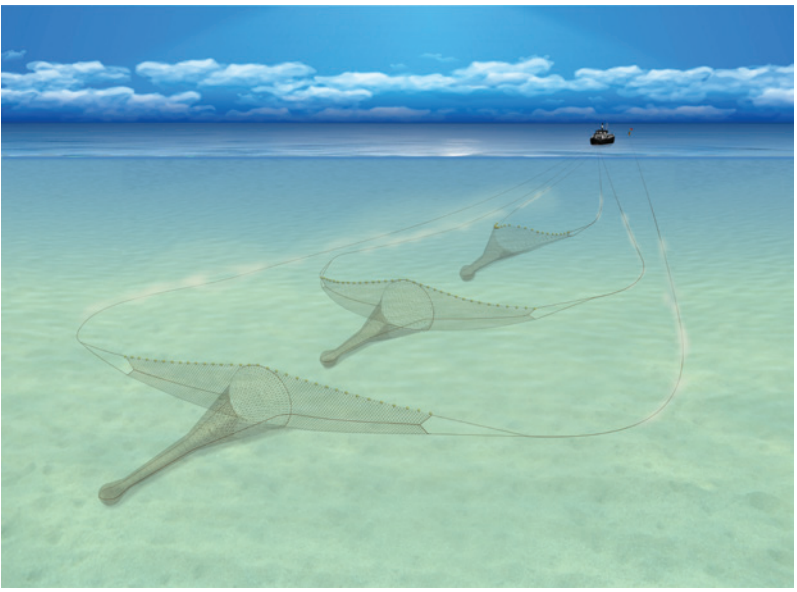
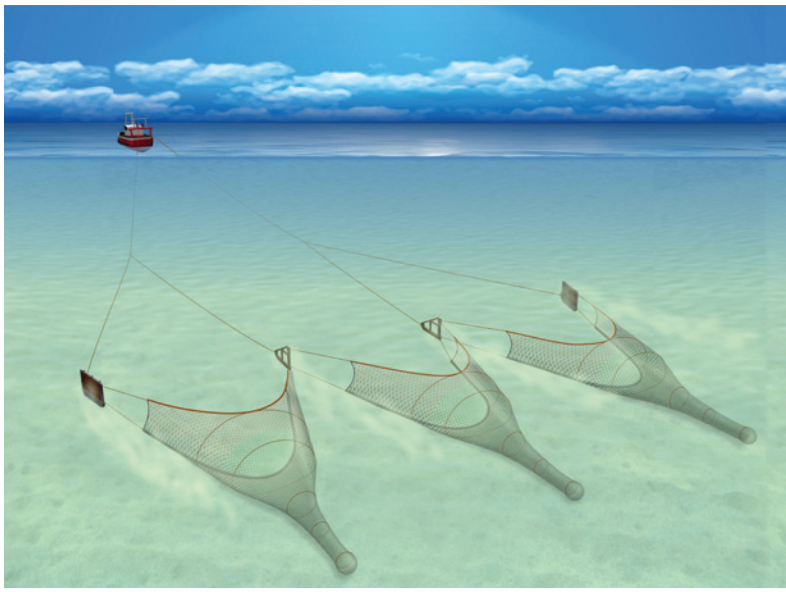
SEAFISH
the authority on seafood

BASIC FISHING METHODS





A comprehensive guide to commercial fishing methods

INTRODUCTION

As an industry used to a changing environment, fishing has adapted over the years in order to remain a sustainable industry. Nowhere is this more evident than fishing gear. Once created to increase production, the environment is now at the heart of innovation in gear technology to support the management of fish stocks and reducing impact on the marine environment.

Years and years of research and development has gone in to gear technology, allowing fishermen to be more selective with the catch. Yet, most people never get the opportunity to see fishing gear in operation - they have very little appreciation of how it works and what it actually looks like when it is fishing. Fishermen will know and understand their own gear very well, but even they rarely see what happens with the gear beneath the water, usually having to rely on the resulting catch to gauge how the gear is working.

This publication, produced by Seafish, provides some basic knowledge of how fish are caught using a range of fishing methods. So if you are keen to see how types of gear work or just interested in the way we fish around the UK, let it help to take some of the mystery out of the fishing gear that we normally see piled up at the harbourside or on the stern of a fishing vessel.

About this guide

This publication deals mainly with UK fisheries with reference to other fisheries throughout the world that supply wild-caught fish and shellfish into the UK markets.

All the gears are described to cover the basic concepts of each fishing method. There will be many regional variations of the generic design and method of operation used around the UK and in other countries. The basic principles for all the gear variations should be very similar.

The gear dimensions used in this publication are based on the average general use of the various gears. In certain areas there may be fishermen who have refined their gear to suit local conditions and work it efficiently outside these general parameters.

Want more information?

For the latest information on fishing gear and selectivity visit the Seafish Gear Database at www.seafish.org/geardb. The database is an online portal detailing all common fishing gears and selectivity devices used in commercial fisheries throughout the UK and Europe. It has full descriptions of the gear, illustrations, video clips and links to scientific trials and reports.

CONTENTS

SEINE NETS	5
PURSE SEINE	13
BEAM TRAWL	17
DEMERSAL TRAWL	25
MULTI-RIG TRAWLING	51
PELAGIC TRAWL (SINGLE AND PAIR)	63
GILL NETS	69
LINES	77
POTS AND TRAPS	85
FISH SPECIES IN THE WATER COLUMN	94
FISHING GEAR IN THE WATER COLUMN	96
GLOSSARY OF TERMS	98

SEINE NETS

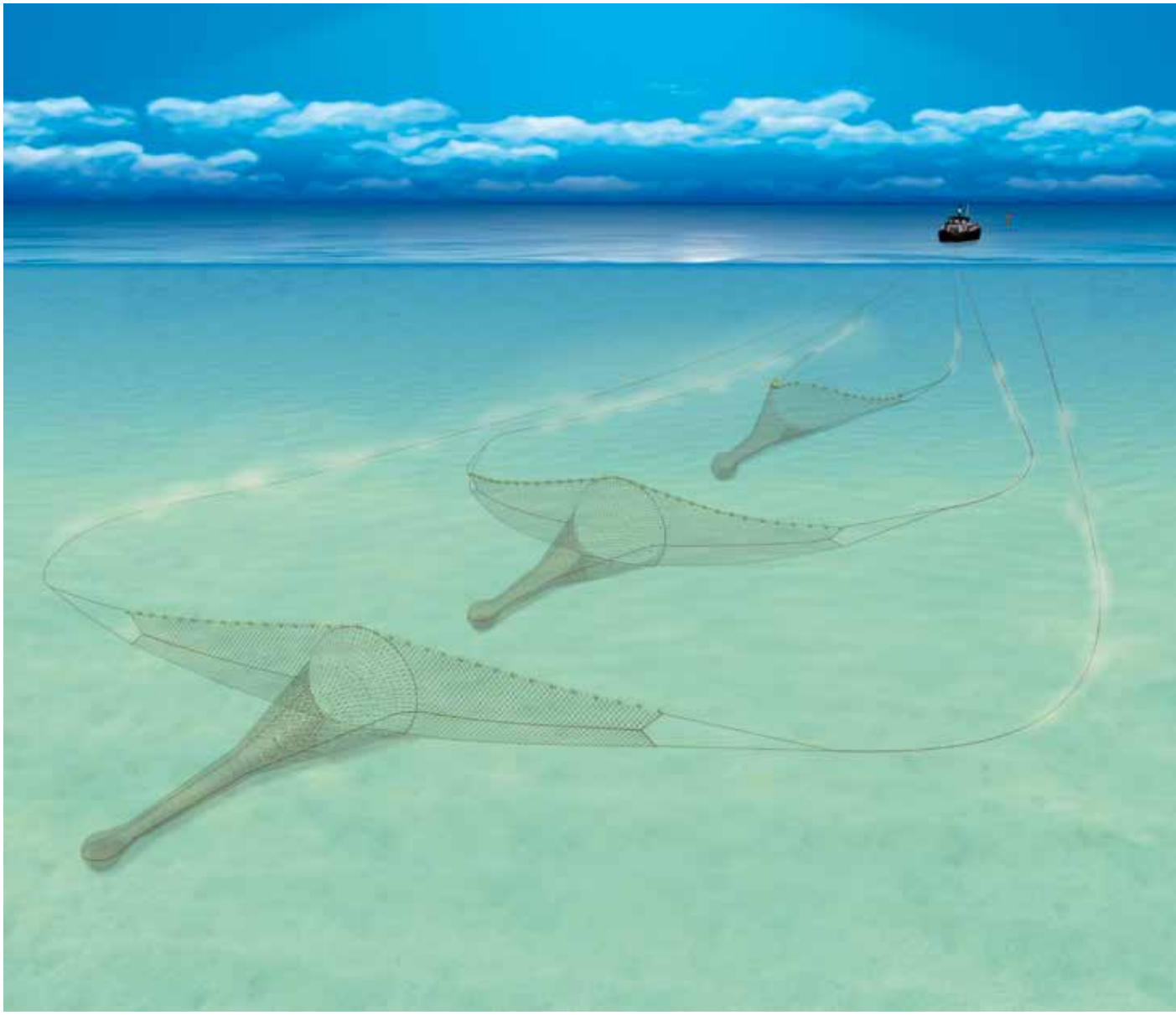


Fig 1.1 Beach seining

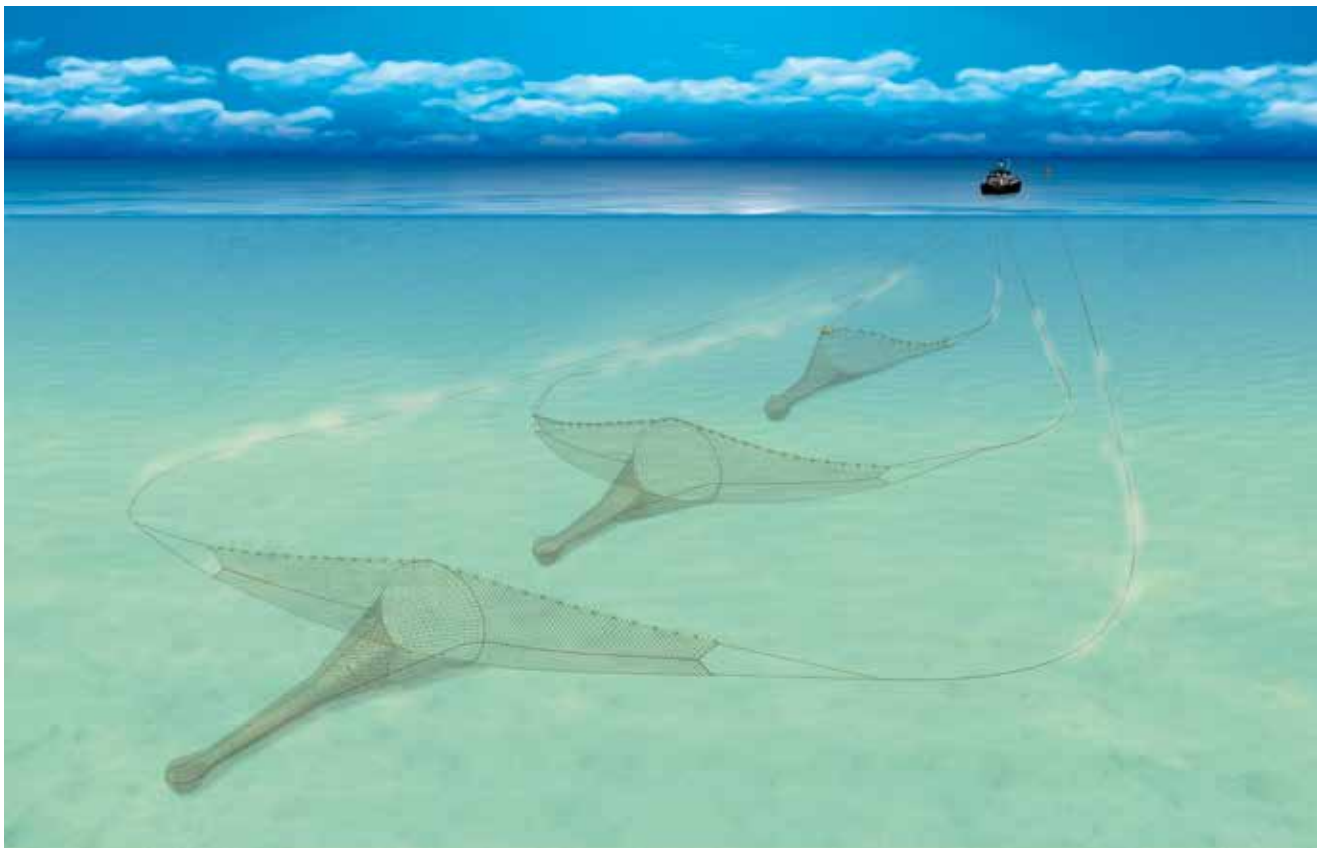


Fig 1.2 Scottish seining

SEINE NETS

There are three main types of seine nets; beach seine, anchor or Danish seine, and fly dragging, also called fly shooting or Scottish seine.

Seine netting is a direct descendant from beach seining, one of the oldest fishing methods with indications that early forms were used in ancient times. This progressed to using longer ropes to get further off shore, then being shot offshore using a sailing vessel and the ropes and net hauled by hand with the vessel at anchor. The seine net methods that we know today are claimed to originate from Denmark, around 1850, where it was first used to catch plaice.

With the coming of power-driven boats with winches on board, longer ropes and larger nets could be worked with smaller crews. In the 1920s, Danish anchor seining was introduced to Scotland, but they quickly dispensed with the anchor by using the vessel's own power to maintain its position while hauling the ropes and net. This method, called fly shooting, proved more successful for catching round-fish (whiting, haddock, cod, etc.).

The main principle of seine net is that long lengths of ropes are laid on the seabed in a circular shape with the net half way round the circumference of the circle. The ropes are slowly closed up, and as they move over the seabed they herd demersal fish into the net.

There are three main types of seine nets; beach seine, anchor seine and Scottish seine.

BEACH SEINE

This was probably the beginning of seine net fishing. In this method, a net is shot from the shore in a semi-circular shape using a small boat or, in shallow water, by hand, by wading through the water. Once the second end of the net is ashore again the two ends are hauled together and the net is hauled back on to the shore and the catch removed from the net. Nowadays, this method is used in many small scale fisheries. In the UK, it used to be common place in estuaries for targeting migrating salmon and sea trout, but this has almost died out, only being used in one or two locations in Scotland now. It is used in a few other areas of the UK to target bass or sandeels for bait. Overseas, it is used in many of the artisanal fisheries to target small pelagics that shoal up close to shore. **Fig 1.1 Beach seining.**

SCOTTISH SEINE (Fly dragging, fly shooting)

Scottish seine is a very skilful operation requiring extensive knowledge in locating fish within the grounds, accurate rigging of the gear, and consideration of tidal streams in relation to the gear throughout the shooting, towing and hauling operation. **Fig 1.2 Scottish seining.**

The modern seine net vessel can work anything up to 14 coils of rope each side of the net. Each coil consists of 220 metres (120 fathoms) of lead cored, abrasion resistant rope, from 19mm up to 32mm diameter depending on the size of vessel. One end of the ropes is shot, with a dhan (buoy) attached. The vessel then steams round in a circular shaped course shooting one side of the ropes, one end of the net is attached to the ropes and the net shot away half way round the circle. The other side of ropes is attached to the other end of the net and they too are shot away with the vessel completing the circle close to the dhan, picking it up, leading both ropes to the winch and starting to 'tow' the gear. The vessel will tow until strain is on both ropes, then engage the winch to begin heaving slowly. At this stage the vessel is moving slowly ahead, the winch is used to haul the seine net ropes in, slowly at first, and speeding up as the gear is closed up. As the ropes are hauled in, the vessel will gradually start to be hauled astern towards the net even although the engine is still trying to drive the boat ahead. Once most of the ropes are hauled in, the gear is almost closed up and the net is hauled to the stern of the vessel, hauled on board and the cod-end emptied on the side deck of the boat or nowadays into a reception hopper. The gear is

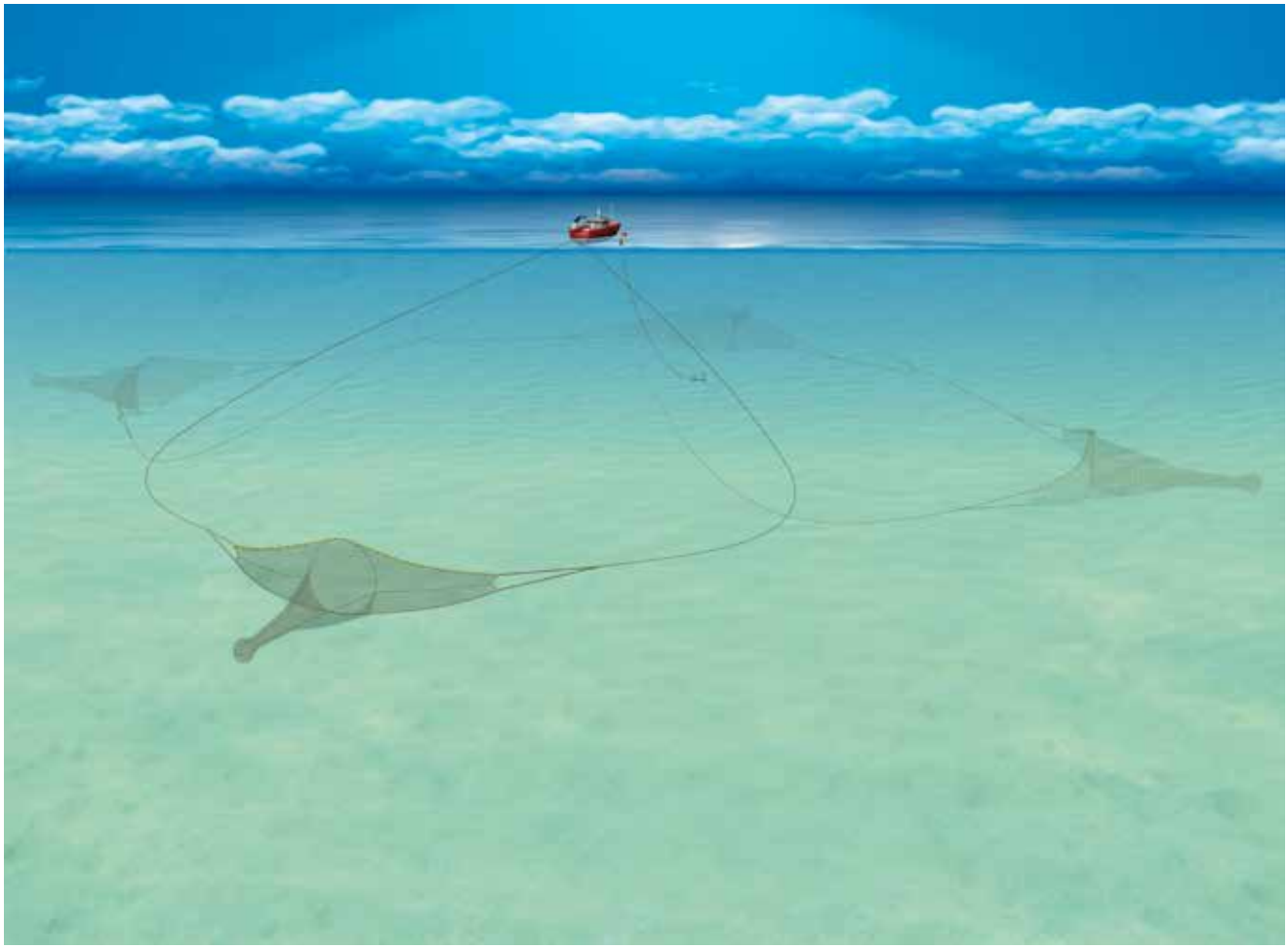


Fig 1.3 Anchor seining

ready to be shot away again, and the skipper will manoeuvre the boat to the next position to shoot the gear. Each hauling and shooting routine will take about an hour and a half to three hours.

The efficiency of seine net very much depends on the skipper's experience and ability to keep the gear square and to get the speed of hauling correct at the various stages, taking into account the weather, the tidal conditions, the behaviour of target species and the depth of water.

At one time (1950s to 60s), Scottish seine net was probably the main fishing method in Scotland for demersal fish. At this time, there would have been only a handful of vessels in England using the method; anchor seining was still their favoured method. Over the years, many vessels have changed to trawling, and up to year 2000 there would have been only a few vessels left using Scottish seine in the UK. However, in recent years, there has been a small resurgence in seine netting, with a few new vessels being built specifically for this method of fishing. This is probably because seine netting is a very fuel efficient method of fishing, and it gives the skipper the opportunity to land fish to the market in prime condition, thereby securing top prices on the market. The main areas of operation in the UK are North and North East Scotland, and Shetland, but only by a few vessels. Over the years, many Scottish vessels have turned to pair seining. This has developed more as a version of pair trawling with these vessels, and will be covered in the pair-trawl section of this publication.

ANCHOR SEINE

Anchor seine is handled in a similar way to Scottish seine, the main difference being that when the dhan is shot away the vessel also drops a large anchor to which the dhan is attached. They will shoot the ropes and net as in Scottish seine, but when the boat returns to the dhan, the crew pick up the other end of the seine net ropes and lead them to the winch, but they will also moor the boat to the anchor. The seine net ropes and net are now hauled in to the anchored vessel, with the anchor preventing the vessel being hauled astern. Once the gear and catch is on board, the skipper will prepare for the next shot, usually without lifting the anchor. He will shoot the gear in a different direction from the anchor, depending on which way the tide is flowing. If there is a good catch, the skipper will take several hauls from the same anchor point, each one covering a different sector of seabed around the anchor, dictated by the direction of tide as it ebbs and flows. **Fig 1.3 Anchor seining.**

Anchor or Danish seine, as the name suggests, originates from Denmark and is still used by many vessels there to target flatfish. This fishing technique moved over to the English ports of Hull, Grimsby and North Shields, and at one point there would have been several hundred vessels from these ports working the North Sea grounds. Traditionally, these vessels were all being painted in a pale blue colour. Over the years in the UK, this fishing method has all but died away with trawling taking over as the preferred fishing method. Today, there are only a handful of English vessels using anchor seine.

The nets used in both types of seine netting are very similar in design to a trawl net. Usually, they will be of lighter construction, with the physical size of the gear being determined by the size and power of boat operating it. The seine net ropes are made from hard abrasion-resistant rope to stand up to being trailed over the seabed. Each strand of the ropes will have a lead core to give the rope weight to make it sink to the bottom quickly and maintain good contact with the seabed to ensure that it is effective at herding the fish into the net. The length of ropes used can range from 8 to 14 coils on each side of the net. Each coil is 220 metres long (120 fathoms), and are either spliced together or some will be joined with stainless steel split-links enabling them to be disconnected easily to allow different lengths of rope to be shot. Therefore, on each side of the net, there will be anything from 1,700 metres to 3,000 metres of rope enabling the vessel to

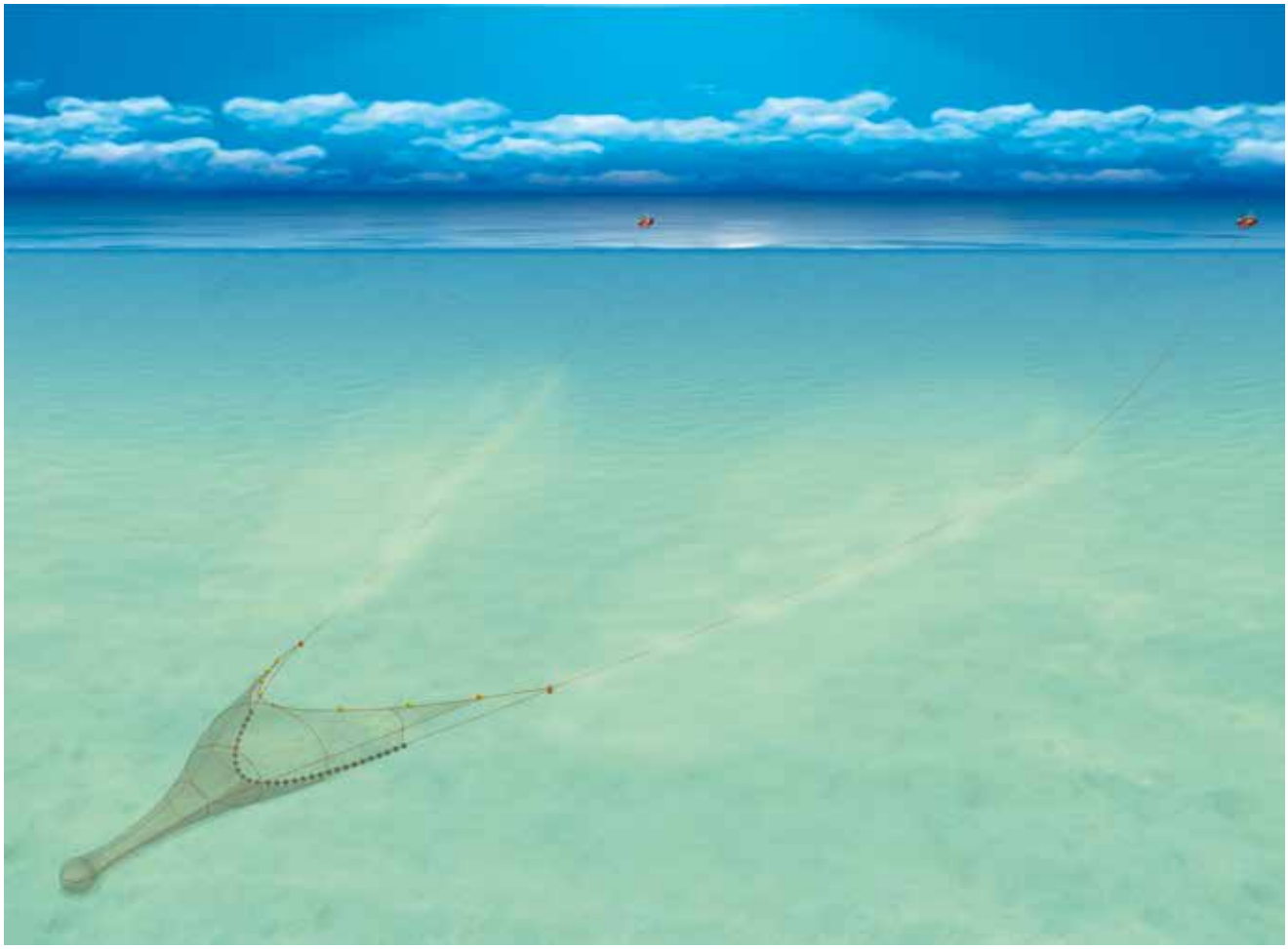


Fig 1.4 Pair seining

encircle an area of seabed with the ropes ranging from 600 to 1,000 metres across. Depending on the amount of rope shot, each haul will take between one and a half and three hours to complete.

Originally, the ropes were hauled and stored on deck in coils, but nowadays, they are usually stored on large reels in preparation for the next haul. Before the advent of shelter decks and rope reels, the long lengths of rope were shot directly off the deck, often going away in bights and dancing over the deck where the crew were working. This could make seine net a fairly hazardous method of fishing, but with the advent of rope reels and shelter decks, allowing the ropes to be shot and hauled clear of where the crew are working, safety has improved dramatically.

Seine netting is a more fuel-efficient method of fishing than trawling because the gear is lighter and it is not being towed by the boat for long periods. Because the fish are only in the actual net for a very short time before the net is hauled and the cod-end emptied, a seine net usually yields a better quality of end product onto the market.

Originally, both Danish and Scottish seine nets were seen as methods of fishing on clean, sandy and muddy seabeds. As it has become more mechanised with rope reels, more powerful winches, power blocks, net drums, etc. and improved rope construction combined with state of the art GPS plotters giving accurate positioning, the skippers are tending to work closer to, and actually onto harder seabeds and deeper water in an attempt to both improve catches, and target different species.

The main target species vary for each style of seine net.

Anchor seine, traditionally, was a method for targeting flatfish such as plaice, lemon sole, etc. with some haddock and cod on a seasonal basis. Scottish seine, because it is hauled faster, was more efficient for catching haddock, cod and whiting, along with some of the plaice and lemon sole.

Both these methods will have some by-catch of other demersal species.

PAIR SEINE

Traditionally, pair seine was actually developed as a way of keeping the seine net gear fishing for longer, thereby increasing catches. The gear is shot as a normal seine net by one vessel dropping a dhan, and shooting a long length of ropes, a net and a second side of ropes. But, instead of picking up the dhan again, a partner boat will pick up the dhan and that side of ropes, and the two vessels will tow the gear between them for a certain length of time, keeping the gear open longer, to extend the fishing time of the gear. When they are ready to haul the gear, the boats would close up together, and the dhan would be passed back to the original vessel, and it would haul the gear just as a standard seine net, slowly closing the ropes and net.

This method is still used in some overseas fisheries, but in the UK it has evolved more as a version of pair trawl, and will be covered in the pair trawl section of this booklet.

Seine net vessels use much less fuel than a similar sized trawler due to the fact that they only 'tow' the gear for a short time and the gear is very light.

The main selectivity measure is the regulation on minimum cod-end mesh size. The entire trawl is usually made from lighter twine and larger mesh than other nets, resulting in many of the smaller fish that may have been herded into the mouth of the net escaping through the large meshes in the front of the trawl. **Fig 1.4 Pair seining.**

PURSE SEINE

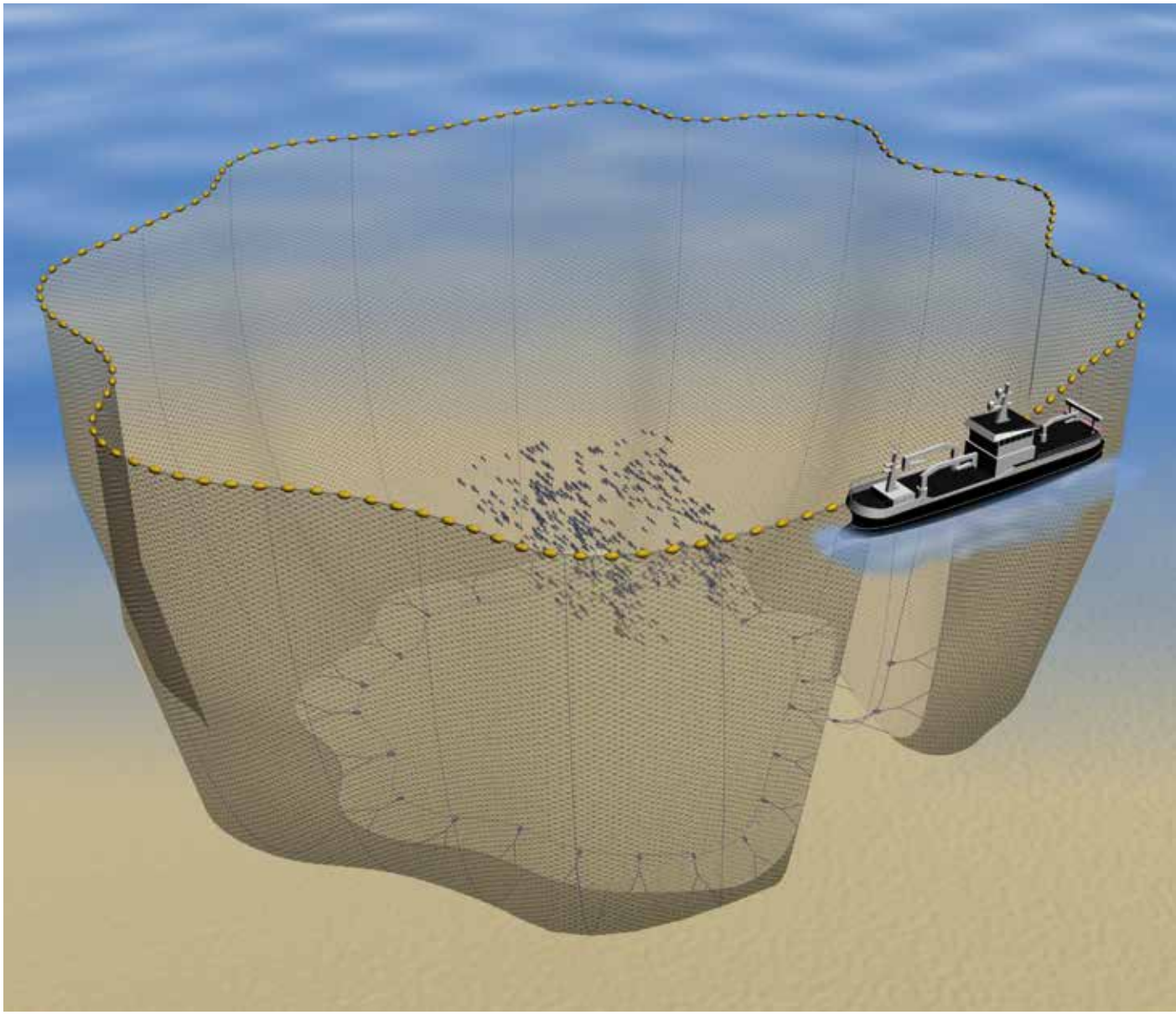


Fig 1.5 Purse seining

The purse seine is used mainly for catching dense, mobile schools of pelagic fish, and includes all the elements of searching, hunting and capture of the targeted fish. The schools of fish are surrounded and impounded by means of large surrounding nets called either ring nets or purse seines, according to design.

