Responsible Sourcing Guide: Scallops

Version 3 – January 2013

Pecten maximus IMAGE © Scandinavian Fishing Year Book

There are more than 40 commercial species of scallop exploited worldwide. Of these, 18 species account for the greater part of the 2.5 million tonnes (t) live weight global production from both capture fisheries and aquaculture (1). Since the 1970s, cultivation of scallops has increased rapidly and now accounts for nearly 70% of total production. As scallops command a high price they are frequently exported from producer countries to the major markets of Western Europe, particularly France, the USA and the Far East.

UK production of king (*Pecten maximus*) and queen (*Aequipecten opercularis*) scallops was 30,700 t and 12,000 t respectively in 2010, with first sale values of £49.8 million and £4.6 million. Most were exported, mainly to France, but there are also significant imports of lower value, mostly frozen scallops, from other countries. UK scallop consumption amounts around 652 t product weight worth around £M13 per annum (3). The French market for scallops is very competitive, with scallops imported from all over the world. However, the UK, Isle of Man and Ireland are well positioned to supply high quality, fresh, roe-on king scallop (Coquille St Jacques) that commands high prices on the French market.

The purpose of this guide is to review the status of all the main exploited scallop species worldwide, from both fisheries and cultivation, and to summarise some of the measures taken to manage the stocks and the environmental effects of fishing.

BUYERS' TOP TIPS

Know method of production and supply source

Scallops can be harvested from wild or cultivated stocks. They can be cultivated in suspended culture or on the seabed. You should know the method of production, since scallops grown in different environments have different characteristics in terms of meat content, shelf life and biofouling (barnacles, algae etc) on the shells. These can all affect marketability. Scallop species differ in taste and appearance. Traceability is essential to comply with EU legislation (2).

Method of production

Buying policies should bear in mind the environmental effects of the method of capture; with a gradient of increasing environmental effects from diving, through trawling to dredging. These effects can be mitigated by suitable management practices.

Beware of biotoxins

Scallops can accumulate naturally occurring marine biotoxins. In Europe suppliers have to demonstrate compliance with an end product standard (2) and its traceability to source.

Seafish Responsible Sourcing Service

This is one of a series of Responsible Sourcing Guides.

See: http://tinyurl.com/seafishrsg

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Status of scallop stocks September 2012

Biology

Scallops are filter-feeding bivalve molluscs that live mainly on sandy gravel or gravel seabeds. The Table on pages 3 and 4 lists the main species exploited or cultivated worldwide, with their most frequently used common names. Large scallops of the genera *Pecten*, *Placopecten* and *Patinopecten* can have a life-span of up to 20 years. Those of the genera *Chlamys*, *Aequipecten*, *Argopecten* and *Amussium* are smaller with a lifespan of less than 10 years, including some, like *Argopecten gibbus* and *Aequipecten irradians*, that are effectively annuals. The market value of scallops is closely related to their size. However, under some circumstances, particularly in cultivation, it may be economically preferable to harvest scallops at a smaller size than is usual for wildstock fisheries, which often have a legal minimum landing size.

Reproduction

At spawning (some species including king and queen scallops are hermaphrodites), the eggs and sperm are released into the water column, often closely synchronised to maximise fertilisation. The resulting larvae can be carried a considerable distance by the water currents before settling to the seabed typically after 30 days. Such dispersal, plus variable environmental conditions during the planktonic and early settlement stages, results in great variability in the annual settlement of juveniles, with inevitable variability in the catch. This is particularly apparent where there are few year classes in the fishery. In some areas, however, water currents retain the planktonic larvae within the parental area and these stocks have been fished on precisely the same grounds for decades (4).

Assessments

Scallops have distinct habitat preferences, aggregated distributions and a sedentary habit. This enables fishermen to adopt strategies to search for scallop aggregations, fish them down to levels no longer commercially viable and then search for new grounds. They also exploit annual recruitment of young scallops on well-known grounds. However, because scallops are sedentary, there is little mixing of adults across larger areas. The resulting degree of spatial variability of the stocks, and of fishing effort, means that the usual fishery assessment methods are not appropriate (5), and it is difficult to define precautionary reference points for scallops.

