour to produce 3 million seed in its first year increasing to 10 million over the next two to three years. One or two small hatcheries are being set up in Scotland to satisfy individual and local needs.

On-growing trials in the UK carried out in the late 1990s using King scallop seed produced in the CEFAS Conwy Laboratory, showed that the performance of hatchery produced seed matched that of wild caught spat. Although techniques for the hatchery production of scallop seed are quite similar to those used for other bivalves, generally scallops are less hardy than other species and need to be handled with more care. Survival during the stage of metamorphosis can be less than 20% of the numbers of mature larvae. The economics of hatchery production at a commercial scale has yet to be assessed in practical terms.

Hatchery Production - 3

Broodstock

Broodstock is the term used for the parent animals that are used in the hatchery production of seed. Generally, broodstock are kept in the sea and brought into the hatchery when they are needed for breeding purposes. Adult scallops are hermaphrodite, i.e. they are both male and female producing eggs and sperm. Egg production increases with increasing adult size. Scallops of 90-120 mm shell height can release anything from 3 to 15 million eggs at a spawning.

Environmental and genetic factors affect the morphological and physiological characteristics of commercially produced shellfish. Genetic selection of broodstock and selective breeding is a method to improve stocks for aquaculture purposes by selecting for specific traits (e.g. for faster growth, higher meat yield, better shell shape and/or colour). Research in this field will undoubtedly expand in the future if aquaculture is to follow the same pathway as agriculture where domesticated animals are very different from their wild counterparts.

Careful management of broodstocks is essential in order to maintain genetic diversity and ensure optimum physiological performance. Using a limited number of broodstock can reduce genetic variability resulting in inbreeding depression, an irreversible loss of genetic diversity and potential detrimental interactions between wild and cultivated stocks.

Hatchery Production - 4

Conditioning broodstock - 1

Larvae and seed production can often be very variable. Generally it depends on the maturity of adult broodstock, as well as the quantity and quality of lipid reserves (especially polyunsaturated fatty acids – PUFAS – such as docosahexanoic acid, or DHA, and eicosapentanoic acid, or EPA, in the eggs produced by the broodstock. Levels of these fatty acids are critical to hatching success of the eggs.

Broodstock scallops are brought into the hatchery and 'conditioned' to spawn. The sea water temperature is raised to mimic the conditions that the animals would experience in nature during the spring when they would be laying down reserves in preparation for spawning in the summer. In order to fatten and ripen, the animals are provided with a mixed diet of microalgae (phytoplankton) at a ration of 3% of the dry meat weight of scallops in dry weight of algae per day. A number of microalgae species have been selected over the years for their nutrient content and their digestibility. The more commonly used species that are suitable for scallops include *Tetraselmis suecica*, T-*Isochrysis*, *Pavlova lutheri, Chaetoceros gracillus* and *Chaetoceros calcitrans*. Generally, the best ration for scallops is equivalent to between 3 and 6% of the dry meat weight of the broodstock in dry weight of microalgae per day.

Hatchery Production - 5

Conditioning broodstock - 2

During conditioning in the hatchery, broodstock animals are held in tanks and supported off the bottom of each tank in a mesh-based tray so that faecal material can fall to the bottom of the tank. Scallops also need a substrate of fine gravel and shell in the tray. An approximate guide is to have 15 litres of water for every animal of 150 g live weight, 20 litres for 200 g animals. For example, a tank of 150 litres containing 120 litres water should hold a maximum of 10 animals @ 150 g live weight per individual. Generally, systems are constructed with a through-flow of heated (to a maximum of 16 ^{o}C) sea water passing through the tanks at 25 mls min^{-1} per scallop. Salinities of 30 parts per thousand and above are essential as scallops cannot tolerate brackish conditions. Natural phytoplankton in the sea water is also an important food source so fine filtration of water before it enters the conditioning system is not recommended. Cultured algae can be added to the incoming seawater using peristaltic pumps or by gravity feed.

Some research has been carried out on conditioning bivalves in re-circulation systems. Although this is possible and will reduce the costs of heating the sea water, through-flow systems are more common.

The tanks should be drained and cleaned to remove sediment and particulate material that settles on the bottom of the tank. The frequency of cleaning will depend on the amount of particles and silt in the water but once a week is a good guide. The closer the broodstock get to spawning, the more care is needed during cleaning to prevent the animals from releasing their gametes. Broodstock need to be kept in a quiet part of the hatchery with the minimum of disturbance.

The scallops are mature when the distal part of the gonad, the ovary, is bright orange and shows no sign of channelling.

Hatchery Production - 6

Spawning broodstock - 1

In the wild, self-fertilisation is prevented because the eggs and sperm are quickly moved away from the vicinity of the animal in the water current. When scallops are induced to spawn in the hatchery, care has to be taken to prevent eggs from one scallop being fertilised by sperm from the same animal.

The easiest method to induce spawning is to put the scallops into a shallow spawning trough and leave them for 2 hours out of water. Then, the tank is filled with filtered (to 2 μm), UV-sterilised sea water at 16 °C. After 30 minutes, the tank is drained and refilled with filtered water at 20 °C. The cycle is repeated until the animals start to spawn. Microalgae (about 50 mls) should be added to the water at each water change to encourage the animals to filter actively. Some eggs removed from one animal and added to the water in the trough will help to trigger spawning.

The eggs and sperm are released into the water. It is advisable to have a grey or black spawning trough to provide a dark background against which the eggs and sperm can be seen. Eggs will appear as an orange granular suspension, sperm as a cloudy, milky suspension. The more mature the broodstock, the sooner they will spawn after the first thermal shock is applied.

Hatchery Production - 7

Spawning broodstock - 2

Usually, the scallops spawn as males first, although this is not always the case. They should be placed in separate glass containers such as a 3-litre beaker containing 2 litres of water at 16 ^{o}C to complete this first phase of spawning. This usually takes from 2-4 hours. As soon as this stage is complete, the scallops should be placed into another container of freshly filtered sea water to release the eggs. This takes around 15 minutes from when the first eggs appear in the water.

After spawning is complete, the eggs should be counted, pooled into a large container and diluted to a density of 4000 eggs per ml. Sperm from the males should be pooled into another container and then added to the egg suspension (2mls of sperm suspension per litre of egg suspension). The longer the time between when the sperm is released from the adult scallop to when it is used to fertilise the eggs, the less successful the fertlisation. After 30 minutes to 1 hour in sea water, the sperm becomes less active and fertilisation success is extremely low. Eggs should also be fertilised within one hour of their release from the parent. Within one to two hours of fertilisation, the first signs of development should be visible under the microscope as cell division proceeds.

Eggs are then incubated for 72 hours in rearing vessels containing filtered (to 2 μm), UV-treated sea water at 16 ^{o}C and a salinity > 30 parts per thousand. The optimum density is around 50 eggs per ml. No aeration is needed

Hatchery Production - 8

Rearing larvae - 1

After 72 hours, the eggs have developed into the first shelled stage called a D-larva owing to it's distinctive 'D' shape. The larvae are collected from the rearing vessel by filtering the water through a series of stacked sieves (235 μm, 90 μm, 60 μm mesh). The larvae which measure around 90 μm in length will be retained on the 60 μm sieve. On average, a recovery of around 35% of the initial egg number is the norm. In a good batch of eggs, in excess of 50% might occur.

D-larvae are put back into rearing vessels filled with filtered (to 2 μm), UV-treated, heated (to 17-18 ^{o}C) sea water at a larval density of 8-10 per ml. Larvae can be reared in flat-bottomed or bottom-draining conical-based vessels. They can be operated as static systems where the water is changed approximately every 48 hours. Alternatively, they can be operated as partial-recirculation or through-flow systems. The costs of pumping and heating water will determine the method that can be used. Aeration should be provided. For a 350 l rearing vessel, aeration should be 350 l/h.

Hatchery Production - 9

Rearing larvae - 2

At each water change the larvae should be collected and graded on a series of stacked sieves (ranging from 60 μm up to 210 μm). It is good practice to check the numbers and condition (activity and colour) of larvae on each sieve and keep records. Periodically, the larvae on the smallest-size sieve can be discarded if they are very pale which is an indication that they are not feeding and will not survive. The average growth rate of larvae is around 5 μm per day. A good survival rate through the larval phase is 50-60 %.

The larvae must be provided with a diet of microalgae. This is added at each water change and topped up between water changes. Optimum diet rations and the quality of the diet is very important. The quantity of food that needs to be provided per larva increases as the larvae grow. A D-larva requires the equivalent of around 5,000 *Isochrysis*-size cells per day. This increases to around 40,000 cells per day when larvae are 200 μm.

The essential highly unsaturated fatty acids (HUFAs) arachadonic acid (AHA) (20:4 n-3), eicosapentanoic acid (EPA) (20:5 n-3) and docosahexanoic acid (DHA) (22:6 n-3) have been shown to play an essential role in the diet of most molluscs. These are provided in mixed diets of microalgae fed to the larvae during culture. Nutritional value for scallops of a range of algae is *Pavlova lutheri.>Chaetoceros calcitrans>Rhinomonas reticulata*>T-*Isochryis>Tetraselmis suecica*. A mix of *P. lutheri.* and *C. calcitrans* is probably the best diet.

Hatchery Production - 10

Disease agents - 1

During development, larvae are continuously exposed to microbes and their defence system is continuously reacting to prevent the accumulation of invading and pathogenic organisms. Maintaining optimal environmental conditions is critical to ensure that the immunocompetence of larvae and post-larvae is not compromised. The performance of the immune system is reduced by stress, e.g. stress resulting from disease agents, pollutants in the water, adverse environmental conditions, excessive handling.

Bacteria

Impairment of the defence system can lead to significant losses of stock because it makes the animals vulnerable to bacterial infection. For example, research has shown that when Pacific oyster were challenged with *Vibrio splendidus* and subjected to mechanical stress, the level of mortality and the degree of infection increased in stressed oysters but remained low in unstressed animals. Bacteria are also thought to play a role in the nutrition of larvae although the importance of this role is far from clear.

The treatment of the water with ultra-violet light will remove bacteria in the incoming water. Although usually an effective method of controlling bacteria levels, it can sometimes produce the opposite effect, especially if harmful bacteria get into the rearing vessel, for example, with the micro-algae food. In such a sterile environment, the harmful bacteria can quickly flourish and affect the larvae.

Other methods of control include the use of antibiotics such as oxolinic acid. The ban on the use of many antibiotics, because it can potentially lead to the development of disease-resistant strains of bacteria, has meant that alternative rearing methods are being investigated. Using completely through-flow systems or partial through-flow re-circulation systems are an option.

Hatchery Production - 11

Disease agents - 2

Herpes virus

Sporadic high mortalities of Pacific oyster larvae and spat have occurred in European hatcheries and in juvenile oysters in the field, especially in France. The causative organism has been a herpes-like virus. Recent reports were also made of similar infections in scallops and it is likely that transmission of the disease can occur between different species of bivalves.

Probiotics

Using antibiotics on a regular basis is discouraged and increasingly in many countries it is not allowed. Probiotics are an alternative that is being investigated, more at a research level than commercially as yet.

Probiotics are more common as live microbial feed supplements that improve the health of man and agricultural livestock. Research into probiotics for aquaculture is driven by a demand for environmentally friendly culture techniques. Currently, a stage has been reached where considerable research efforts are required to develop applications to an aquaculture scale. Probiotic microbes act by being antagonistic to pathogens, by having colonisation potential and by increasing their host's resistance to disease. In addition, many other beneficial effects are possible including competition with pathogens for nutrients and adhesion sites.

The gastrointestinal microbiota of shellfish is dependent on the external environment because of water continually passing through their digestive tract. Most bacteria are transient in the gut with new microbes invading continuously with the water and food cells passing through the gut. Those bacteria that are diet supplements that survive in the gut and that improve the health of the host can become probiotics.

Hatchery Production - 12

Settlement of larvae and metamorphosis

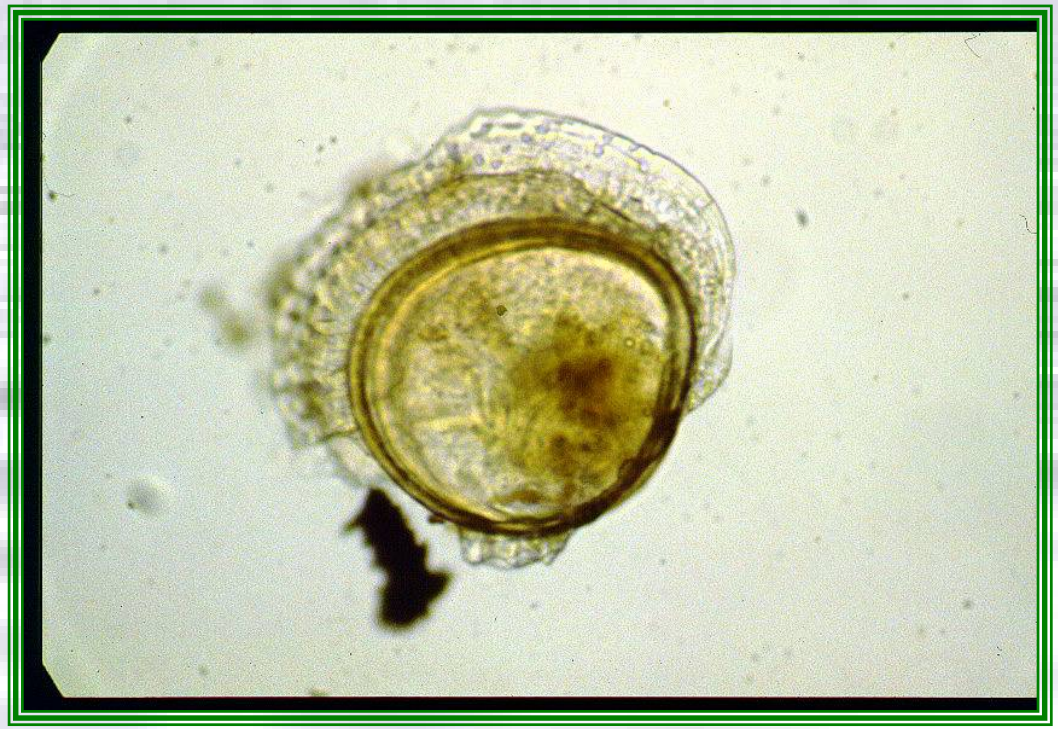
At approximately 250 μm shell length, scallop larvae develop a pigmented eye-spot that is easily visible under the microscope. This is an indication that the larvae are mature and ready to undergo metamorphosis into the benthic juvenile stage which is called a 'spat'. They also develop a foot which is used to crawl over the substrate when seeking a place to settle. King scallops take approximately 22 to 25 days to reach this stage.