The origins of the purse seine can be traced back to one of the most basic types of fishing gear, the beach seine (Fig 1.1 Beach Seining, page 6), which has been used, through the ages, almost all over the world. A deep beach seine, operated offshore, would be seen as an early form of ring net or lampara net. By being made deeper still, and fitted with primitive purse rings and purse line, it could be regarded as an early purse seine. In many of the smaller fisheries, the nets are referred to as ring nets — although very similar, they are actually two different methods of fishing

RING NET

In many European fisheries, the ring net was the fore-runner to purse seine for targeting shoals of pelagic fish. Ring nets are generally smaller and lighter than a purse seine and, in the beginning, were operated by two vessels. The main difference between a ring net and a purse seine is that in a traditional ring net, the footrope is fixed to the bottom of the netting by short ropes, where as in a purse seine, the footrope runs through rings that are attached to the bottom of the netting. This allows the bottom of the purse seine to be closed up (pursed) by hauling on the purse line that runs through the rings. Nowadays, many modern ring nets also use the running purse line system to close the bottom of the gear.

In some fisheries, they classify the different pelagic surrounding nets by the way that they are hauled, and where the fish are congregated before taking them on board. A purse seine is hauled from one end, with the strengthened bunt section at the last end of the net to be hauled on board. A ring net has the bunt section at the centre of the net, and is hauled from both sides at the same time. A lampara net, used in some overseas fisheries, is more like a traditional ring net, having a fixed footrope, the bunt in the middle and is hauled from both ends.

PURSE SEINE

A purse seine is shot in a circle around a shoal of fish, to form a deep curtain of netting hanging vertically in the water. The net is fitted with rings (purse rings) along its lower edge, through which a strong cable is passed. As this cable is hauled in it closes up the bottom of the space encircled by the purse seine, preventing the fish from escaping downwards. The net will now form a bowl-like shape in the water containing the fish.

In both ring net and purse seine, the skipper will firstly locate and track a suitable shoal of the target species. Nowadays, this is done using a package of sophisticated electronics including sonars, echo sounders and GPS systems. However, this is still a very skilful part of the fishing operation, success depending very much on the skipper's ability and experience. Once the shoal is located, the vessel will drop one end of the net, with a dhan on it, and shoot the net in a circle around the shoal of fish forming a curtain of netting around them. As the vessel completes the circle, they will pick up the dhan and first end of the net. In some fisheries, a second smaller boat called a skiff is used to take the end of the net, instead of just using a dhan, and tow it round to meet the main vessel and complete the circle. Once both ends of the net are back on board the purse seiner, they will then start to close up the bottom of the net by hauling in the purse line to prevent the fish from escaping downwards. Once this is hauled in, the fish should be contained in a huge bowl shape of netting alongside the boat. The net is slowly hauled on board, gradually decreasing the size of the 'bowl' containing the fish, until all the fish are alongside the boat in the strengthened section of the net called the 'bunt'. They will then start to take the fish on board the vessel. Originally, this was done using a brail that is similar to a large version of an angler's landing

PURSE SEINE

net to scoop the fish out and dump on deck. This method is still used for larger pelagic fish, but for small pelagics such as herring and mackerel, nowadays, it is normal practice for the larger, more modern, boats to use fish pumps to pump the fish on board. **Fig 1.5 Purse seining.**

As the catch comes on board, it will pass through a water separator, the surplus water flows directly back overboard and the fish will be channelled into large tanks of refrigerated sea water (RSW tanks) for storage. Smaller boats may use a simpler system of chilled sea water (CSW tanks) that contains a mixture of sea water and ice to cool it down. Larger pelagic fish, such as tuna, tend to be stored below decks in a refrigerated or freezer hold.

As the purse seine is hauled, it is passed from the side of the vessel to a pound, aft, where it is stowed ready to shoot again.

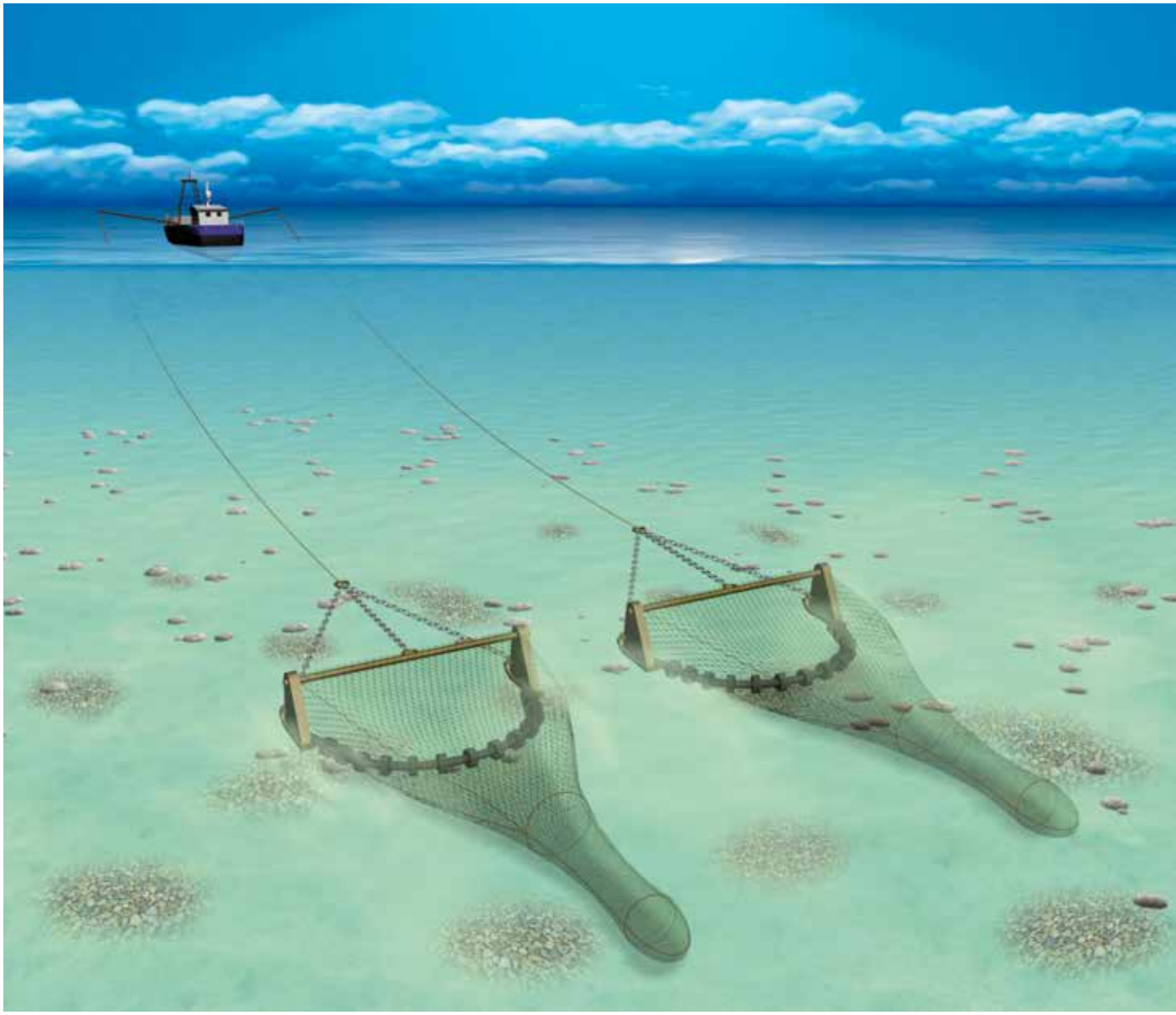
The larger UK registered purse seiners (60 - 70m in length) will use very large nets that can be large enough to fill the back of an articulated lorry! These will be in the region of 700 metres long and 200 metres deep, that would encircle an area approximately 250 metres across. The cost of the gear will be about £250,000. The nets are made very heavy at the bottom by adding several tons of lead or zinc weights to get the net to sink quickly as it's shot away. Many floats, often several thousand, will be fixed to the top of the net to keep it on the surface, and ensure that the netting hangs vertically in the water. Spaced out along the weighted footrope are many short lengths of ropes with steel rings attached, to run the purse wire through. The purse wire will be a heavy steel cable that is hauled on to a winch to close the bottom of the net. The skipper will be very careful not to allow the net onto the seabed in case of damage, as repairs to such a large net can be very time-consuming and expensive. The physical size, weight and cost of the net will be scaled up or down to suit the size of vessel using it. The design of the net will be slightly different in different areas, and to suit the target species and how the vessel handles it.

In the UK all the larger purse seine vessels are based in NE Scotland and Shetland where they mainly target herring and mackerel. Over the past 10 or so years many of these vessels have been using pelagic trawling to catch these species, but there is a trend back to purse seine as demands on the industry change.

Both purse seine and ring net are used in many fisheries throughout the world to target pelagic fish. One of the main fisheries is the ocean-going purse seiners targeting various species of tuna. In this fishery, there can be a mix of tuna species congregated together, creating the possibility of a by-catch of other tuna species in the purse seine. In some fisheries, the vessels make use of fish aggregation devices (FADs) that encourage the tuna to shoal up around them, making an ideal target for the purse seiner. One of the main problems with the use of FADs is that they can encourage many other species around them, and attract large predators such as sharks into the vicinity, all of which may be caught in the purse seine (by-catch) when it is shot around the FAD.

Apart from the by-catch issue when FADs are used, the purse seine can be considered as environmentally friendly. It is very species selective, the gear does not come into contact with the seabed to cause any seabed impact, and because the gear is not towed by the vessel, it has relatively low fuel consumption.

BEAM TRAWL



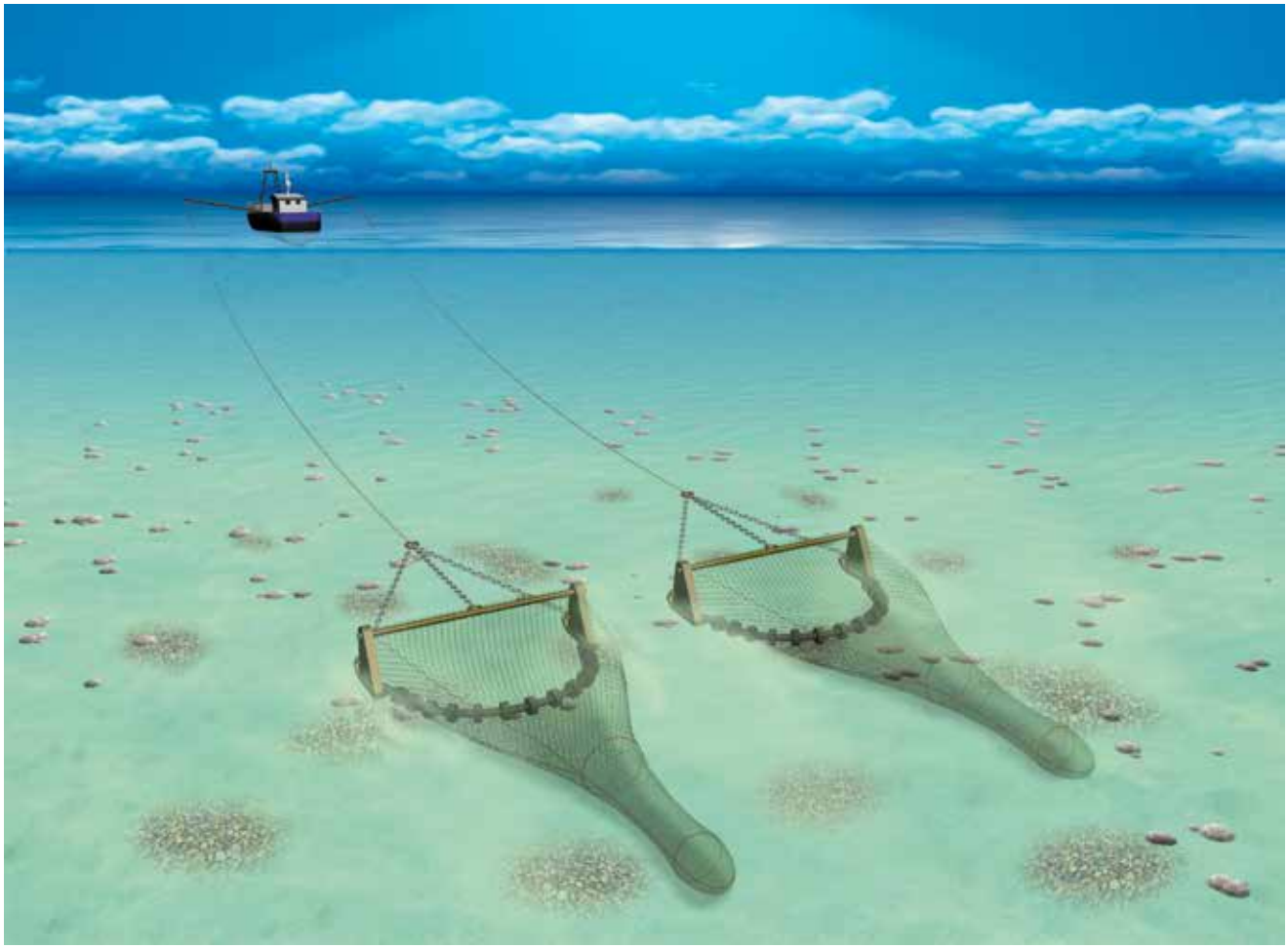


Fig 2.1 Beam trawling

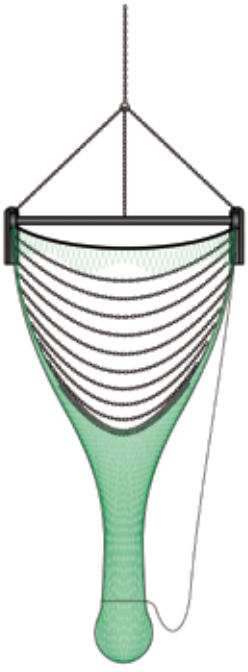


Fig 2.2 Open gear

Fig 2.3 Chain mat gear

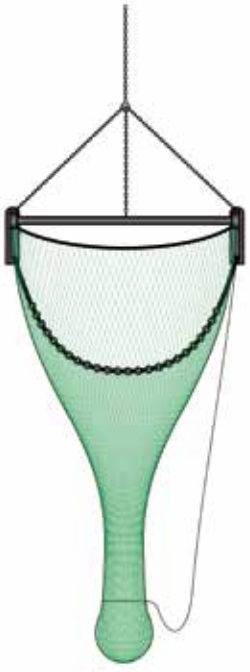


Fig 2.4 Beam trawl

BEAM TRAWL

The beam trawl is one of the earliest forms of towed fishing gear. Its origins are claimed to date as far back as the late 18th century, in Brixham, SW England where they developed a sailing boat specifically for towing a trawl. The net is held open by a rigid framework to maintain the opening of the trawl irrespective of changes in towing speed. This made it ideal for towing behind early sailing boats with their unpredictable course and speed. As the vessels evolved with modern engines and mechanised gear handling, the size of the gear and towing speeds increased in an effort to cover a larger area of seabed to increase catches. In the early days of beam trawling, only one net was towed from the stern of the boat. Nowadays, most commercial beam trawlers use two beam trawls towed from long derricks projecting over each side of the vessel. **Fig 2.1 Beam trawling.**

The beam trawl consists of a heavy tubular steel beam supported by steel beam heads at each end. These beam heads have wide shoes at the bottom which slide over the seabed. The beam and beam heads form a rigid framework that keeps the mouth of the trawl open and supports the net. On the early beam trawls, and some modern day small scale trawls, timber was used for the beam. The cone-shaped net is towed from this framework with the head rope attached to the beam, and each end of the footrope connected to the bases of the shoes. As the gear is towed over the seabed, the footrope forms a 'U' shape curve behind the beam and shoes, with the net and cod-end behind this. The headline height of the trawl is limited to the height of the beam off the seabed. The beam is usually towed using a chain bridle arrangement from both shoes and the centre of the beam attached to the end of the trawl warp leading to the vessel.

There are two common types of beam trawl, referred to as 'open gear' and 'chain mat gear'. Open gear is a lighter rig with several chains, called ticklers, towed on the seabed across the mouth of the net. These ticklers help to disturb the fish from the muddy seabed, causing them to rise and be caught by the net. This rig is used on clean, soft ground (seabeds). **Fig 2.2 Open gear.**

The chain mat gear is used for towing over harder, stony areas of seabed, and it is more commonly used by the bigger class of vessels. In this rig, there is a lattice work of chains towed from the back of the beam, sloping down to the footrope of the net. The purpose of this is to guide the trawl over any rough ground and boulders on the seabed, thereby minimising damage to the netting. Some beam trawls are also fitted with 'flip up ropes' to prevent stones from entering the net and damaging it. This is a fence-like structure made of rope covered with plastic tube, towed around the mouth of the trawl to lift the footrope over any obstacles on the seabed. **Fig 2.3 Chain mat gear.**

Lighter styles of beam trawl, with fewer tickler chains and without a chain mat, are used in several locations in the UK to target shrimp. **Fig 2.4 Beam trawl.**

The largest class of beam trawlers are around 25 - 40 metres long, generally having in the region of 1,000 horse power, towing two beam trawls 12 metres wide. This size of beam trawl can weigh up to nine tonnes each, enabling the trawler to tow at speeds up to seven knots. The medium class of beamers, from 12 - 18 metres, usually have between 300 - 500 horsepower to tow 4 - 7 metre beams. Many of the vessels under this size would tow just one trawl from the stern of the vessel. The size of beams towed, and the horsepower of many vessels, is restricted by fishery regulations in the area that they fish. The beam trawls need to be heavy to ensure that the trawl maintains good seabed contact while the vessels are towing at relatively high speeds, to cover enough ground to remain viable.

The majority of the UK beam trawl activity is in ports on the South coast of England, with one or two vessels scattered throughout the other fishing ports in the UK. The UK fishing effort is concentrated mainly in the South West Approaches and English Channel with some in

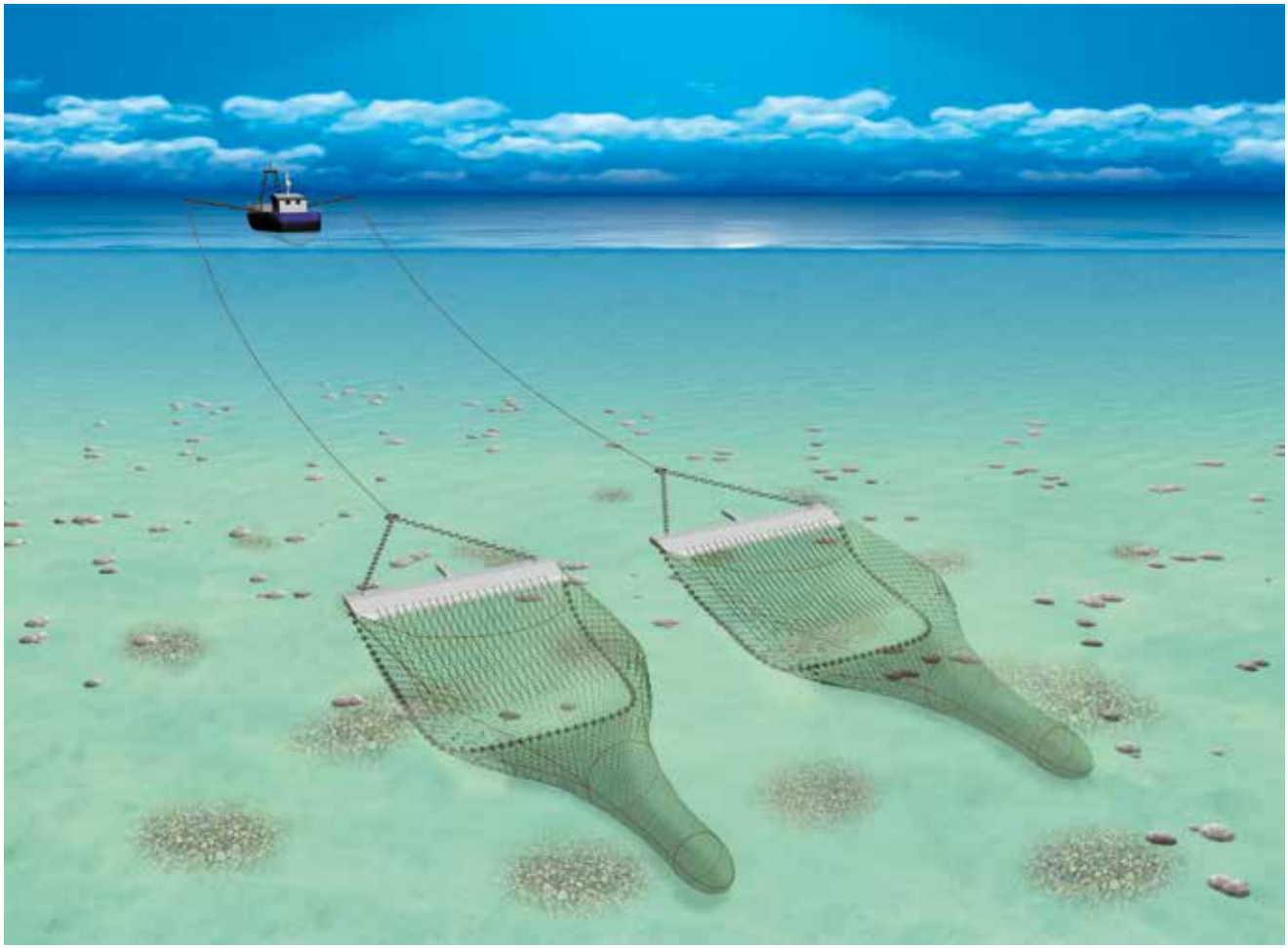


Fig 2.5 Sumwing pulse trawling

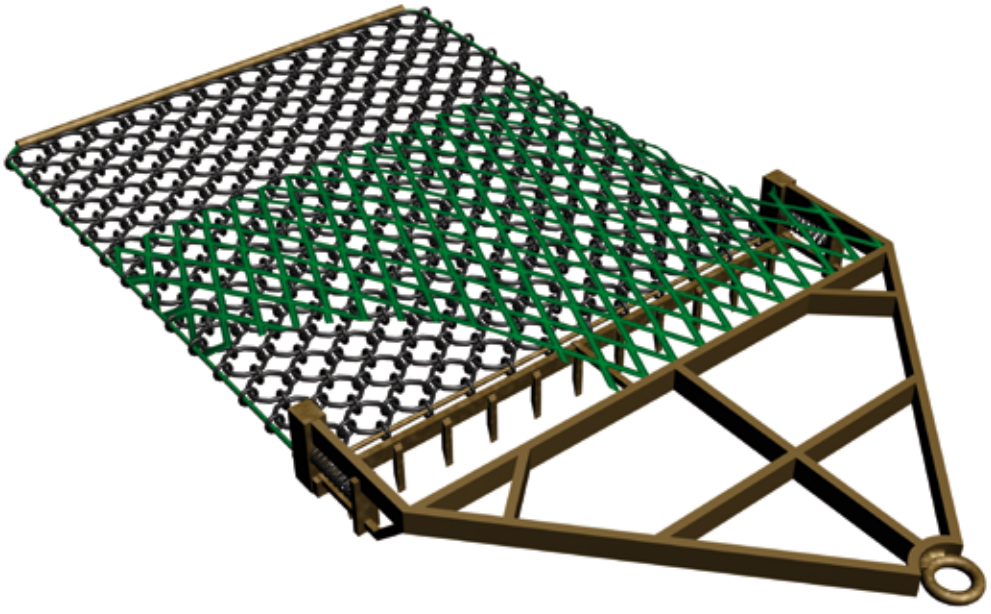


Fig 2.6 Scallop dredge

the Southern North Sea and up into the Irish Sea. Beam trawling is very popular with the Belgian and Dutch fishing fleets, many of these vessels work similar areas to the UK vessels.

The target species are Dover sole, plaice, shrimp, lemon sole, skate, cuttlefish, with megrims and monkfish being caught in deeper water.

MODERN TRENDS

Many skippers have modified the beam shoes by fitting large rubber wheels to reduce seabed impact and also gear drag to help reduce fuel consumption.

As a result of scientific projects (e.g. SOBETRA project, CEFAS 50%), there has been a trend in the industry to reduce discard rates by using a variety of gear modifications, such as large mesh top panels, cut away headlines, benthic release panels, and square mesh cod-ends. The beam trawl used in UK shrimp fishery usually employs a 'veil' to release any small fish.

In recent years, there has been a move to alternative fishing methods for some of the EU beam trawl fleet. Some have taken up out-rig trawling (see page 61) or the pulse trawl (a form of electric fishing often using a 'Sumwing' beam rather than the common steel tube beam). Some of the UK beam trawl fleet have recently converted to scallop dredging.

SUMWING PULSE BEAM TRAWL

This fishing method was first used in Holland in 1992, with the Dutch and Belgian trawlers experimenting with it, and further developing it to where it is today. It is still operated on an 'experimental' basis with only a limited number of vessels permitted to use the pulse system.

It is a technologically advanced adaptation of beam trawling where the tickler chains and chain mat of the beam trawl are removed and replaced with trailing electrodes. The removal of the tickler chain and chain mat vastly reduces the seabed impact of the trawl gear, and reduces the fuel consumption of the vessel by about 40%.

A dedicated power cable from the vessel to the trawl transmits the electric current to the electrodes. The electrodes then send a mild electric pulse into the seabed to stimulate the fish to rise up and be caught by the trawl, with minimum sea bed disturbance. A similar system is being trialed in the North Sea shrimp beam trawl fishery.

Many of the vessels using this system have also adopted the Sumwing to replace the beam and beam shoes, further reducing their seabed impact and fuel consumption. The Sumwing works on a principle of an aerofoil cross section to get the gear onto the seabed and maintain its position just above the seabed, with the trawl and electrodes trailed behind. This gear is in the region of 25% the weight of a standard beam trawl. **Fig 2.5 Sumwing pulse trawling.**

SCALLOP DREDGE

Dredges are rigid structures that are towed along the seabed to target various species of shellfish. In the UK, the main dredge fishery is for king scallops, and to a lesser extent queen scallops, mussels, oyster, and razor clams. Each dredge is designed specifically to suit the fishery and target species.

Scallop dredges consist of a triangular frame, about 750mm wide, with a toothed bar at the front to flip the scallops out of the seabed and into a collecting bag behind it. This bag is made of chain links forming a chain mesh on the bottom, and chain or netting on the top.
Fig 2.6 Scallop dredge.

Several of these dredges are towed behind a heavy spreading bar, usually one bar from each side of the vessel. The length of bar and number of dredges is dictated by the power of the vessel and its length of side deck to work the dredges over. The number can vary from three or four on a small 10 metre boat, up to 18 - 20 on a 30 metre

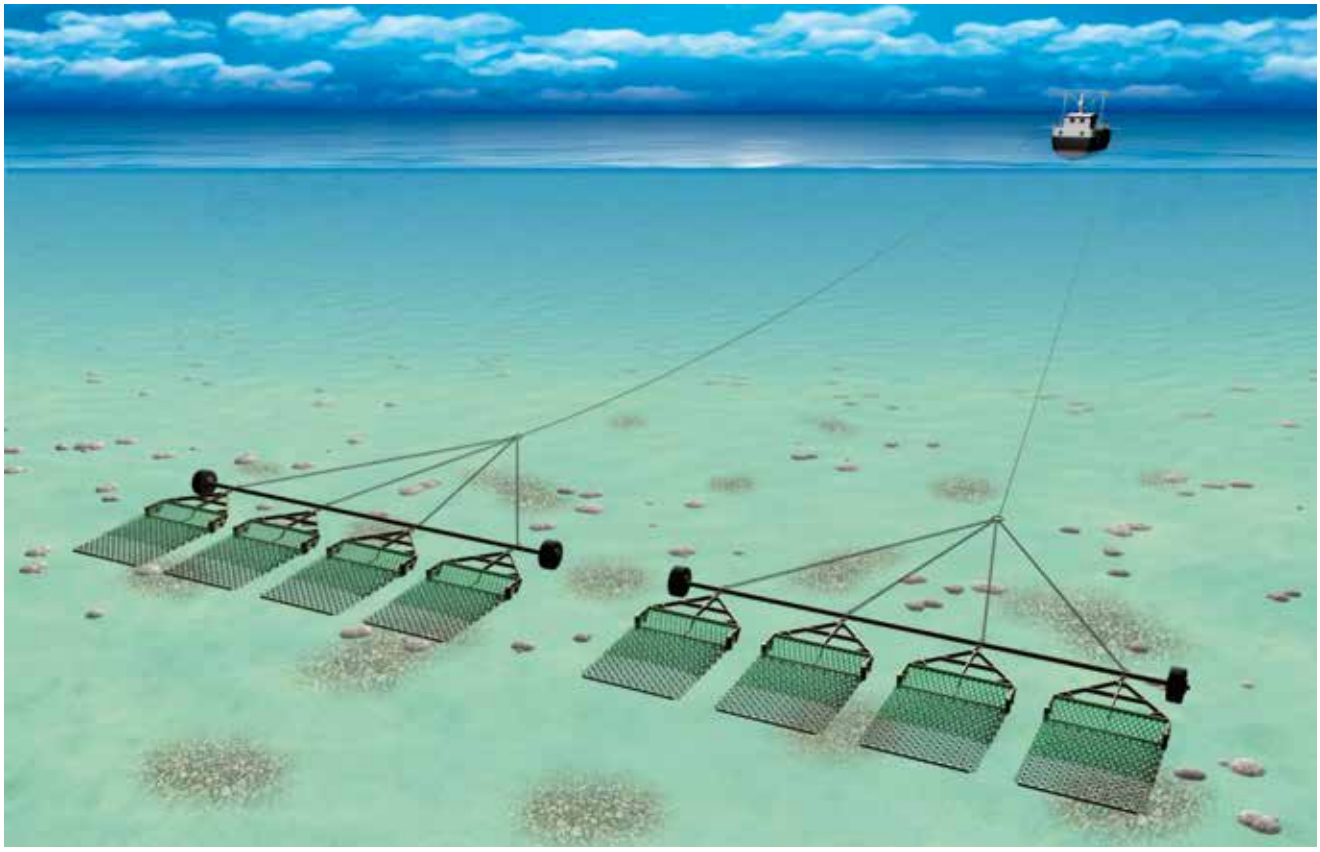


Fig 2.7 Scallop dredging

vessel with a 1,500 horsepower engine.
Fig 2.7 Scallop dredging.