Scallop fisheries are generally managed by national and local bodies on the basis of localised stock assessments. Analysis of the age structure of a population gives an indication of its stability, as fisheries relying on populations containing a small number of age-classes (in many cases just the recruiting age-classes), are invariably less stable than those containing a broader range of ages. More detailed information on stock status can be gathered by underwater video and dredge-based biomass surveys, together with an analysis of commercial catch rates.

There is a substantial and growing literature on ecosystem effects of scallop dredging: including studies of damage and mortality of by-catch animals in the dredge (6) and on the seabed (7); detailed short-term studies of seabed substrates (8) and communities before and after dredging (9,10,11); long-term studies comparing areas of differing fishing intensity (12); studies of the recovery of closed areas (13,14,15); and comparisons between scallop dredging and other methods of fishing (16).

Name of stock	Mg'ment Authority	Catch [1] (t) 2010	Scientific status and management measures
EUROPEAN PRODUCTION OF SCALLOPS – mainly by wild harvest			
Pecten maximus Great Atlantic scallop Coquille St. Jacques	France	26,888	All stocks are fully or overexploited with fisheries more or less solely dependent on recruitment of young scallops. Stocks assessed by annual surveys. Three levels of regulation apply 1. EU sets a minimum landing size (MLS) of 100mm for all waters except the eastern English Channel, where MLS is 110mm,as well as fishing access permits. 2. National summer closure from 15 May – 1 October, minimum belly ring size of 92mm, no shucking [2] at sea. 3. Local complex series of regulations including licensing, effort, catch and gear restrictions. In Bay of Brest and elsewhere, areas are enhanced with hatchery-produced spat and fished in rotation.
	United Kingdom	30,780	Although stock status is apparently healthy with landings increasing by 50% since 2005 and catch rates and recruitment maintained in the Channel, there is no formal assessment for English and Welsh stocks. CEFAS[2] and University of Bangor are developing surveys of to fill this gap and there is also a survey in Northern Irish waters. Assessments have been carried out for Scottish stocks and there has been advice for control of fishing mortality and/or increased MLS in some areas (17). Periodic intensive fishing by large (>15m) 'nomadic' boats from England and Scotland in recent years has threatened the viability of small-scale inshore fleets that rely on local beds. As a result the Isle of Man and the devolved administrations (Scotland, Northern Ireland & Wales) introduced regulations (18,19,20) to protect stocks within their 6 and 12 nm zones and similar restrictions were introduced for English waters in October 2012(21). In all regions local gear and fishing time regulations limit inshore fishing effort and control gear selectivity. EU restrictive licencing has been applied since 1999 for vessels >10m, the permitted fish by-catch is 5% and shucking[3] at sea banned. MLS is 100mm in all waters except eastern English Channel and Irish Sea where 110mm MLS applies. The fishery is also subject to the Western Waters effort regime which has resulted in short closures during the last two years and >15m boats currently work a set allocation of days at sea. The Shetland scallop fishery is MSC certified (22).

[1] Data from FAO (1) and national sources

[2] CEFAS; Centre for Environment Fisheries and Aquaculture Science www.cefas.defra.gov.uk