Scallop larvae

Hatchery Production - 13

Settlement of larvae and metamorphosis - 2

Once larvae are mature, suitable settlement materials are added to the rearing vessels to encourage settlement and metamorphosis, e.g., mesh bags containing monofilament netting (like the bags used to collect spat in the wild), corrugated PVC sheets. Alternatively, mature larvae can be put into mesh-based (170 μm) down-welling trays.



Newly settled scallop spat

Hatchery Production - 14

Nursery stages

Immediately after settlement and metamorphosis, scallops grow very slowly taking around 20 days to grow from 0.5 mm to 2mm and another 20 days to reach 5 mm. It is during the first 20 days that the majority of mortalities will occur. Once they reach 4 - 5 mm, there is a rapid increase in size-specific growth rate and spat grow at around 2 mm per week. After another 4 weeks, around half of the spat will have reached 10 -15 mm and can be placed in pearl nets in the sea.

Unlike oysters and clam spat and seed, scallops will not tolerate rearing in upwelling nursery systems. Instead they are grown in down-wellers with only a single layer of spat in each. Consequently, the demand for nursery space is high and it is advisable to put seed into the sea as soon as is practical.

In the commercial hatchery production of bivalve shellfish, the nursery stage is the most demanding in terms of food requirements and rearing space. The production of algae accounts for around 30% of the nursery costs. For *P. maximus* spat a diet of 0.15 g (organic weight of algae) g^{-1} (live weight of spat) wk^{-1} is required. Although this is approximately half of the ration required by oyster and clam spat, it is still a labour intensive part of the operation.

Hatchery Production - 15

Transporting scallop seed from the hatchery

Scallop seed may have to be transported many miles from a hatchery to the on-growing site. Trials have shown that in moist conditions, the maximum time of transport is 12 hours. The best survival is when transport times are < 6 hours. Once out of water, the heartbeat increases for 2 - 3 hours and then decreases to <10 beats/min (normal = 22 beats/min). It can take a few hours for the normal rate to be restored once the animals are returned to water and the growth rate can be affected for up to 2 weeks after transport.

Behavioural responses are simple and good methods of determining vitality of scallops after transport – e.g. the degree of gaping and time to recover once in water,or the ability of the scallop to right itself if upside down.

Hatchery Production - 16

Algae - 1

Commercial hatcheries need to produce large quantities of micro-algae to feed animals, especially during the nursery phase. The estimated cost of producing marine micro-algae species is approximately 30% of the total cost of seed production. Therefore, efficient means of production, good utilisation of the food to promote rapid growth and selecting high nutritional value algae species are critical.

Continuous flow algae systems, using bag cultures, have been developed commercially for a range of the commonly cultured algae species. The method is now used in a number of countries world wide.

Hatchery Production – 17

Algae - 2

The rearing of juvenile invertebrates can be very demanding in terms of manpower and other resources needed to supply sufficient quantities of food. One option adopted by commercial bivalve hatcheries is to transfer juveniles to outdoor ponds in which natural species of micro-algae can be produced extensively. The addition of inorganic nutrients and fertilisers (such as urea, triple superphosphate and sodium metasilicate) to the water can enhance the amount of algae in the ponds. The species composition of the naturally bloomed algae is more difficult to control due to seasonal conditions. The reliable management of ponds can take several months, even years to perfect. Growth of algae in outdoor ponds is dependent on light and temperature as well as nutrients. Therefore, in temperate latitudes, the productivity of algae during the spring and summer is greater than in late autumn and winter. The cost of producing algae extensively in ponds has been estimated at less than 1% of the cost of producing algae in intensive, indoor systems. Sprinkler systems can be used to distribute the water and manage ponds more effectively.

Scallops require 0.15 g (organic weight of algae) g^{-1} (live wt of spat) wk^{-1} when fed a mixed diet of cultured micro-algae. To obtain a similar rate of growth when fed on pond water, a ration of around 0.3 g g^{-1} wk^{-1} is required. It is higher because some of the species of algae in the pond water are likely to be less nutritious than intensively grown algae which have been selected over the years for their nutritional value. To calculate the ration, you need to make an assessment of the number of food cells (individual algae) in the water within specific size ranges and multiply by the average weight of each food cell. Average cell weight is approximately 15 pg (picogram or 10^{-12} grams) at 2-5 μm cell-diameter, 170 pg (5-10 μm), 680 pg (10-15 μm) and 2270 pg (15-20 μm).

Hatchery Production - 18

Alternatives to live algae

To reduce the reliance on live algae, alternatives such as spray-dried algae and algal pastes are available commercially. Generally, none of these alternatives can replace live diets but they can be useful as supplements for feeding larvae, juveniles and broodstock.

Lipid emulsions have also been used to successfully supply DHA and EPA to scallop broodstock. They provide a tool for assessing lipid requirements of invertebrates. However, there is one drawback. As particles in lipid emulsion are very small (majority < 2 μm), it has been assumed that the uptake of the emulsion is at a rate equal to that observed for the uptake of microalgae also provided in the diet. This may not be the case and quantitative estimates of PUFA requirements may be subject to error. It is essential that a method for measuring the true uptake of emulsions can be found (e.g. tracer dye or radioactive marker) if meaningful projections on food requirements are to be established.

Wild Seed Collection - 1

Longlines and collectors are prepared in April/May and put out in the sea in May through to July at a time to coincide with the peak period of spat settlement. This is variable between sites and between years. For example, on the west cost of Scotland it can be anytime from June to early August.

Therefore, it is advisable to use plankton hauls to monitor sea water samples for the occurrence of scallop larvae and to put out test collectors to determine the best time to deploy the main collectors.

Scallop larvae will only settle on clean collectors and once in the sea collectors will only remain effective for about 10 days. Commercial growers sometimes avoid putting out collectors at the time of peak scallop settlement to prevent the settlement of larval stages of predators and competitors. The best settlement of spat occurs between depths of 10 metres from the surface and 5 metres off the seabed.

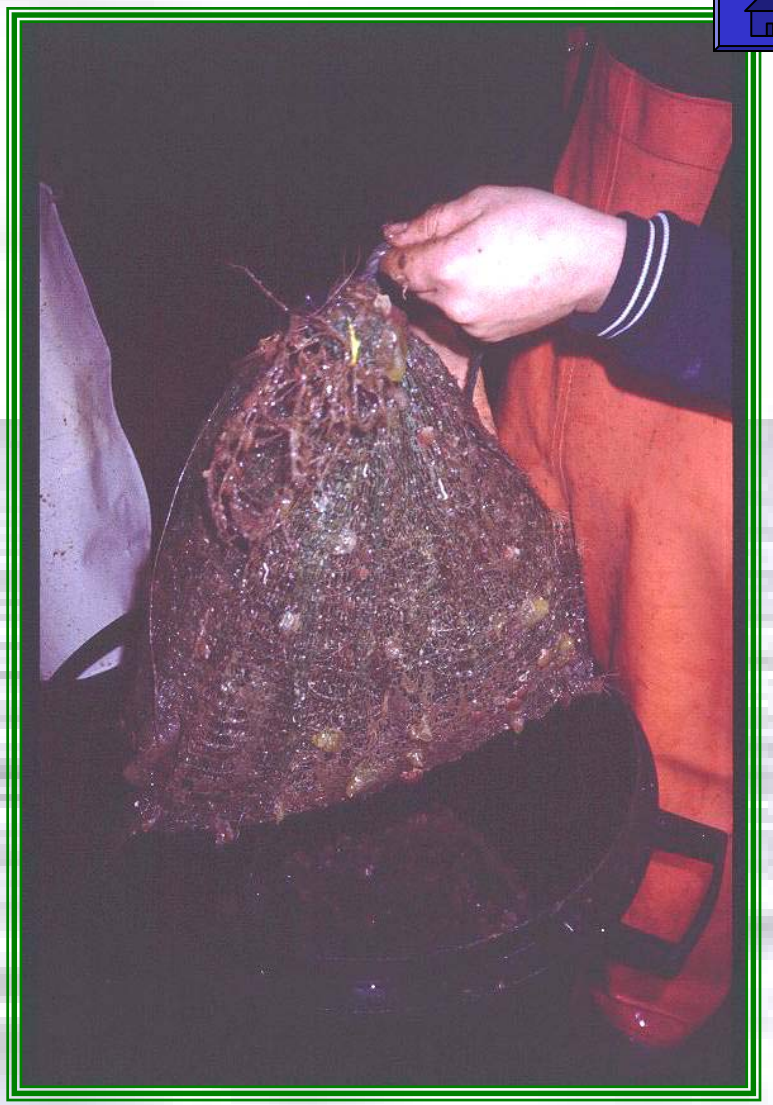
Wild Seed Collection - 2

The collectors must remain undisturbed for approximately 2-4 months to ensure the spat are large enough to handle (10-15 mm). Then the lines are lifted from the water (a few at a time) to remove the collectors which must be kept in damp conditions using a sea water spray or by covering them with seaweed or a damp tarpaulin.

The spat (and larger animals too) should always be kept in water or moist conditions and out of direct sunlight, strong winds and rain or they will become stressed and many will die.

Collection of spat can be very variable between sites and between years. It is probably safe to assume 50 – 100 King scallop spat per collector will result for an average site. Queen scallop spat are generally more plentiful on collectors.

Spat may be removed from the collectors in the on-shore facility by gentle agitation of the filler in a barrel of seawater.

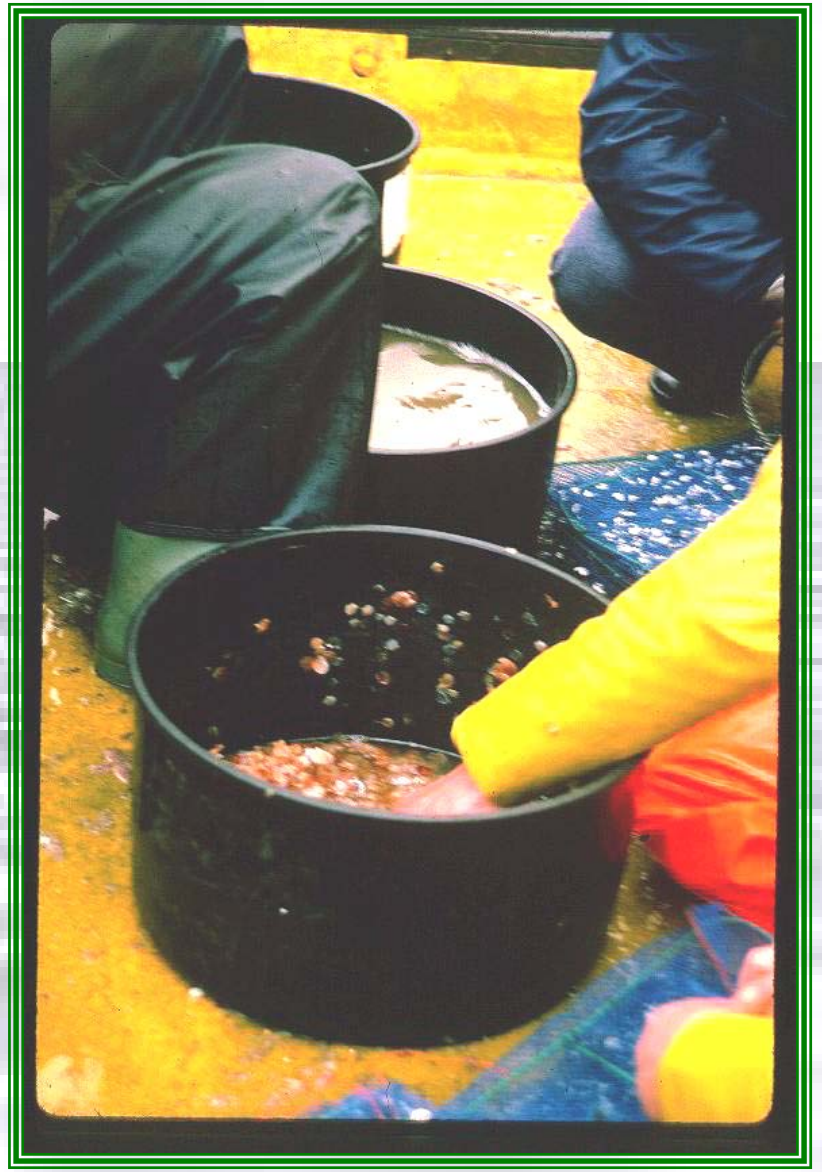


Collector bag recovered from sea containing spat

Wild Seed Collection - 3

Once removed from the collector, King and Queen scallop spat may be sorted speedily by placing them on the bottom of a tank and then introducing a series of vertical plates or baffles. In operation, it has been found that Queen scallop spat tend to climb up the vertical surfaces, leaving the King scallops on the floor of the tank. Once covered, the baffles can be lifted out and the Queen spat removed. This can be repeated until few Queen scallops remain in the tank; they are never removed entirely using this system but they cause no problems later. This method is less time consuming and gentler than attempting to hand-sort the spat.

After sorting, spat should be placed into pearl nets and put back into the water.