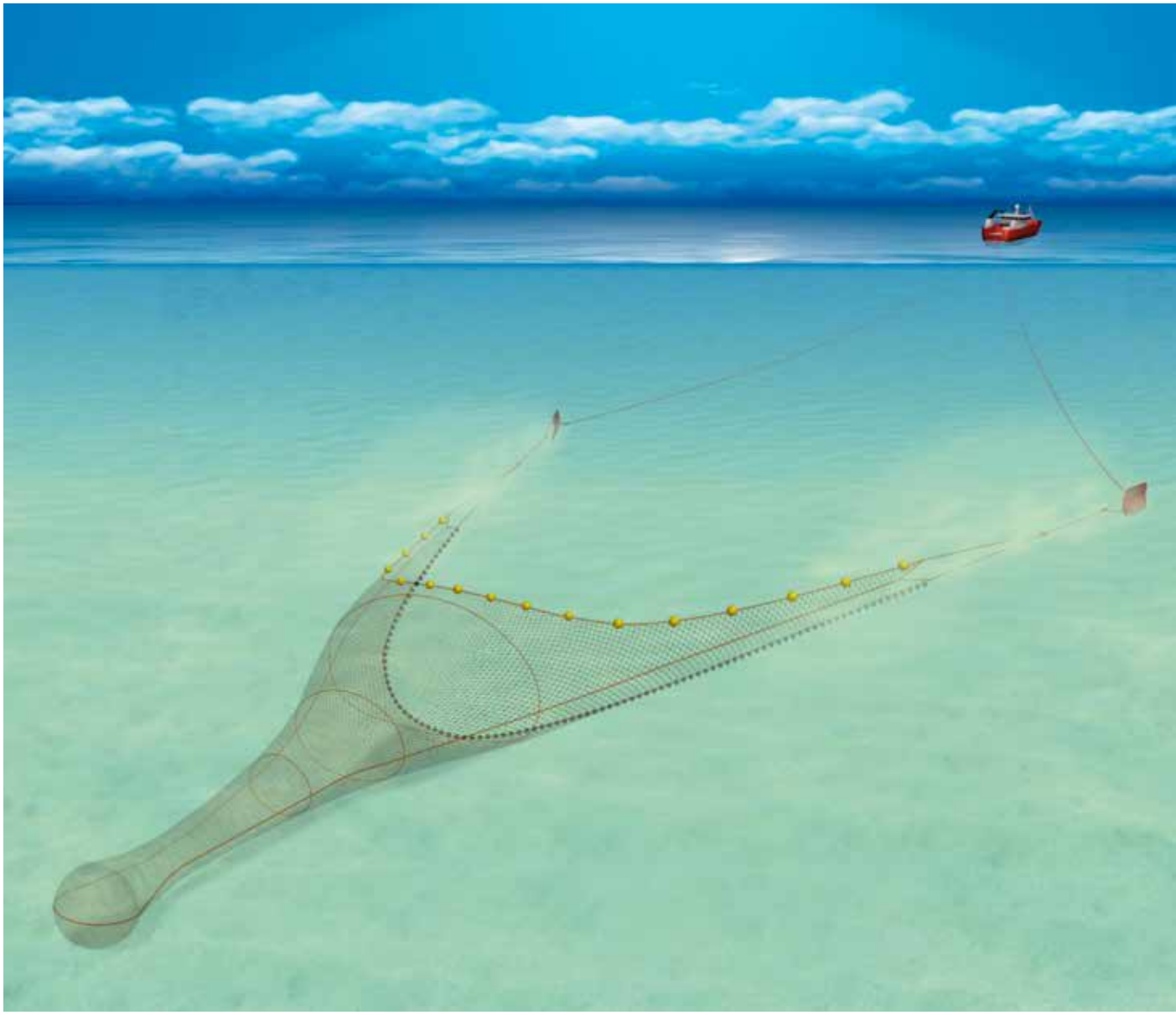
The vessels and rigging are very similar to that of beam trawling, with the beam trawls being replaced by the steel bar with multiple dredges towed behind it. In recent years, many beam trawlers have been converted to enable them to tow scallop gear.

Although the majority of scallop vessels are registered to a few ports scattered throughout the UK, they are quite nomadic in their fishing patterns, tending to move to where there is good fishing of scallops at that particular time. They will land at any port close to the fishing grounds, and overland their catch by road to the processing factory.

There are various other types of dredges used in the UK to target other species of shellfish. Dredges to target queen scallop tend to be larger and lighter made than dredges for king scallop, and they do not have the tooth bar to disturb the seabed. In other areas, specific styles of dredges are used to target oysters and mussels.

The size selectivity of a scallop dredge can be set by regulating on the size of the chain rings used for the bellies. Although the teeth on the bar at the front of the dredge are about 120mm long, only about 20mm of this will penetrate the seabed to flick the scallop out of the sand. There is strict legislation on the size and number of dredges used in various areas around the UK.

DEMERSAL TRAWL



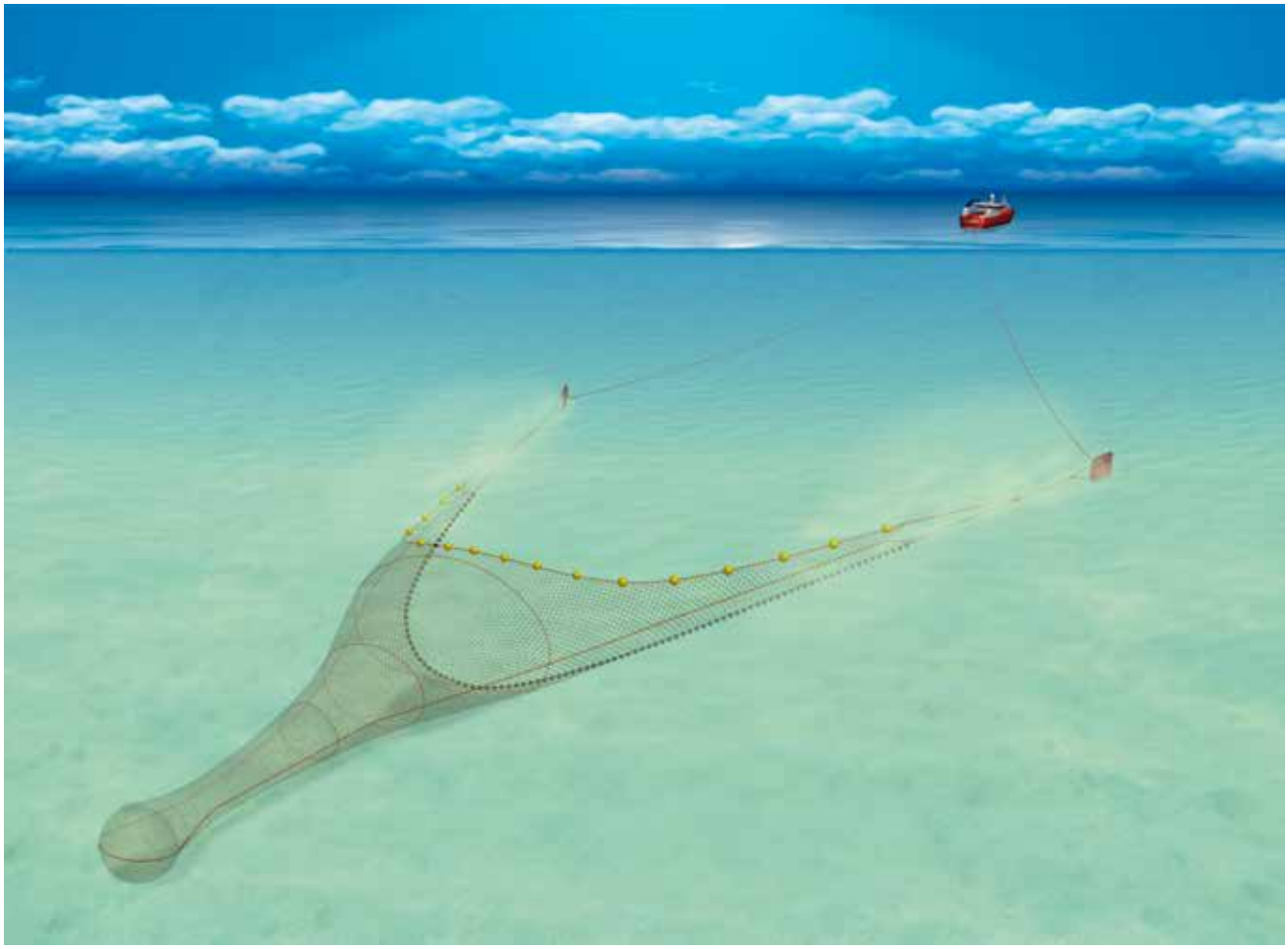


Fig 3.1 Demersal trawling

Fig 3.2 Wood trawl door

Fig 3.3 Steel V door

DEMERSAL TRAWL

Demersal trawling is a direct descendant of the early beam trawl. The original form of towed fishing gear used by sailing boats with their unpredictable towing power was generally a beam trawl. The size of the gear being restricted to the length of beam that could be stowed aboard the vessel, and the limitations on available wind power. With the introduction of steam-powered vessels, and later diesel propulsion, otter boards were developed to spread the nets in place of the rigid beam of the beam trawl. This allowed nets to be made much larger. To begin with, the otter boards or trawl doors, as they are more commonly called nowadays, were attached to the wing ends of the nets. Later, with the understanding that certain species of fish could be herded into the path of the net by ropes or wires on the seabed, short bridles or sweeps were added between the wing end of the net and the trawl doors, allowing a larger area of seabed to be swept by the gear. Nowadays, the sweeps and bridles can range from none at all, right up to 300 metres, depending upon the target species and the type of seabed being fished.

A basic trawl is made up from two shaped panels of netting, laced together at each side to form an elongated funnel shaped bag. This funnel tapers down to the cod-end where the fish are collected until the net is hauled. The remaining cut edges of the netting, and the mouth of the net, are strengthened by lacing them to ropes to form 'wings' that help shepherd the fish into the mouth of the trawl. The rope along the upper edge of the net is called the head line, the one along the lower edge is termed the foot rope or fishing line, and the side ropes are called the wing lines. The head rope has floats attached to it to lift it clear of the seabed, and hold the net open in a vertical direction. The footrope, usually has some form of weighted 'ground gear' attached to help it to maintain contact with the seabed and protect the net from damage. The wings of the net are attached to a pair of trawl doors by wires or ropes, called bridles or sweeps. As a result of the drag of the gear, and the floats on the headline, the actual weight of a demersal trawl on the seabed will be in the region of 10 - 20% of its weight in air. **Fig 3.1 Demersal trawling.** Also, see pages 30/31.

The trawl doors, made of steel or wood, are designed to be towed through the water at an angle, causing them to spread away from each other, to open the net in a horizontal direction. The trawl doors, in turn, are attached to the boat by wires called trawl warps.

As well as spreading the net, the trawl doors have to be heavy enough to keep the gear on the seabed as it is towed along by the trawler. As the trawl doors are towed along the seabed they kick up a sand cloud that initiates the herding of fish towards the mouth of the trawl.

The early trawl doors were flat rectangular-shaped objects made from timber, with steel reinforcing. These simple doors are still used today in some fisheries, but many boats use steel doors with the plates bent into a 'V' shape. Recently, many manufacturers of trawl doors have introduced new designs of trawl doors using curved plates, and aerofoil type sections, in an attempt to improve their hydrodynamic shape, making them more efficient at spreading the gear. The more elaborate designs tend to be more expensive, and more intricate to use well. Correct weight distribution and towing chain lengths are critical to getting a trawl door to spread the trawl gear effectively.

COMMON DESIGNS OF TRAWL DOORS:

Flat wooden door. This is one of the earliest known designs of otter boards. Nowadays, in the UK, it is used mainly by smaller trawlers towing in shallow water. They are easily constructed and easy to maintain. In some fisheries, plywood is used instead of the wooden planks.
Fig 3.2 Wood trawl door.

Steel 'V' door. Probably the most commonly-used trawl doors in the UK fishing fleet today. Theoretically not the most efficient trawl door, but

Fig 3.4 Cambered V door

Fig 3.5 Bison door

Fig 3.6 Round trawl door

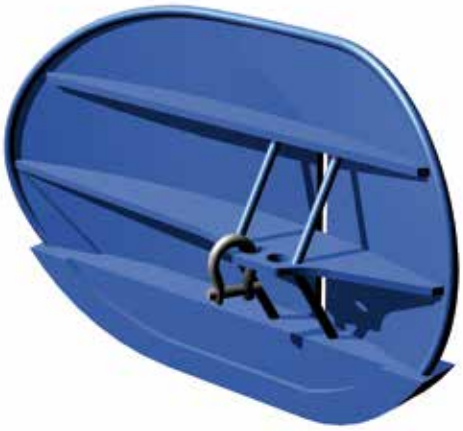


Fig 3.7 Oval cambered door

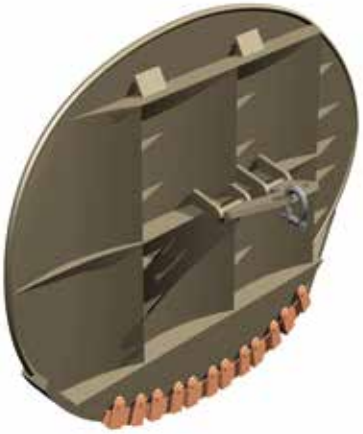


Fig 3.8 Foil door

Fig 3.9 Modern multi foil door

they are cheap to construct and easy to work. **Fig 3.3 Steel V door.**

A cambered 'V' trawl door. The idea of the curved plate is to improve water flow around the trawl door, thereby improving efficiency. **Fig 3.4 Cambered V door.**

'Bison' trawl door. This door uses three or four curved foils to reduce drag and improve performance. **Fig 3.5 Bison door**.

'Lindholmen' trawl door. Used to be a favourite of the North Sea Nephrops trawlers but many have now changed over to foil type doors **Fig 3.6 Round trawl door.**

Cambered Oval trawl door. Oval shaped doors are favoured by the deep sea fleet. They are designed to be good for towing over rough seabeds. **Fig 3.7 Oval cambered door.**

Oval shaped foil trawl door. Combining the benefits of a foil trawl door with that of an oval one. **Fig 3.8 Foil door.**

Modern multi foil trawl door with a higher aspect ratio, tending towards a higher more square shaped door with foils. **Fig 3.9 Modern multi foil door.**

Generally, immediately behind the trawl door, there is a length of wire or rope referred to as the sweep or single sweep. This, in turn, is connected to the top and bottom bridles, which are then attached to the net. The main purpose of the sweeps and bridles is to continue the herding action started by the trawl doors, all the way to the mouth of the trawl. By trailing on the seabed, the sweeps and bridles disturb the sediment to create a sand cloud in the water that slowly herds the fish into the path of the trawl.

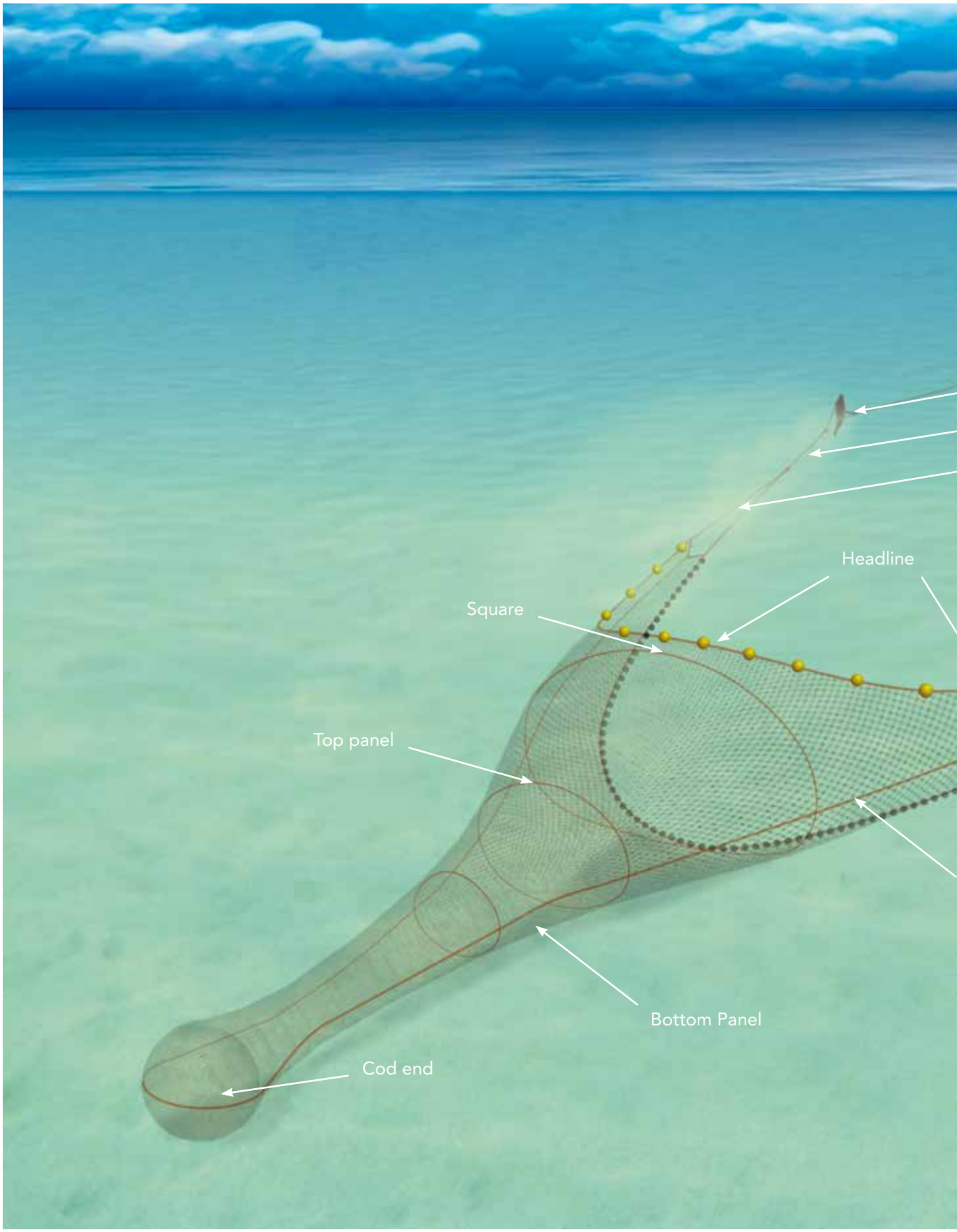
The sweeps and bridles between the net and the trawl doors can be made up using rope, wire, combination or chain. The top bridle, usually of lighter weight material, is attached to the headline of the net and the bottom bridle to the fishing line and ground gear.

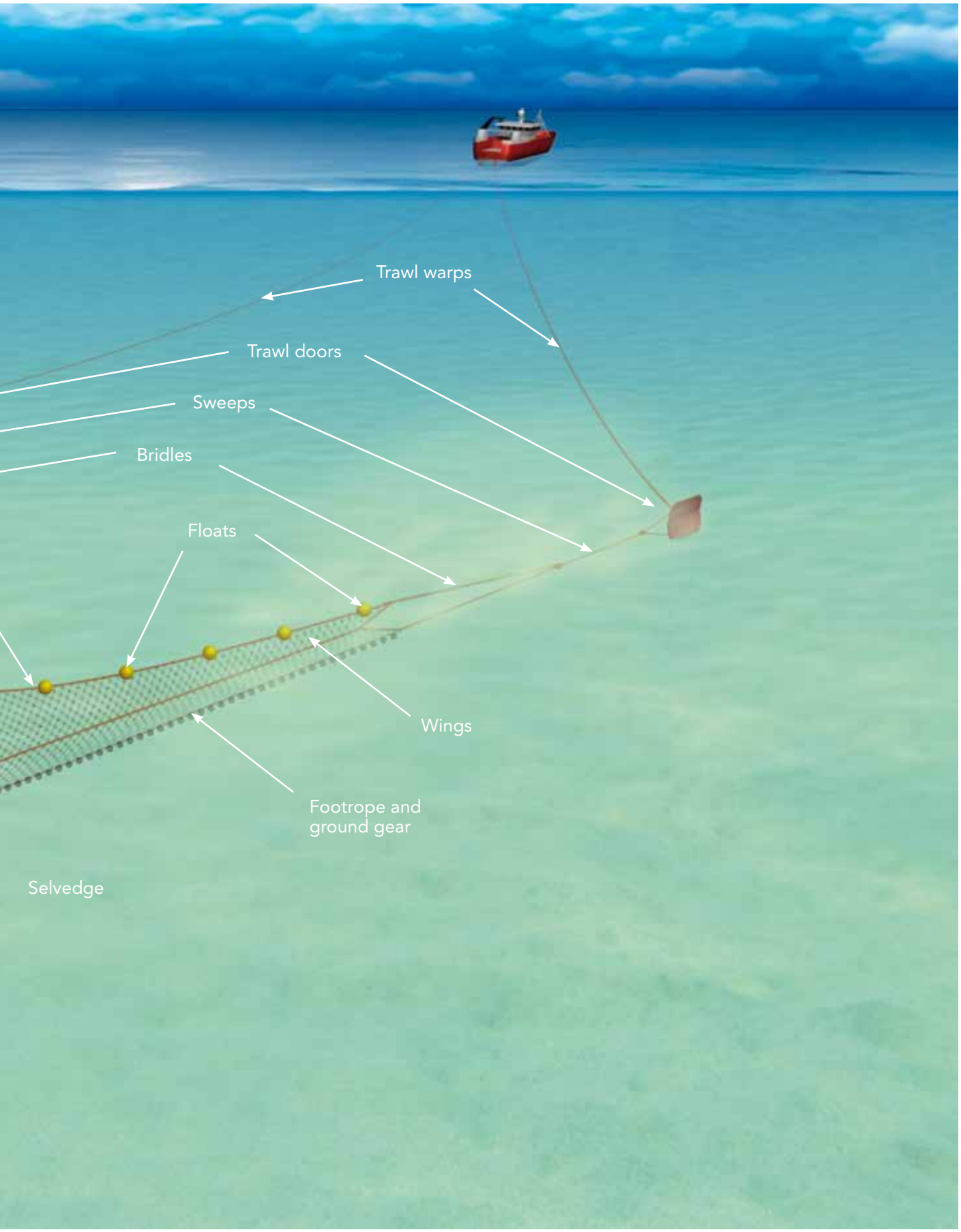
The choice of material used depends upon the size of gear and the type of seabed that the gear is being towed over. The bigger trawlers tend to use thick wire and chain, while the smaller inshore boats use thin wire and combination rope on what are, generally, the softer sea beds.

The length of the bridles varies with the type of net being used. A net with a low headline will only have short bridles. A higher standing net will need longer bridles to allow it to open up fully in a vertical direction. The combined length of the sweeps and bridles can range from two metres long to as much as 300 metres. The overall length of the sweeps and bridles, and the distance between the two trawl doors, needs to be accurately tuned to suit the species of fish that the vessel is targeting for them to work effectively. Species such as lemon sole and plaice can be herded into the trawl for a long way therefore skippers extend the length of their sweeps to as much as 300 metres when targeting these species. For haddock, whiting, cod, etc. 80 metres to 150 metres of sweeps are found to be efficient. The use of long sweeps and bridles is not very effective for fish that live very tight on the seabed such as Dover sole, monkfish and Nephrops.

The mesh size used in a common demersal trawl varies with the type of trawl. In the larger nets targeting round-fish (haddock, whiting, cod, etc.) the mesh size may vary from 150 - 300mm in the top wings, with slightly smaller in the lower wings, decreasing gradually towards the cod-end where it is usually from 70mm - 120mm, dictated by the legislation referring to the species to be caught and the area to be fished. In nets used for catching bottom fish and Nephrops, the complete net may be made from smaller mesh sizes. Recently in the UK, there is a tendency towards increasing the mesh sizes in trawls, particularly in the top panel and wings to improve the selectivity of the gear. Over the years, several distinct styles of trawls have evolved to target specific species of fish or groups of species, taking account of their natural behaviour, how they react to fishing gear and where they swim in the water column.

Basic components of trawl gear




Trawl warps
Trawl doors
Sweeps
Bridles
Floats
Wings
Footrope and
ground gear
Selvedge

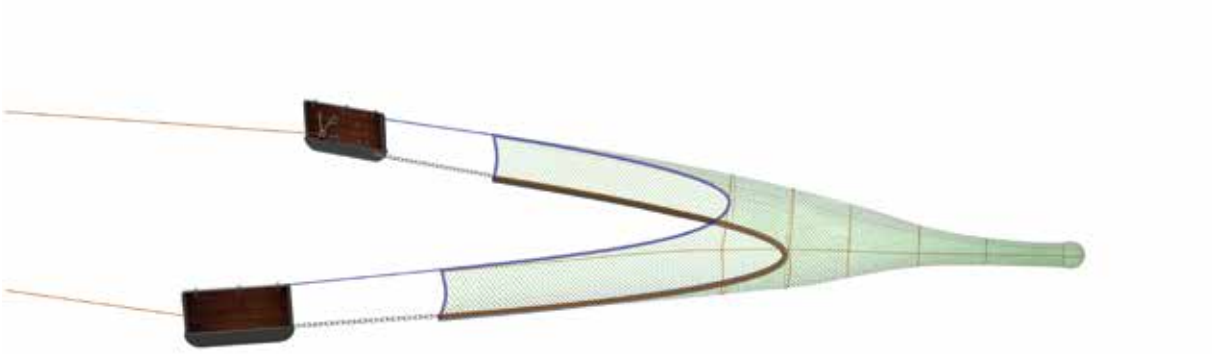


Fig 3.10 Sole trawl

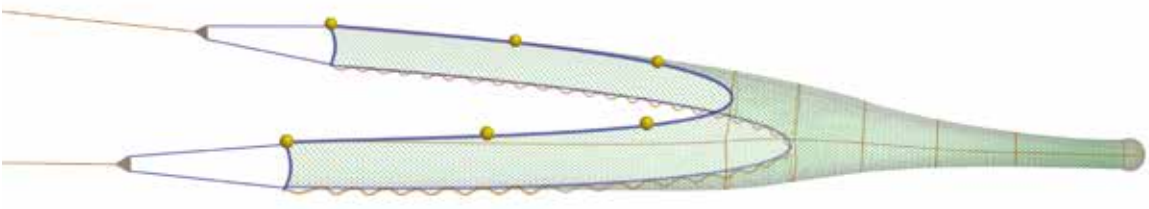


Fig 3.11 Nephrops trawl

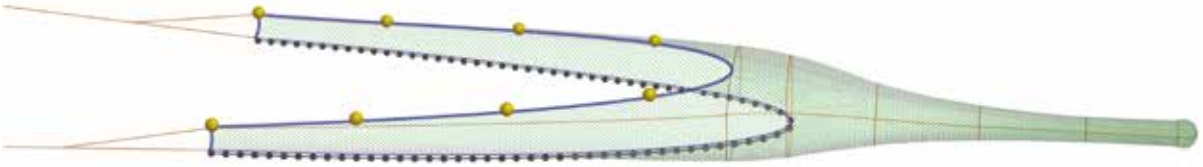


Fig 3.12 Scraper trawl

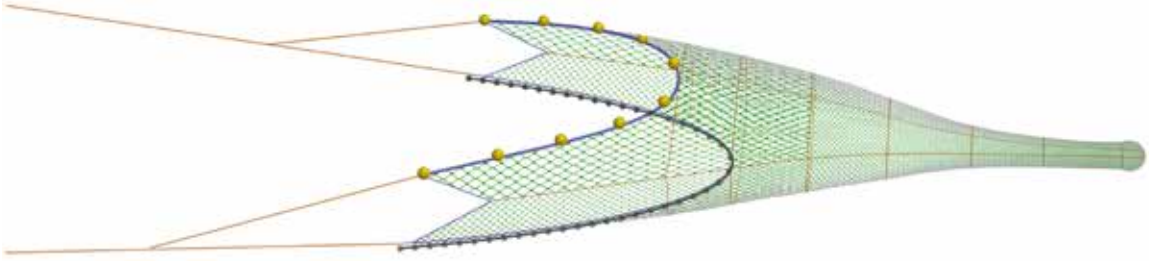


Fig 3.13 Two panel trawl

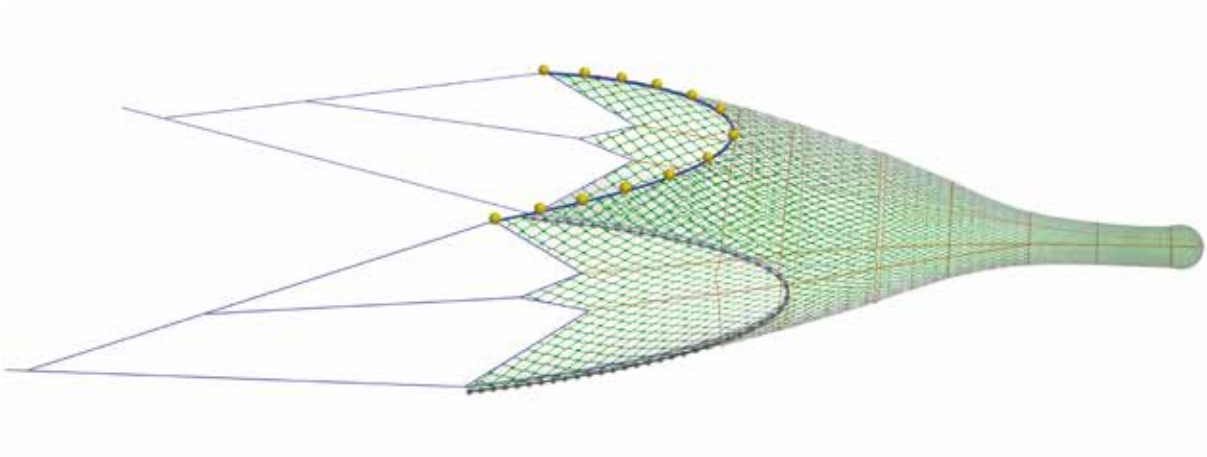


Fig 3.14 Three bridle trawl

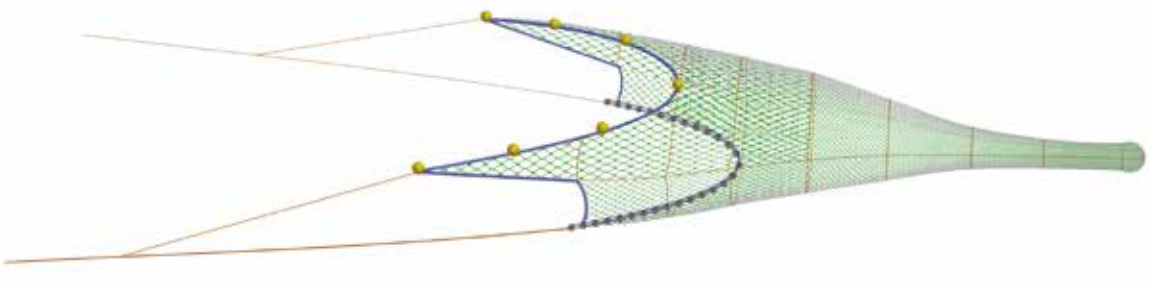


Fig 3.15 Hopper trawl

TYPES OF TRAWL

Sole trawl. Designed to target Dover sole and some other bottom-living species. These are fairly small nets featuring very short wings, a wide mouth and a low headline. The headline is usually no more than 750mm off the seabed, many will be as low as 300mm high. These nets are usually towed directly behind the trawl doors, without any sweeps and bridles, as Dover sole are not herded by the sweeps. They are often used in twin- or triple-rig configurations, particularly on inshore grounds. **Fig 3.10 Sole trawl.**

Nephrops trawl. Designed to catch Nephrops, also known as Langoustine and Dublin Bay Prawn, but are commonly referred to as 'prawns' by people in the in UK industry, hence the name prawn net. It is a long low net with lightweight ground gear for towing over the soft muddy areas where Nephrops are found. Sweeps and bridles are used with this net as the fishermen usually want to catch some of the other bottom-dwelling species such as plaice, monkfish, etc. to boost their landings. **Fig 3.11 Nephrops trawl.**

The scraper trawl or 'scrapper trawl' is similar to the prawn net but has longer wings and the headline height is slightly higher. It has evolved from the prawn net, designed to catch more of the valuable bottom-living species such as monkfish and megrims, as well as demersal round-fish that live close to the seabed. As with the sole net, this is often used as a twin-rig trawl. The sole net, prawn net and scraper net usually have a simple vertical wing end that is designed to restrict the headline height. **Fig 3.12 Scraper trawl.**

The two panel trawl has its origins in the early wing trawls that evolved to catch demersal round-fish such as haddock, whiting and cod. It usually has larger mesh in the front panels of the trawl to decrease drag and minimise capture of small fish, with the mesh size decreasing in size towards the cod-end where the mesh size is chosen to allow release of fish of the target species that are below the minimum landing size. The ends of the wings are cut in a 'V' formation that, combined with long bridles, allow the headline to rise and achieve a headline height up to six metres, depending on the size and design of the particular trawl. Sweeps and bridles are used with this trawl to create a sand cloud and herd the fish into the path of the trawl. **Fig 3.13 Two panel trawl.**

Three bridle trawl. This net has an extra centre panel of netting fitted into each side of it, making it into a four panel trawl. There is also a third bridle attached to the front end of this panel. The main objective of this design is to give an increase to the headline height of the trawl, with some of the larger trawls regularly working with a headline height in excess of 10 metres. To achieve this height without excessive drag, the trawls are usually of light construction using large mesh sizes. By slight adjustments to the length of third (centre) bridle, the general shape and catching ability of the net can be changed from being a low net with good ground contact, to being a high net that is just skimming across the seabed. There are some four panel trawls designed to be towed using only two bridles. **Fig 3.14 Three bridle trawl.**

The hopper trawl is so called because of the rock hopper ground gear used with this style of hopper trawl. This net is a modified two panel trawl specifically tailored by redesigning the lower panels and fitting the rock hopper ground gear to minimise damage when towing over hard, rough seabeds. Sweeps and bridles are used with this trawl to herd the fish into the trawl, although the length of these is usually reduced to reduce the chances of them hooking up on seabed obstructions. **Fig 3.15 Hopper trawl.**

There are many 'hybrid' trawl designs that have been designed to suit the mix of species found in particular areas, at specific times of the year, that combine several of the design features of these basic designs of trawls.