[3] Shucking; removal of meat from shell

Name of stock	Mg'ment Authority	Catch [1](t) 2010	Scientific status and management measures
Pecten maximus Great Atlantic scallop Coquille St. Jacques	Isle of Man	1,316	Stock status variable, but with an overall trend of increasing abundance over the last 10 years. Stocks assessed by annual surveys. Annual seasonal closure from 1 June-31 October. Strict effort control in IoM three and 12-n.mile zones with regulations controlling boat size, fishing hours, and various technical measures governing the gear (23). Five small closed or restricted areas now protect inshore scallop stocks; the oldest has been maintained as a spawning refuge since 1989. MLS is 110mm.
	Ireland	1,975	Stock status stable. Surveys show low exploitation rates and stable age structures. Fleet capacity and days at sea limited plus local restrictions on effort. MLS is 100mm.
	Norway	748	Stocks stable with regular recruitment. Steady increase in catch over the last 10 years, particularly at S-Trøndelag. All catch by divers. Main stocks surveyed. Controlled by diver certification, daily catch limits, MLS of 100mm and options to close areas.
	Belgium	1037	Mostly beam trawl bycatch
	Others	1,667	Small, variable fisheries in Channel Islands (516 t), Spain (150t, some cultivation), and Netherlands (315 t).
Pecten jacobaeus	Italy	71	All stocks probably fully exploited or overexploited. Small, variable, fisheries with landings in Mediterranean, Adriatic and Aegean ports. Probably under-reported.
	Croatia	17	
	Turkey	4	
Aequipecten opercularis Queen scallop	Faroes	4,771	Small but stable fishery based on good stock status with consistent recruitment. Fishery managed by strict limitation on effort (only one boat licensed) and areas fished.
	France	3937	Small, sporadic, fishery based on irregular settlement. Landings have increased in recent years, mainly from the western English Channel. In addition, some 500t of *Chlamys varia* are landed annually with main grounds in the eastern part of the Bay of Brest and in the Perthuis Charentes. Local gear restrictions are applied.
	Isle of Man	2,817	Trawl and dredge fishery, with substantial spatial and temporal variability reflecting variable recruitment. Biomass increased 2004-2010 but fell sharply in 2010/11 due to very large increases in effort and landings. Main grounds to the east and south of the Isle of Man, both inside and outside the Isle of Man 12 nm limit, many coincident with *Pecten maximus* grounds. Legislation (24) restricts the type of gear that can be used, the areas where certain gear can be used, the power of vessels, a MLS of 50mm, various monitoring requirements and makes provision for setting a TAC. The annual TAC is set, based on formal stock assessments using a Catch-Survey Analysis and its uptake is managed by a Queenie Management Board (25), with UK participation. Trawl fishery MSC certified (22).
	United Kingdom	13,082	Main fishery in the Irish Sea, both inside and outside Isle of Man territorial waters, with landings mostly in Scotland; small, sporadic fisheries elsewhere. Effort and catch has increased sharply in recent years. Manx regulations apply in Isle of Man waters; elsewhere some local effort and gear restrictions.

Name of stock	Mg'ment Authority	Catch [1](t) 2010	Scientific status and management measures
WORLD PRODUCTION OF SCALLOPS – mainly by wild harvest			
Placpecten magellanicus Sea scallop	USA	215,270	Massive wild capture fishery on inshore and offshore fishing grounds. The offshore Georges Bank and mid-Atlantic grounds are by far the most productive, with all shucking at sea. Offshore stocks assessed by a spatially explicit, size-based model (CASA),tuned using dredge and video camera survey data (26). Landings mostly by 350 large vessels with limited access permits, managed using long-term and rotational closed areas, output controls (limits on landings per trip combined with allocations of trips to recently reopened rotationally closed areas), and input controls (days-at-sea, crew and gear limits) in other areas. In addition, some 600 smaller vessels with 'general category' permits dredge mainly the nearshore beds with a restrictive ITQ. Biomass and landings historically cyclical but very high in recent years since rotational closures have enabled high densities of young scallops to be protected and larger scallops to be targeted.
Placpecten magellanicus Sea scallop	Canada	59,700	Inshore and offshore fishing grounds, with the Canadian portion of Georges Bank the most productive. Stock status varies by area. Most areas managed by annual quotas including enterprise allocations, individually transferable and competitive quotas. Targeting of fishing effort using multibeam sonar limits footprint of the fishery to dense aggregations, reducing environmental impact. Offshore fishery MSC certified(22)
Zygochlamys patagonica Patagonian scallop	Argentina	50,870	Offshore fishery on extensive beds at the shelf-break front along the 100m isobath. Managed by FRC with scientific advice and surveys. Two companies licensed, each with two factory ships fishing with bottom trawls. Adaptive management with total allowable catch (TAC) set at 40% of biomass, open and closed areas, some rotational harvesting, ITQ quota. MLS 55mm. MSC certified (22).
Argopecten gibbus Atlantic calico scallop	USA	Historically 0 – 170,000	Highly variable stock and fishery. Once massive (1980s), now very small due to irregular recruitment, high exploitation and disease. Stock may return but fishery may not as catching and processing capacity has been lost.
Argopecten irradians Atlantic bay scallop	USA	486	Inshore populations along east coast USA. Very limited commercial fishing but large recreational fishery and some cultivation. Landings mostly August-December. Protected resource throughout range with strict local catch limits and many stock restoration projects.
Argopecten purpuratus Peruvian calico scallop	Peru	62,827	Stock abundance and landings highly variable, correlated with El Niño-Southern Oscillation Cycle: currently the highest ever recorded. Wild harvest by divers closely follows stock biomass. Stocks in south Peru have declined but effort has moved to bays in northern Peru where stocks are increasing, aided by restocking. MLS 65mm but no monitoring.
Patinopecten yessoensis Yesso scallop Japanese scallop	Russian Federation	3,508	Wild populations mostly overexploited. In addition, suspended and seabed cultivation is developing (854 t in 2010) but great scope for expansion.