Larger undesirable predators and competitors can be removed by hand

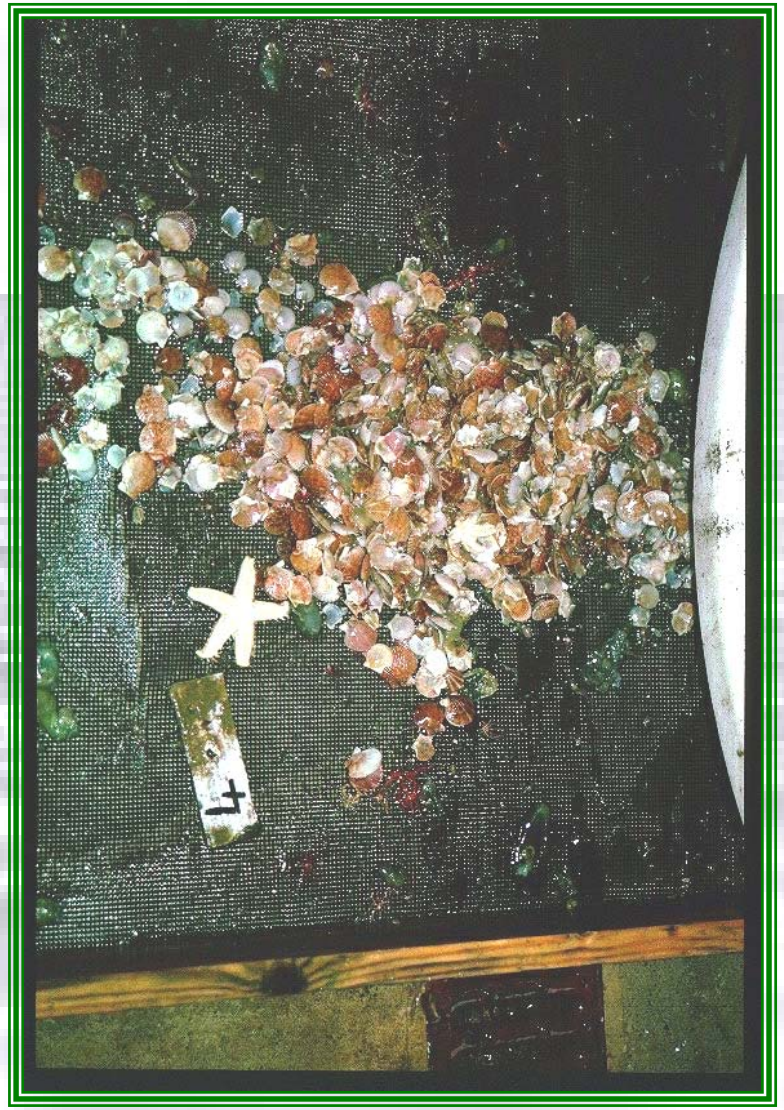
Wild Seed Collection - 4

Buying-in spat

An alternative to collecting spat yourself is to buy them from others who collect on a commercial basis. This is only economic for King scallops.

In autumn, 2001, seed collected from Mulroy Bay were available at around 2.5 p per shell for 10-15 mm seed.

Over-wintered 1-year old King scallop seed (25 mm) and 2-year old stock (50 mm) were available at 6p and 16 p per shell respectively from growers in Raasay Sound, Isle of Skye.



The unsorted contents of a collector bag

Transporting spat

The time taken to transport spat and seed from the collecting site to the on-growing site is critical to their subsequent growth and survival. The maximum that scallop juveniles can be held out of water in damp, humid conditions is no more than 12 hours. Even then, this can sometimes be too long if the animals are not in peak condition before being transported.

While they are out of water, major physiological changes occur. Ideally they should be transported in water (e.g. in well-boats) or in vivier lorries but this can be costly. Scallops are sublittoral animals and are therefore poorly adapted to survival out of water.

If held out of water for more than 12 hours, scallop spat and seed will gape widely and be unresponsive to touch.

The number of flaps they make on return to water, and the recessing speed and righting behaviour of animals once they have been transferred to the seabed (or into a test tank) can also be used as a rough guide to their condition and chances of survival.

Nursery Stages - 1

Scallop spat (at 10 – 15mm) can be taken off the collectors in October/November (i.e. 3 to 4 months after the peak spawning period) and transferred into 4.5 mm and 9 mm mesh pearl nets with 10 nets per dropper.

As a guideline for stocking scallops in pearl nets or lantern nets, the area of floor space occupied by the animals should not exceed 33%. This gives them room to grow and prevents the shells from interlocking which can lead to mis-shapen animals and mortalities. This normally corresponds to 80-100 small (10-20 mm) seed and 20-30 larger (20-30 mm) juveniles per pearl net.

Some growers transfer spat directly from collectors into lantern nets they have made themselves from plastic discs surrounded by a disposable outer mesh. These may be much cheaper than Japanese lantern nets. Initially 100 spat are stocked per level and then thinned to 50 per level in the spring.

Nursery Stages - 2

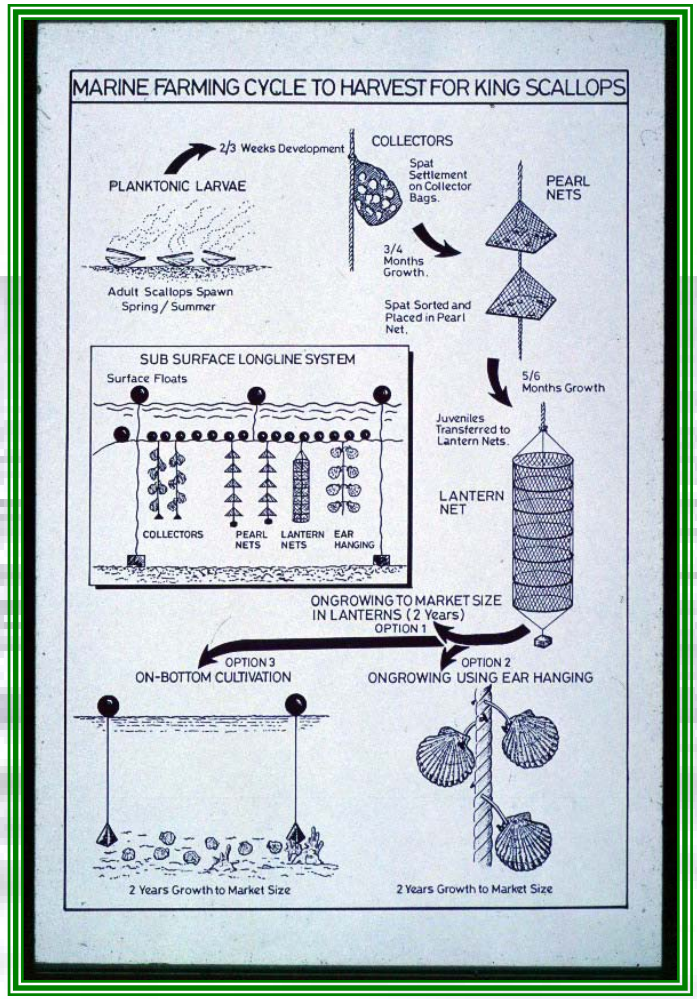
Another option is to transfer spat from the collectors to North-west Plastic (NWP) trays placed in stacks on the seabed or suspended from longlines. Using the latter method, trays should be held at least 3m below the surface of the water or growth could be retarded by freshwater layers in winter, higher temperatures in summer and lower food levels throughout the year compared with deeper water. Holding spat in NWP trays is not successful if sea water temperature drops below 10 ^{o}C.

Queen scallop spat may be transferred to pearl or lantern nets for on-growing in a similar manner to King scallops. However, it may also be placed directly in to disposable 'pocket net' systems which can be used for growing through to final harvest.

MAIN ONGROWING TECHNIQUES

The ongrowing options for King scallops are shown in the figure. Once the "nursery" phases in pearl and lantern nets have been completed, the 3 main options for ongrowing are:

- **Sub-surface longline**
- **On the bottom**
- **Ear-hanging - this is no longer considered economic in the UK and is not practised by the industry.**



Ongrowing - 2

Suspended Cultivation - 1

Once they reach 50 mm and are less prone to predation, there are different options for the final stages of cultivation. Queen scallops can be harvested or held ready for market in lantern nets. King scallops can be grown in lantern nets on longlines until they reach market size (initial stocking densities for 60-80 mm scallops is 10-15 per layer) or they can be transferred to the seabed for the final stages of on-growing. Another method that has been used is called ear-hanging where a hole is drilled in the shell and the scallop is tied to the longline. Seabed cultivation is the better option. Unless lantern nets are cleaned on a regular basis, particularly during the summer months, they can become covered with fouling organisms. This reduces the water flow through the nets and hence decreases the food available to the scallops inside. The shells of the scallops can also become heavily fouled in suspended culture and this is likely to decrease their value at first sale.

Longline at stern of boat ready for deployment

Suspended Cultivation - 2

Suspended cultivation is likely to be more expensive in terms of time and money as it involves regular maintenance of nets and the addition of extra buoyancy as the scallops grow and the longlines get heavier. As a guide to manpower requirements, for a 100 t farm 2 full time staff, with diving experience, would be needed initially when the farm was set up. An additional 2 or 3 casual staff would be required at busy times such as grading juveniles and restocking nets, and at harvest.

At all stages during cultivation, even when animals are 50 mm they should not be kept out of water for too long. It is important to remember this when taking scallops off collectors, when putting them into pearl nets, and when cleaning and changing nets or transferring scallops to the seabed. It is especially important in the summer when air temperatures are high. It is also best not to handle or disturb stock when water temperatures are at their lowest in December through to January/February.

Ongrowing - 4

Seabed Cultivation

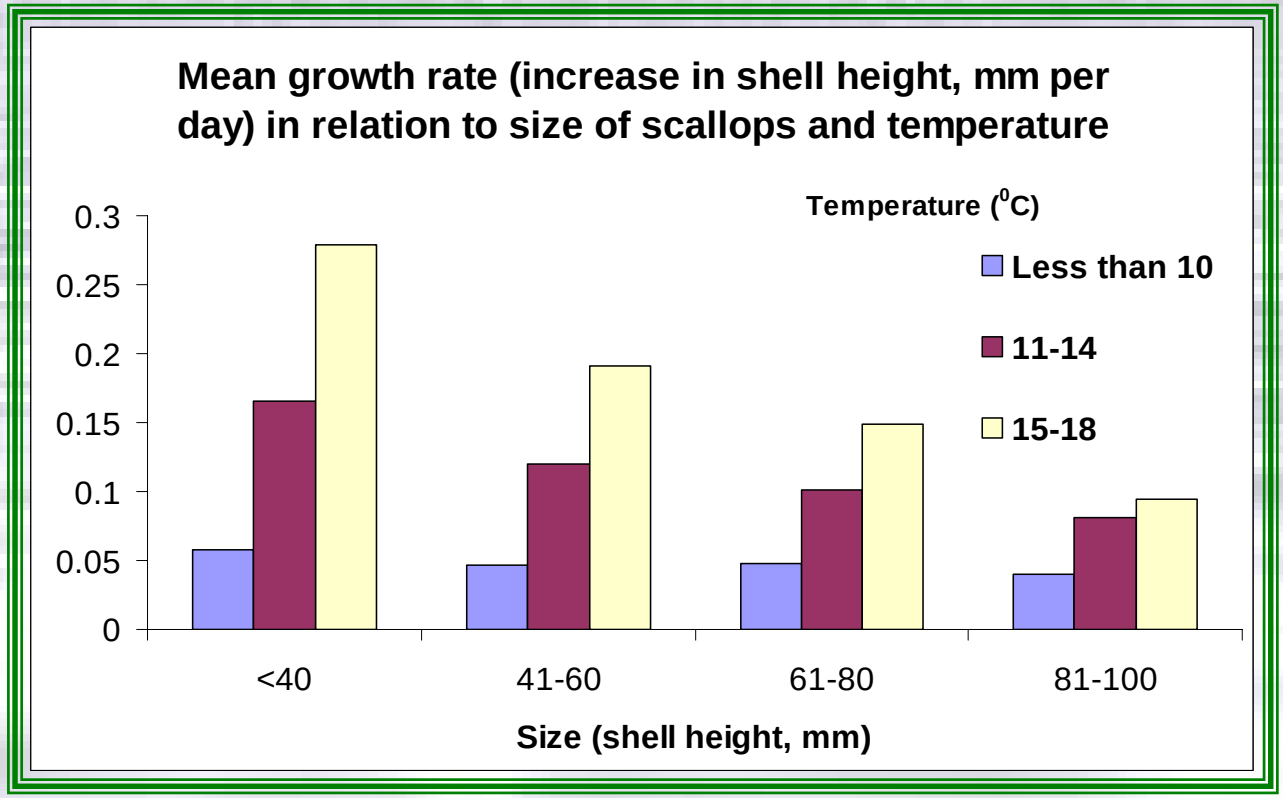
King scallops are transferred to the seabed at 2-years old (50 mm shell height). If they are seeded over areas containing older year classes, producing a plot containing mixed ages and sizes, then predator removal can be conducted at the same time as harvesting scallops. It is very important to remove larger starfish and other predators before seeding takes place by making regular dives during the week before seeding to remove any predators from the area. This needs to be continued for three weeks after seeding to reduce losses from predation because juveniles are at their most vulnerable at this time.

As scallops are mobile, they can move from seeded plots if conditions are not suitable or there are strong currents. To help prevent this, reseeding is best carried out in the spring and summer. A good indication of the suitability of the site and the condition of the stock after seeding is how quickly they recess into the sediment. For example, scallops are more likely to swim away off a hard substrates than a sandy substrate. Seeding densities are normally 5 or 6 animals m^{-2} but in extremely good sites have been as high as 24 m^{-2}. If the density is too high, the animals are more likely to starve and die.

Some growers have looked at 'cage' systems for holding or containing animals on the seabed. It is possible to erect rigid mesh fences or cages around plots to help prevent scallops from swimming away. Regular checking of enclosures and the removal of predators is essential. Stacks of NWP trays and heavy cages have also been used. There is limited information on the criteria for these methods and their advantages/disadvantages compared with other techniques. As a general guide, a high current speed (> 2 knots) is needed to ensure scallops in the centre of cages get an adequate food supply. A firm substrate is essential to prevent the structure sinking into the substrate and depths of 5 - 20 m are likely to be the most suitable for this type of culture.

Growth in relation to size

The growth rate of scallops, as increase in shell height (mm per day) varies with shell size as well as with temperature. However, as the animals grow, these differences become less ie. a large scallop grows at a similar rate regardless of temperature, whereas a small scallop grows faster the higher the temperature.