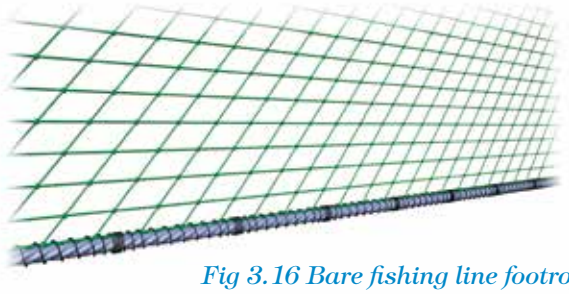


Fig 3.16 Bare fishing line footrope

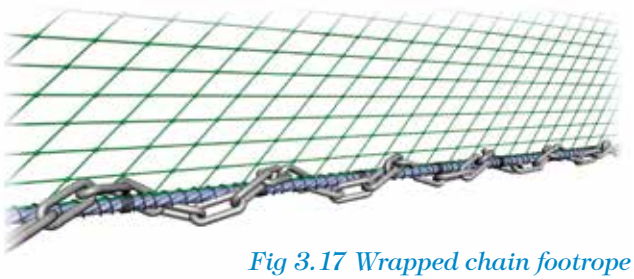


Fig 3.17 Wrapped chain footrope

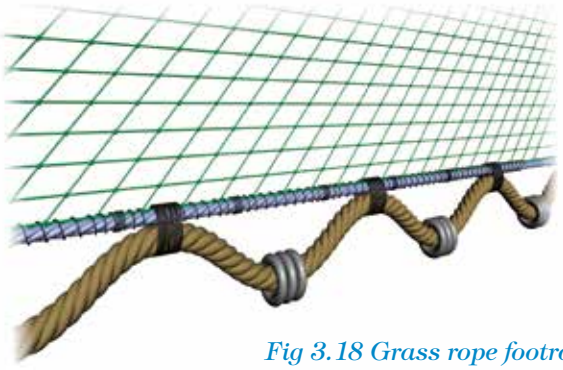


Fig 3.18 Grass rope footrope

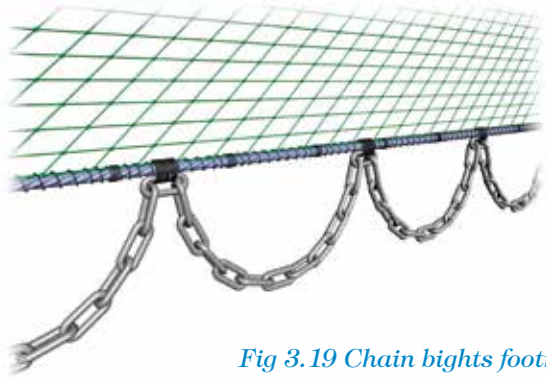


Fig 3.19 Chain bights footrope

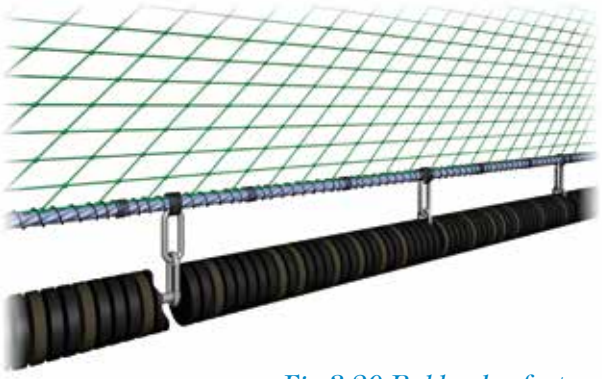


Fig 3.20 Rubber leg footrope

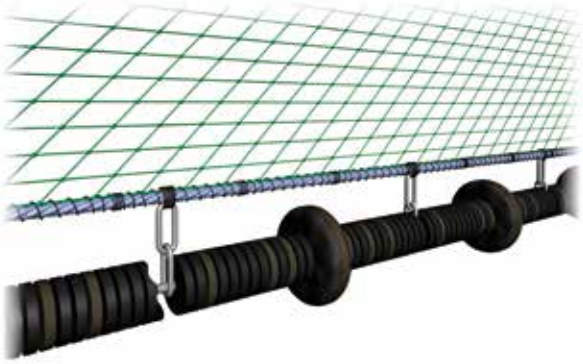


Fig 3.21 Small discs footrope

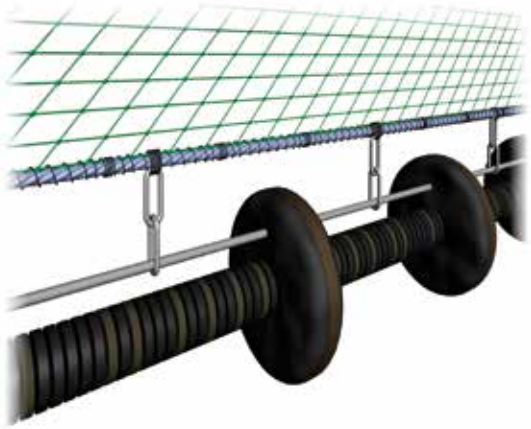


Fig 3.22 Large discs footrope

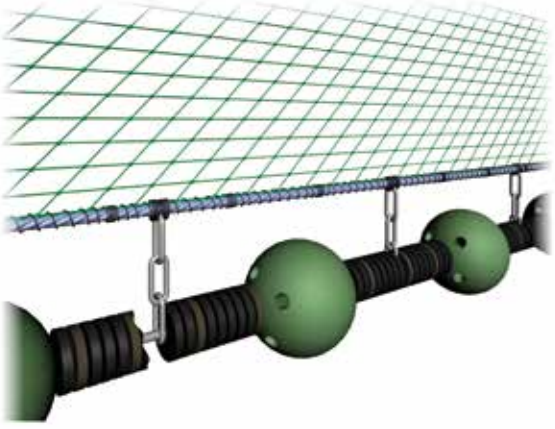


Fig 3.23 Spherical bobbins footrope

STYLES OF TRAWL FOOTROPE

All these trawls will have some form of ground gear attached along the foot rope on the lower edges of the trawl. The purpose of this ground gear is to protect the relatively fragile netting from damage on the seabed, and the weight of it helps maintain the trawl in contact with the seabed. These ground gears come in many different forms depending on the type of seabed that the trawl is towed over.

The most basic of these ground gears is where they use a bare fishing line, and the netting is laced directly to the rope or combination rope (fishing line). This is used on smooth sand or mud seabeds without any obstructions. Sometimes it will be wrapped with light rope for added protection against abrasion. **Fig 3.16 Bare fishing line footrope.**

Wrapped Chain — The fishing line is wrapped with chain or leaded rope to give it extra weight to maintain good seabed contact. This is only for use on smooth sand and mud. **Fig 3.17 Wrapped chain footrope.**

Grass Rope — A soft, loose laid rope is attached to the fishing line in bights (loops). Lead rings are threaded onto the rope and hang at the bottom of the bights of rope to provide weight. The idea is for the bottom of the bights to settle on the seabed, with the actual fishing line and netting skimming just above the seabed. **Fig 3.18 Grass rope footrope.**

Chain bights — A length of chain is lashed to the fishing line, in a similar manner to the grass rope, the bights hanging down to make contact with the seabed. The fishermen can easily monitor the trawls' seabed contact by checking the polish on the underside of the chain as a result of its contact with the seabed. **Fig 3.19 Chain bights footrope.**

Rubber leg — Small rubber discs are threaded onto a wire and attached to the fishing line by one or two links of chain. The rubber leg maintains good contact with the seabed throughout its length, while keeping the fishing line clear of the seabed. This rig will be used on firmer sea beds of smooth sand and mud.
Fig 3.20 Rubber leg footrope.

Small discs. This is a progression from the smooth rubber leg, where small discs (approx. 140mm diameter) are spaced about a metre apart along its length. As with the rubber leg, this is for firmer seabeds where the discs keep the net slightly higher from the seabed and prevent capture of many of the small creatures and shell fish that live on the seabed. **Fig 3.21 Small discs footrope.**

Large discs. Similar to the disc footrope, but larger discs between 150mm and 250mm diameter are used to lift the footrope further from the seabed and allow the fishermen to fish firmer seabed with some small rocks and obstructions scattered around it. **Fig 3.22 Large discs footrope.**

Spherical plastic bobbins. A light footrope with hollow plastic bobbins spaced out along a small rubber leg footrope. This is usually attached to the fishing line using short lengths of chain, about 300mm long, to allow the fishing line to be towed clear off the seabed. This prevents the capture of many of the seabed dwelling organisms.
Fig 3.23 Spherical bobbins footrope.

Bobbin ground gear. This is the type of ground gear often used by the larger class of trawlers. Large steel or rubber bobbins (up to 600mm diameter) are threaded onto a chain with rubber 'spacers' between them. They are fixed to the fishing line by a short length of chain, between 300mm and 1 metre long, that is threaded around a steel spacer called a 'lancaster'. This arrangement allows the bobbins to rotate and roll across the sea bed enabling the gear to be towed over hard stony seabeds without damage.
Fig 3.24 Bobbin footrope.

Rock hopper ground gear. This is a modern version of the bobbin ground gear where the large rubber discs, up to 600mm diameter, are cut from discarded tyres. These are threaded

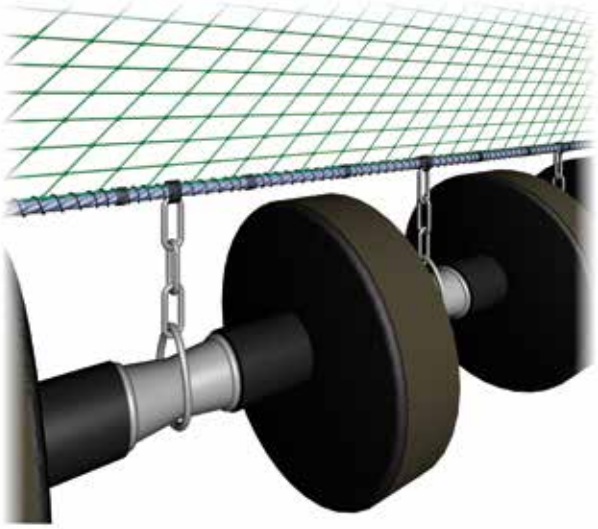


Fig 3.24 Bobbin footrope

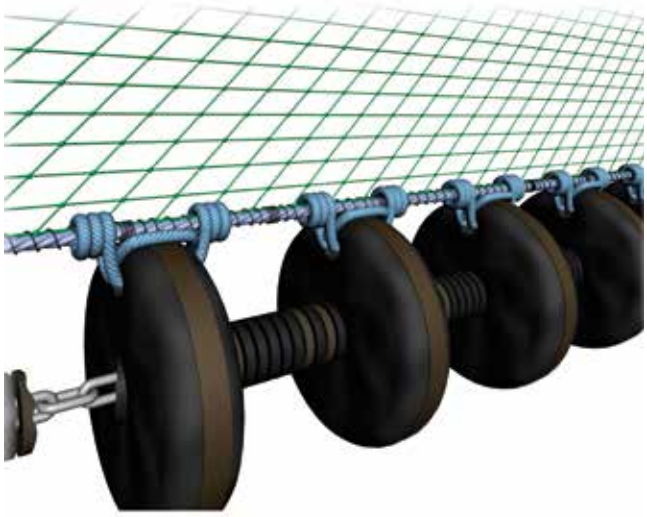


Fig 3.25 Rock hopper footrope

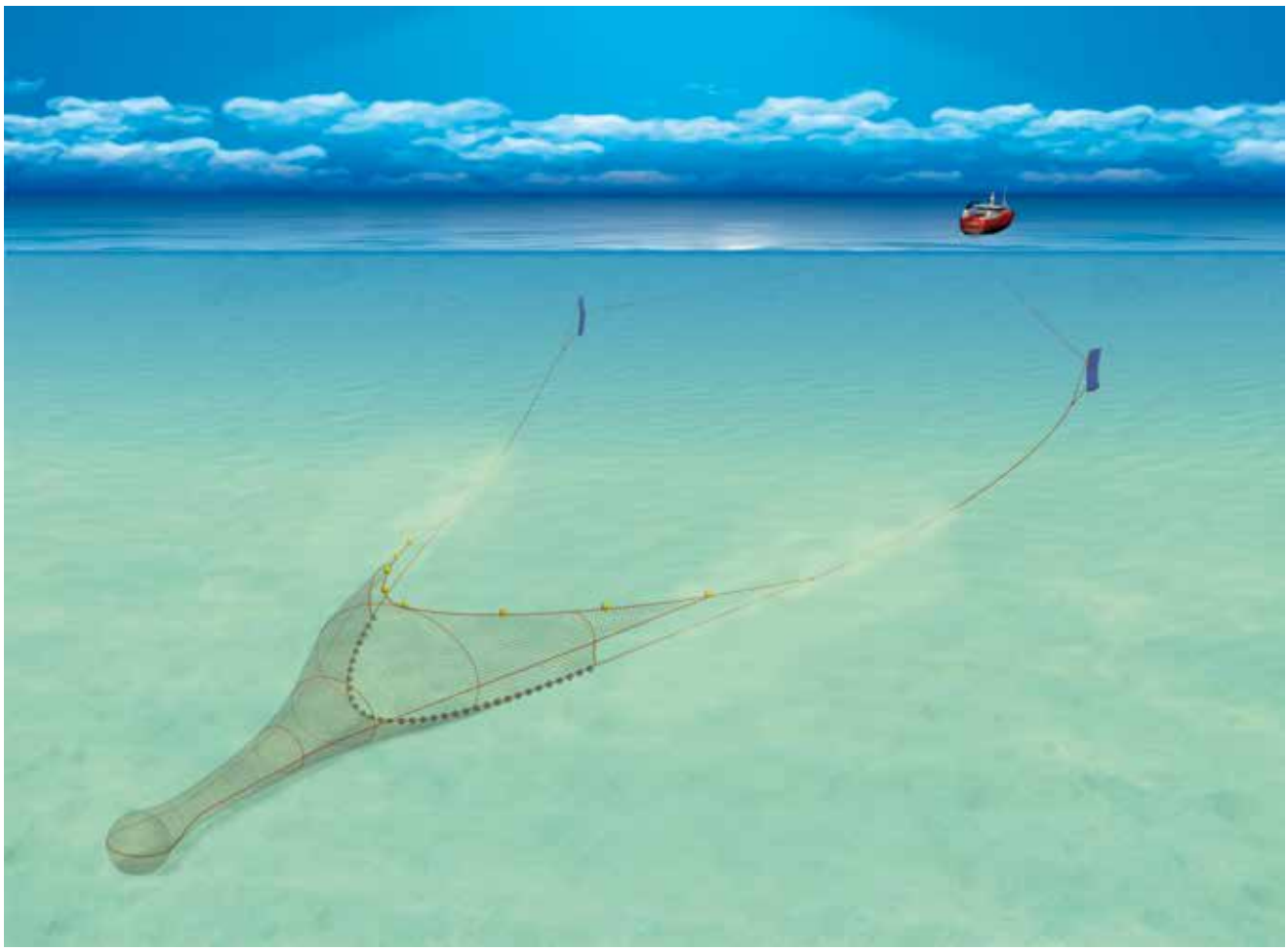


Fig 3.26 Semi-pelagic trawling

onto heavy wire or chain, with smaller rubber discs used to space them out. The discs are attached, tied to the fishing line of the trawl by light rope, through a hole in the top of the disc. This rig can look very heavy and cumbersome on the quay, but it will lose about 80% of its weight once immersed in seawater, and actually, it will be quite light on the seabed to allow it to 'hop' over the hard rocky seabed, thereby preventing the relatively fragile net from too much damage.
Fig 3.25 Rock hopper footrope.

TRAWL VESSELS

Throughout the EU, there are a wide variety of sizes and types of fishing vessels operating demersal trawls, from small 5 metre inshore boats right up to 80 metre deep sea stern trawlers. All of these vessels will shoot and haul their trawl warps using some form of trawl winch; the smaller boats will handle their nets by hand, the bigger ones being more mechanised. The larger vessels will shoot and haul their gear using power blocks, cranes and net drums to handle the gear in and out of the water, and to take the catch on board. Nowadays, most vessels will shoot and haul their gear over the stern of the boat, shooting the gear by dropping the cod-end over the stern, then letting the net run out as the vessel steams slowly ahead. The sweeps and bridles, if used, will be paid away from the winch or net drum depending on the deck layout of the vessel. The trawl doors are then attached to the gear by some form of quick release mechanism, and the warps slacked away from the winch until the gear is in position on the seabed. The gear will be towed for anything up to five hours depending on the depth of water, the type of seabed, the target species and the expected amount of fish on the grounds.

The hauling operation is virtually the reverse of shooting, with the cod-end containing the catch being hauled up a stern ramp on the bigger trawlers or hoisted over the stern or side of the vessel on the smaller boats to empty the fish on to the deck or into a reception hopper. From here it is processed by the crew and stored in the chilled fish hold.

Demersal trawls are used to target all demersal and bottom dwelling species, including several species of shell fish such as Nephrops and queen scallops. Many of the fisheries around the UK are mixed species fisheries where the trawls will catch several different species during the same haul.

Much has been done, over the years, to improve the selectivity and general environmental credentials of trawl gear. Many of these are adopted as standard in many modern fisheries. In the UK, many of the trawlers are using more hydrodynamic trawl doors to reduce drag (fuel usage) and decrease their requirement for heavy seabed contact. Recently, in several fisheries around the world, skippers and trawl door manufacturers have been working on ways of operating the demersal trawl doors actually flying above the seabed, rather than on it, to decrease the gear's impact on the seabed, and further reduce the overall drag of the gear. This is often referred to as 'off bottom doors', 'flying doors' or 'semi-pelagic trawling'. **Fig 3.26 Semi-pelagic trawling.**

There are several ways of doing this — the illustration shows one of these.

This method has yet (2014) to be taken up by many UK trawlers, but a similar method of 'semi pelagic trawling' has been operated by fishermen in Northern Ireland for many years to target cod and haddock. In this method, they used a pelagic trawl and pelagic trawl doors, but rigged it so that the trawl was skimming just clear of the seabed.

GEAR SELECTIVITY

One of the main legislative tools used to minimise the capture of undersize fish is regulating the minimum size of meshes that can be used in trawls and trawl cod-ends to suit the minimum size of the fish being targeted. Many skippers are voluntarily using larger meshes than required by legislation in the cod-ends to further improve their selectivity.

Another method of improving the selectivity of trawls is by fitting square mesh panels into the

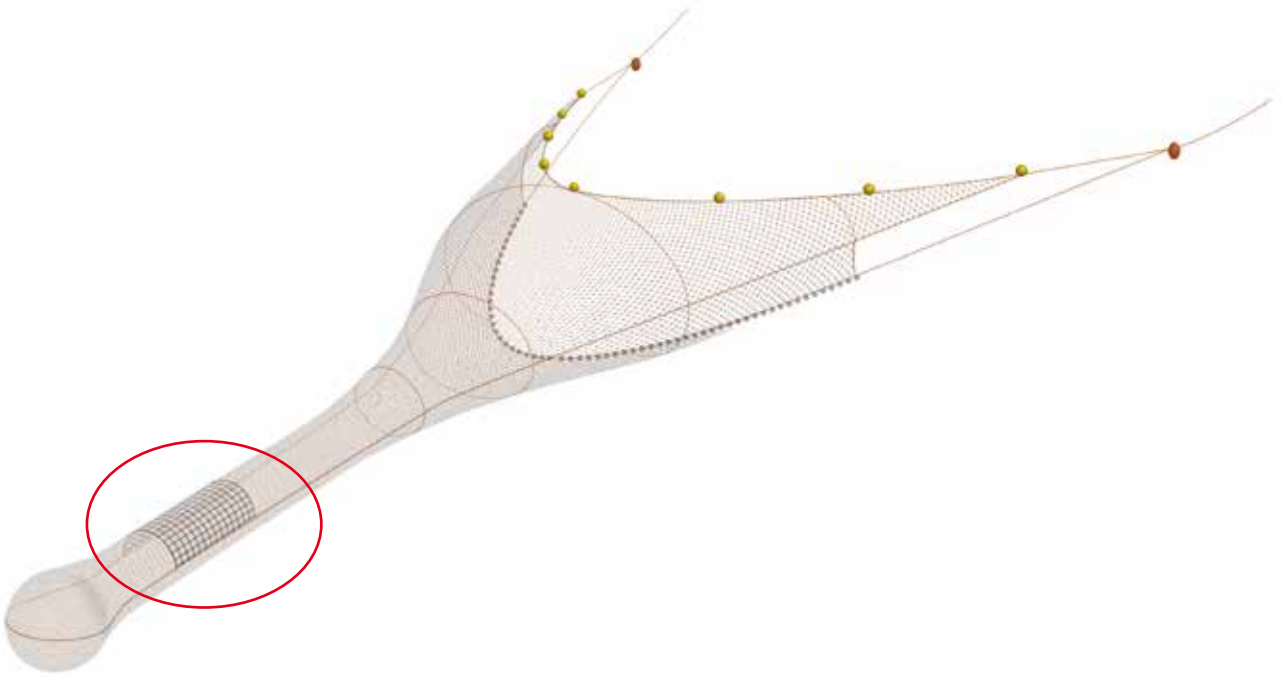


Fig 3.27 Square mesh panel fitted in demersal trawl

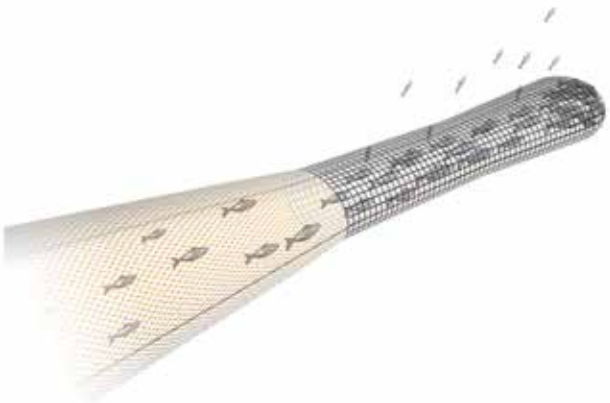


Fig 3.28 Square mesh cod-end

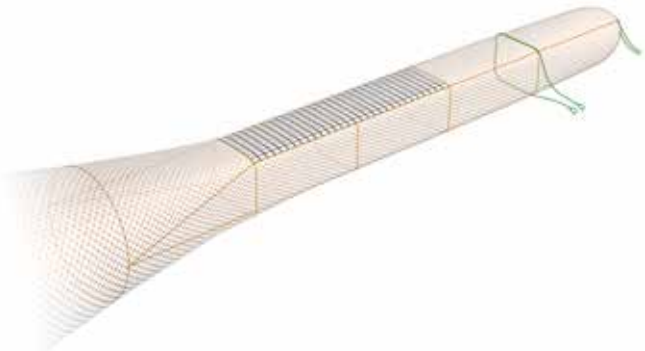


Fig 3.29 Seltra cod-end

trawl. This is where a panel of netting is turned through 45 degrees so that the meshes take up a square shape rather than a diamond shape, sometimes referred to as T45. In this orientation, the meshes remain open throughout the fishing cycle of the trawl, and provide an exit window for smaller fish to escape from the trawl. **Fig 3.27 Square mesh panel fitted in demersal trawl.** By increasing the mesh size of the square mesh panel, larger fish can be allowed to escape. Traditionally, the square mesh panels required by fishery legislation were fitted in the top of the trawl just ahead of the cod-end or extension. When the early experimental work was done, this was found to be the most effective area to fit the panels. However, nowadays, many skippers are voluntarily fitting extra panels in other areas of the trawl, and increasing the mesh size of the square mesh panels far beyond what is required by legislation to improve the selectivity of the gear, and reduce the amount of discards.

Some beam trawlers have fitted square mesh panels in the bottom panel of their trawls to release small seabed creatures and shells from their trawls, thereby reducing their discard rates considerably. These are called 'benthic panels'

To further improve selectivity, some skippers of both beam trawlers and otter trawlers have started to experiment with the use of cod-ends made entirely from square mesh.
Fig 3.28 Square mesh cod-end.

Another variation of the square mesh panel has been creating interest in Danish fisheries, and to some extent other countries in the EU, is called the Seltra panel. This is where they have converted the traditional two panel net into four panels to keep the cod-end and extension more open, and fitted a section of large, square mesh in the top panel, and achieved good results in reducing discards. **Fig 3.29 Seltra cod-end.**

Another selectivity design that is gaining favour with many skippers is the use of a coverless trawl. Over many years of trawl evolution, the cover developed as a design feature to retain certain species that have an escape stimulus to swim upwards, ahead of approaching danger, such as the mouth of a trawl. In this trawl, the cover or square of the trawl is removed to allow many fish to escape upwards ahead of the trawl, before capture. **Fig 3.30 Coverless trawl, page 42.**

One of the most effective selective trawls that has been developed is the separator trawl. In this design, an extra horizontal panel is fitted inside the trawl to create two chambers, one above the other in the trawl, each one with its own cod-end. **Fig 3.31 Separator trawl, page 42.**

This device works using the same principle as the coverless net in that some species have an escape stimulus to swim forward and upwards to escape predators and danger; in this case, the danger is the mouth of the trawl. The actual height of the front edge of the panel can be altered to suit the target species to separate the fish and shellfish that swim close to the seabed into the lower chamber, and the fish that swim slightly higher off the seabed into the top. To further improve selectivity and minimise discarding, each chamber or cod-end can be fitted with a secondary selective device to suit the particular species retained in each. As an example, this could be an 80mm diamond mesh cod-end on the lower chamber to retain Nephrops, with a square mesh cod-end on the top to release small round-fish, but retain all the larger ones.

In many fisheries, rigid grids are used to separate target species from by-catch. Grids are most effective where the unwanted by-catch is physically much larger than the target species. These are used in several shrimp fisheries where there is a possible by-catch of turtles, or large pelagic species, where there is a release gap in the top of the trawl, and an inclined rigid grid below it, to guide the unwanted by-catch out through the hole, but the relatively small shrimps pass through the spaces between the bars and into the cod-end. **Fig 3.32 Inclined grid, page 42.**

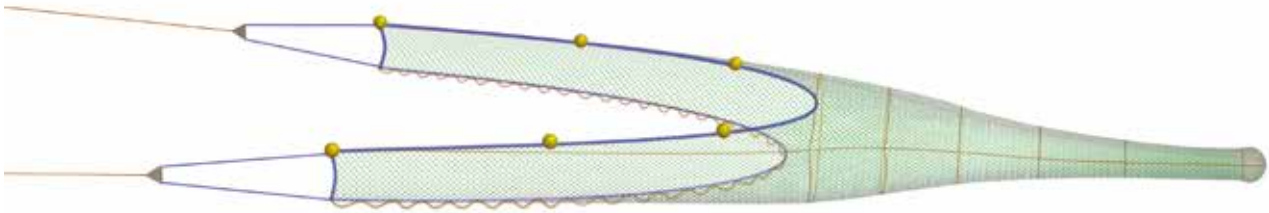


Fig 3.30 Coverless trawl

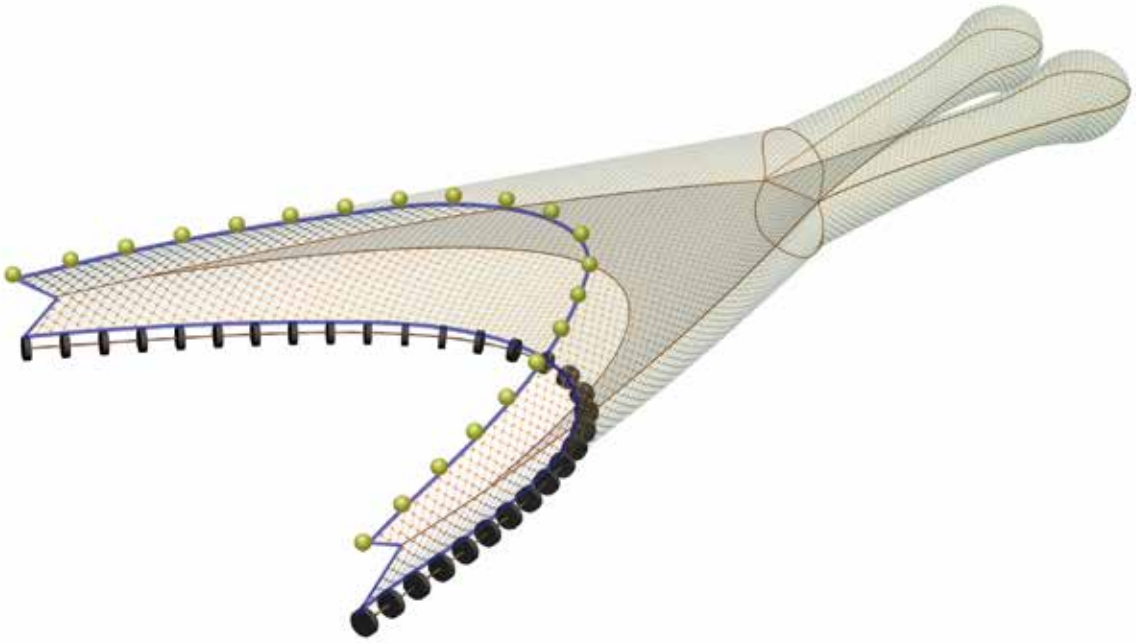


Fig 3.31 Separator trawl

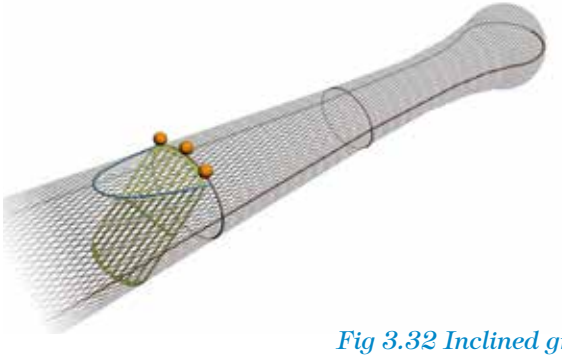


Fig 3.32 Inclined grid

Similar styles of grids are used in many European shrimp and prawn fisheries to release any by-catch of fish from the trawl. The spacing of the bars in the grid is set to allow the target species to pass through, but to guide the by-catch to the release hole in the net.