Name of stock	Mg'ment Authority	Catch [1](t) 2010	Scientific status and management measures
WORLD PRODUCTION OF SCALLOPS – mainly by wild harvest			
Chlamys islandica Iceland Scallop	Canada	508	Main areas St Pierre Bank and Quebec. St Pierre Bank is a quota managed fishery, with shared jurisdiction between France & Canada (70:30%).
	Greenland	392	Once fairly stable fishery but recent declines in catch. Main fishing grounds off western Greenland. Stock assessed by surveys; fishery regulated by licensing and a yearly quota. MLS is 65mm
	Iceland	Closed	Historically 8-17,000 t pa but closed since 2004. Poor recruitment, coupled with high natural and fishing mortality led to stock collapse.
Patinopecten caurinus Weathervane scallop	USA	1,818	Fairly stable, conservatively managed fishery, with harvest levels well below MSY. 100% observer coverage. Strict controls on Annual Catch Limits, fishing permits, crew size, gear specifications and number, and crab by-catch. Area closures.
Amusium balloti Saucer scallop	Australia	5,445	Sub-tropical species fished off Queensland (2,920 t) and Western Australia (2,525t). Fairly stable trawl fisheries with separate management systems. Both highly regulated with limited entry, spatial and seasonal openings and gear size limits. Broodstock reserves in Queensland are fished rotationally.
Pecten fumatus Australian/ Commercial scallop	Australia	2,091	Historically, highly variable due to irregular recruitment and uncontrolled high fishing effort. Tasmanian, Victorian and Bass Strait fisheries administered separately. In 2010, all landings from Bass Strait as Tasmania and Victoria were closed. Management regime varies between regions. In all, fishery is seasonal to optimize yield. MLS 85 mm in Victoria, 90 mm elsewhere.
Pecten novaezelandica New Zealand scallop	New Zealand	122	Three regions support commercial fisheries: Northland, Coromandel and Southern. Stocks in all vary greatly with recruitment. A quota management system operates in all areas, based on biomass surveys, plus various additional regulations. MLS varies between areas. Golden Bay and Tasman Bay in the Southern region operate a fishing plan that involves enhancement with wild-caught spat and rotational fishing. Although once very successful (26), biomass has fallen substantially since 2002 and these bays are not currently fished. In contrast, Marlborough Sound, also in the Southern region, operates a wild fishery and biomass has remained relatively stable.
Aequipecten tehuelchus Tehuelche scallop	Argentina	Historically 200 – 4,530	Highly sporadic inshore dredge and diver fishery; based on intermittent single year-classes. No landings since 2006. Managed by opportunistic allocation of effort to maximise yield, MLS 60mm,TAC, company quotas, fishing season and rotation of areas.
Argopecten ventricostatus Pacific calico scallop	Mexico	16,499	Very variable artisanal fishery, historically producing 900-32,000t per annum with up to 800 boats. Main grounds in Baja California. Mostly diver caught (down to 20m), with some developing cultivation. Catch data contains landings of other pectinids (*Nodopecten subnodosus*, *Euvola vogdesi*), important in some areas. Biomass estimations based on catch per unit area. Boats licensed,days fished and daily quota are set. Closed season 15 Dec to 31 March, MLS 60mm.
Other pectinids	Russian Federation	1,881	Small fisheries for *Chlamys islandica*, *Chlamys behringiana*, *Chlamys albida*, *Chlamys chosenia* and *Chlamys farreri* occur in different areas with considerable scope for expansion of fisheries and aquaculture.