Courtesy CEFAS/LINK

Ongrowing - 6

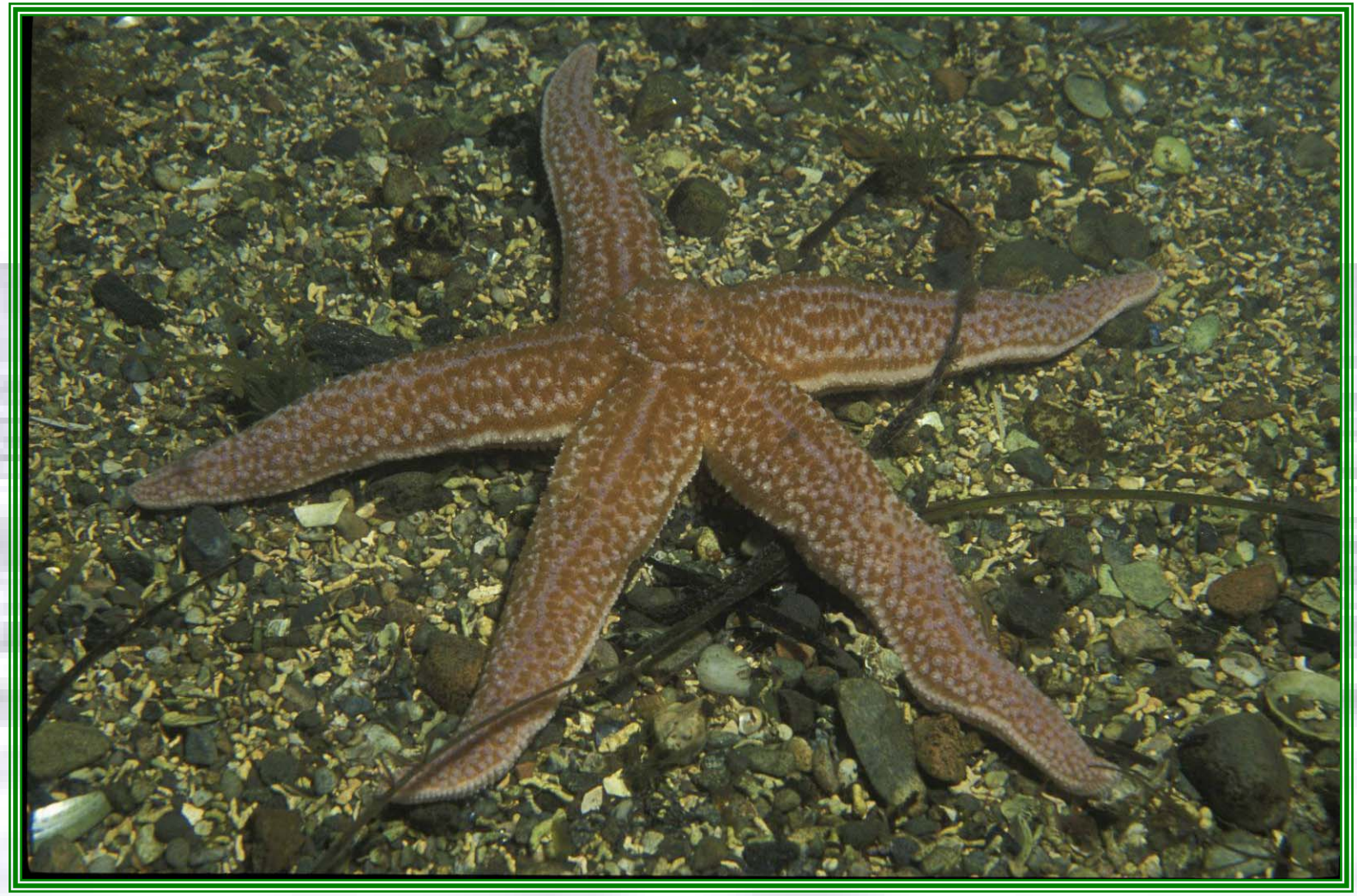
Predators

There are several natural predators particularly when scallops are cultured on the seabed. The more abundant are the common starfish (*Asterias rubens*) and crabs (including the shore crab, *Carcinus maenas*, and the edible crab, *Cancer pagurus*). Starfish pull apart the shell valves of the scallops to consume the meat inside. Fish can pick at the tentacles if they protrude beyond the margins of the shell. Scallops are mobile animals and can swim short distances to escape from predators.

When scallops are contained in nets on longlines, they cannot swim away from predators. As all of the common predators have planktonic larval stages, they can settle inside the nets and become a threat. You can help reduce the number of predators and competitors by trying to avoid changing or cleaning nets until after they have spawned and their larval stages have settled. Clean meshes seem to attract more starfish larvae to settle on them compared with nets that are covered in fouling organisms. In bad years, there are reports of as many as twenty starfish in each collector bag and sometimes as many as forty have been found but it is very variable from year to year. Smaller-mesh nets seem to reduce fouling on the scallops when in suspension.

As a guide, you can help to avoid the settlement of crab larvae by keeping collectors and nets > 5m off the bottom. Starfish larvae tend to settle on structures nearer the surface of the water and it is advisable to set collectors deeper than 8 m from the surface.

Ongrowing – 7 (Predators)



Common starfish

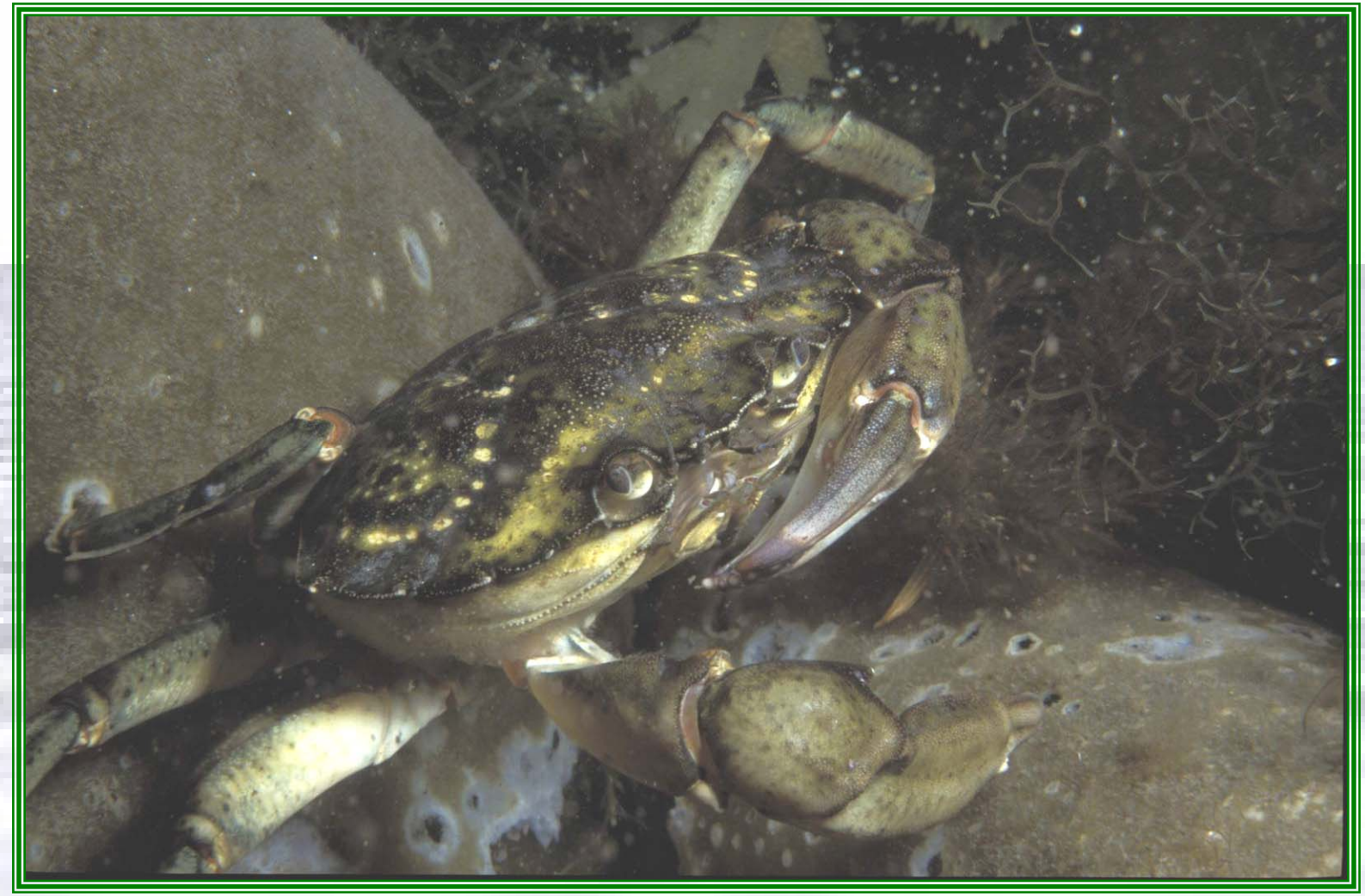
Courtesy C Burton

Ongrowing – 8 (Predators)

Edible crab

Courtesy C Burton

Ongrowing – 9 (Predators)



Shore (Green) crab

Courtesy C Burton

Competitors

Competitors such as sea squirts, bryozoans, tube worms, mussels and barnacles often occur as fouling organisms on pearl and lantern nets and on scallop shells. It can be costly because it increases the weight and drag of longline systems and can affect the appearance of the shell. Heavy fouling reduces water flow rates through the nets, the fouling organisms compete for food, they can smother spat in severe cases and low oxygen levels may occur inside the nets. Cleaning or changing pearl and lantern nets is a solution but it can be stressful to the scallops and reduce growth rates.

Transferring King scallops to the seabed at 50 mm helps to keep the shell clean because of the abrasive action of the sediment.

Ongrowing – 11 (Competitors)

Juvenile scallop covered in barnacle, sea squirt and hydroid fouling

Environmental Issues

Shellfish cultivation is still at the mercy of unpredictable natural events. Closures of areas as a result of biotoxin outbreaks can have serious effects because harvesting of the shellfish is stopped until the harmful algae disappear. Biotoxin outbreaks are the result of the presence of toxic microalgae species in the water. The metabolites they release are accumulated in the tissues of shellfish. Once the toxic algae disappear from the water, toxins in the shellfish also disappear. Amnesic Shellfish Poisoning (ASP) has been particularly devastating to the natural scallop fishery in Scotland although Queen scallops seem to be less affected than King scallops.

At the current scale of scallop cultivation in the UK, environmental impacts of cultivation techniques are likely to be minimal. The colour and size of marker buoys etc. on longline systems is something that you should consider so as to minimise any adverse visual impacts. In most, if not all cases, cultivation sites will be in deeper water with access by boat. On occasions where you may be on the foreshore, there may be some disturbance to birds feeding. Usually, this is intermittent and of a localised nature and should cause no more harm than someone walking or bird watching on the beach. Keeping to recognised tracks can minimise any effects of treading and of tyre tracks from vehicles that may be brought on to the foreshore.

SUMMARY

TYPICAL SEABED CULTIVATION CYCLE - SCOTTISH SITUATION

Year 1

Install longline (May/June); make up spat collectors; spat collectors out (July); add buoyancy to line as required. (An alternative is to buy in 1-year or 2-year old stock in May.)
Collectors in (mid/late October); sort and grade spat; transfer to pearl nets before sea temperature < 10 ^{o}C.

Year 2

Repeat collection of spat by installing new longline (May/June). Clean and inspect other longline.
Clean/inspect over-wintered year 1 stock and transfer from pearl nets to lanterns (May/June when sea temperature > 10 ^{o}C); buoy line; inspect/clean stock in lanterns (September/October).
Collectors in (mid/late October); sort spat etc. as in year 1.

Year 3

Clean/ inspect longline. Repeat spat collection.
Remove predators from on-bottom site. Transfer 2-year old scallops (> 50 mm) from lanterns to bottom (May - October).
Over-wintered stock to lanterns.

Years 4 and 5

Repeat year 3

Year 6

Repeat year 3.
Longline maintenance and replacement if necessary.
First harvest of approximately 25-50 % of first seeding (Year 1) stock (November/December).

Year 7

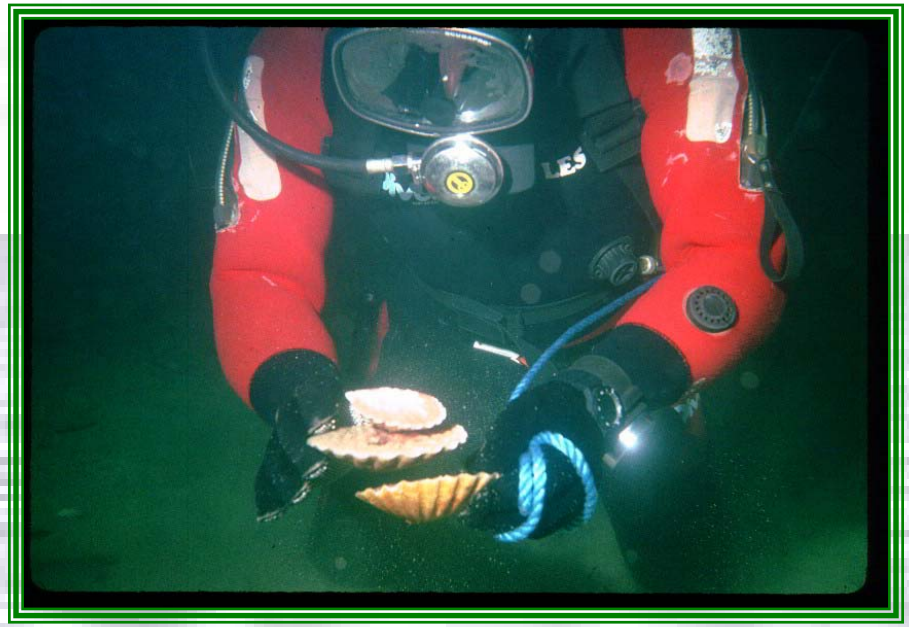
Repeat year 3.
Harvest remaining 50-75 % of year 1 + 25-50 % of year 2 stock .
Clean and inspect equipment

Year 8

Repeat year 7, harvesting stock from previous years that have reached market size.

Harvesting - 1

In cultivation, King scallops are generally considered ready for market when larger than 120 mm shell length (at approximately 250 g live weight, giving a meat yield of 55 - 60 g). The time taken to reach this size varies depending on whether you are in the south of England, where it can be 3 - 4 years from spat collection, or in Scotland, where it is more likely to be 5 - 6 years. You can harvest scallops at 100-110 mm shell length (approximately a year earlier) but the price you are likely to get for them may not make this worthwhile. The time taken to reach market size and the selling price are major economic considerations when setting up your farm.