Grids are being used in some Nephrops fisheries with the bars spaced to allow the Nephrops through, but release any by-catch of fish. These grids are made from metal or plastic, depending on what is more suitable for the fishery. One of the failures of a grid is that they are not very effective at excluding small immature fish that are of similar size to the target species, be it shrimps or Nephrops.

PAIR TRAWL

Pair trawl has evolved mainly from a single boat trawl combined with the technology of ring netting with two boats. This is where a net is shot round a shoal of fish, with a boat at each end of the net. Instead of bringing the ends of the net together immediately, they would tow it a short distance first — a form of pair trawling.

In this method, a demersal trawl is towed by two boats simultaneously, one towing each side of the trawl. The design of a pair trawl differs very little from a single trawl that would be used by an individual vessel, apart from being larger. Trawl doors are not used in this method, the horizontal opening of the trawl being maintained by the distance between the two vessels as they tow the gear. The distance apart of the two vessels can vary depending mainly upon the depth of water and the target species, but is usually in the region of 300 - 400 metres.

As there are no trawl doors, the overall drag of the gear is reduced, allowing the vessels to tow a slightly larger net without increasing their fuel consumption. Bridles and sweeps, similar to that used in a single-rig trawl, are used, with the trawl doors being replaced either by a clump weight or a length of heavy trawl wire (100 - 200 metres) to help keep the gear on the seabed. This wire on the seabed acts as an extension to the sweep in that it will help to herd the fish into the path of the trawl. Additionally, in shallow water, the vessel's engine and propeller noise does not disturb the fish in the path of the trawl, but actually helps with the herding effect of the gear. **Fig 4.1 Demersal pair trawling, page 44.**

Vessels of all sizes operate as pair trawlers. The main criterion is that they are equipped with a trawl winch and means of hauling the gear in a similar manner to a single net trawler.

The trawl is shot and hauled by one vessel in a similar manner to a single trawl. The difference comes when the net has been shot, where, instead of hooking on a set of trawl doors, one side of the trawl will be passed to the partner vessel. This is done by throwing a lightweight heaving line that is attached to one side of the trawl from one vessel to the other, enabling the partner vessel to haul across one side of the trawl and shackle it onto their trawl warp. The two vessels then start to move apart while they both pay out the required amount of trawl warp to get the gear on the seabed. The amount of warp used is dictated by the depth of water that the vessels are fishing in; it is usually between four and six times the depth of water.

As with a single trawl, the boats will tow for up to five hours at 3 - 4 knots, then both vessels will heave in their warps and edge closer together with one vessel taking both sides of the trawl to haul it aboard, as if handling a single trawl. The hauling boat will usually take the catch as well, however if there is a large haul they may split the catch between the two boats by passing the cod-end between the boats.

The size of gear very much depends on the size of the vessels, but a rough guide for two 20 metre trawlers, a demersal pair trawl would open horizontally to approximately 20 - 25 metres, and vertically to between two and six metres, depending on the target species and the design of trawl. The skippers have to judge carefully

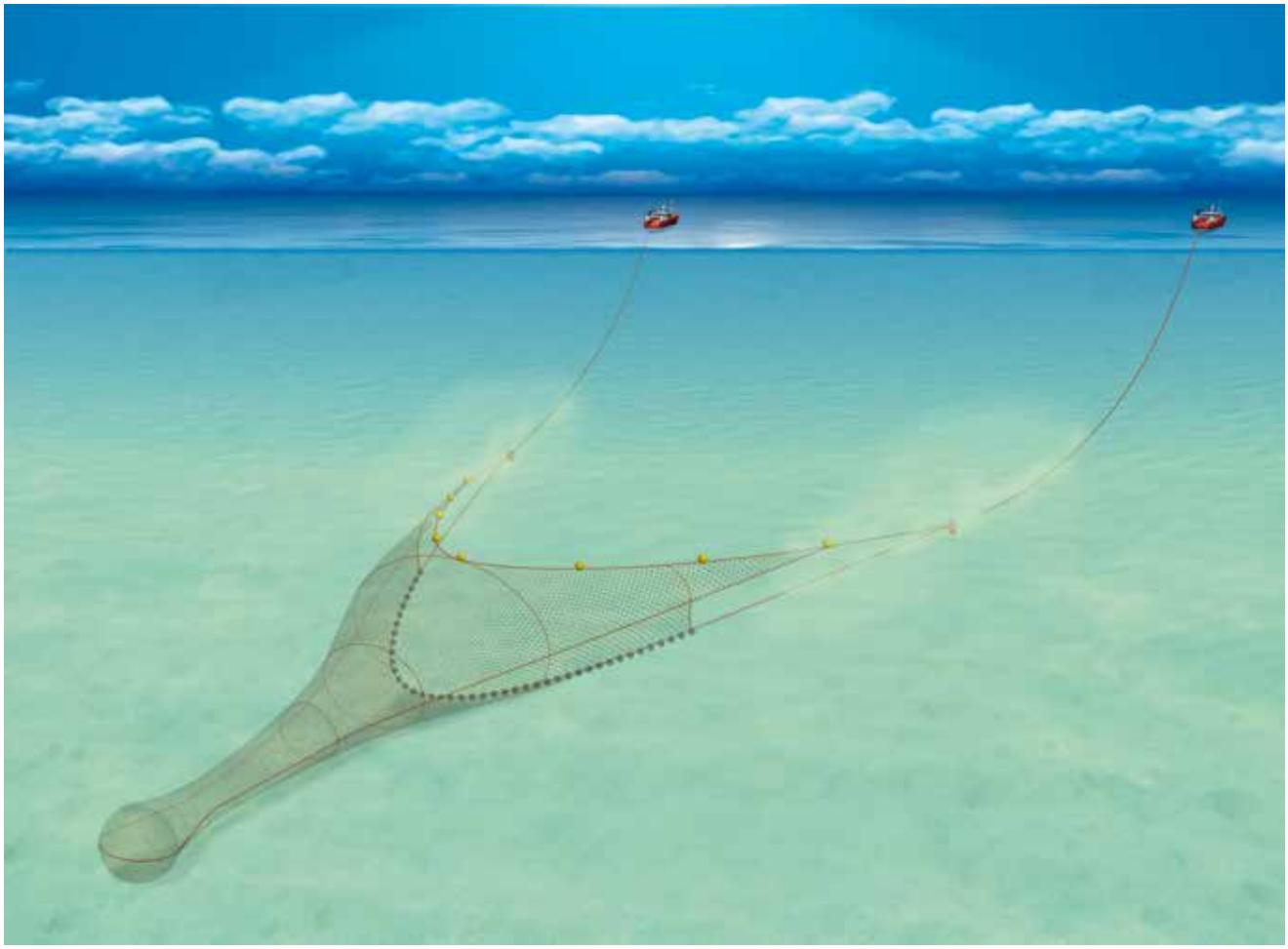


Fig 4.1 Demersal pair trawling

what size of trawl they use, as a larger trawl will have much greater drag, resulting in greater fuel consumption, but will not necessarily return larger catches. In a similar manner to a single-trawl, pair-trawls have ground gear fitted to their footrope to protect the trawl from damage.

The main target species in the EU tend to be haddock, whiting, cod, etc. rather than the bottom-living species, although there will often be a by-catch of these species. Demersal pair-trawl is used in many fisheries throughout the world, from small boat artisanal fisheries right up to deep sea freezer trawlers. Many EU vessels that used to operate as pair-trawlers have modified their vessels and gear to enable them to operate in a similar manner to pair seiners.

There will be some disturbance to the seabed through the contact of the sweeps and the ground gear of the net, but because pair trawl gear does not need trawl doors, there will be reduced seabed impact. However, despite the lack of trawl doors, pair trawl gear will sweep a wider area of seabed than a single trawl. Usually, pair trawl is used over sand, mud and shingle seabeds that are already subject to regular disturbance through the natural movement of tides and currents, therefore, any disturbance by the gear should have minimal long term effects.

As with single boat demersal trawls, the vessels are strictly regulated through TAC and gear regulations to minimise environmental impact and by-catch. As the gear is towed on the seabed, where, in many fisheries, there tends to be a mix of fish species, there is the opportunity for a by-catch of non-target species. The capture of immature fish is minimised by use of larger cod-end mesh sizes, some due to legislation but more recently as a result of the skippers choosing to use mesh sizes larger than the minimum dictated by regulation, to generally improve the selectivity of their gear and minimise discarding.

PAIR SEINE

Originally, this method of fishing developed where one boat would shoot its seine net and the long ropes on each side. Rather than that vessel heading back to the dhan and picking it up, the partner vessel would move in and pick it up. Both vessels would then tow the gear between them for a length of time, keeping the gear open for longer, therefore fishing longer, before passing the dhan back to the vessel that shot the gear to allow it to haul the gear as a traditional seine net.

As this method evolved, the skippers started to add more seine net rope and wire to each side of the net to increase the area of seabed swept by the gear, thereby increasing the catching ability of the gear. Due to the long lengths used, it became more convenient for the vessels to handle the gear in a similar manner to a pair trawl, with one vessel shooting the net, then passing one side of the net to the partner vessel, and both would then shoot their own side of the long lengths of rope and wire before towing the net between them for several for several hours.

The gear is hauled by each vessel winching in their own side of the wire and rope as the two vessels gradually close up the distance between them. When all the wire is hauled in and the net is almost at the surface, the vessels will be close enough together for one of them to pass the their side of the net back across to the partner vessel. This vessel will then haul the bridles and net onboard over the stern of the vessel, usually using a net drum. This vessel will then take aboard the catch, if there is a large haul the other vessel may move in closer and take some of the catch aboard their vessel too. The pair will then prepare to shoot the pair seine gear again and tow for several hours as the crew process the catch and stow it in the refrigerated fish room.

Modern pair seine in most EU waters is, therefore, very similar to pair trawling, but much longer lengths of seine net ropes and combination wire are used instead of trawl warp. On each side of the net, as much as 1,500 metres of wire and rope

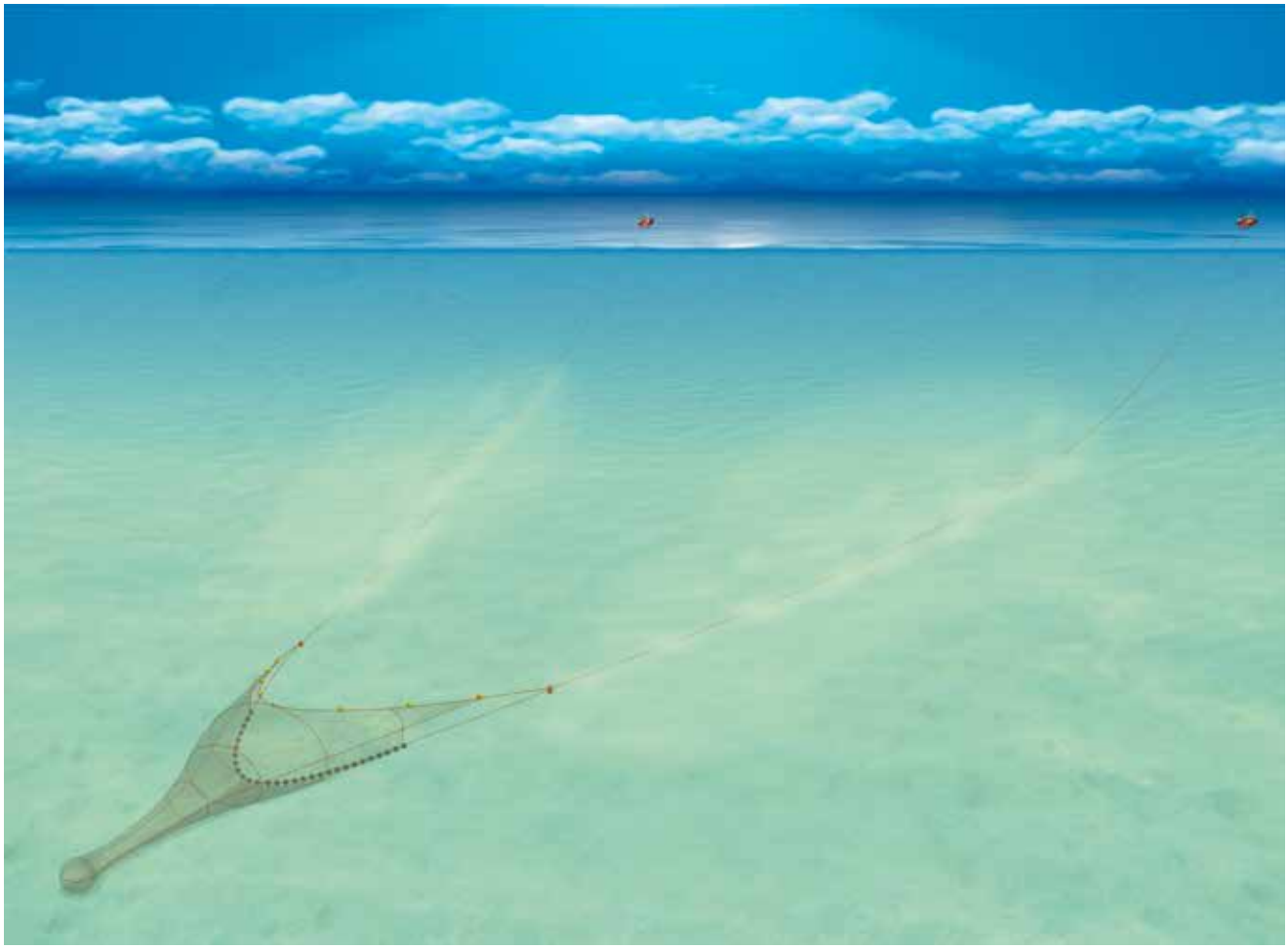


Fig 4.2 Pair seining

is towed on the seabed to create a sand cloud that will herd fish from a wide area of seabed into the path of the net. The boats will be anywhere between 300 metres and 800 metres apart, depending on the depth of water and the amount of warp that is shot. Pair seine is usually used to sweep large areas of clean ground, whereas pair trawl tends to be used in smaller areas of harder sea beds.

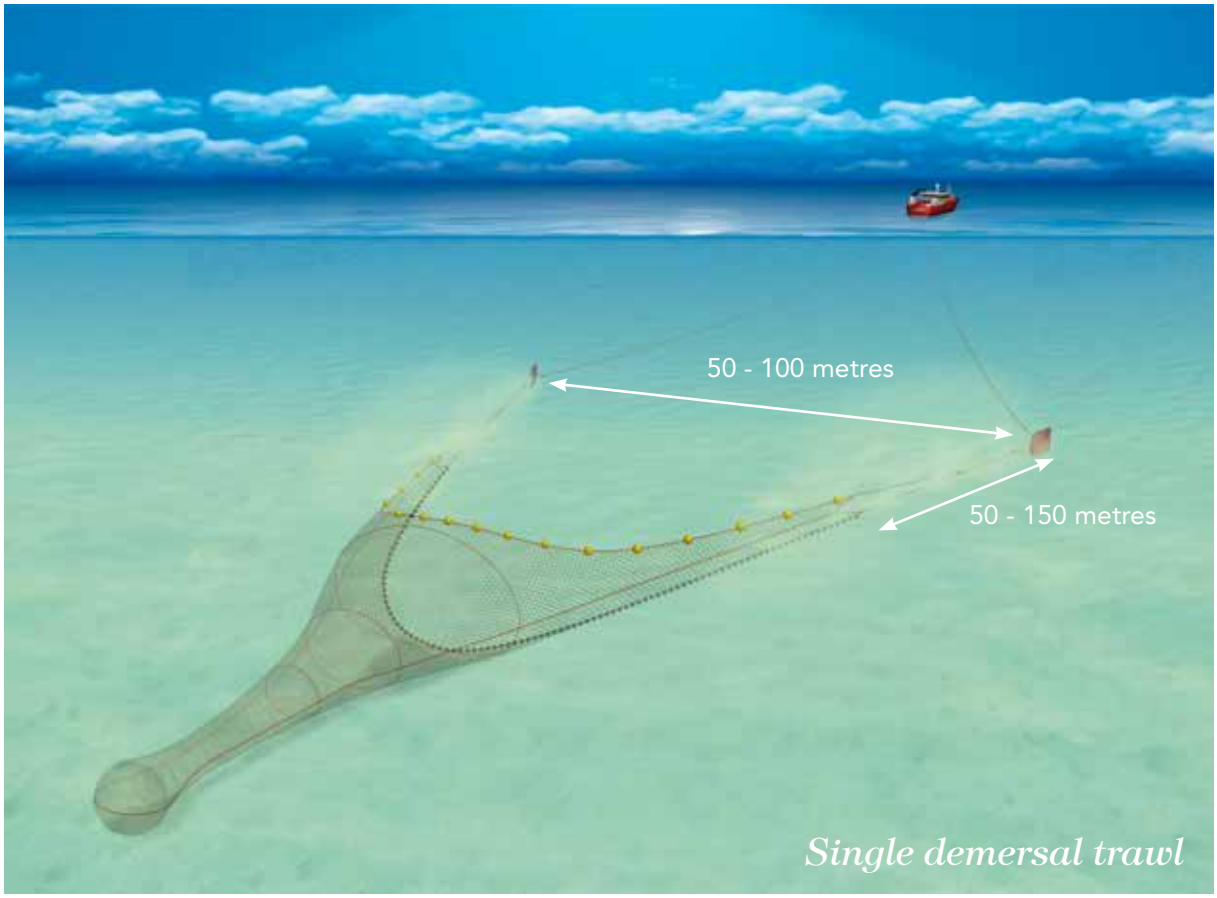
The vessels are virtually the same as that for pair trawlers or seine net vessels. Many vessels are equipped to fish using Scottish seine net, pair seine and pair trawl, depending on the area they are in and what their target catch is at that time. Modern pair seine vessels are rigged with large capacity winches dedicated to hauling and storing the long lengths of wire and rope used to herd the fish into the net. **Fig 4.2 Pair seining.**

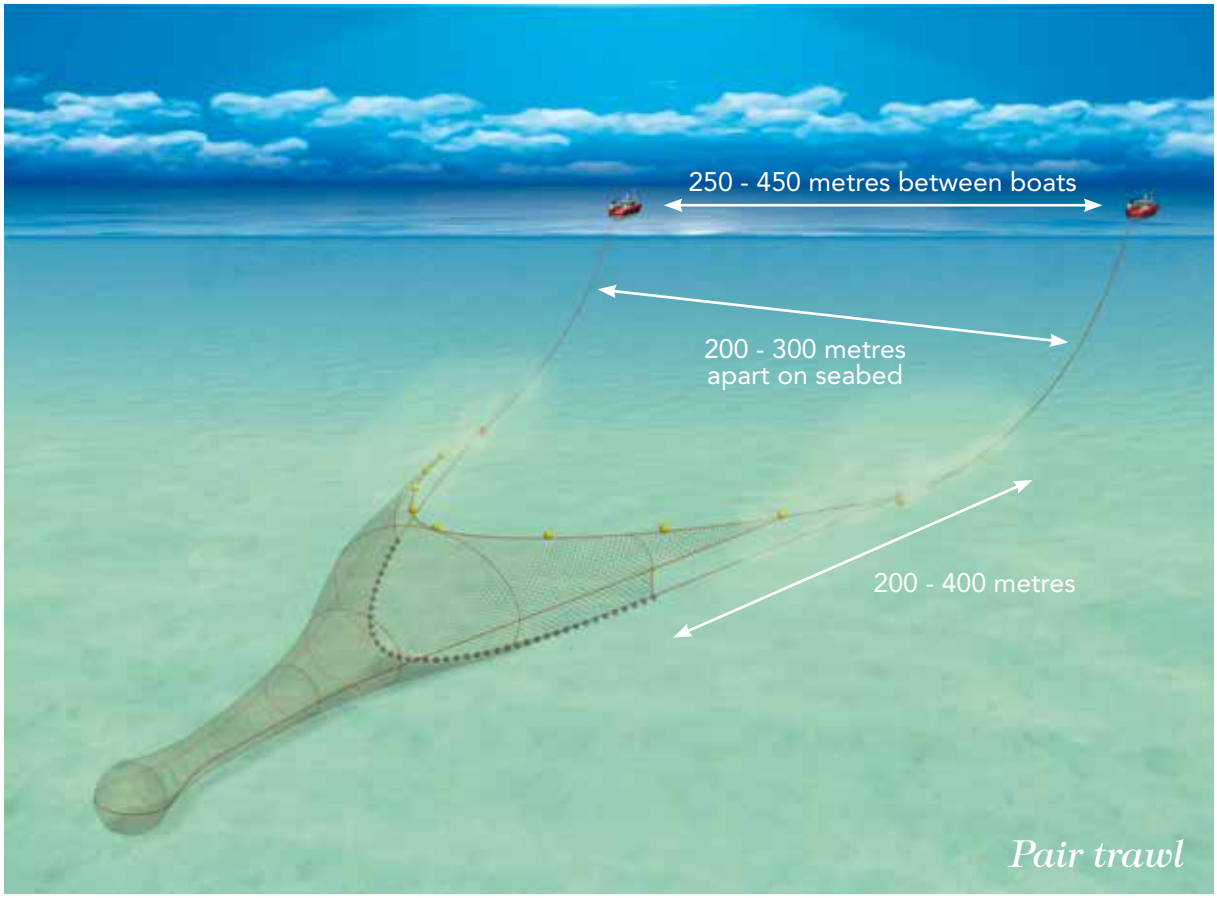
One of the problems of both pair seine and pair trawl is that the two vessels have to come close together to pass the tails of the net across. This can be hazardous in poor weather.

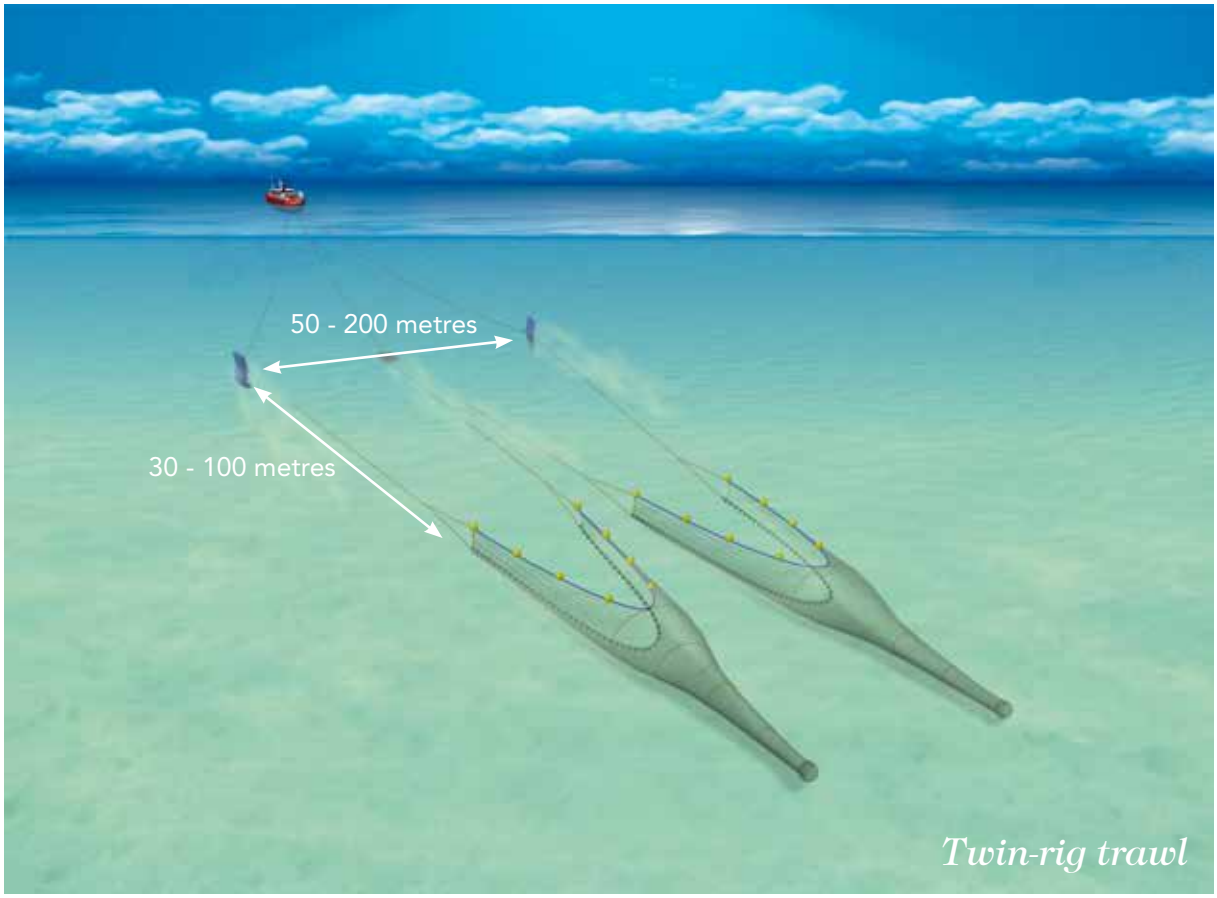
Similar species are targeted with both pair seine and pair trawls.

The environmental and by-catch issues are similar to that of pair trawl.