Name of stock	Mg'ment Authority	Catch [1](t) 2010	Scientific status and management measures
PRODUCTION OF SCALLOPS – mainly by cultivation			
Patinopecten (Mizuhopecten) yessoensis Yesso scallop Japanese scallop	Japan	546,749	Massive, long-established, cultivation industry based on spat collection mostly in the Hokkaido and Aomori regions. Of this, 220,000t came from hanging culture, 327,000t from bottom culture and enhanced wild production.
	China	200,000[3]	Massive, cultivation industry for this non-native high-value species, based on hatchery culture of spat and on-growing in suspended or bottom culture in the sea. Spawning stocks introduced from Japan in the 1970s. Recently production has declined due to summer mortalities.
	Korea (total)	453	Democratic People's Republic (200 t); Republic of Korea (253 t)
Chlamys farreri Zhikong scallop/Jicon scallop	China	300,000[4]	Massive cultivation industry for this native species from northern China, based on spat collection and on-growing in suspended culture in the sea. Recent declines due to massive summer mortalities and disease.
Chlamys nobilis Noble scallop	China	50,000[3]	Large cultivation industry for this native species from southern China, based on hatchery culture and wild caught spat, with on-growing in suspended culture in the sea.
Argopecten irradians Atlantic bay scallop	China	850,000[3]	Massive cultivation industry for this non-native species, based on hatchery culture of spat and on-growing in suspended culture in the sea. Spawning stocks originally imported from USA in 1982, with further introductions later to increase genetic diversity. In recent years selective breeding for all cultivated species has produced varieties with faster growth and better stress resistance . Recent increased production due to problems with zhikong and yesso scallop cultivation.
	USA	361	Small scale culture operations, mostly to support restoration projects
Argopecten purpuratis Peruvian calico scallop	Chile	8,840	Large cultivation industry based on collection and hatchery culture of spat, with ongrowing in suspended culture in the sea. Wild harvest of natural stocks banned since 1988. Production has declined in recent years due to competition with Peru and is likely to fall further due to damage from the Japanese tsunami in 2011.
	Peru	58,101	Very large, developing, cultivation industry based on collection of juveniles from natural banks, spat collection and hatchery production. On-growing in suspended culture and on the seabed. Cultivation provides increasing, more stable, supply.

[4] Estimated proportion from total Chinese landings of 1,407,467 t in 2010

Fishing methods

There are three methods that are traditionally used for harvesting scallops: diving, trawling and dredging and there is a gradient of increasing environmental effects from diving, through trawling to dredging.

Both surface-supply and scuba diving are efficient, size-selective methods of harvesting scallops. However, in the UK divers should operate under Health and Safety Executive guidelines (28). Although collection by divers is of reduced environmental impact compared with dredging, divers can target concentrated areas of scallops inaccessible to dredges, which may be acting as spawning stock over a wider area; it is as important to manage diver fisheries as it is dredge fisheries.

Trawling

Bottom trawls, like those used in the Argentinean Patagonian scallop fishery or the Manx summer trawl fishery for queen scallop, are used in some fisheries on smooth seabeds. Trawls are particularly useful for scallop species that can swim and avoid dredge gear. This has been observed as a seasonal effect (peaking during the summer and autumn) in Irish Sea queen scallop fisheries (29). This method takes very little by-catch and causes little disturbance to the seabed.

Dredging

Most scallop fisheries use some form of heavy steel-framed dredge. These dredges have steel teeth that penetrate the sediment surface to capture species such as *Pecten maximus* that recess into the seabed (Figure 1).

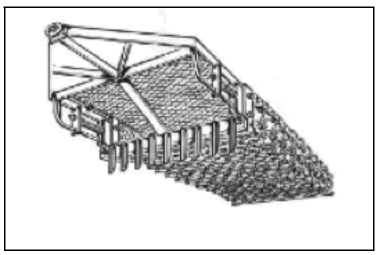


Figure 1: Toothed dredge used for king scallops (*Pecten maximus*) approx 75cm wide.

'Skid' dredges without teeth (Figure 2) can be used for queen scallop and other species that lie on the surface of the sediment (30).

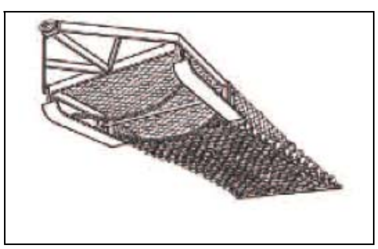


Figure 2: Skid dredge used for queen scallops approx 75cm *wide.*

Sea scallop fisheries in the USA typically use gangs of Digby dredges inshore, which are the most efficient gear on rocky and gravel bottoms, and the very large (5 m) Bedford 'drag' offshore (Fig 3 and 4).