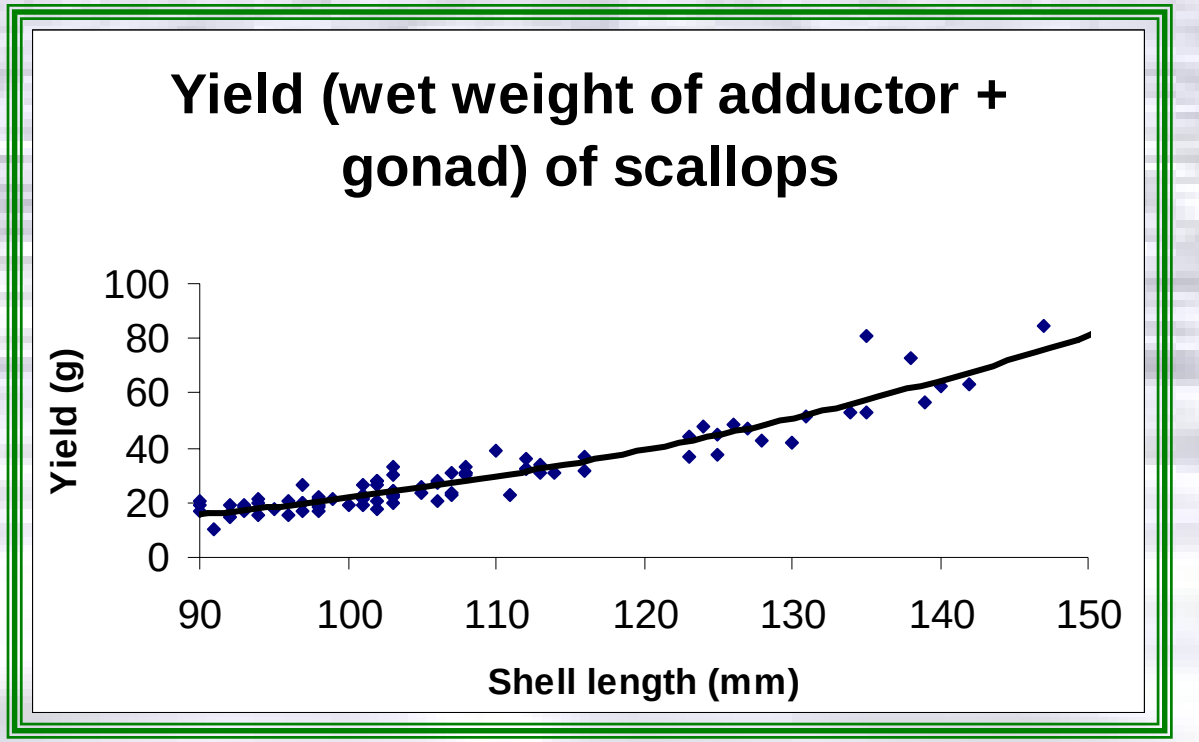


Queen scallops can be harvested after 2 - $2^{1/2}$ years (at around 40 g live weight, giving a meat yield of 10 g). Smaller animals can be sold as 'Princess' scallops. If you are intending to produce King scallops on your site, cultivating some queen scallops is often a good way to help with your cashflow, particularly during the early years of establishment and production.

Harvesting - 2

Yield

The 'meat yield', which is the combined wet weight of the edible parts, i.e. the adductor muscle and gonad, from market size scallops increases with shell size. The larger the scallop the greater the proportionate gain in the meat yield, this is why larger animals attract a higher price in the market. This has been in incentive for producers to retain their stock for an additional year of on-growing after it has attained the minimum marketable size. However, in recent times, the need to generate cashflow has reversed this trend.



Courtesy
CEFAS/LINK

Harvesting - 3

When harvesting from longline systems, any scallops too small to harvest can be put back into lantern nets for further on-growing. When divers harvest King scallops off the seabed, they can select just those that are large enough to sell. Diver-caught scallops are a premium product and can generally be sold for a higher price than scallops dredged from a commercial fishery. However, the value of farmed stock is controlled by the price of the wild fishery catch and you will need to lift between 300 and 400 animals per dive for it to be worthwhile.

The best time for selling scallops is in December for the Christmas market. Demand is generally at its lowest between Christmas and Easter. It is advisable to try and sell to local markets because scallops have a relatively short shelf life compared with most other bivalve shellfish so you do not want to have to transport them long distances if it can be avoided. However, there are good markets abroad for King scallops, particularly in France. A variety of scallops species are cultivated in several countries around the world and you need to remain aware of any potential competition from cheaper imports.

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 scallop production

Hatchery - 1

In the event that hatchery-reared scallops became required within the UK, a “typical” scallop hatchery would be located near to the sea, and housed in one or more buildings. In addition there may be outdoor tanks for water storage and other purposes. The seawater supply would be pumped into the unit - either continuously or on an intermittent basis. The Marine Farming Unit at Ardtoe provides an indication as to how a larger hatchery facility might look.

Broodstock Holding

Scallops for use as broodstock are usually conditioned at sea before transfer to on-shore tanks which can be of any shape or size. In the tanks, they are fed a diet of micro-algae to maintain condition until they are spawned.

Hatchery - 3

Algal Culture Unit

Reliable daily production of high-quality microalgae is essential in any marine bivalve hatchery. Whilst not technically complex, there are a range of production options to consider. Algae is usually sub-cultured in 250 mL, 1L and 10L flasks.

Bulk algae can be grown in carbouys for regular daily cropping. Polythene bags or even large tanks are also common, and cropping can be semi-continuous or on a batch production basis.

Algal production in carbuoys

Algal production in 100L bags

Hatchery - 4

Larval Culture Vessels

Scallop larvae can be held in a variety of tanks and vessels during the algae feeding phases

Larval rearing bins

Wild Seed Collection

Artificial collectors are designed to provide a suitable surface for larvae to settle on (a net filler) and an outer bag to give rigidity and prevent loss of spat. They are made of a monofilament bag with a 6 mm lockstitched mesh (such as an onion bag), containing a filler material such as 5x5 mm netlon mesh to give a large surface area and tied at the neck. The collector bags are attached to the dropper ropes at 0.5 m intervals and should be held at depths >2m above the seabed to avoid heavy fouling, siltation and crab predation.

An example of spat collector bags

Wild seed collection - 2

Recovering spat collectors from the longline

Wild Seed Collection - 3

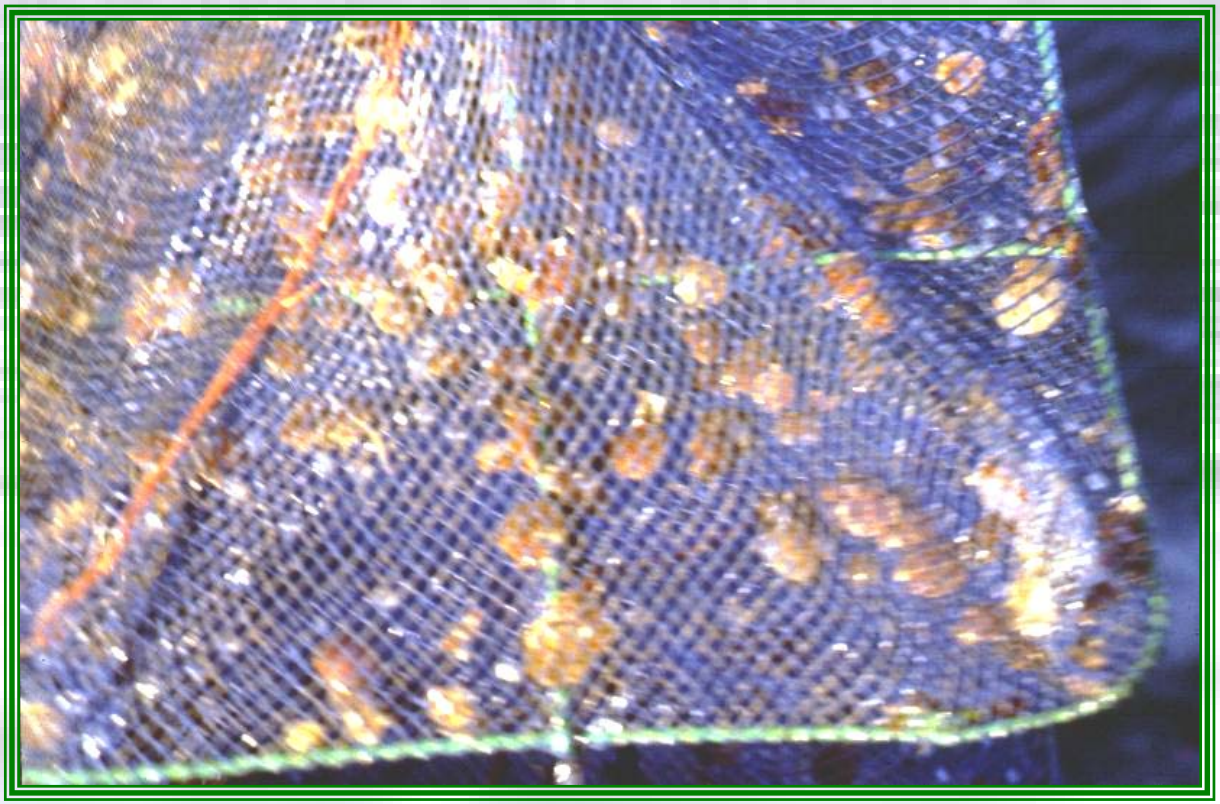
Spat can be washed gently from the collector bags

Wild Seed Collection - 4

King scallop spat after separation from other material in the collector bag

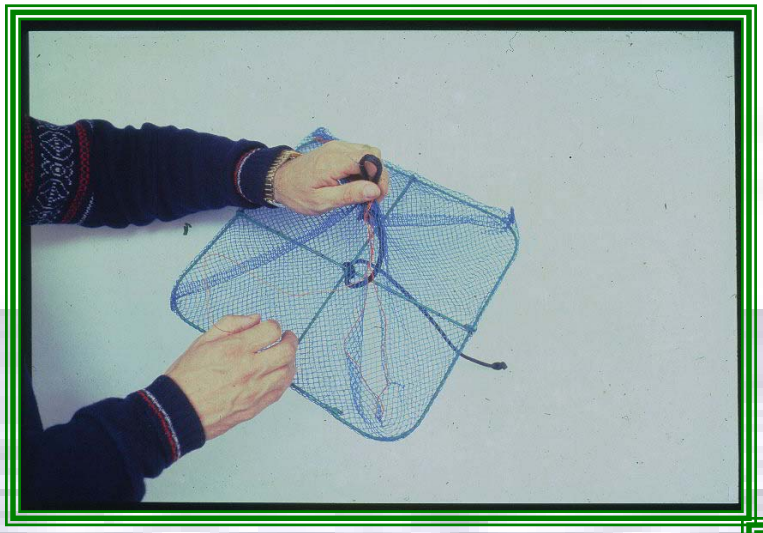
Nursery Units - 1

Whether from a hatchery or from the wild, small scallop spat has to be placed in “pearl Nets” and the “lantern nets” suspended from the surface. Pearl nets and lantern nets are available commercially although it may be possible to make a cheaper alternative yourself, if you wish. Scallops are put into the nets through an opening along one side which is then loosely sewn together to prevent them from escaping and to prevent predators getting in. (NB All of the predators have larval stages which can settle inside the net)



Scallop spat in a pearl net

Nursery Units - 2



A pearl net

A lantern net stocked with juvenile scallops

Ongrowing - 1

You will need a boat for getting to your site and for working the gear or using as a diving station. Its size will depend on the scale of your farm but a suitable boat is likely to be between 6 and 10 m long, have a maximum displacement of 3 to 4 tonnes with an inboard diesel engine. A large, self-draining deck is essential. Some useful pieces of equipment on deck include pulleys, line haulers, winches and lifting arms. Particular attention should be paid to stability requirements under side-loading.

Landing craft-style vessels can often be suitable

Ongrowing -2

Longline Details

As a guide, a minimum of 3 longlines will be needed for producing 100, 000 scallops (25 t). Longlines can vary between 100 m and 350 m although many growers use longlines that are 200 m long with headlines made of 16-18 mm 'seasteel' rope. Generally, the line will need to be replaced every 6 years, unless 'seasteel' is used. The headlines should be 8 -10 m below the surface to protect the stock from the effects of wave action and heavy fouling. Dropper ropes for collectors and nets are in 8 -10 mm polypropylene rope and they should be at least 2 m short of the seabed to avoid siltation and predation. A weight (1 - 5 kg) should be attached at the end of each dropper to act as a ballast. Collectors for catching spat, and pearl nets and lantern nets for on-growing the scallop spat and juveniles (see below), need to be spaced 1 m apart along the headline. The moorings for each longline can be a single 2-tonne block or a steel anchor (40 kg) weighted with link chain at each end of the line. The anchor warp should be 18 mm rope. If two longlines are laid, one continuing after the other, then you will need only three blocks or anchors for two lines rather than four. Additional buoyancy will need to be added to the line as the weight of the stock increases. Surface buoys are used only as markers and if only $^1/_3$ of the buoy is visible, additional sub-surface buoys will need to be added.

Ongrowing - 3

Longline with Japanese anchor coiled for deployment

Ongrowing - 4

Paying out a longline from the stern of the vessel

Ongrowing - 5

Pearl nets suspended from the longline headrope

Ongrowing - 6

Preparing to deploy a lantern net

Ongrowing - 7

Queen scallops in a ‘pocket net’ on-growing system

Ongrowing - 8

An example of scallops growing on the seabed

Courtesy C Burton

Ongrowing - 9

Drilling a juvenile scallop for ear-hanging

Putting ear-hung scallops to sea

Ear-hung scallops

Harvesting

Scallops are harvested according to their final method of on-growing:

• Suspended scallops are hauled on to the boat, in either the lantern or pocket net systems.They are removed from the nets and sorted by size. Small animals may be placed in fresh lanterns and returned to the sea whilst market-sized animals are transferred to covered baskets or bags for transport ashore.