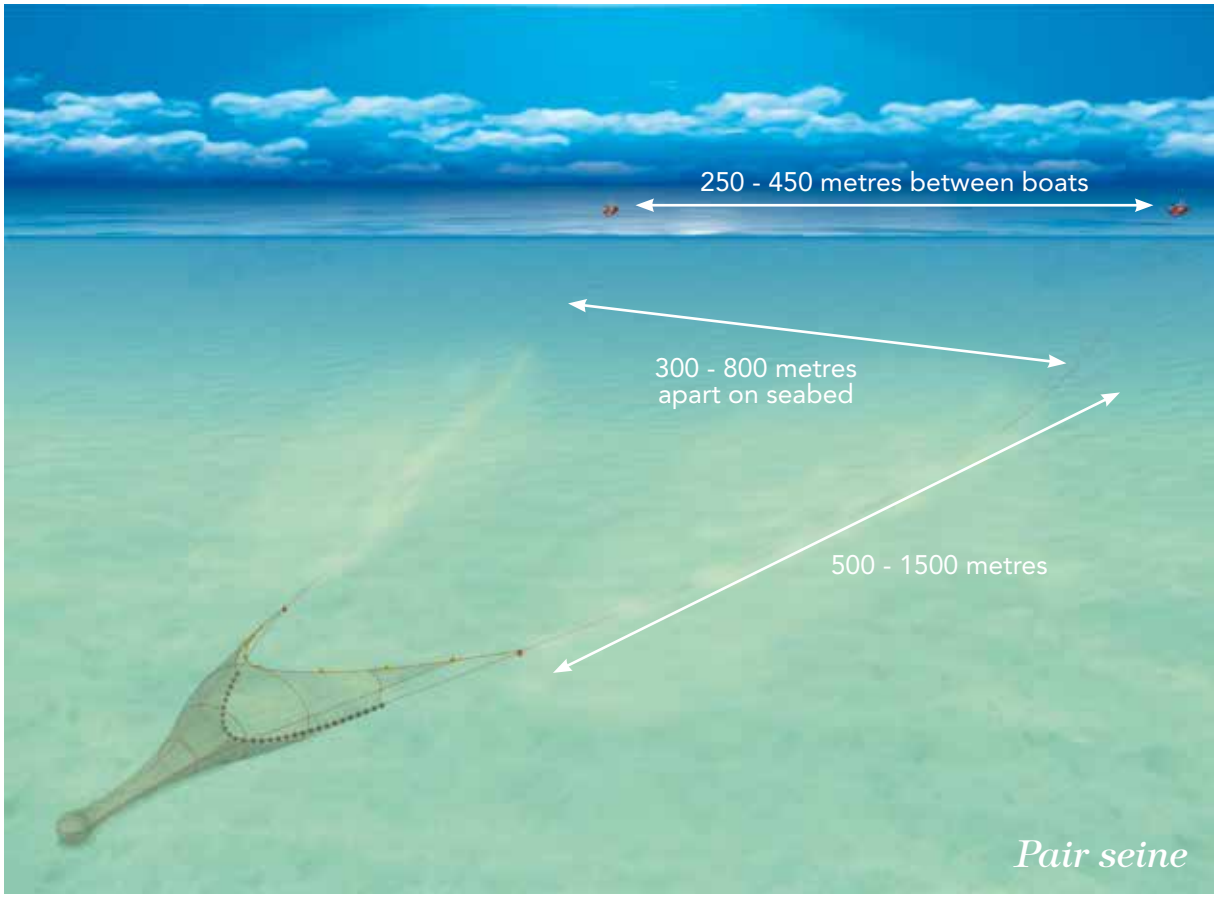
COMPARISON OF SWEPT AREAS OF DIFFERENT TOWED GEARS





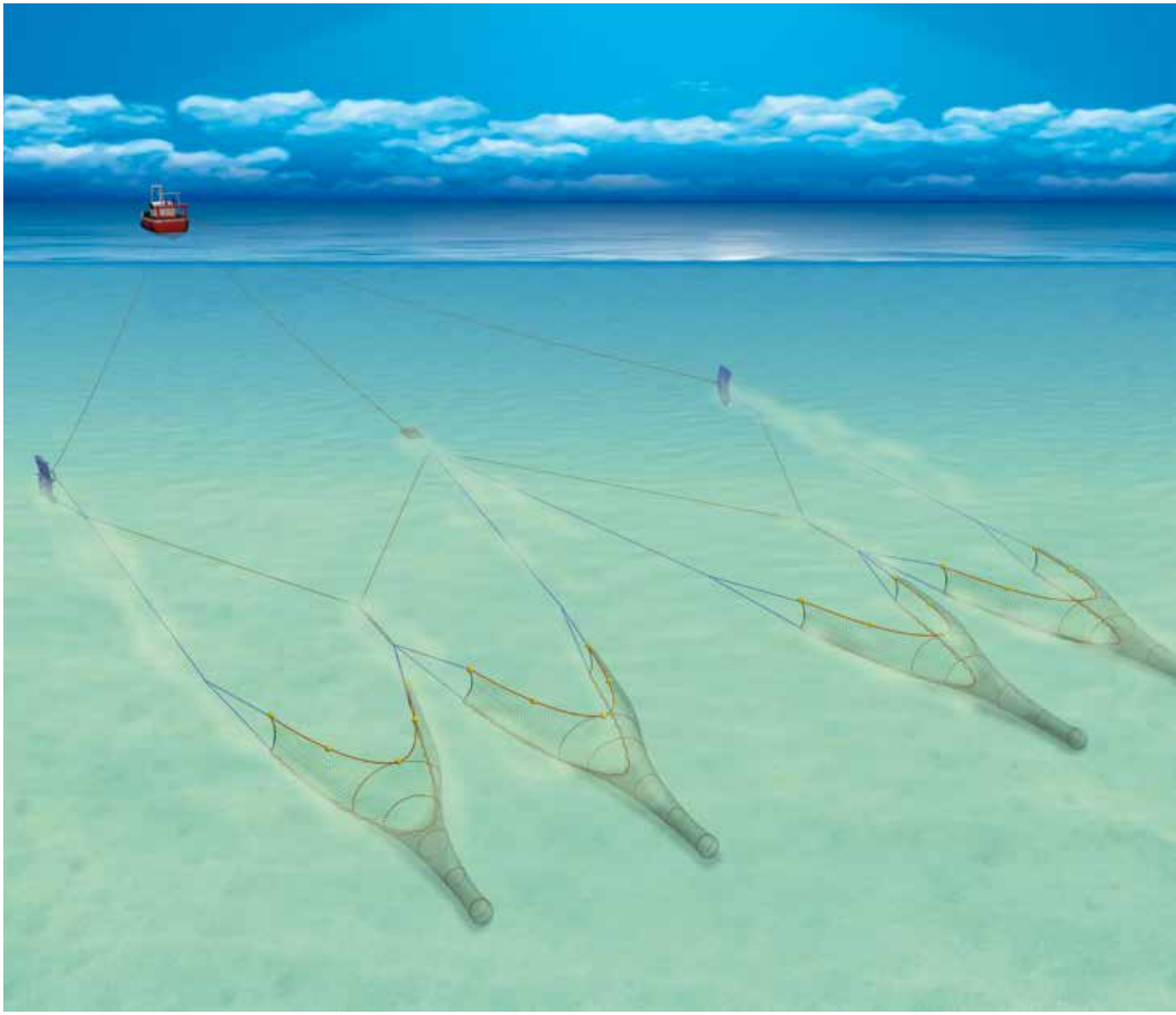


Twin-rig trawl



Pair seine

MULTI-RIG TRAWLING



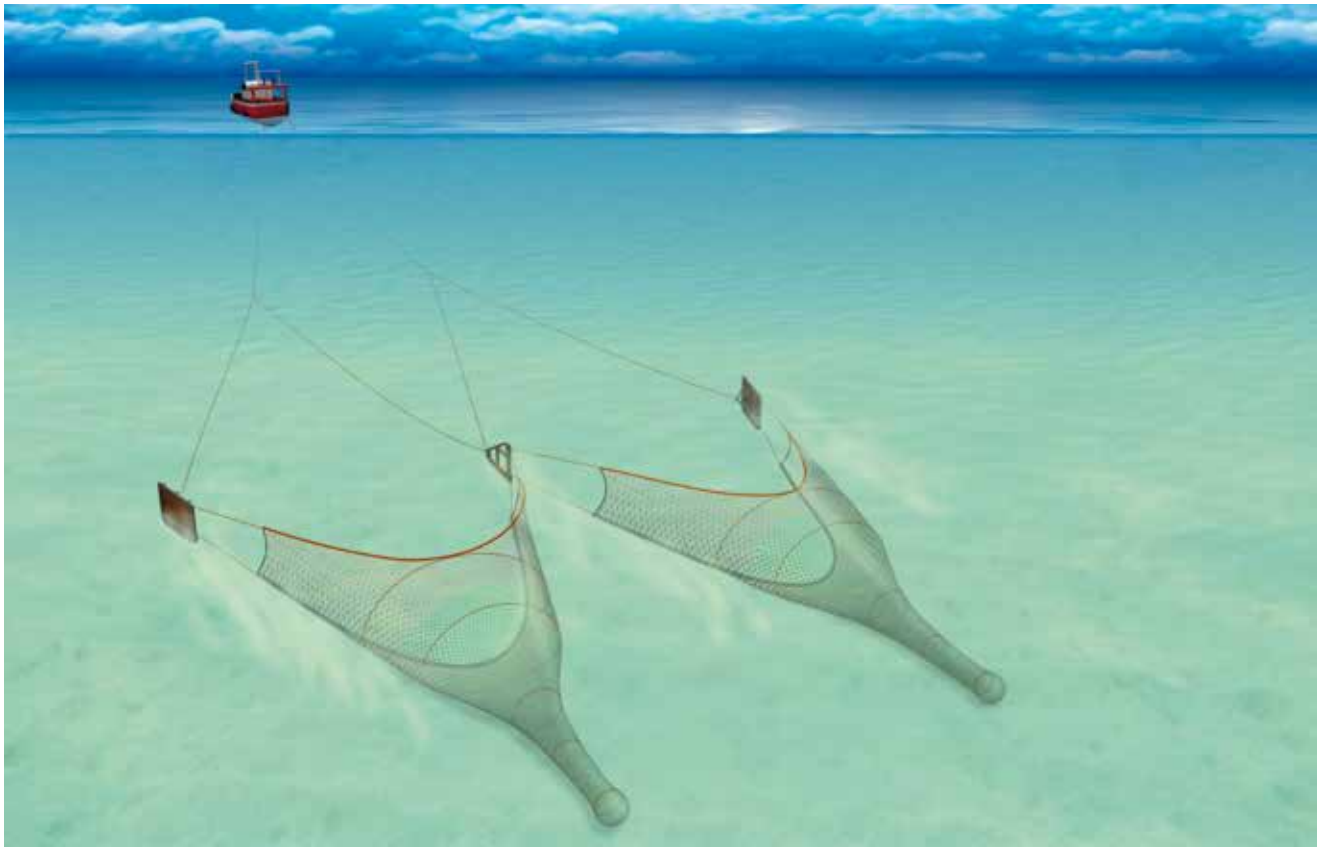


Fig 5.1 Sole twin-rig trawling

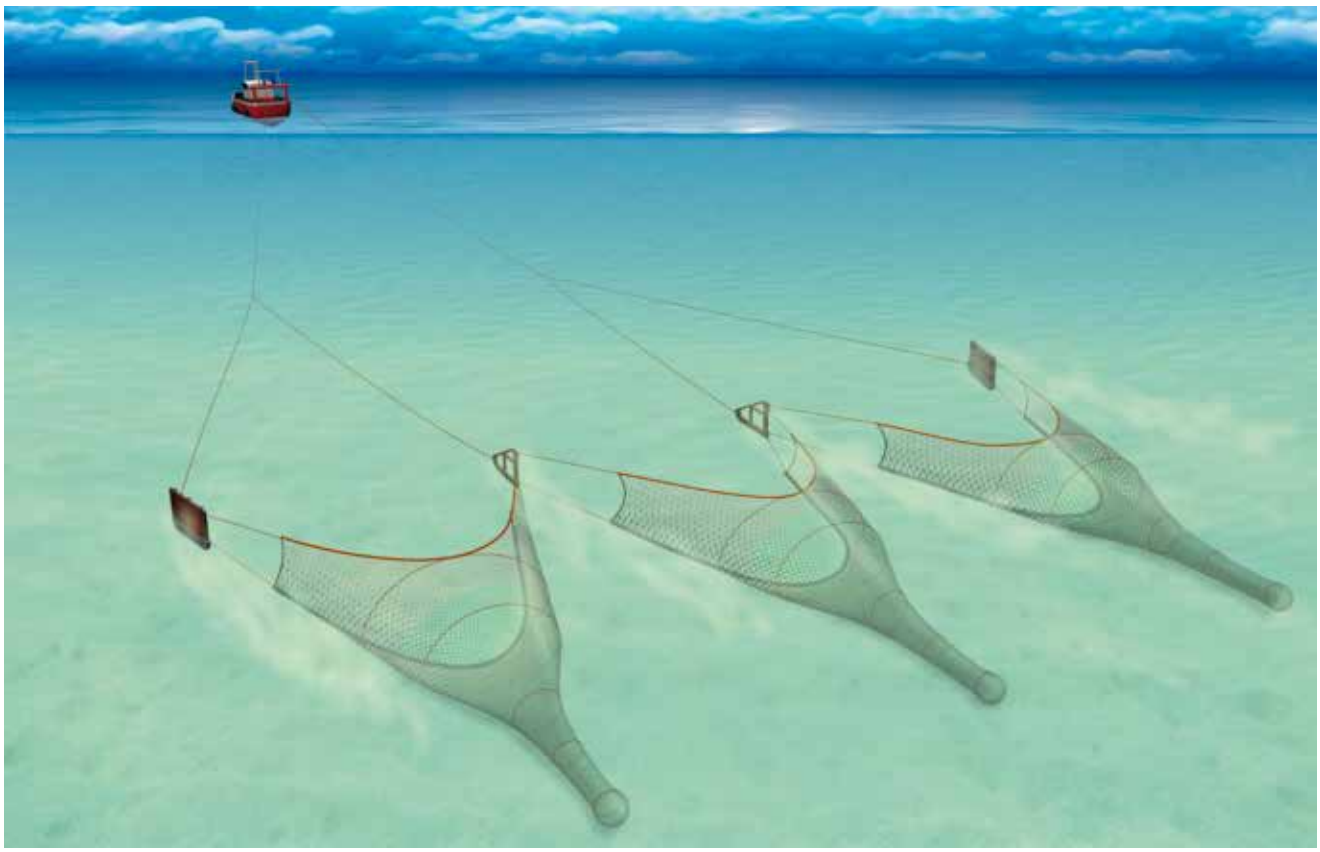


Fig 5.2 Sole triple-rig trawling

MULTI-RIG TRAWLING

Multi-rig demersal trawling is a technique of towing two or more trawls, side by side, on the seabed. The concept of multi-rig trawling is that by using several smaller nets it is possible to fish a wider area of seabed without any increase in the drag of the gear. In principle, this will result in a greater quantity of catch for a given amount of fuel used, making multi-rig a more efficient method of fishing for certain species.

Although multi-rig fishing has been a fairly recent development in UK fisheries, various versions of multi-rig techniques have been used extensively in overseas fisheries for many years and proved very efficient for certain species. In Australia and the Gulf of Mexico, as many as five nets are towed using out-riggers for prawn and shrimps.

In the early 1980s, multi-rig trawling, using two nets was introduced into the Danish prawn and shrimp industry. The English trawlers adopted this method, and developed it further for targeting sole using both twin- and triple-rigs. The prawn (Nephrops) trawlers in Scotland also followed the Danish trend, and it spread to the vessels targeting bottom-living fish. Although most European vessels are towing two or three nets, there are a few boats towing as many as six nets, with some experimentation taking place with vessels towing as many as 12 trawls, side by side. Multi-rig trawling in a wide variety of rigging configuration is used in many fisheries worldwide to target bottom-living species.

Probably the earliest form of multi-rig used in the UK was the development, in the early eighties, of twin- and triple-rig fishing for Dover sole on the inshore grounds in SE England.

TWIN- AND TRIPLE-RIG – Dover sole

In this version of multi-rig trawling, two (twin-rig) or three (triple-rig) standard sole nets were rigged to be towed side by side. The two trawl doors are fitted very close to the outer wings of the trawls, with the inner wings being supported by a triangular frame, or skid, that is a similar height to the trawl doors. In the triple-rig arrangement, two of these frames are used each side of the centre net and on the inner wing ends of the two outer nets. The headlines of the trawls are attached to the top of the trawl door, or skid, and the footrope attached to the bottom of the trawl door, or skid. Unlike most other trawls, floats are not required on the headlines of these trawls; the height of the trawl is set by the height of the trawl doors and skids where the headline and footrope are attached. Only very short bridles are used between the nets and trawl doors and skids, as the main target species, Dover sole, does not react to the herding effect of sweeps and bridles.

These two rigs are towed using a standard two barrelled trawl winch with two warps that split into four split warps approximately 20 - 25 metres ahead of the trawl doors. The vessels using this type of rig in the UK are usually less than 14 metres in length, using two or three trawls, each one being between 12 and 20 metres in length, with a height of less than 0.8 metres. Many fishermen still prefer to use the older style of flat wooden trawl doors with this rig, as they work well in shallow water, but some are using the more modern foil style of trawl doors. Despite the gear set up appearing to be complicated many of the vessels are operated single handed, or with only a skipper and crewman on board.
Fig 5.1 Sole twin-rig trawling and Fig 5.2 Sole triple-rig trawling.

Although the main areas of activity for both twin and triple sole rig are the ports in SE England and the Thames estuary, both methods are used by one or two vessels in various other ports around the English coastline.

The main target species is Dover sole, with a few skate and rays on the inshore muddy grounds. There will be a limited by-catch of other species of flats, and a few of the bottom-dwelling demersal fish. Much of the catch from the fishery in SE England is transported directly to the fish auction in Urk, in Holland, for sale.

The basic design of this gear, with no sweeps or bridles and the reduced headline height, ensures that it already rates highly in species selectivity.

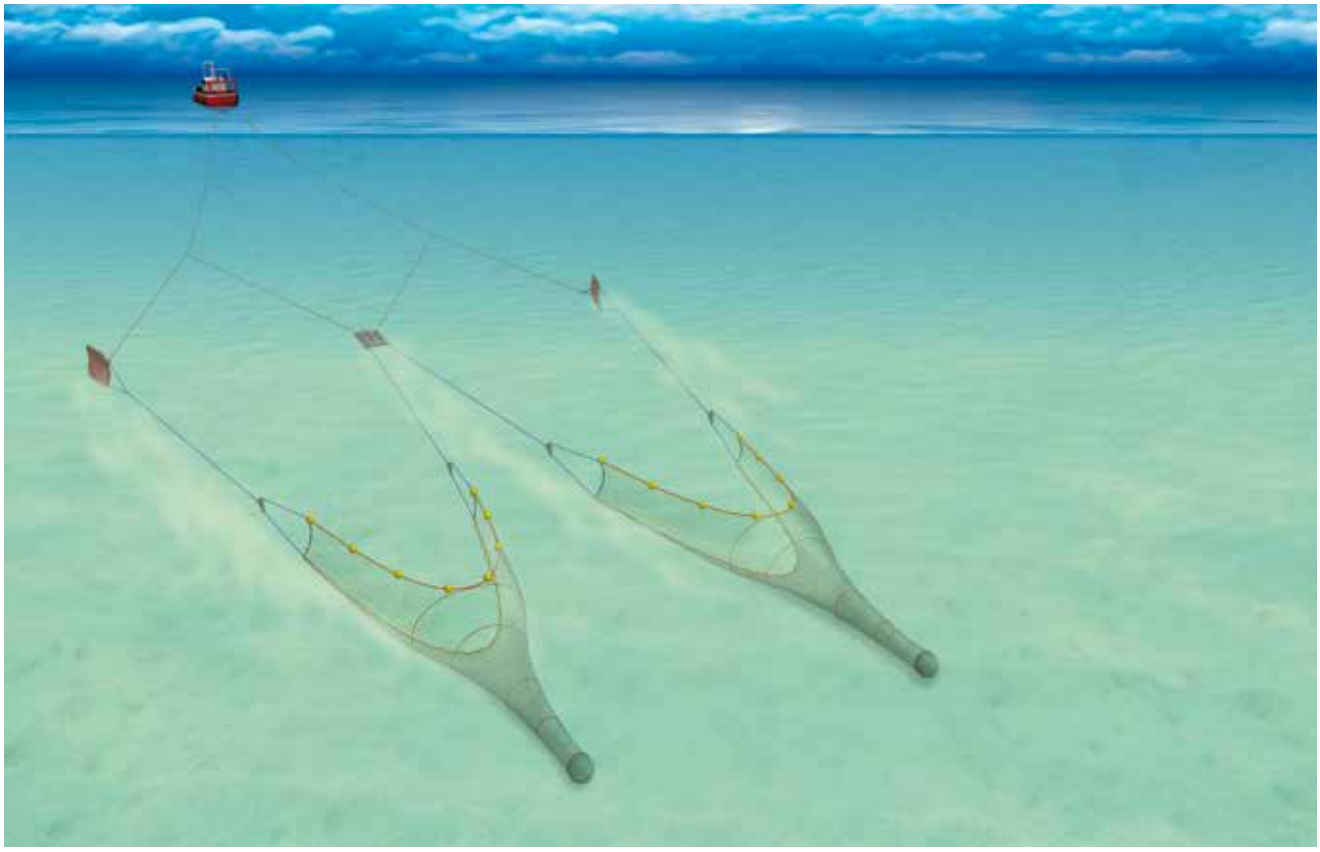


Fig 5.3 Two warp, twin-rig trawling

Fig 5.4 Chain clump weight

Most of the size selection is done by legislation covering minimum cod-end mesh sizes. However, some fishermen are experimenting with other selectivity and discard reduction devices to further improve the species selectivity and minimise capture of small fish.

Two warp, twin-rig trawling - Nephrops

The Nephrops twin-rig developed initially in NE Scotland as a follow on from the Danish twin-rig set up for shrimp and Nephrops. To start with, the boats adopted a two warp system, a larger version, using sweeps, of what was already in use in the twin and triple sole rig in SE England. It fairly quickly progressed to the more versatile three warp system.

The two warp system enables vessels fitted with a standard two barrel trawl winch to tow two trawls simultaneously using their existing winch, with minimal alterations to the deck layout. **Fig 5.3 Two warp, twin-rig trawling.** The trawls used are smaller versions of that used by the vessels if they were towing a single trawl. The nets, sweeps and bridles would all be decreased in size by approximately one third compared to what the vessel would use as a single trawl, to achieve a sensible size for the vessel to operate as twin-rig.

A typical rig for a two warp twin-rig Nephrops vessel, working clean ground, would be two 30 metre prawn (Nephrops) trawls with a total of 100 metres of sweep and bridles each side of the trawls. This gear would be spread using a pair of trawl doors attached to the sweeps from the outer wing ends of the trawls; the sweeps from the inner wing ends of both nets would lead to a clump weight. The purpose of this clump weight is to keep the inner wing ends and sweeps on the seabed. In a two warp system, it is usual to use several links of very heavy chain as a clump weight. **Fig 5.4 Chain clump weight.**

The gear would be towed using two warps that split into four, about 100 - 150 metres ahead of the trawl doors. The outer two warps tow the trawl doors, and the inner two come together to tow the centre clump weight. To a certain degree, the skipper can regulate the spread of the gear by altering the length of the split warps. To ensure the trawls are symmetrical when being towed, it is necessary for the outer split warps to be extended slightly. It is very difficult for the fishermen to judge this, particularly if the gear is towed in varying depths of water. Nowadays, the two warp system tends to be used only by the smaller boats, on the inshore Nephrops grounds, using fairly small trawls. To haul this gear, they would normally use either a power block or net drum on the stern of the vessel.

Nephrops is the main target species for most vessels using two warp twin-rig. There will be a small by-catch of other bottom living fish, but only a minimal by-catch of round-fish. As with other gears, there is a minimum regulation mesh size for the cod-ends to minimise capture of small fish, and all Nephrops fisheries have to use square mesh panels to further improve the overall selectivity of the gear.

Three warp, twin-rig trawling - Nephrops

In some fisheries, the three warp method has preceded the two warp system with the latter being introduced by vessels who do not want to undertake the outlay of fitting a new three barrelled winch and altering the vessel to accommodate the three warps. The three warp rig has proved to be more versatile, allowing the skippers to alter the spread of the gear during the fishing operation by making slight alterations to the length of the centre warp. The ability to do this makes the gear more efficient for catching a wider variety of species.

To operate the three warp system requires the fitting a three barrel winch, and usually major alterations to the vessels deck machinery and layout. Many skippers have had new vessels built, specifically rigged to use three warp twin-rig trawling.

The basic rig of sweeps and bridles is similar to that of the two warp system, but as it is generally the larger vessels that use the three warp system, the gear is also larger and heavier. The outer two warps tow the trawl doors, and the centre warp a clump

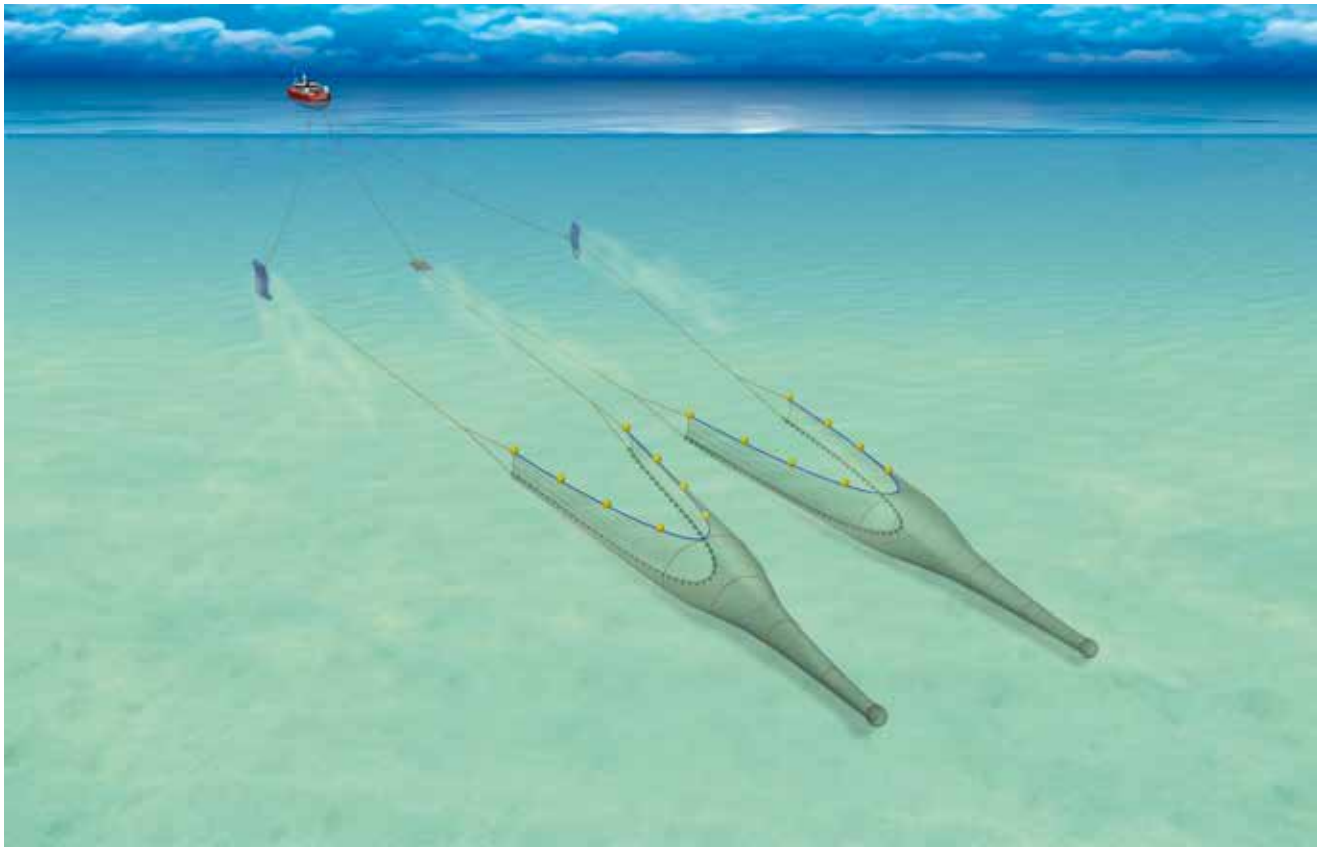


Fig 5.5 Three warp, twin-rig trawling

Fig 5.6 Roller clump weight

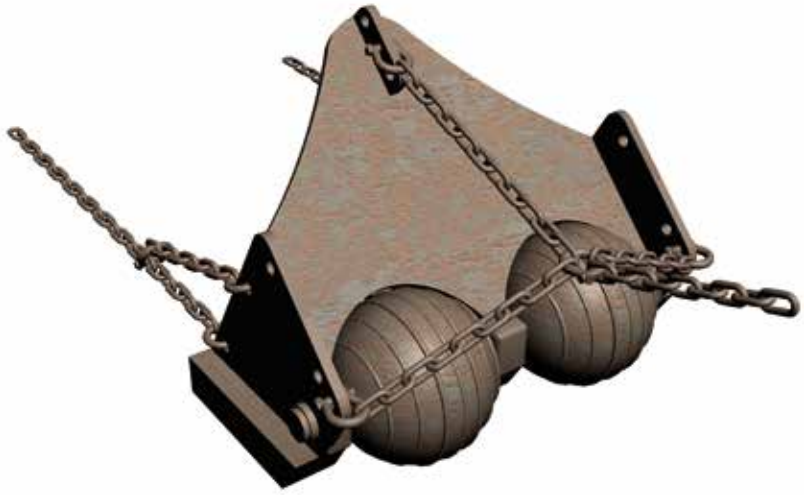


Fig 5.7 Depressor clump weight

weight. **Fig 5.5 Three warp, twin-rig trawling.**

This can be a simple clump of chain, as in the two warp system, or more commonly, a purpose built clump weight designed to roll over the seabed, rather than be dragged along it. **Fig 5.6 Roller clump weight and Fig 5.7 Depressor clump weight.** Some trawl door makers have designed roller clump weights with an angled flat plate, to exert a depressing force as the weight is pulled along the seabed, helping the gear to maintain seabed contact. The choice of which clump weight design to use is down to the skipper's preference and the design of the stern of the vessel for hauling and handling the clump weight onboard.

In a three warp rig, the centre warp has to be shortened slightly to maintain the nets in a symmetrical shape, and in their optimum fishing position. However, compared to a two warp system, it is much easier to calculate this difference and it can be altered while the gear is being towed, making this the more versatile system to operate. Originally, the nets would be prawn or scraper style of trawls, similar to that used in the two warp system to target Nephrops, and many vessels still use this style of gear. However, as the gear's potential for catching all demersal species was realized, the nets and rigging evolved to increase its efficiency in targeting these species. The three warp system is the favoured method of most of the larger twin-rig vessels working further offshore, therefore the gear is also larger to suit the vessels. A typical twin-rig scraper style trawl would be about 50 metres long along the footrope, and stand about two metres high. The vessels targeting a mix of demersal fish and Nephrops would use a scraper style trawl of a similar length but standing approximately 2 - 2.5 metres high. The larger vessels, looking for a larger percentage of round-fish and bottom species in their catch, would use nets of similar length, but have them designed to give greater height, probably up to about four metres high, with the design getting closer to that of a rock hopper trawl.

The whole concept of twin-rig trawling is that the increased area of seabed covered by the gear makes it very efficient for targeting bottom living species such as Nephrops, monkfish, flatfish and other bottom-living demersal species.

Most modern three warp twin-rig vessels use a three barrelled winch, or three separate winches (split winches), to haul and store the trawl warps; the trawl doors being hauled up to the stern of the vessel, as in a single trawl and the clump weight being hauled up in the centre of the vessel's stern. Most boats have a purpose-built ramp or cradle at the stern to haul the clump weight into, and ensure that it is prevented from moving while on board the vessel. Once the trawl doors and clump weight are on board the vessel, the sweeps, bridles and trawls will be transferred to the net drum to be hauled on board. Many vessels will have the net drum divided into four sections — two to haul the working nets, and the other two to store two spare nets on. Once the nets are hauled and the cod-ends are alongside, they are taken on board, one at a time, and the catch emptied into a reception hopper.

The shooting operation is basically the reverse of hauling.

The UK vessels operating twin-rig can vary in size from 10 metres long with around 250 horsepower engines operating on inshore grounds, right up to the 30 metre trawlers fishing deep water (in excess of 200 metres) that would have engines in the region of 1,000 - 1,500 horsepower. These large vessels would be using trawl doors weighing around 1,000 - 1,500kg and a clump weight of 25 - 50% heavier than this, to spread their heavy rock hopper style trawls.

In the UK, multi-rig is used all around the coast to target Nephrops and demersal fish. In the UK, the main concentrations of Nephrops twin-rig activity are in NE Scotland, the West coast and Minches, in Scotland, stretching right down to the Clyde area, into the Irish Sea where Nephrops are targeted from the ports in Cumbria and Northern Ireland. The Nephrops stocks in the Southern

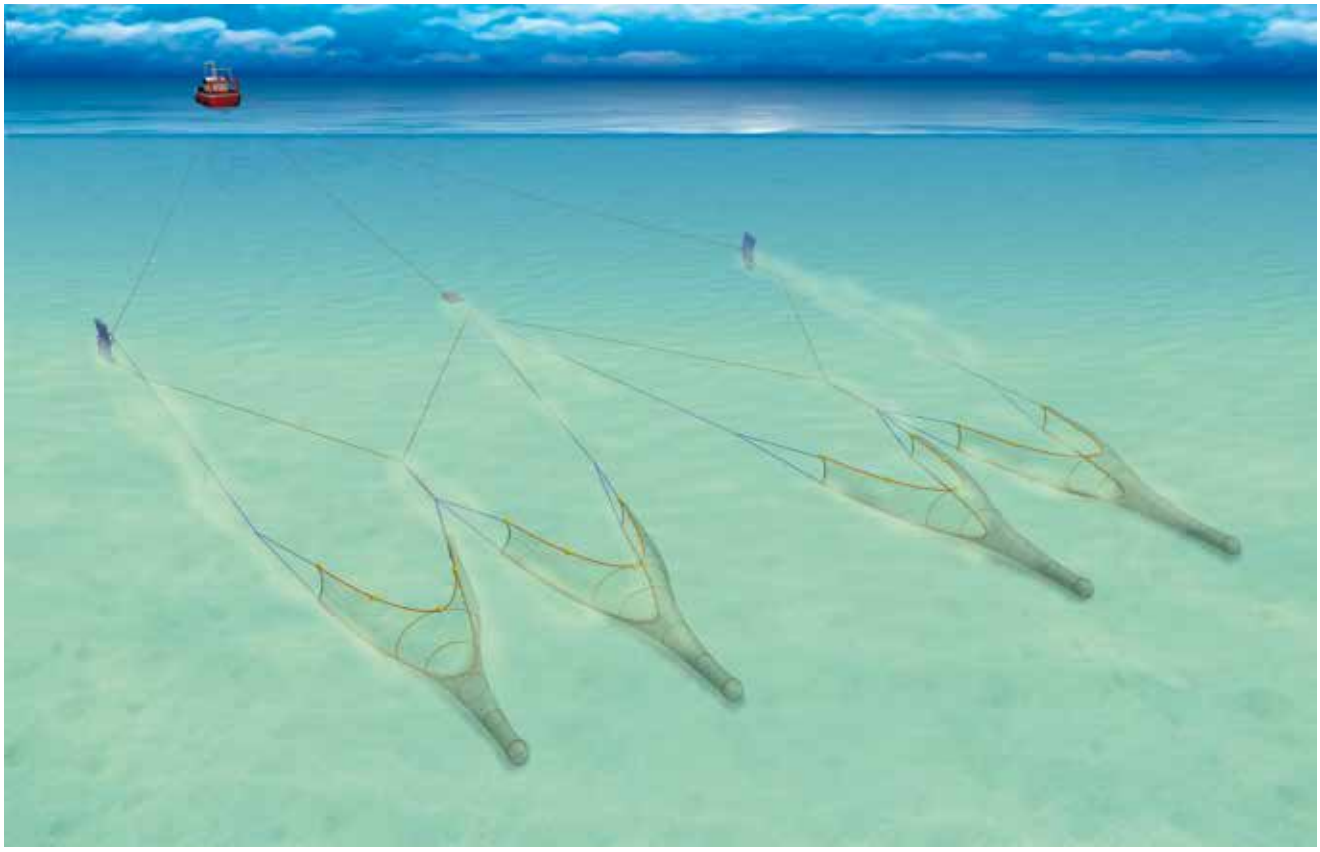


Fig 5.8 Quad-rig trawling

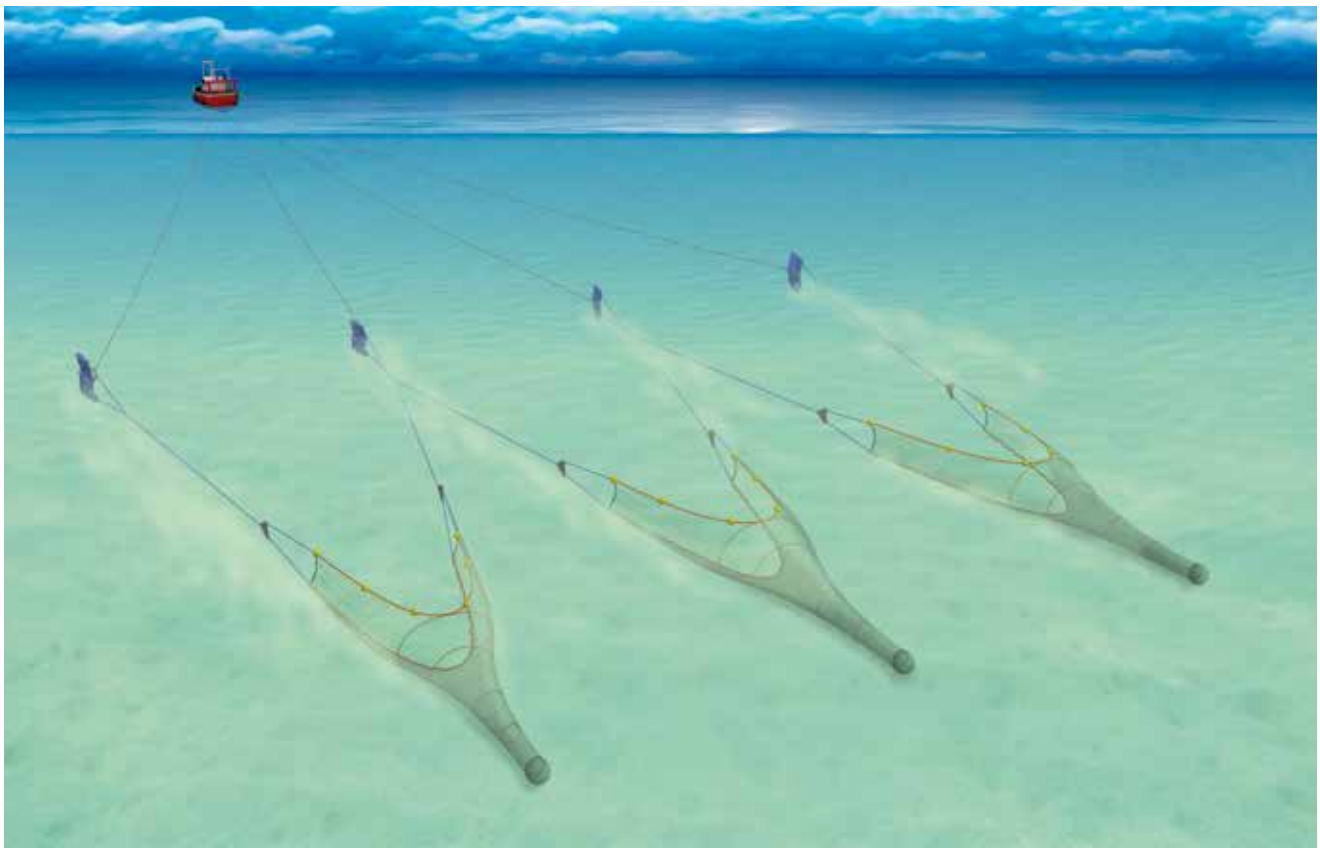


Fig 5.9 Triple-rig trawling (4 warps, 4 doors)

Irish Sea and West of Ireland are fished by the fleets from the Republic of Ireland using twin- and quad-rig. There is also a North Sea fishery from the ports in the NE of England. Twin-rig is also used by the larger trawlers to target bottom living species such as monkfish and megrims, as well as a selection of other demersal fish in the deeper waters (deeper than 160 metres) of the West coast of Scotland, up to north of Shetland. Most of the Nephrops caught by UK multi-rig boats are exported to France, Spain and other EU countries. The same is true for a large proportion of the monkfish and megrims.