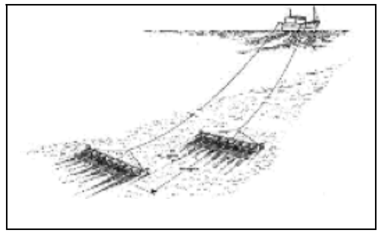


Figure 3: Typical dredge configuration on a towing bar

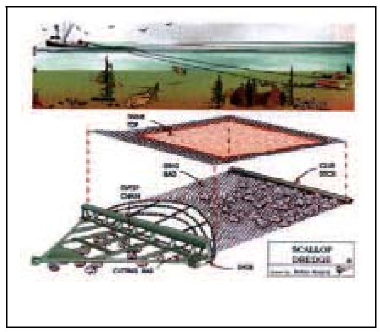


Figure 4: New Bedford 'drag'.

FAO: The Food and Agriculture Organisation of the United Nations is a neutral forum where all nations meet as equals.
EU: The European Union manages fisheries within the European Economic Zone.
MSC: The Marine Stewardship Council is an independent organisation that certifies responsible fishing practices.
FFC: Federal Fisheries Council or Consejo Federal Pesquero manages Argentinian fisheries.

Mitigating environmental effects

A practical approach to scallop dredging is to manage the fishery so that environmental effects and the footprint of the fishery are reduced as much as possible.

The heavy steel dredges used in the majority of scallop fisheries have the most significant effect on the seabed structure (16). Such gear can change the nature of seabed sediments and marine communities, reducing habitat complexity and biodiversity, and replacing vulnerable and long-lived species by mobile, more robust, fast growing opportunists (8). Dredging can also make the seabed less suitable for scallops by removing and damaging the organisms on which scallop spat settle (31).

To mitigate effects on scallop dredging grounds, a combination of permanent and rotational closures has been successful. A four-year closure of large areas of Georges Bank, off the east coast of North America, resulted in a 14-fold increase in sea scallop biomass (32), while the reproductive biomass in a small area off Port Erin, Isle of Man, closed to mobile gear since 1989,was over 12 times higher than on the adjacent fished grounds by 2003 (33).

In certain areas, slow growing organisms and highly structured habitats such as maerl beds (12), horse mussel beds (34), and mudstone reefs (35) need protection through permanent closures. Realtime satellite tracking of vessels while they are fishing can provide assurance that vessels do not dredge in these sensitive areas.

Practical measures

Efforts to design dredges with reduced environmental effects have had limited success, particularly for catching species such as *Pecten maximus* that recess into the seabed and require digging out of the sediment (30,36,37).

Practical measures that have had some success include targeting the gear on the areas where scallops live and avoiding other areas (38). Improving ground discrimination and seabed mapping technology can play an important part in keeping fishing within the areas of scallop habitat. Also, the gear mesh or ring size should be as selective as possible to allow juvenile scallops to escape.

In inshore waters there are also potential conflicts between static gear fisheries such as pots and gill nets, and mobile gear fisheries such as trawls and dredges. These are best resolved by agreement between the parties. In some cases this has evolved into permanent areas closed to mobile gear including dredges, such as the South coast of Devon around Start point.

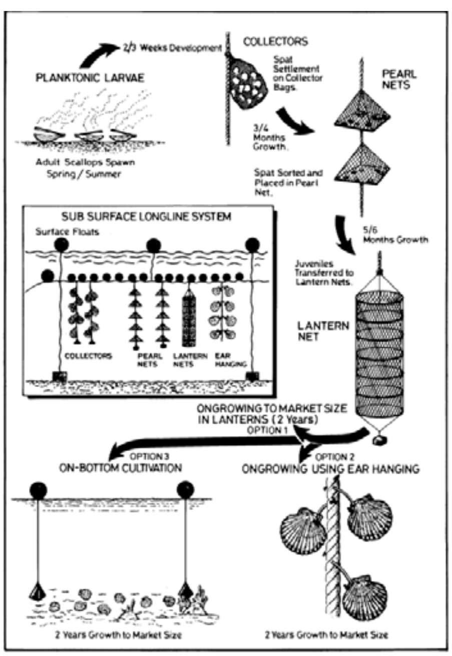
Cultivation

As with all intensive mariculture, scallop cultivation has the potential for substantial environmental effects depending on the location and scale of operation (39).