• Seabed scallops are hand-collected by divers. They are gathered from the seabed and placed in a buoyed harvest-bag by the diver. Once the bag is full or the dive at an end, the bag is recovered in to the diving support vessel. Sorting is usually un-necessary as selection takes place on the seabed. The animals may be transferred to baskets or bags so that the harvest-bag can be re-used on subsequent dives. The stock is kept moist and protected from the environment whilst it is transported ashore.

Harvest - 2

Diver hand-gathering King scallops

Harvest - 3

Lifting a lantern net at harvest (covered with heavy marine growth of sea squirts, peacock worms and barnacles).

Harvest - 4

Harvesting Queen scallops grown in a suspended ‘pocket net’ system

Harvest - 5

Harvesting ear-hung King scallops covered with marine fouling

Depuration - 1

Experiments have shown that it is possible to successfully depurate category B level scallops to end product standards without any detrimental effects on the product quality. Standard equipment and techniques commonly used in the UK to depurate a range of shellfish species, whereby they must be purified for a minimum of 42 hours, can be used.

The technique is still underdevelopment, but the current indications (2002) are that conditions required to depurate scallops successfully are -

- Only natural seawater may be used.
- Salinity must be maintained at 30 psu or above.
- Temperature must be maintained at 10°C or above.
- Purification must commence within 10 hours of harvesting.
- Scallops may be loaded up to a maximum of 2 layers high with the cup side shell down.
- Scallops must be prevented from escaping from baskets during depuration. Any method used to contain shellfish in baskets must not interfere with their ability to open and filter.
- Scallop to water ratios should not be any less than 1:12

No upper temperature limits are set. This is because higher temperatures do not usually compromise the depuration process. However, excessively high temperatures may detrimentally effect the quality of the marketable stock. In the case of scallops previous studies suggest that temperatures greater than 18 ^{0}C should be avoided. It is known that scallops will depurate effectively at 20 ^{0}C, but with some post depuration mortality.

THE TECHNOLOGIES

Depuration - 2

Those intending to depurate should seek up to date advice on the best practice for depurationg scallops. This can be obtained from CEFAS Weymouth or alternatively Seafish Technology in Hull.

Example of a small-scale depuration unit, which might be suitable for depurating scallops

SITE SELECTION

Introduction

This section of the Hyperbook will consider how locations for scallop 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.

The selection of a suitable site is crucial to the success or failure of a scallop farm. Growth and survival of scallops are influenced by a range of physical, biological and chemical factors including sea water temperature and salinity, water flow rate and phytoplankton content, substrate type, 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 scallops grow and survive

Site selection

Introduction

Selecting a site that is suitable for scallop 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.

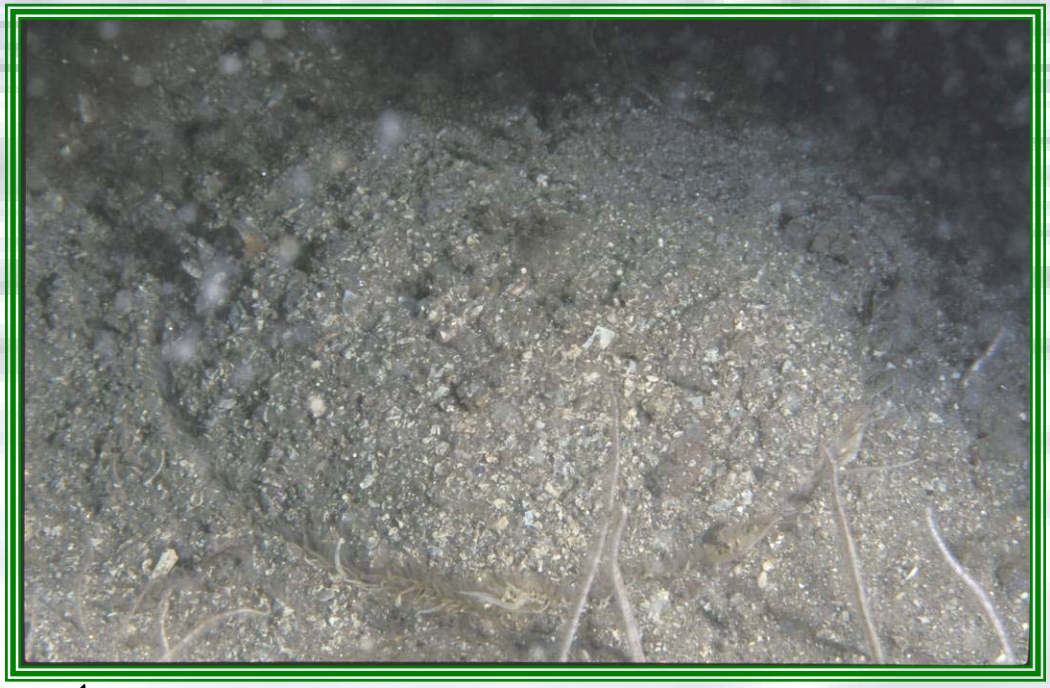
If at all possible, it is advisable to monitor the conditions at any prospective site for at least a year before any commercial culture begins and to carry out a pilot study to see how well scallops grow and survive. Growth differences between sites usually reflect differences in conditions that may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

It should also be remembered that a successful and profitable scallop cultivation operation will need good husbandry and management of the stock, as described in previous sections, as well as a suitable site.

The Site Environment - 1

Substrate

Scallops prefer substrates of clean, firm sand, fine gravel or sandy gravel, sometimes with an admixture of mud. This is their natural habitat. They will only survive on fine sediments provided current speeds are reasonably slow to prevent disturbance of the sediment, which could suffocate the scallops, if they became covered. Hard sediments are unsuitable, as the scallops are unable to bury themselves sufficiently to avoid predation.



Recessed scallops can be hard to see

Courtesy C Burton

The Site Environment - 2

Depth of water

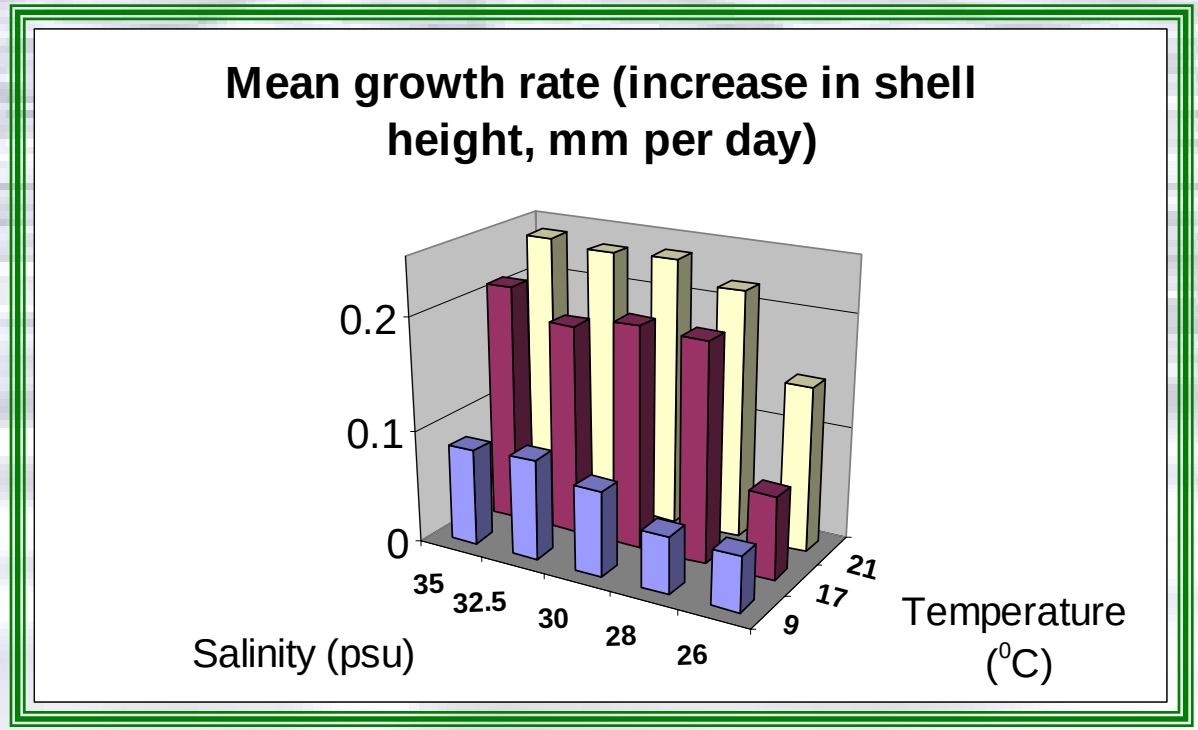
It is essential that scallops be submerged continually. Sites with a depth of water between 15-30 metres are ideal. Allowing for tidal fluctuations, it is essential that nets should not be in contact with the seabed. This avoids predators such as starfish and crabs, which are the two main enemies of scallops, gaining access during the suspended cultivation stage, when the small scallops are most vulnerable. Also, deeper water sites allow on-growing equipment to be sunk to a depth below the influence of wave action. Shallow water sites will be subject to excessive temperature fluctuations and must be avoided.

Many Scottish sea lochs, such as Loch Sunart, have areas suitable for scallop cultivation.

The Site Environment - 3

Salinity

Usually, cultivation sites are chosen at which salinity varies within 30-35 psu (practical salinity units) and where these salinity conditions prevail, it is temperature (see later) that is generally considered to be the most important factor affecting performance of the spat. However, cultivation sites may occasionally be subjected to lower salinity conditions, due to increased fresh water input from rivers and land run-off, following heavy rainfall. An ambient salinity of 28 psu or above is required for successful scallop cultivation. Below this there is a dramatic decrease in growth rate (see figure). At lower temperatures the growth at 28 psu will be slightly lower than at 30 psu.



Growth in relation to salinity at different temperatures.

(courtesy Laing (2002) Aquaculture 205:171 - 181)

The Site Environment - 4

Salinity (continued)

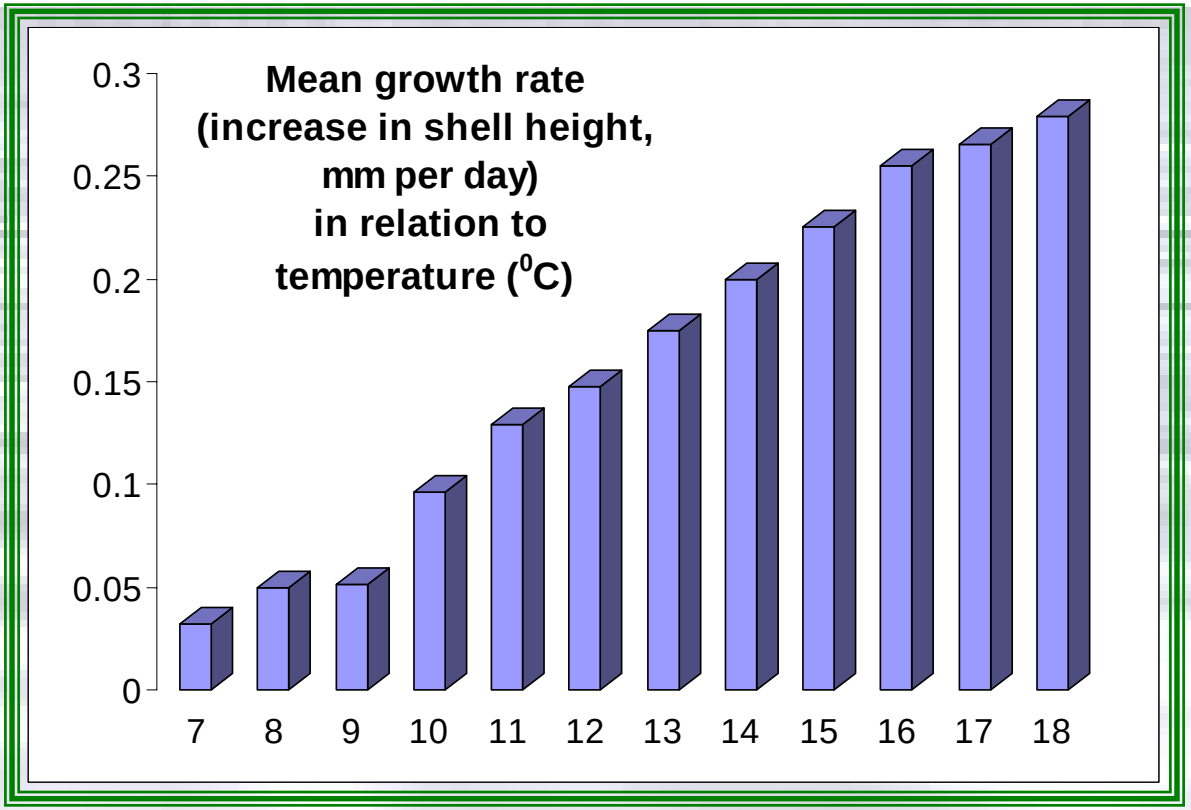
Lower salinity is stressful to king scallops. Growth rate is significantly reduced and mortality can result. However, scallops are able to tolerate short exposure (for example, up to 6 hours per day for 3 days) to lower salinity (20 psu), although this will be followed by a short-term reduction in growth rate and may also result in mortality, particularly at temperatures less than 10 ^{0}C. It is generally recognised that the stressful effect of low salinity is greater at lower temperatures. For example, one study showed that scallops can survive temperatures as low as 3 ^{o}C at salinities above 30 psu, but they may die at temperatures below 5 ^{o}C if salinity falls to less than 26 psu. Other stress factors, such as crowding in the nets during the suspended cultivation phase, will reduce tolerance to the combined effect of these extreme conditions. This shows the importance of considering local salinity profiles at potential sites where the winter seawater temperature tends to be low. If the site is also subject to episodes of low salinity then that site is probably best avoided.

Fresh water is less dense than seawater and in some circumstances, for example in calm conditions in sheltered areas after heavy rainfall, will form a layer, as much as 2 to 3 metres in depth, on the surface. Scallops will not tolerate this and it emphasises the need to keep suspended cultivation equipment well submerged at sites where this problem may arise.

The Site Environment - 5

Temperature

It is well known that seawater temperature has a major effect on the seasonal growth of cultivated bivalve molluscs. It has been shown that growth rates of scallops at existing cultivation and some trial sites in both Scotland and England are strongly correlated with temperature. This is seen from the figure.