There has been much controversy in the UK as to the selectivity issues surrounding twin-rig and multi-rig trawling in general. Much of it comes from a lack of accurate catch, selectivity and economic data in relation to the various forms of multi-rig to allow accurate comparison with the traditional single-rig gear. In some fisheries, the use of multi-rig or fishing with more than two nets, is actually banned to all vessels as a result of its efficiency and concerns about discard rates. Because all forms of multi-rig are designed to target species that live tight on the seabed, often in areas of mixed species, there can be problems with by-catch and discarding in certain fisheries. Much of this is dealt with by the use of large-sized square mesh panels and restrictions in cod-end mesh size. Many skippers have refined their twin-rig gear to be very species and size selective, landing a high quality product onto the market with almost zero discards or unwanted by-catch.

OTHER FORMS OF MULTI-RIG

QUAD-RIG TRAWLING

In recent years in the North Sea, some of the vessels from the UK and Denmark have been experimenting with the use of more than two trawls. One method that has seen favour is the move from three warp twin-rig to quad-rigging using three warps. One of the main reasons is that there is no need for vessel alterations, and the same three warps, trawl doors and clump weight can be used for both rigs, resulting in the only major financial outlay being on four new smaller trawls. As they make the move from two to four nets, the actual size of the gear is further reduced by about 30%. Quad-rig allows the vessels to cover an even wider area of seabed but with a lower trawl headline height, this has the potential to increase the Nephrops catch but should reduce the by-catch of round-fish such as haddock and whiting. The push for quad-rig in Europe has mainly been by Danish and Republic of Ireland vessels. **Fig 5.8 Quad-rig trawling.**

Some of the Danish vessels have gone further than four trawls, trialling towing six nets using four warps, eight nets with five warps and even up to 12 nets. To tow this number of trawls needs great financial outlay in major vessel modifications and new gear to rig the vessel out. Apart from the few Danish vessels trialling these forms of multi-rig, there has been no sign of general acceptance by the industry in the UK and EU of these multi-rig methods. It would appear that, at this time, the use of four nets as a quad-rig provides enough increase in efficiency and financial benefits without excessive complication and financial outlay.

TRIPLE-RIG TRAWLING using four warps and two sets of trawl doors.

Some of the more ambitious skippers in the UK have opted to experiment with a method of towing three trawls (triple-rig) using two sets of trawl doors. A large set on the outside and a small heavy set at the point where the inside wings of the two outside nets meet up with the wings of the centre net. These small doors are acting as both a trawl door (spreading device) for the centre trawl and a clump weight for the two outside trawls. **Fig 5.9 Triple-rig trawling (4 warps, 4 doors).**

This method of multi-rigged trawling, rigged with sweeps and bridles, is similar to the Nephrops three warp twin-rig, and has proved very effective at targeting bottom living demersal fish and Nephrops. There has not been much take up of this method in the UK as it does require extensive modifications to an existing vessel to operate the

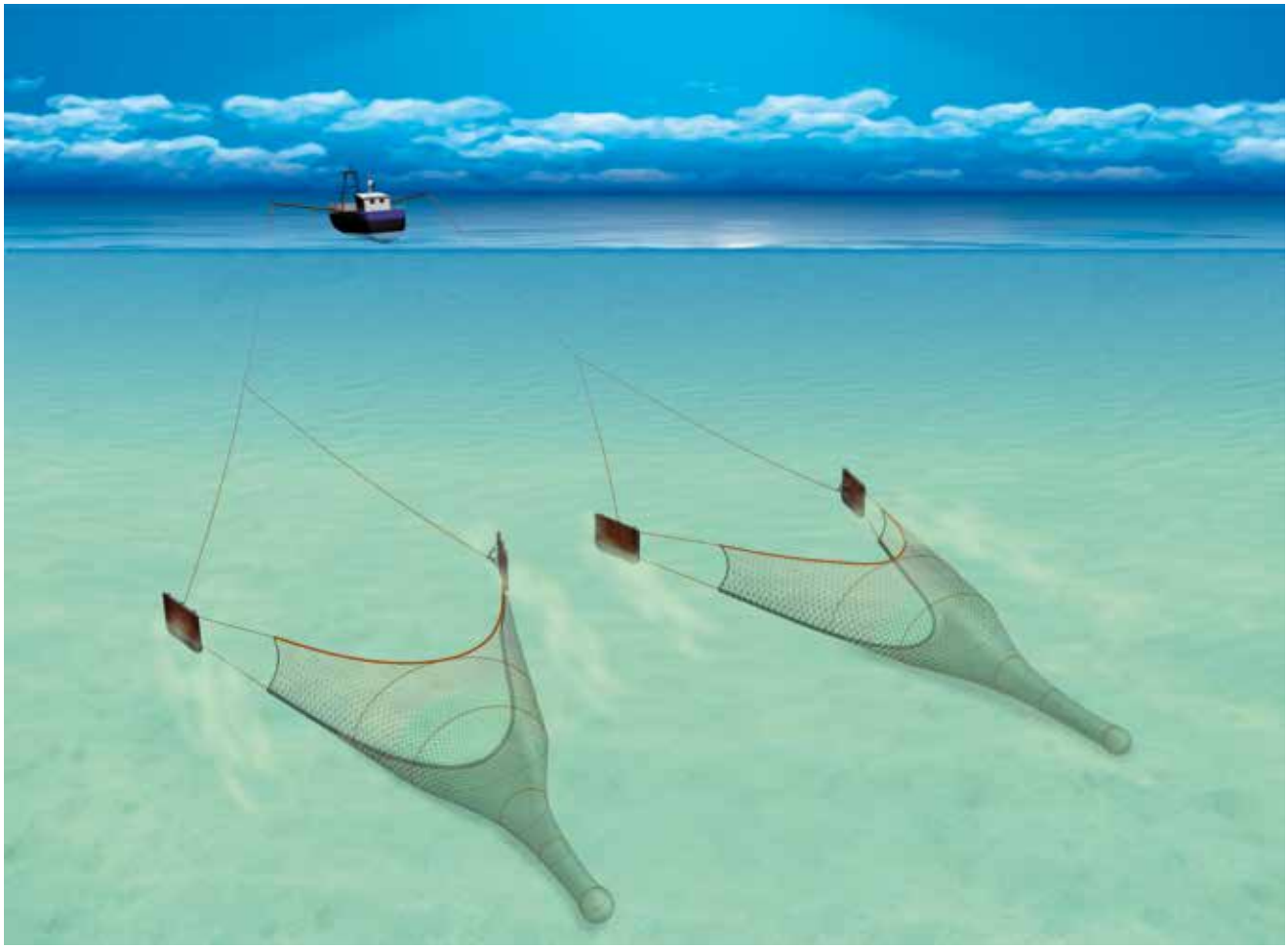


Fig 5.10 Out-rig trawling

two extra warps and the two sets of trawl doors simultaneously. In certain areas in the UK, there are also restrictions in the use of more than two trawls in multi-rig trawling that prohibits vessels using this rig.

Multi-rig trawling, in its many forms, is used throughout the world to target bottom living demersal fish and shellfish. If used properly, when compared to using one single trawl, multi-rig trawling should:

a. be more efficient at targeting bottom living species due to the wider area of seabed covered by the gear.
b. use less fuel due to decreased drag of gear.
c. be more efficient in species selection due to the lower headline height of the trawls.
d. prove to be a very efficient method of trawling if the fishery is managed well.

OUT-RIG TRAWLING

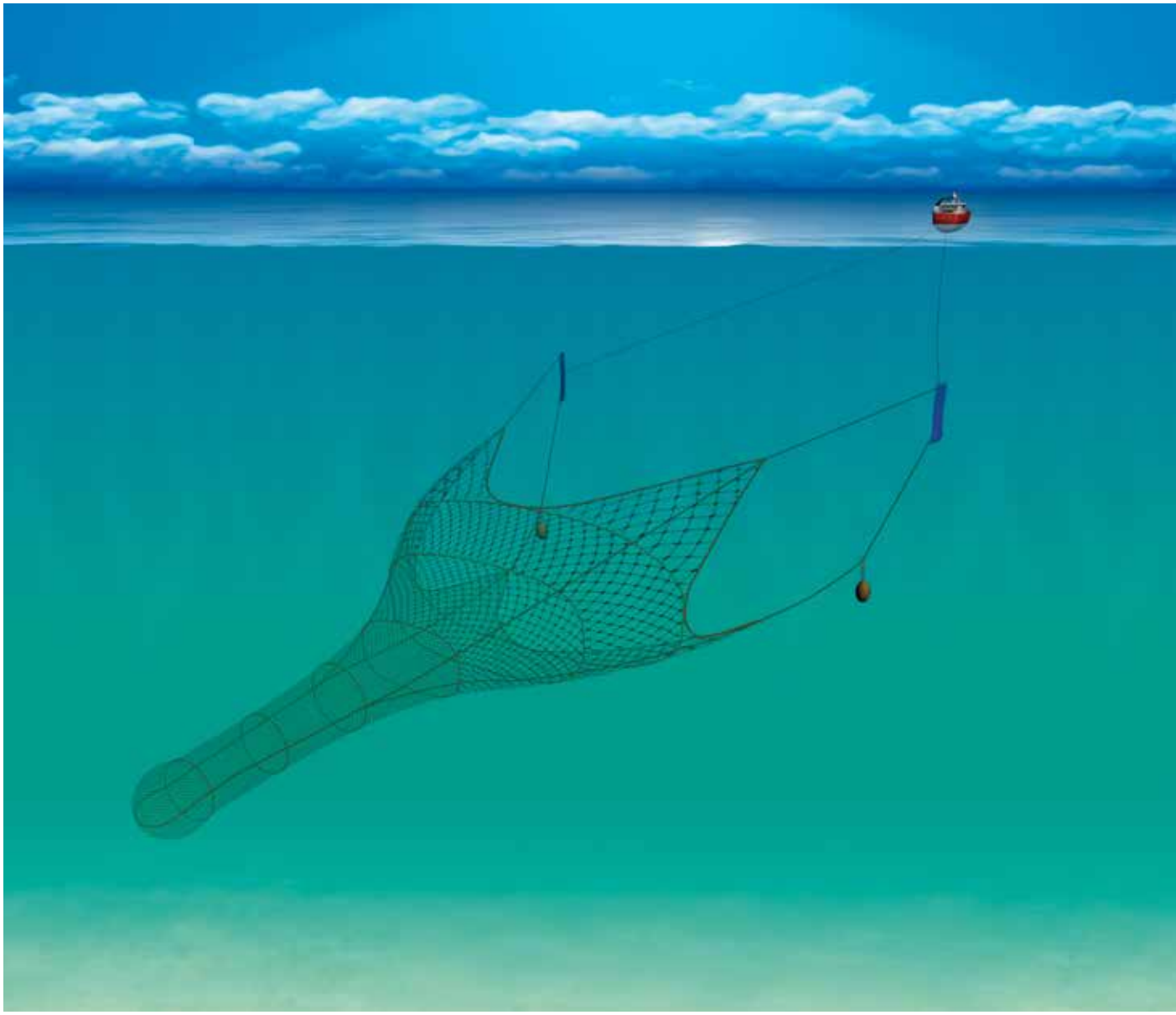
Out-rig trawling is a method of multi-rig trawling where two small trawls are towed from the ends of out-rigger derricks in a similar way that a beam trawler tows its gear. Fig 5.10 Out-rig trawling. In many cases, it can be as simple as replacing the two beam trawls with two small otter trawls. This is a direct adaption from the rig used in Australian prawn fishery and the shrimp fishery in Southern USA. In the EU, there has been several experimental trips trialling out-rig trawling, and it has been adopted by some of the beam trawl fleet as an alternative form of trawling, to enable them to be more efficient at catching certain species. One of the main reasons for converting to out-rig trawling is to allow the vessels to target alternative species to the traditional beam trawl target species, thereby optimising their allocated TAC. There are other criteria that have influenced the move by some beam trawlers to out-rig trawling, such as the increasing criticism of beam trawling from the environmental groups, skippers looking to cut fuel consumption, and for some to access areas where beam trawling is prohibited.

In the EU, it has mostly been the Belgian beam trawlers that have taken up out-rig trawling, with a few of the UK vessels trialling it. The beam trawls are replaced with two small, low headline otter trawls, each one having its own pair of trawl doors, attached close to the wing ends of the nets in a similar manner to that of a sole trawl. The gear is shot and hauled in a similar manner to a beam trawl, but instead of the beam trawl trailing from the end of each derrick, it is a set of trawl doors with the net trailing behind. The cod-end is then hauled in and emptied on board the boat in the normal way.

In comparison to the beam trawls that the vessel would normally tow, the out-rig nets will be of thinner, lighter netting, fitted with smaller, lighter weight ground gear, and as a result, will not fish so tightly on the seabed. Because they are dependent on the trawl doors to spread each trawl and provide the weight to maintain bottom contact, the out-rig gear cannot be towed so fast either. To compensate for this, the out-rig gear will cover a wider area of seabed with less drag (less fuel usage) and show a decrease in seabed impact. The out-rig trawls will deliver a completely different mix of species in the cod-ends, compared to a beam trawl. There will probably be fewer Dover sole and other species that live tight down on the seabed, but more of the other demersal species due to wider ground coverage and greater headline height. There has been criticism of some of the EU beam trawlers converting to out-rig trawling as it enables them to be classed as an otter trawler rather than a beam trawler, and can allow them to fish in areas closed to beam trawling. In many areas twin-, triple-, quad-rig, etc. has been banned or restrictions put on the use of these rigs due to concerns about efficiency and selectivity. In many situations, it is very difficult to legislate exactly what would come under the category of twin- or triple-rig.

Throughout the UK and EU, many skippers use 'hybrid' multi-rig systems that they find make their boat more efficient and the gear easier to handle, on their specific vessel. This can result in even more anomalies in categorising specific gears.

PELAGIC TRAWL (SINGLE AND PAIR)



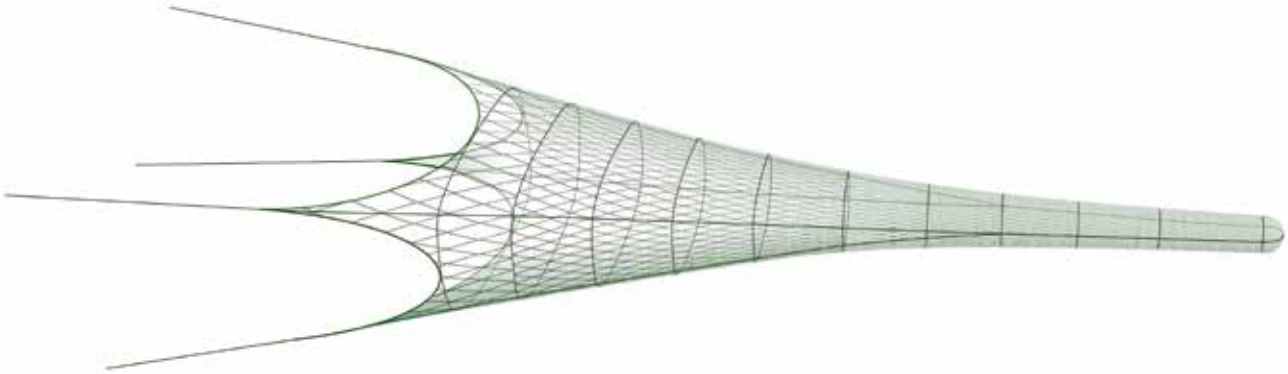


Fig 6.1 Pelagic trawl

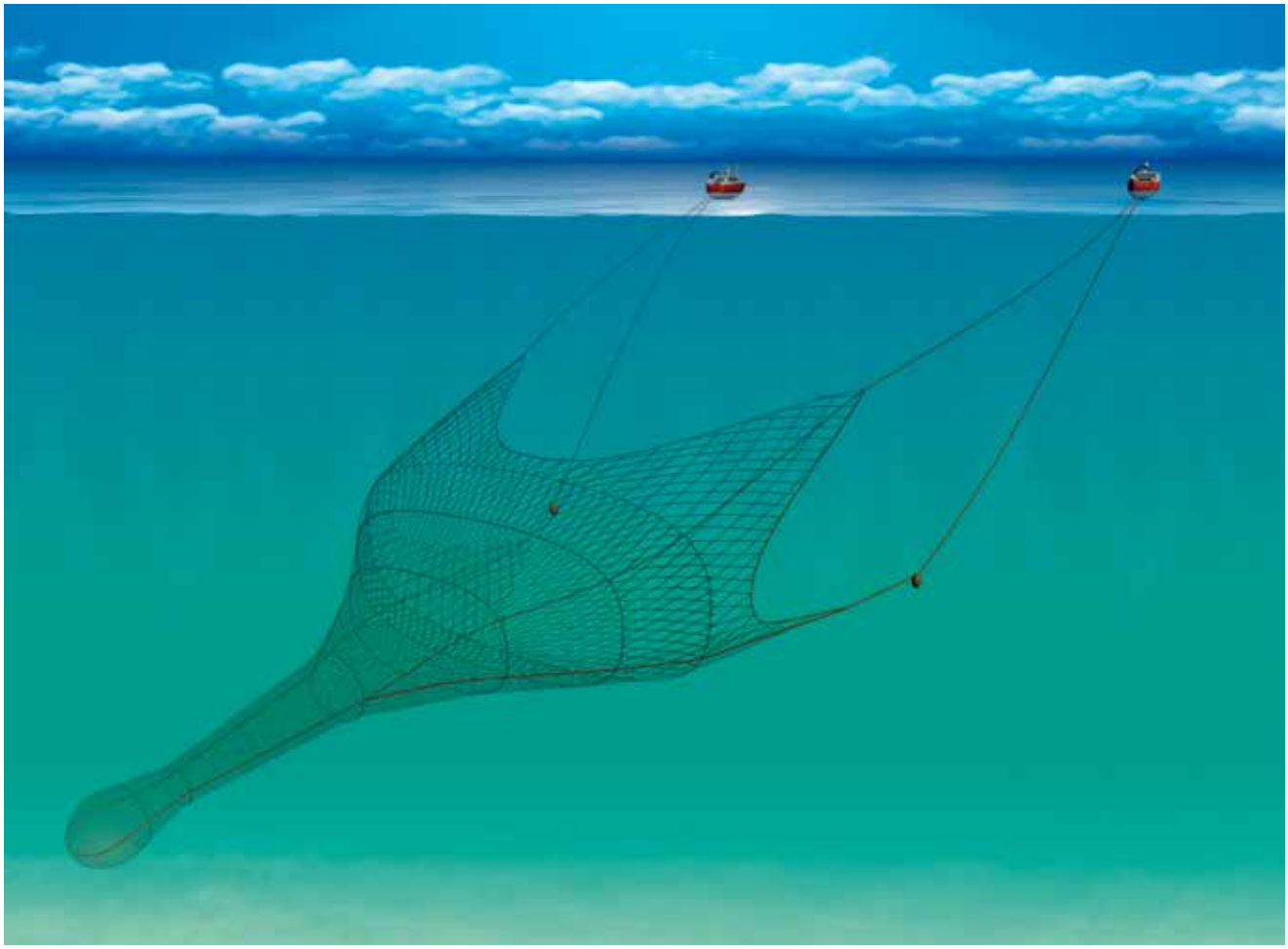


Fig 6.2 Pelagic pair trawling

PELAGIC TRAWL (SINGLE AND PAIR)

PELAGIC TRAWLING

Pelagic trawling is a method of towing a trawl in mid-water i.e. at any point in the water column between the surface and seabed. It is, generally, used to target shoaling species such as mackerel, herring and sprats.

The beginnings of pelagic trawling come from demersal trawling where they tried to make a large net and tow it between two vessels (pair-trawling) and lift it off the seabed. Gradually, the mouth of the trawl was made bigger by the inclusion of large meshes in the forward sections of the trawl. With the advancement of underwater acoustic technology, initially by the military, in the way of echo sounders and sonars, then the adoption of this into the fishing industry, it became possible to locate shoals of pelagic fish and shoot the nets at the correct height within the water column to catch these species. The introduction of lightweight hydrodynamic trawl doors and the use of acoustic measurement sensors on the trawl, enabled the new design pelagic trawls to be towed by one vessel as a single trawl. Nowadays, much of the pelagic trawling activity, both single and pair trawl, is done by modern powerful vessels equipped with state of the art electronics to find and track the shoals of pelagic fish. However, throughout the UK and EU, there are many small-scale pelagic fisheries undertaken by smaller, less sophisticated vessels.

Modern pelagic trawls have a much larger opening than demersal trawls — some as large as 160 metres deep and 240 metres wide. This is achieved by having very large meshes, some as big as 50 metres, in the mouth and forward sections of the trawl. Pelagic trawls tend to be constructed using four panels — a top, a bottom and two side panels — to enable them to achieve a much greater height than demersal trawls. The trawls can be either rectangular in cross-section, where the top and bottom panels are wider that the two side panels, or square, where all four panels are the same size. **Fig 6.1 Pelagic trawl.**

Depending upon the size and type of trawl, the individual meshes in these leading sections of the trawl can be anything from five metres up to 50 metres in length. The mesh size gradually decreases as it get closer to the cod-end of the trawl. The cod-end mesh size usually being dictated by legislation and / or the size of the target species. Unlike demersal trawls the cod end mesh size is considerably smaller than the fish that is targeted by the trawl. This is to prevent meshing of the fish in the 'back' end of the trawl.

In reality, the mouth of the trawl resembles a large array of light-weight ropes that lead the shoals of target species into the body of the trawl. These large meshes are effective for most small pelagic species as they are schooling fish. This means that when one fish becomes aware of the meshes of the net it moves away from the 'danger' and the whole shoal moves as one, clear of the danger. Repetitions of this action gradually moves the shoal into the centre of the trawl and eventually into the codend. To be effective at herding the shoals, the nets have to be designed with great care, and towed at the correct speed, to shepherd the fish into the trawl carefully, without making the shoal scatter and the fish escape through the large meshes. These large meshes allow much larger nets to be used, in effect filtering a much larger volume of water. No ground gear is needed on the bottom of pelagic trawls as the trawl should not come into contact with the seabed.

The position of the net between the surface and seabed is controlled by the speed of the vessel and the amount of trawl warp shot. In larger boats, this can be monitored using electronic sensors on the headline to give a depth for both top and bottom of the net, allowing the skipper to position his net inline with the shoal. On smaller vessels, the skipper has to rely on his knowledge and experience to place his net at the correct depth where the target shoal of fish are.

The nets for single and pair trawling are basically the same but the bridle and towing arrangement differs.

Fig 6.3 Pelagic trawl door

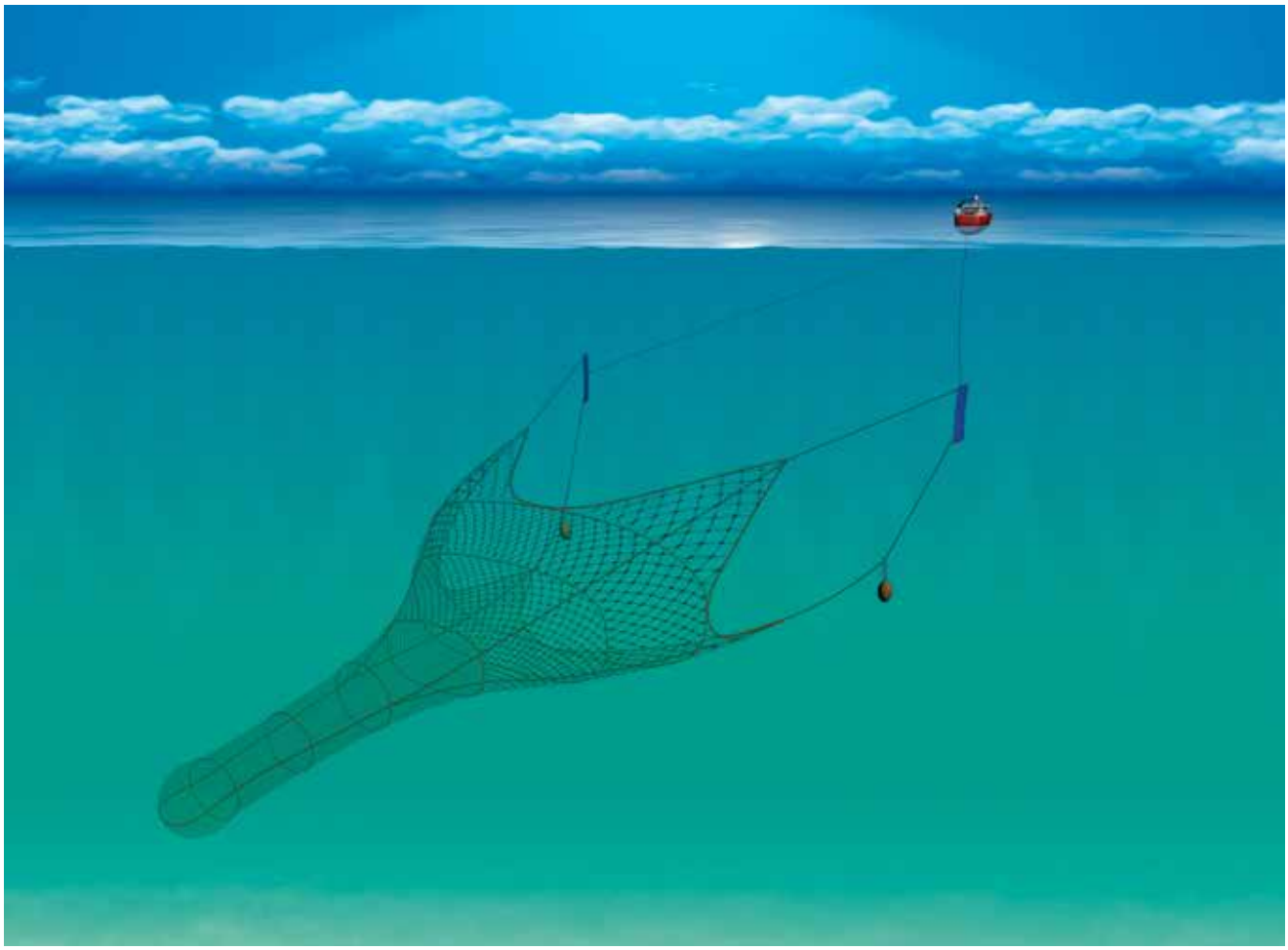


Fig 6.4 Pelagic single trawling

PAIR TRAWL – In this rig, the net is towed by two vessels, one towing each side of the net. As in demersal pair trawl, no doors are used, the net's horizontal opening being set by the distance between the two vessels. This is monitored using the vessels own radar screens. The net is opened vertically by the use of a chain clump on each lower wing end and by the upward pull of the upper warp. Some pelagic trawls will have floats on the headline to assist with the vertical opening.

Normally, in pelagic pair trawl, the vessels will tow the trawl on two warps from each boat, one going to the top (headline) of the net, the other to the footrope, (bottom).

By slight alterations in the length of the warp to the top of the net compared to that of the lower warp, the net can be made to alter shape, and move up or down in the water column to some degree. However, the general position within the water column is controlled by the towing speed of the vessel and the amount of warp paid out. **Fig 6.2 Pelagic pair trawling.**

SINGLE TRAWL – In this rig, the net is towed by one vessel using a set of midwater doors (pelagic trawl doors) to open the net horizontally. The net is opened vertically by the use of a chain clump on each lower wing end and by the pull of the upper bridle. The position within the water column is controlled by the towing speed of the vessel, the amount of warp shot and the amount of weight on the wing ends of the trawl. **Fig 6.3 Pelagic trawl door.**

The trawls are shot and hauled in a similar manner to that of a demersal trawl in that the cod-end is shot away, and the rest of the trawl slowly paid away from the stern of the vessel. In pair trawl, one side of the trawl is passed across to the partner vessel, before the warps are paid out by each vessel. In the single trawl, the aerofoil shaped pelagic trawl doors are attached to each side of the trawl to spread it horizontally. Both are hauled in the reverse manner, with smaller vessels lifting the catch on board with the cod-end; larger vessels, generally, use a fish pump to pump aboard the catch. In the larger vessels, this can amount to several hundred tonnes of small pelagic fish. **Fig 6.4 Pelagic single trawling.**

The larger vessels will pump their catch straight into RSW or CSW tanks on board the vessel; smaller boats will box the fish with ice or store it in tubs with slurry ice to chill the fish and maintain quality.

All classes of trawler can use pelagic trawls. From 10 metre inshore vessels targeting shoals of pelagic fish in shallow water, up to the specialist pelagic vessels, around 40 – 80 metre long, with RSW tanks to store their catch in. Then, the even larger 'super trawler' class of ocean-going vessels with freezing capacity for several thousand tonnes of fish.