Suspended culture can cause local water quality changes that affect both planktonic and seabed communities, particularly in enclosed bays with limited water exchange. Predator removal and intensive harvesting during seabed culture also has major effects on seabed communities. High-density cultivation can also promote the incidence and spread of parasites and diseases. Successful, sustainable, cultivation must entail the maintenance of healthy environmental conditions and well-managed operations to ensure sustainable use of space.

Cultivation method

Scallop cultivation was developed in Japan in the late 1960s where it rapidly restored production to levels lost through overfishing (40). The Japanese process, which is outlined for king scallops in the illustrations on this page, is based on the collection of naturally produced larvae settling on plastic mesh collectors. Initially, the collected spat are placed in small, pyramidal, pearl nets followed by larger lantern nets for final culture. Juvenile scallops are also suspended individually from hooks inserted though a hole drilled in the 'ear' of the shell. Lines of collectors, pearl nets, lantern nets and ear-hung scallops are all suspended in mid-water from sub-surface longlines that are fixed together to form extensive grids. Many scallops are grown to market size in suspended or hanging culture, but very large quantities of one-year old scallops are also taken from the longlines, and placed on the seabed in areas cleared of predators, and subsequently fished in rotation (sowing or on bottom cultivation).



China

The Japanese success encouraged many other countries to try these methods. Some have been highly successful. In China, culture of the local zhikong scallop started in the 1970s, followed in 1982 by bay scallops imported from the USA. For both of these species it was not possible to collect naturally produced spat so large-scale hatchery culture was developed, followed by suspended culture in the sea. Such was the growth of this industry that, by 1997, 1 million tonnes of cultivated scallops were produced (41). Furthermore, as the cultivated stock of zhikong scallop increased, natural spawning also increased enabling natural spat collection. Today, there is virtually no hatchery production of this species, but in recent years there has been a sharp fall in zhikong scallop production caused by summer mortalities. To compensate there has been expanded production of non-native bay and Japanese yesso scallops. The Chinese also culture small quantities of the local huagui scallop in the south, and yesso scallops in the north.

Peru and Chile

After China and Japan, the third largest scallop aquaculture producer is Peru, followed by Chile. Chilean culture of the Peruvian calico scallop started in the 1980s and is based on highly variable natural settlement on collectors, supplemented by hatchery production. Planned production and efficient use of facilities is possible as the hatcheries can produce spat virtually all year round. Peru followed similar methods and with warmer waters and cheaper labout now exceeds Chilean production. Small quantities of king scallops have been cultivated in Britain and Europe for many years. More recently both Chile and China have become well advanced with trials to cultivate imported *Pecten maximus* and if either, or both, prove successful, this will have significant implications for European producers and markets.

Management and conservation

Scallop fisheries are notoriously difficult to manage due to the enormous variability of stocks from year to year and between grounds, and the mobility of scallop fishing boats. Some stocks have been fished for a long time and appear to be sustainable, while other fisheries are sporadic and highly variable. The main issues for scallop fisheries production whether it is by dredge, trawl or diver harvest, or by cultivation are:

Control of size selection

Gear selectivity measures and minimum landing sizes (MLS) are common measures to ensure that scallops are not harvested wastefully at too small a size for breeding or growth. These are effective conservation measures because most undersized and undamaged scallops survive capture and release by gear selection or discarding.
Harvesting controls

Scallop fishing occurs where there are economically viable densities of scallops of suitable quality for the market. Therefore, they are likely to be exploited intensively in areas of high density, and then left to recover once fishing becomes uneconomic, or the quality of the scallops deteriorates due to spawning. Management measures tend to build on this pattern. Where there is a clearly defined growing and/ or spawning season, area closures may be implemented during these periods. Detailed adaptive micromanagement of individual grounds and fishing activities is practised in France and many other countries.