Growth(y-axis) in relation to temperature (x-axis)

(courtesy Laing (2000) Aquaculture 183: 325 - 334)

The Site Environment - 6

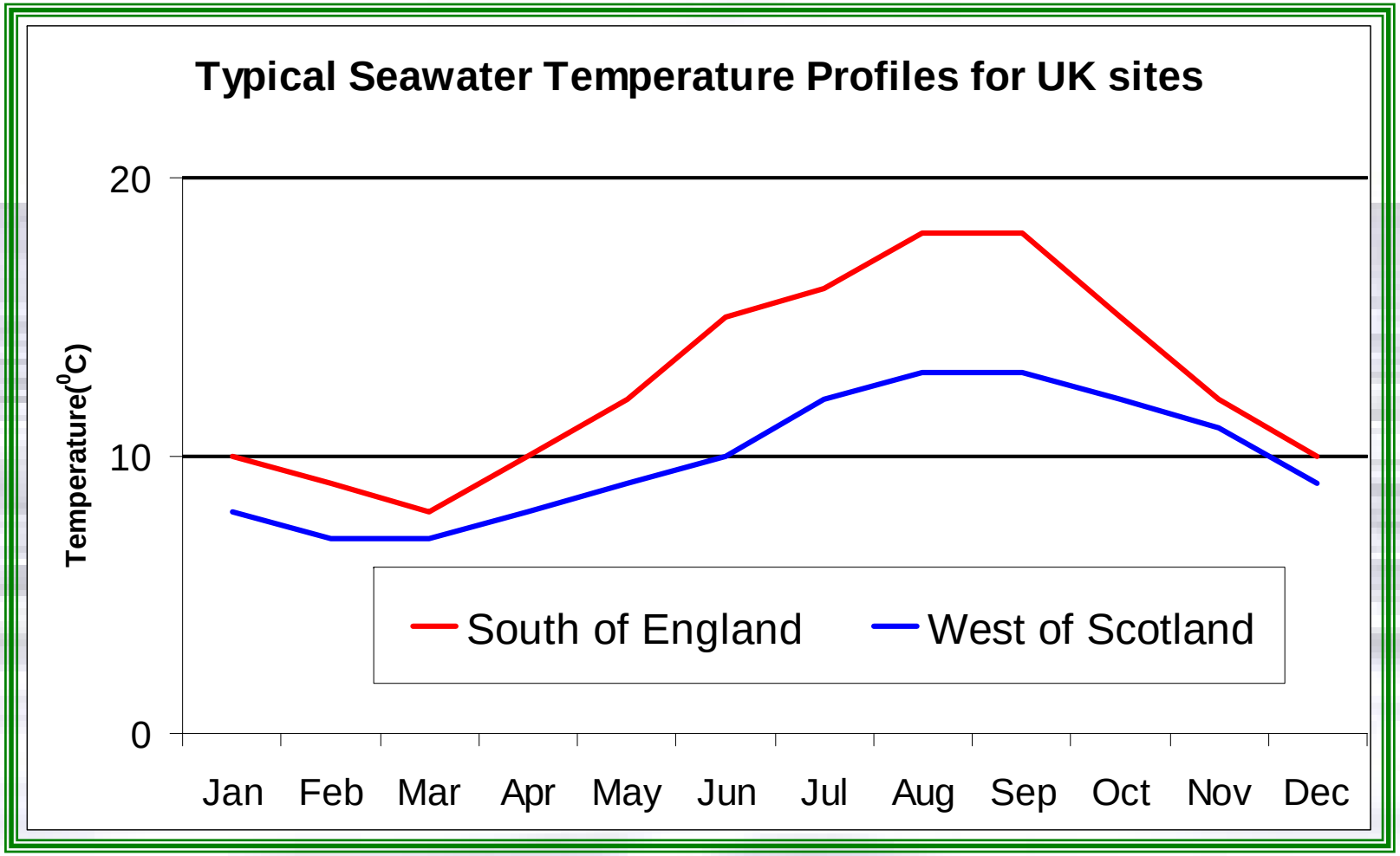
Temperature (continued)

King scallops do not grow at all below 6.5 ^{0}C. While measurable, growth is minimal between this temperature and 10 ^{0}C. This is the point above which the metabolism of the scallops changes from 'winter' to 'summer' mode. Growth rates increase with temperature above 10 ^{0}C, and, in laboratory experiments, will continue to increase up to the maximum tested temperature of 23 ^{0}C. However, at temperatures above 17-18 ^{0}C the condition of the animals tends to be lower, and there is some other evidence that suggests that these higher temperatures are stressful. It follows that the best sites for scallop cultivation are those where temperature is between 10 ^{0}C and 17 ^{0}C for the maximum length of time.

In summer, the highest mean temperatures are recorded on the south coast of England. Waters around the north and west of Scotland may be as much as 4 - 5 ^{o}C cooler. Differences are usually less in winter. However, these differences result in a longer 'growing season' (time when temperature is above 10 ^{0}C) in the south, starting in the early spring. This, together with the higher summer seawater temperatures will give shorter grow-out times in the south. Temperatures on the east coasts of both Scotland and England may decline to 5 - 6 ^{o}C or lower in winter and this, together with the lack of sheltered sites means that these areas are not usually well suited to scallop cultivation.

The Site Environment - 7

Temperature and geographical location



SITE SELECTION

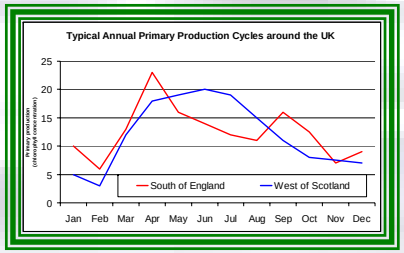
The Site Environment - 8

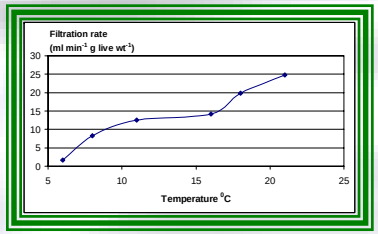
Food - the amount available

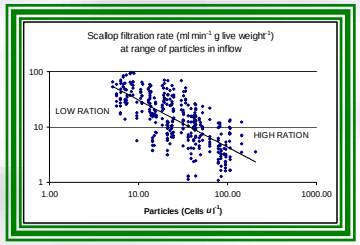
Scallops feed by filtering mainly microscopic algae (phytoplankton), but also some organic detritus, from seawater. Algae are simple types of plant and, like all plants, they contain chlorophyll. The amount of food (primary production) available to the scallops can be estimated from the chlorophyll content of the seawater. Studies have shown that the growth of small scallop spat is positively related to the concentration of chlorophyll in the water. Generally, there is abundant algae in the water during the summer growing season. The south of England line shows the classic 'twin peak' primary production curve with highest productivity in spring and a smaller peak in the autumn. However, in the west of Scotland chlorophyll levels may be maintained throughout the summer, mainly due to constant mixing of the waters and long daylight hours.

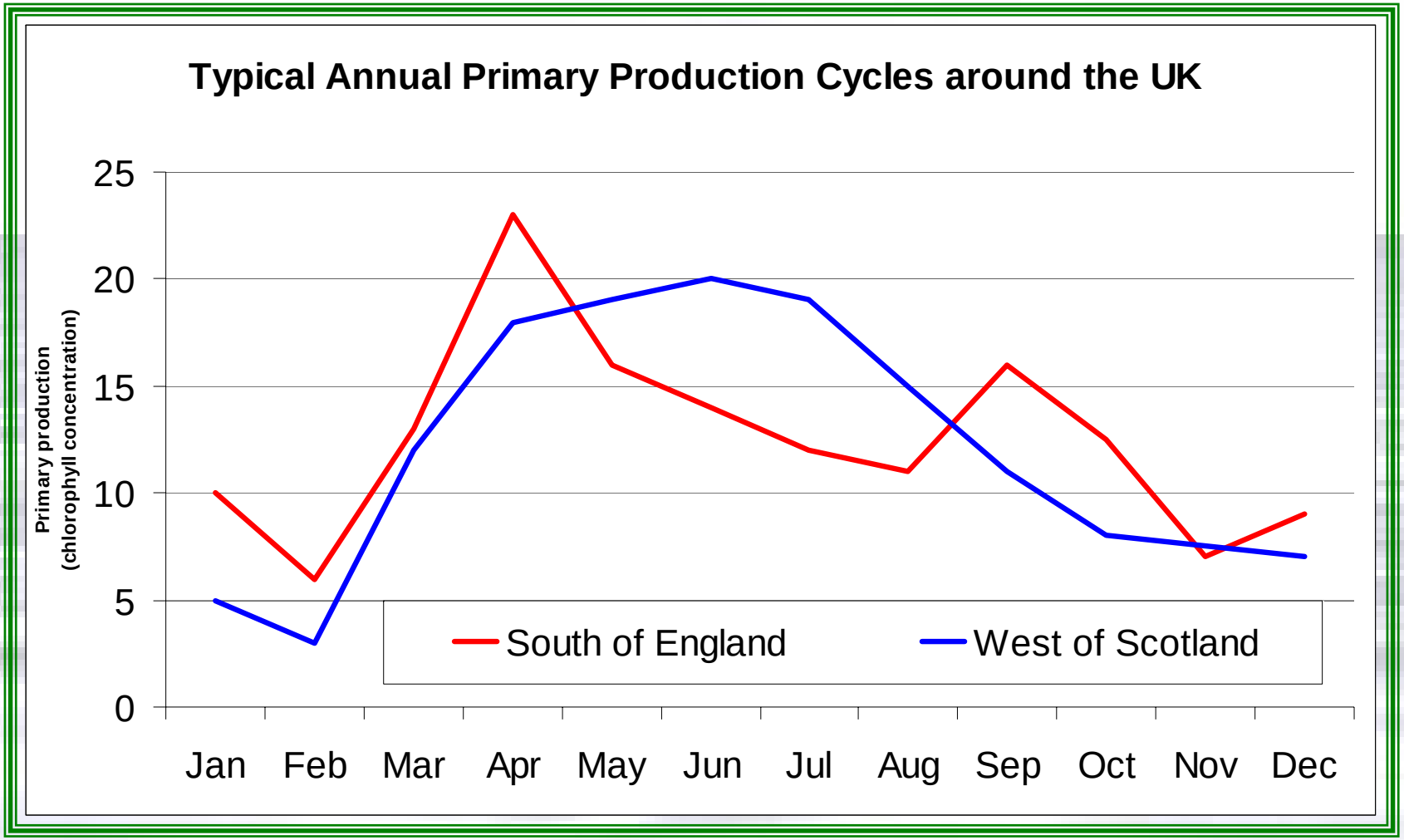
In general, scallops increase their filtration rate as temperature increases. Naturally, there is an upper temperature limit (> 25°C) beyond which the filtration rate decreases. Scallops can also regulate their filtration rate in relation to food availability; increasing it when food is less abundant and decreasing it as food becomes more available. This serves to maintain their required food intake. As a consequence, the amount of algae consumed by scallops can be estimated for any temperature. In general, most locations around the UK have more than enough algae available for scallop growth. However, this tends to be the total quantity of food available, and it does not take in to account the quality of the food.

Click on the thumbnails to see more data about food resources and feeding









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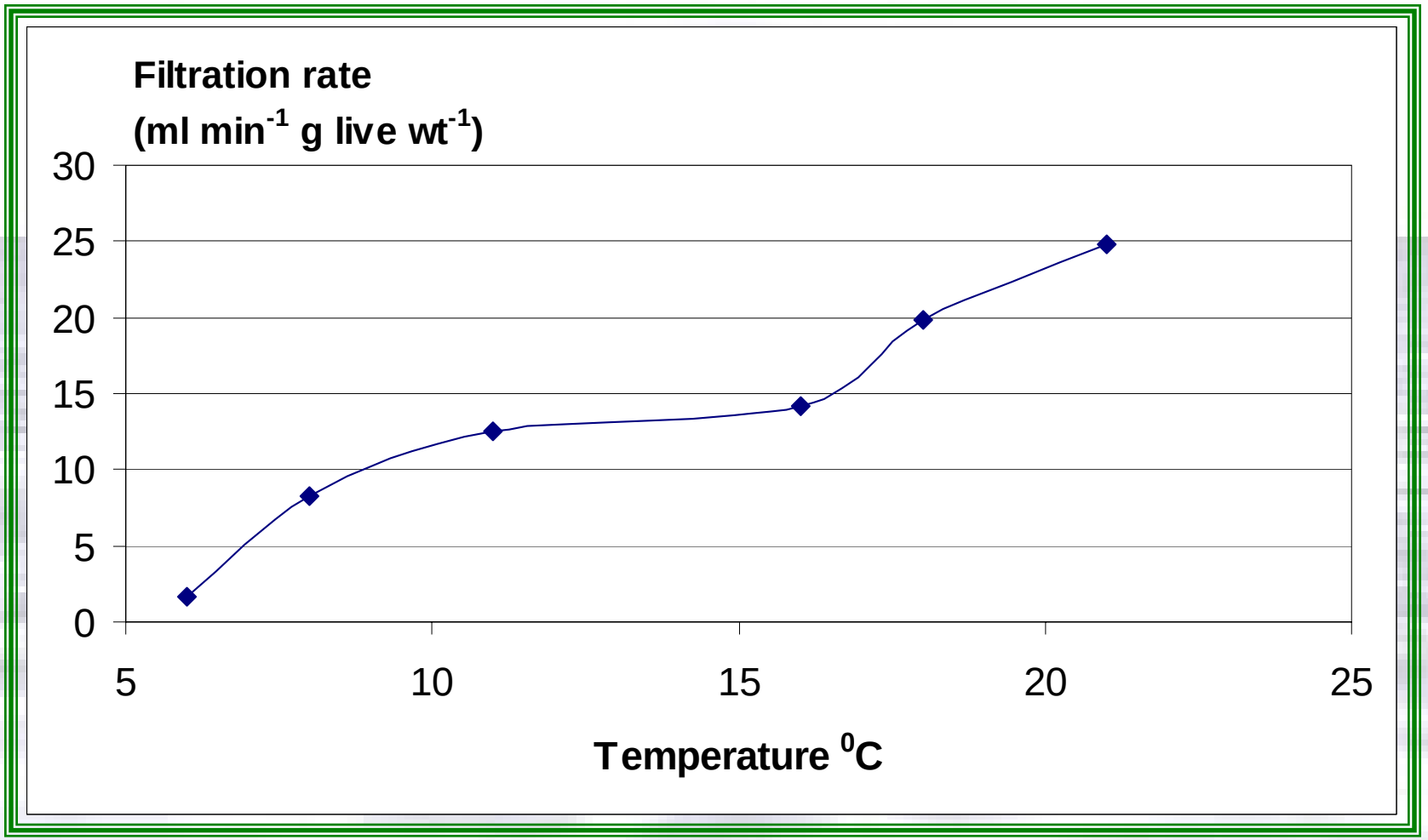

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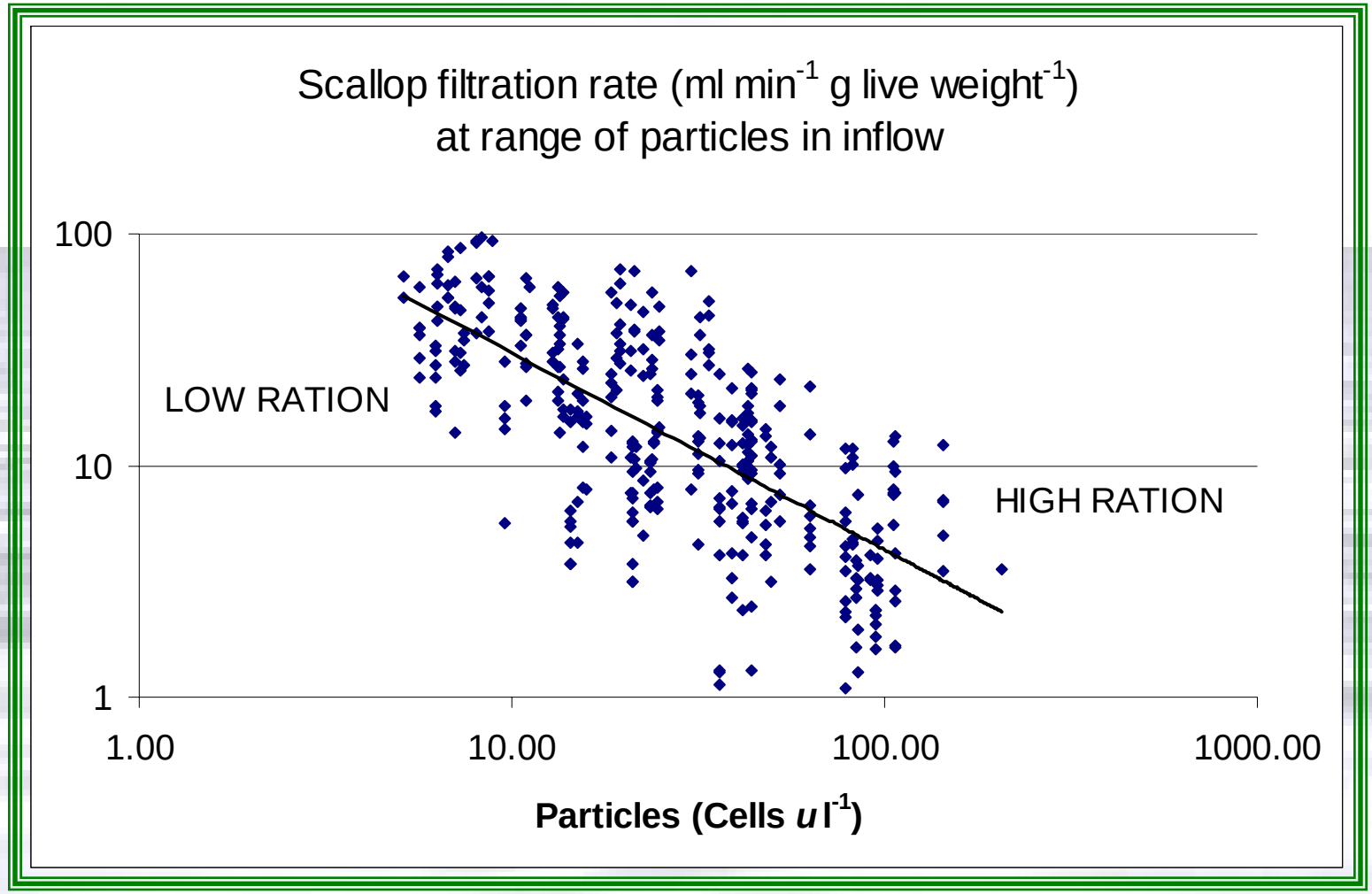

Courtesy CEFAS/LINK

The Site Environment - 9

Food - quality

The quality of the diet has an influence on performance (growth). Food quality is much more difficult to assess from water samples than food quantity (chlorophyll concentration). Filtration rate of scallops also varies with the type of algae available, being lower when species with a low nutritional value are present. As a result, growth rates may be lower than expected if the phytoplankton mix of a site is of low nutritional value to the scallops, or conversely, it can be higher if the algae is of high nutritional value.

Periods of slow growth have been observed during blooms of certain diatom and dinoflagellate species, particularly those that generate algal toxins (e.g. *Gymnodinium*). The effect is generally greater for older scallops.

The Site Environment - 10

Water quality - bacteria and viruses

As all bivalves, including scallops, filter phytoplankton from the seawater during feeding, 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 scallops 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

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

Water quality - pollutants

Waters subject to heavy industrial contamination (e.g. heavy metals and organic compounds) are unsuitable for all types of bivalve culture and should be avoided. Sites near large urban and industrial developments are generally unsuitable for scallop cultivation because of potential pollutants in the water.

The Site Environment - 12

Water quality - toxic algae

Certain types of naturally occurring algae produce toxins which can accumulate in the flesh of scallops which are feeding on them. The occurrence of the algae responsible and the levels of toxins in the shellfish are monitored closely and where concentrations exceed permitted levels the beds are closed to harvesting and the animals cannot be sold. Without this safeguard, people eating shellfish containing high levels of these toxins can become ill. Different toxins may cause either paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP) or diarrhoetic shellfish poisoning (DSP). The first two are potentially more serious since in very rare and exceptional cases they can result in death. ASP toxins are the ones most commonly found in scallops. Cooking does not denature the toxins responsible nor does cleansing the shellfish in depuration tanks eliminate them. The presence of the algal toxins does not seriously harm the bivalves themselves, although there may be a short-term reduction in growth.

An overview of the areas where sites are most likely to be affected by temporary closures as a result of algal toxins can be found in the summary of the results from the algal toxin monitoring programmes for the previous year. This is published annually in the May issue of Shellfish News - http://www.cefas.co.uk/publications/shellfish_news.htm). However, past record can be a poor indicator of future performance in many areas.

The Site Environment - 13

Exposure

The prevailing weather conditions, especially wind strength and direction, need to be considered carefully. Strong onshore winds can generate extreme wave action and there is some evidence that the disturbance this causes can affect the growth and survival of scallops in suspended cultivation, particularly of larger animals. At more exposed sites, robust installations are necessary to withstand the extra buffeting by the waves. These are usually more expensive to build and potentially more difficult to service than installations at less exposed sites.

Strong tidal currents can also damage equipment. Sheltered areas usually provide the best conditions. Suspended scallop cultivation can be successful in water of minimal flow, where water exchange is driven only by the rise and fall of the tide and gentle wave action. A current velocity of 0.4-1.8 knots (0.2-0.9 metres per second) is most suitable for suspended culture systems and 1 knot is optimal for seabed culture, although up to 2 knots can be tolerated.

The Site Environment - 14

Access

The chosen site must have good access, ideally with the potential for shore based development, for example for installing equipment for nursery stage cultivation of seed (2 to 10 mm) and/or plant for depuration tanks for cleansing the bivalves free from contamination prior to marketing. In this respect, the shore base needs to be located adjacent to the sea, where pumped seawater is readily available. For seabed or suspended cultivation of scallops it will be necessary to use a boat, and the proximity of a suitable and accessible launch site is an important consideration.

The security of a site needs careful consideration at the onset of the site selection process. Theft by poaching may be a problem in some areas.

Access to markets is also of major importance to the business enterprise. Live bivalves may be sold to local or national markets and so require ready access to an efficient road system to ensure that the product reaches its destination quickly and without loss of quality. Long journeys increase costs and should be avoided wherever possible. Scallops are particularly vulnerable to journey times of more than 60 hours. Specialised misting techniques during transport are being developed to reduce desiccation of the scallops' gills. This is to enable the tissues to receive sufficient oxygen to extend the transportation time significantly.

LEGAL AND ADMINISTRATIVE ISSUES

Introduction

To set up a scallop farm 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 scallops. 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 beds 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 scallops 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 scallops 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

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

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. While there are no serious diseases of scallops, the controls still apply, to ensure that the scallops do not carry disease to stocks of other species.

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 scallops within the UK are controlled according to the health status of these areas. Anyone wishing to deposit or relay scallops 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

Scallops 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 scallops 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 scallops 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 "exit" 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)**

  Specifically: www.cefas.co.uk/fhi

- **Department of Environment, Food and Rural Affairs (DEFRA)**

  Specifically: www.defra.gov.uk/fish

  www.defra.gov.uk/corporate/regulat/forms/fish

- **Department for Agriculture and Rural Affairs, Northern Ireland (DARDNI)**
- **English Nature**
- **Northern Ireland Environment and Heritage Service (NIEHS)**
- **Foyle, Carlingford and Irish Lights Commission (FCILC)**

- **General Guide to Government Websites**

SUPPLIERS

Introduction

This section of the Hyperbook covers suppliers to the industry who might be able to support scallop 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:

- Biological suppliers (seed)
- Hardware suppliers (equipment)
- Services suppliers (advisors, utilities, financial)

Biological Suppliers

Seed

•Rasaay Sound Shellfish Growers, c/o 2 Harrapool, Broadford, Isle of Skye. IV49 9AQ Tel/Fax: 01471 822498

•Deegagh Point Shellfish Ltd, Mulroy Bay, Cranford, County Donegal, Ireland. Tel: ++ 353 74 53122 Mobile: ++ 353 87 2061802 E-mail: slaterj@gofree.indigo.ie

Continuous algae culture units:

SeaCAPS, Seasalter Shellfish (Whitstable) Ltd, The Hatchery, Old Roman Oyster Beds, Reculver, Kent, CT6 6SX (Tel: 01227 363359/272003; Fax: 01227 740518/273775; website: seasaltershellfish.co.uk).

Algae pastes:

(Instant Algae) Reeds, www.seafarm.com

Nutrients for algae culture:

Cellpharm Ltd., Malvern Hills Science Park, Geraldine Road, Malvern, WR14 3SZ. (Tel: 01684 585345; Fax: 01684 585388; www.cellpharm.co.uk)

Hardware Suppliers

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

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

Suppliers

Hardware Suppliers - continued

Ropes

•Gael Force Marine (see moorings)

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

•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

Lantern and Pearl Nets

•Loch Fyne Seafarms, Tarbet Industrial Estate, Campbelltown Road, Tarbet. Argyll. PA29 6SX Tel: 01880 820100 Fax: 01880 820120.

•Pacific Rim Aqua Products, Dinghai, Zhoushan, Zhejiang. China. 316000. Tel: ++ 86 580 3695958 Fax: ++ 86 580 3695960

Hardware Suppliers - continued

- ***Netting:***

  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

  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

- ***Pumps:***

  Honda (UK) – Power Equipment, 470 London Road, Slough, Berks, SL3 8QY (Tel: 01753 590500; Fax: 01753 590000; website: www.honda.co.uk).

Hardware Suppliers - continued

- ***Pipework:***

  Motherwell Industrial Plastics Ltd., Braidhurst Industrial Estate, Bellshill Road, Motherwell, Strathclyde. (Tel: 01698 261414; Fax: 01698 275424).

  Pisces Aquacultural Engineers, Easter Poldar, Stirling, FK8 3QT (Tel: 01786 870014; Fax: 01786 870379; website: www.pisces-aqua.co.uk)

  Everyvalve Equipment Ltd., 19 Station Close, Potters Bar, Herts., EN5 1TL (Tel: 01707 642018; Fax: 01707 646340; website: www.everyvalve.com).

  Glynwed Pipe Systems Ltd., Headland House, New Coventry Road, Birmingham, B26 3AZ (Tel: 0121 700 1000; Fax: 0121 700 1001; e-mail: enquiries@glynwedpipesystems-uk.com).

- ***Depuration Systems:***

  CJ Skilton Aquarist (Fax: 01245 400585; e-mail: cjskilton@aquaskil.co.uk

  The Falmouth Oyster Company, Unit 2A Empire Way, Tregoniggie Industrial Estate, Falmouth, Cornwall, TR11 4SN. (Tel: 01326 374748; Fax: 01326 377668)

  Tropical Marine Centre Ltd., Solesbridge Lane, Chorleywood, Herts, WD3 5SX. (Tel: 01923 284151; Fax: 01923 285840; website: 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

- ***Washers/graders:***

  All in a Shell Ltd., Dooniskey, Lissarda, Co Cork, Ireland. (Tel: + 353 26 42267; Fax: + 353 26 42645; e-mail: allinashell@tinet.ie)

Hardware Suppliers - continued

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

General shellfish equipment & machinery:

Dryden Aquaculture Ltd., Butlerfield Industrial Estate, Bonnyrigg, Edinburgh, EH19 3JQ. (Tel: 0187 5822222; Fax: 0187 5822229).

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 moorings)

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

•Cosalt (Scotland), Unit 1 & 2, Kessock Road Industrial Estate, Freaserburgh. 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.hydroshpere.co.uk

•Gael Force Marine (see moorings)

•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 Web: www.cymru.org.uk/subiagriculture

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 scallop cultivation. The section will provide an overview of business planning, but mainly introduces the Scallop Economic Model - a Microsoft Excel-based planning tools. 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 scallop cultivation
- To use this Hyperbook to inform them about other people's plans concerning scallop 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 scallop 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 Scallop Cultivation is contained within your SCALLOP HYPERBOOK Folder. Access the READ ME FIRST file once again, just to remind yourself how to use the model.