Long term closures

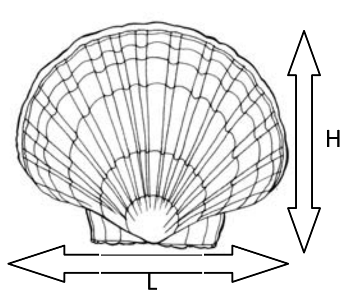
Management measures which employ closed areas for periods of several years, to increase yield or protect part of the spawning stock, have been found to be very successful, bringing high returns in terms of increasing yields and spawning stock (see Mitigating environmental effects page 7). In Japan, France and elsewhere, rotational closures are also used successfully, together with enhancement with cultured juveniles, to improve yields.

Marine Spatial planning

Improvements in marine spatial planning, such as those derived from the UK Marine and Coastal Access Act, are helping to improve protection for areas that are vulnerable to adverse effects by dredging. For cultivation of scallops such measures are clearly of benefit, because these activities require optimum conditions within a secure legal framework. The increased use of closed areas, and recent technological developments in 3-dimensional bottom imaging to map scallop dredging grounds and sensitive features, together with satellite-based vessel monitoring, now offer greatly improved spatial management in scallop fisheries (42).

Measuring scallops

The length of a scallop shell which in many cases defines the minimum landing size is measured across the shell parallel to the hinge, and the height is from the hinge to the round edge of the shell (Fig 5). The width measures the deepest part of the shell (Fig 6).



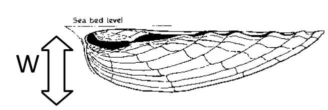


Figure 5 Height (H) and Length (L) and Figure 6 width

Product characteristics

When they are fished, scallops sometimes contain grit. Vessels can reduce this by 'degritting' scallops alive in onboard tanks (43,44).

Scallops are marketed either in-shell (usually alive) or as shucked meats (shell removed). The traditional European market is for roe-on meats (adductor muscle plus roe), while the USA and many other markets require a roe-off product (adductor muscle only).

Roe-on meats must be shucked manually as shucking machines cannot provide a roe-on product. Both roe-on and roe-off meats are traded as fresh, chilled, frozen, air-dried, smoked, canned or otherwise processed product.

Scallops undergo a seasonal spawning cycle that causes the condition and quality of the gonad and adductor muscle to vary. For each species the timing and extent of variation depends on the stock and can vary over short distances and from year to year; local knowledge is essential.

Like other filter-feeding bivalves, scallops can accumulate pathogens from contaminated water and natural biotoxins from harmful algal blooms. Both can pose public health hazards.

Microbiological contamination with pathogenic bacteria and viruses are rarely a problem in scallops fished in uncontaminated offshore waters.

However, in Europe fixed cultivated sites have to be classified in relation to their microbiological contamination (2). Biotoxins are a potentially serious and apparently increasing problem worldwide.

In the UK, the responsibility for ensuring food safety rests with the supplier who has to demonstrate that end product standards are met (45). The frequency of testing is derived from a risk assessment based on the origin of the scallops.

Several factors can control the risk from naturally occurring biotoxins:

Traceability is crucial in controlling the biotoxin risk; it is a requirement under EU legislation (2).

Tests are available designed to determine levels of toxin these can be used when there are known environmental risk factors such as location and season. For background information see refs 45; operators should be aware of the accreditation status of suppliers for analytical services (46).

In most species biotoxins do not accumulate in the adductor muscle, so 'roe-off' product is usually safe.

Using the correct technique for processing live scallops in the kitchen can prevent contamination from biotoxins in stomach contents. This also reduces risk (47).

An important caveat to the above is that species differ in their characteristics, and risk mitigation may vary between species and location. In Europe the supplier is responsible for meeting the end product standard (2) and should be aware of the characteristics of the species.

Supply chain standards

Responsible practice in the chilled and frozen supply chain depends on correct catching, gutting, washing, chilling or freezing, processing and handling practices throughout the chain. There are standards which cover these aspects from capture to retailer:

Seafish Responsible Fishing Scheme. Sets best practice standards for fishing vessels, based on British Standards Institution specifications (BSi: PAS 72:2006);

British Retail Consortium (BRC) Global Standard & Safe & Local Supplier Approval (SALSA) certification. Designed to raise standards in the seafood processing/wholesaling sectors.

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