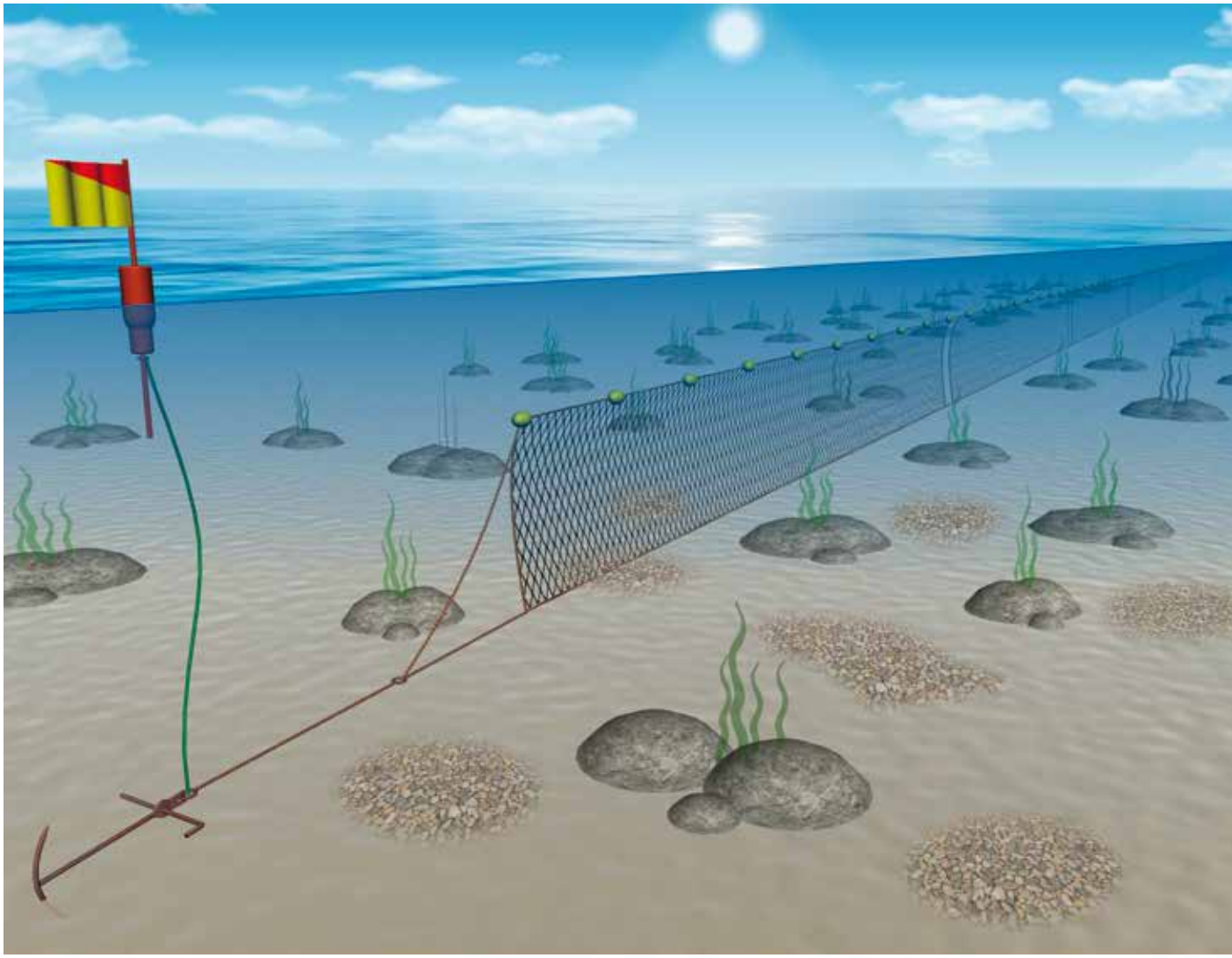
Pelagic trawling is used, to some degree, all around the UK coastline, and in many other sea areas throughout the world. The large boat pelagic fleets in the UK are mainly based in North East Scotland and Shetland, where they target mackerel, herring, blue whiting, and scad, on a seasonal basis throughout the year as their quota allocation allows. There are a few large freezer vessels targeting the same species further south in English waters. There are various other pelagic fisheries in the UK, such as a bass fishery in the English Channel and a small scale herring / sprat / mackerel fishery in the same areas.

There is some criticism of pelagic pair trawling due to its interaction with various species of cetaceans, but regulations are now in place to minimise this. As this gear is towed in midwater, there is no contact with the seabed, therefore seabed impact is negligible.

By-catch is minimal due to the ability of the skippers to target shoals of specific target species in certain areas, at particular times of the year.

The opening of the trawls is very big, but because of the large meshes at the front of the trawl, only the targeted shoals should be herded into the trawl; most other fish will escape through the large meshes before capture.

GILL NETS



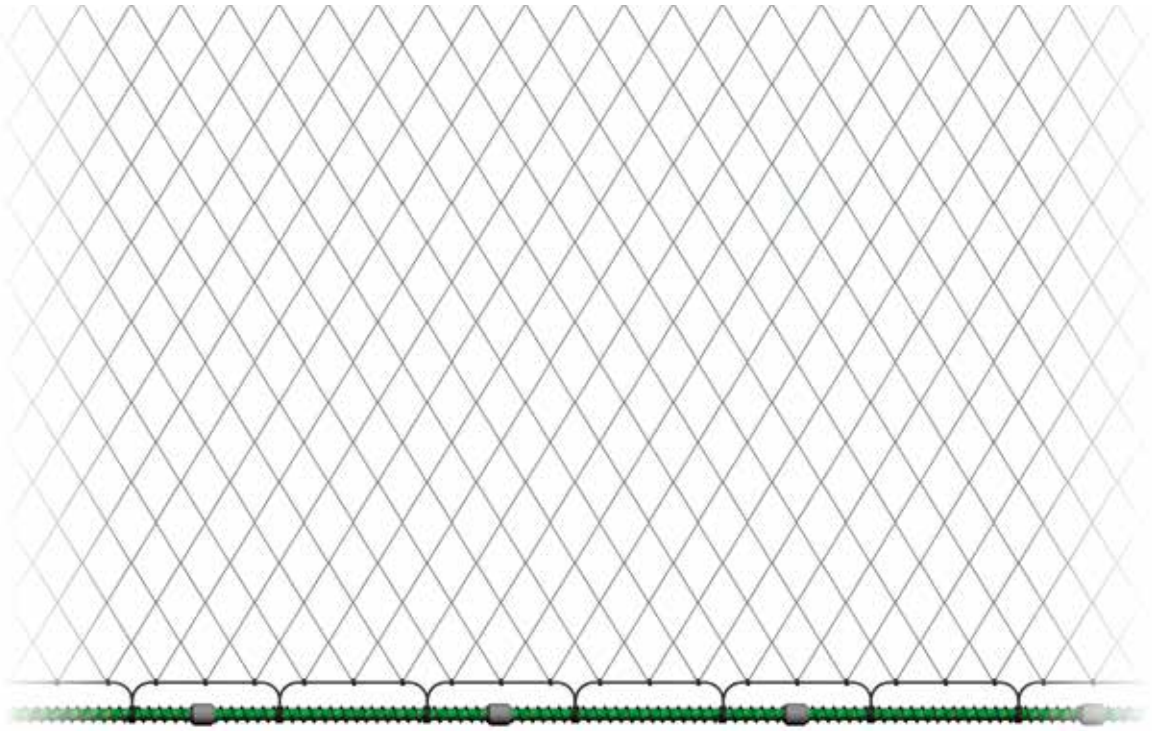


Fig 7.1 Gill net

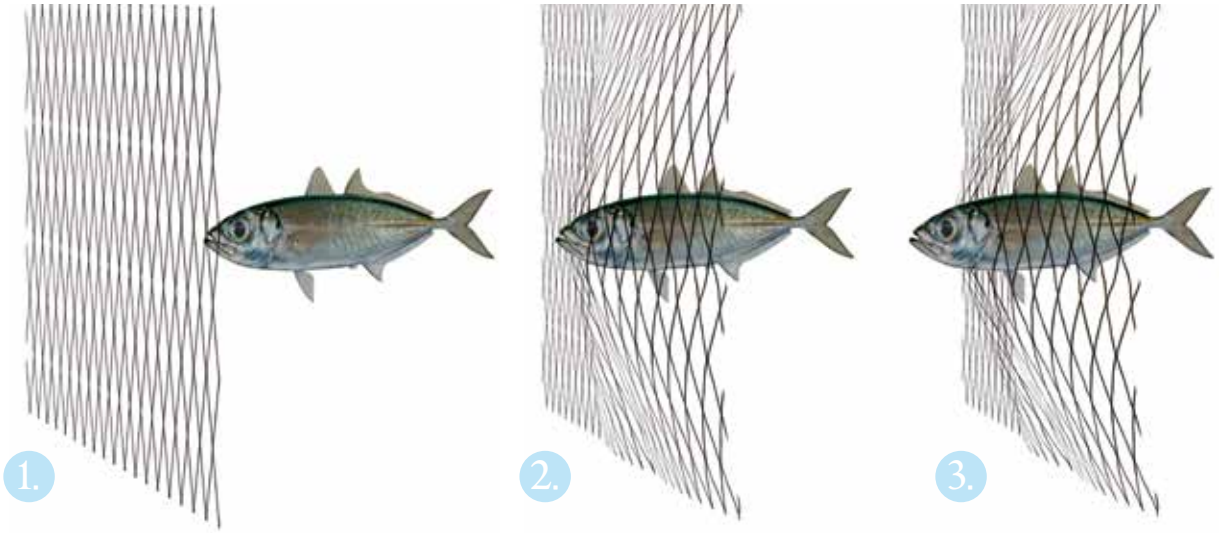


Fig 7.2 Gill net catching method

GILL NETS

Gill net is used as a generic name for many different styles of nets as well as being a specific style of net in itself. Many of these nets will be referred to by different names in different fisheries.

In basic terms, any gill net is a curtain of fine netting hung in the water, either anchored to the sea bed (gill nets or set nets) or allowed to drift with the tide (drift nets) for fish to swim into and become entangled or meshed in the fine netting.

Some form of gill nets has been used by man to trap fish for many thousands of years. Their efficiency improved dramatically with the use of modern twines. In the early days gill nets were made of natural fibres such as cotton, then twisted nylon and nowadays most of the nets will be made with monofilament or multi-monofilament. Gill nets in many guises are extensively used throughout the world, with the nets being rigged slightly differently in each fishery to suit the size of boat and the target species in that area.

GILL NETS

Gill nets consist of a single layer of fine netting that is weighted at the bottom and supported at the top by floats attached to a rope headline so that the net hangs vertically in the water column.
Fig 7.1 Gill net.

They can be rigged to fish on the seabed or at any position between the seabed and surface, depending on the target species. The nets will stand on the seabed anywhere between one metre and six metres high. The netting is very fine, almost invisible to the fish, and the fish swim into it and get caught in the meshes by their gills.
Fig 7.2 Gill net catching method 1 / 2 / 3.

TRAMMEL NETS

Trammel nets are similar to a gill net, but are made up of three layers of netting. Two outer layers of large mesh with a sheet of fine small mesh sandwiched between them.
Fig 7.3 Trammel net.

The inner layer of smaller mesh netting is hung onto the headline and foot rope much slacker that the outer two layers; it is also made much deeper than the two outside layers. This creates plenty of slack netting that the fish swim into and get tangled in pockets of netting between the two outer layers. As with the gill net, the netting in the trammel net is almost invisible to the fish. They will swim through the meshes of the first layer of large mesh netting, into the layer of slack small mesh, forcing the slack small mesh netting through the meshes of the second layer of large mesh and entrapping them in a pocket of the inner small mesh netting. **Fig 7.4 Trammel net catching method 1 / 2 / 3.**

Trammel nets are found to be more efficient at catching and retaining a broad range of species and size of fish than a single-walled gill net.

The trammel net is rigged, shot and hauled in a very similar manner to that of a gill net.

WRECK NETS

Types of gill or trammel nets that have been rigged to shoot over wrecks or areas of hard ground on the seabed.

TANGLE NETS

Very similar to a gill net in that it is a single wall of netting, but in this rig the netting is hung onto the ropes to create a greater amount of slack netting. Tangle nets will usually have less floatation on the head rope and will not stand as high when fishing, as the average gill net. The loose netting is more effective for catching many of the bottom living species such as flatfish, monkfish and shellfish that, due to their body shape, would not easily be meshed by a standard gill net, but will get entangled in the slack netting. As with other types of gill net, tangle nets will be rigged with a mesh size and the amount of slack netting to suit the particular target species.

They tend to be rigged using a stronger and large mesh size than gill nets to enable larger fish to be retained without damage to the net.

Trammel nets

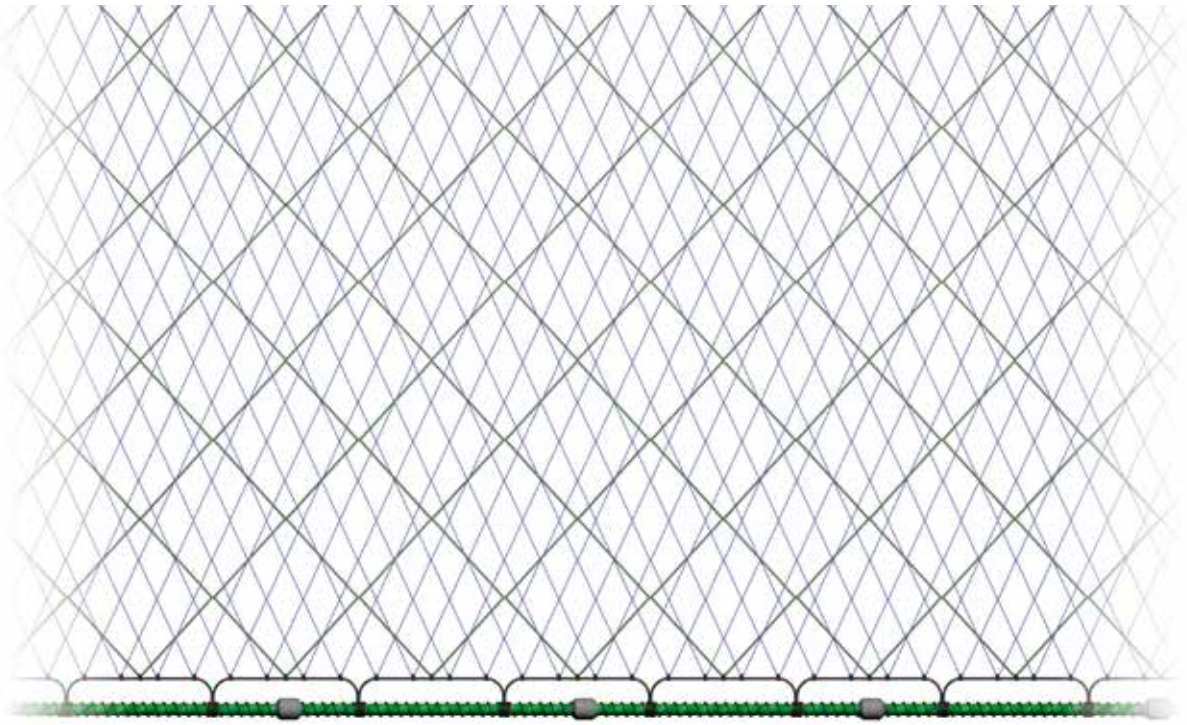


Fig 7.3 Trammel net

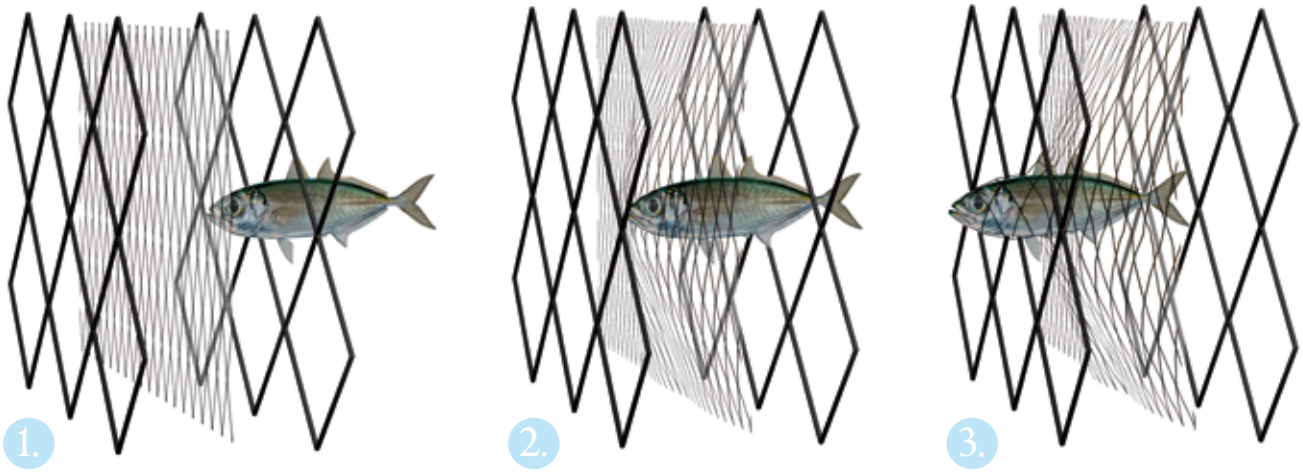


Fig 7.4 Trammel net catching method

DRIFT NET

This is type of gill net that is suspended in the water, usually just below the surface, but can be worked anywhere from the seabed to the surface to target pelagic species. The depth below the surface can be set by rigging the floats on the rope strops attached to the headline. As with other gill nets the mesh size is chosen to suit the size of the target species. The main difference with this type of gill net is that it is not anchored, but allowed to drift with the tide, usually with one end attached to the boat. The soak time will also be much shorter than that for bottom set gill nets.

Fig 7.6 Fleet of drift nets.

The use of drift nets to target pelagic fish is fairly widespread throughout the world. In the UK, drift nets are used on a small scale in various areas to target small pelagic fish including bass. In some areas, drift nets are set to drift very close to the seabed to target demersal species. Drift netting is also used in many overseas fisheries to target tuna, swordfish, and a few other large pelagic fish. There are concerns with some of these fisheries due to their accidental by-catch of other fish species, sharks and cetaceans.

The procedure used when fishing fixed nets is similar whether gill, trammel or tangle nets are being used. The nets are usually fished in groups (or fleets as they are widely known) with the end of each fleet attached by bridles to a heavy weight, or anchor, on the seabed. Each weight, or anchor, is attached to a marker buoy or dhan flag, on the surface, by a length of rope equal to about twice the depth of water. Depths of water fished usually range from 15 metres to 140 meters, with some fisheries going as deep as 1,800 metres.

Fig 7.5 Fleet of gill nets.

Length of individual nets can vary from 50 metres to 200 metres, and the size of fleets from 300 metres to 5,000 metres. The length of nets being fished (set on the seabed), at any one time will depend on the size of the vessels and the target species and can range between two and 30 kilometres. The soak times, the time that a fleet is left fishing for, can range from a six hour tidal soak up to 72 hours. These figures are dependent on which species are being targeted and whether there is any possibility of conflict with other boats using mobile fishing gear in the area.

The nets are shot over the stern of the vessel whilst steaming with the tide, and are fished along the direction of the tidal stream, rather than across it (there are some exceptions to this). This reduces the chances of the nets being flattened, or tangled, in the strong tidal conditions found in many areas of the UK. Shooting starts with dropping the dhan overboard and the vessel steams away from it, paying out the rope, until it reaches the anchor which is also dropped overboard. The fleet of nets follows until the full length of netting has run out and the second anchor and dhan follow. Retrieval of the gear is carried out in the same order, first picking up the dhan, then the anchor, then the net and eventually the remaining anchor and dhan.

The catch is normally removed from the nets as the gear is hauled onboard. It will then be set aside for onboard processing that usually consists of gutting and washing. It will then be passed into the chilled fish room where it will selected by species and stowed in iced boxes. On smaller vessels the catch may be retained on deck and stowed in specially designed insulated boxes or tubs. The fish will be laid on a bed of crushed or slush ice (ice mixed with water) to chill the fish quickly and retain quality.

Virtually all boats now use net haulers to help them retrieve the gear. The basic design consists of a rotating drum covered with rubber, which is driven by a hydraulic system run off the main engine. The rubber grips, the head rope and foot rope (frame ropes) of the net allows the hauler to take the strain of the net and haul it on board the boat. Variations on this basic design include rubber belts or spheres which exert a downward pressure on the top of the net as it passes over the hauler. This gives the hauler a better grip of the ropes and netting making it easier to haul the gear.

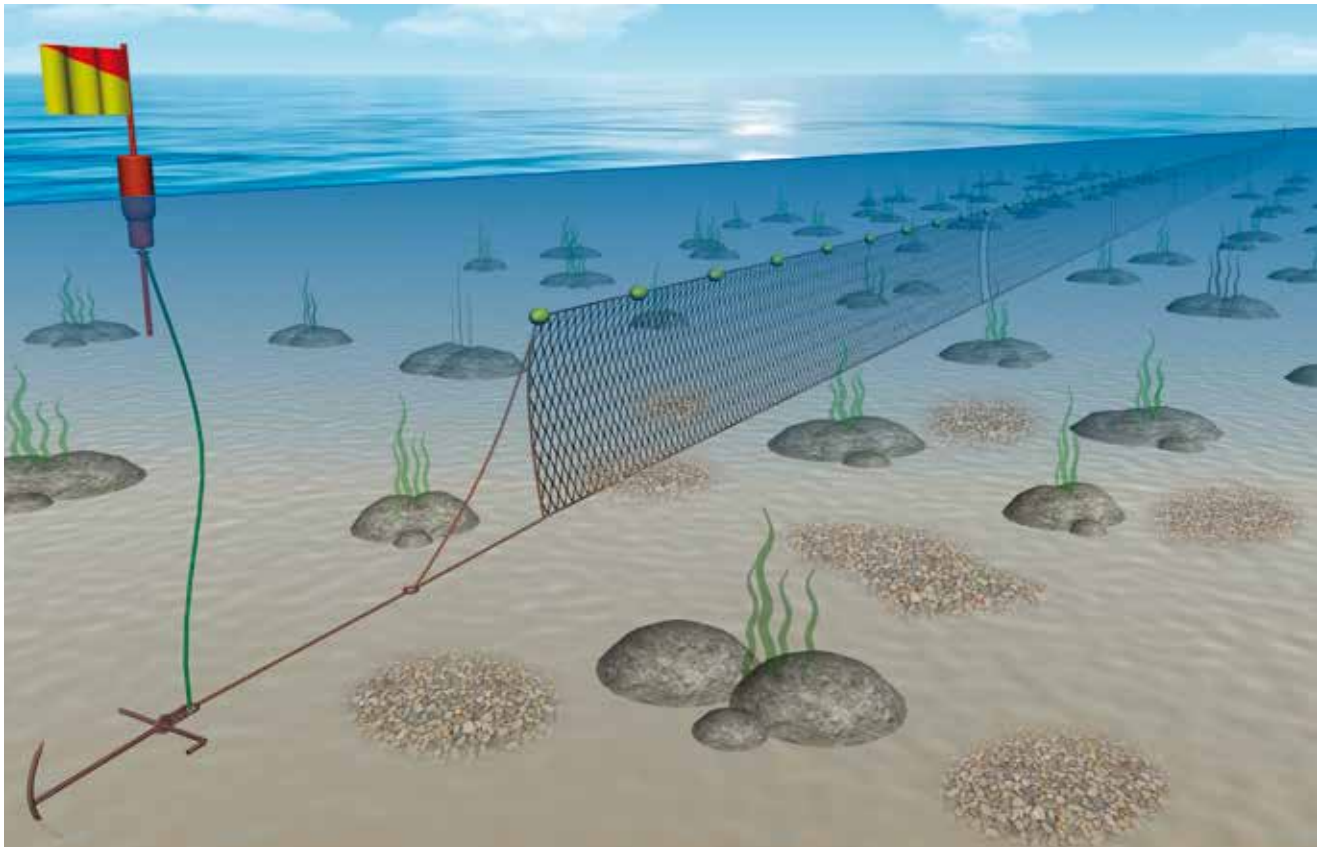


Fig 7.5 Fleet of gill nets

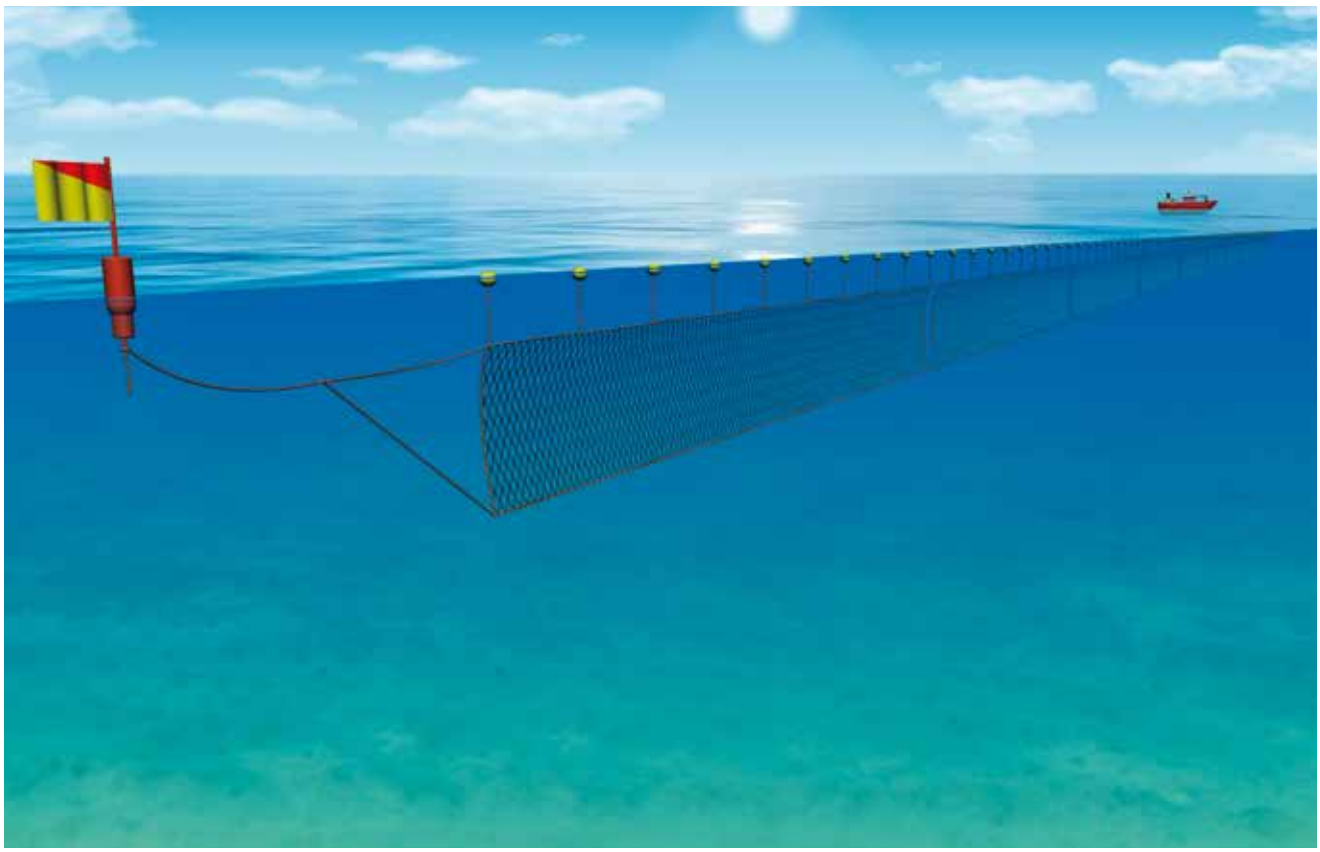


Fig 7.6 Fleet of drift nets

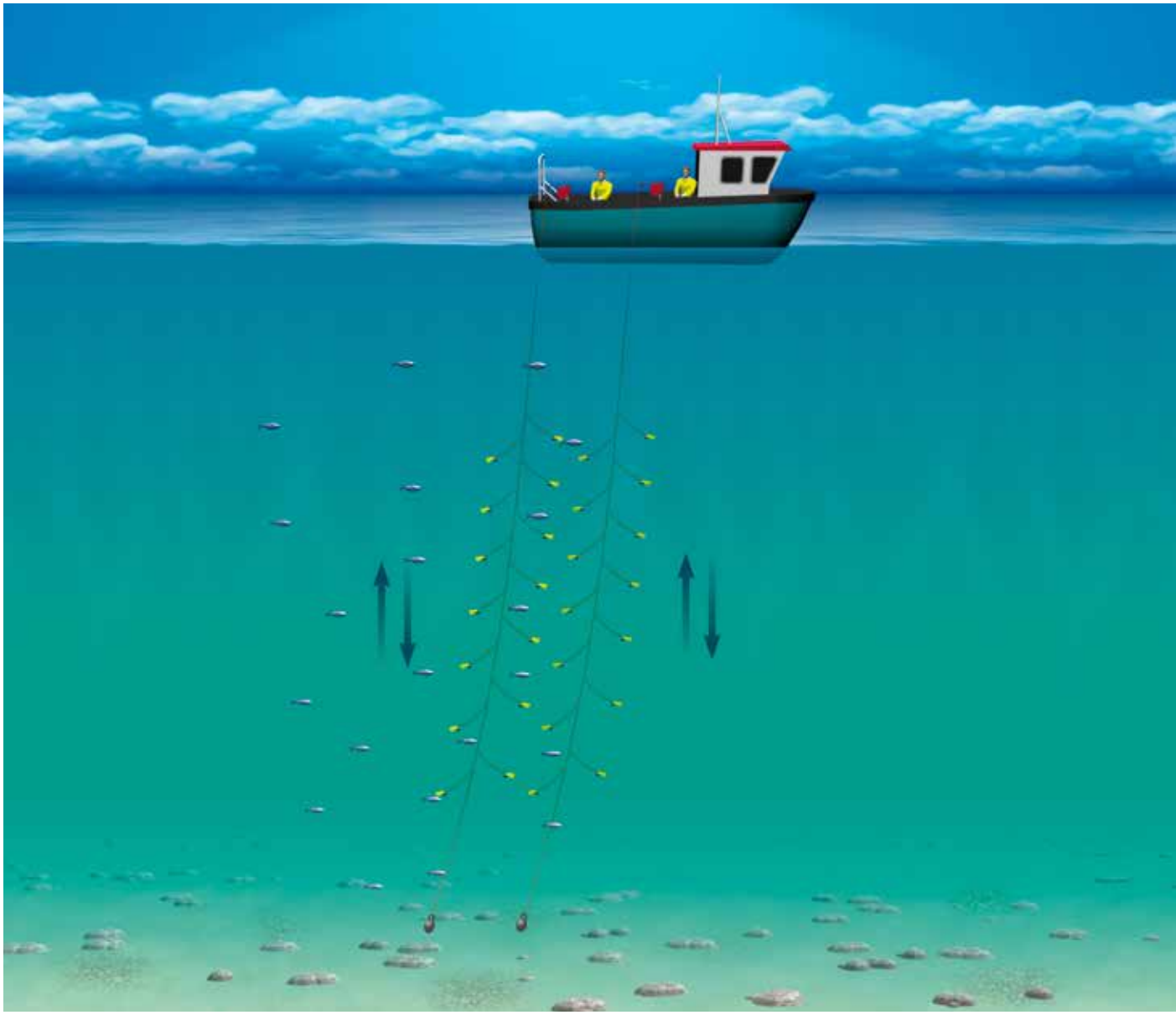
All types of demersal fish are targeted in different areas, with the gear being rigged to suit that species. Drift nets are more commonly used for pelagic fish and migratory species.

Gill nets are seen as having a low impact on the environment and are very good in relation to size selectivity as the size of fish caught can be regulated by the mesh size used. Small fish will swim unhindered through the mesh, whereas larger ones will be caught. They can also be species selective due to the area that they are shot in. The skipper will use his experience to place his gear where he expects there to be an abundance of the target species, at that particular time, thereby reducing the chances of by-catch. There can be problems with cetacean by-catch in some areas, but in most fisheries, the skippers are already aware of this and have adopted the use of acoustic pingers to keep the cetaceans away from the gear.

Seabed impact is minimal with gill nets as the footrope is very light on the seabed. The small anchors at each end of the fleet will penetrate the seabed, but the penetration is very localised. As the gear is not towed over the seabed, there should be very little abrasion. There have been reports of problems with 'ghost fishing' in the past; this is where the nets are lost and continue fishing for some time after they are lost. There have been attempts to mitigate this by encouraging fishermen to report lost gear so that it can be retrieved at a later date. It has also been found that lost nets will very quickly get shrouded with weed and become visible to the fish, and eventually sink to the seabed.

With the introduction of accurate GPS systems for vessel navigation and electronic plotting systems for recording data on board fishing vessels, there is much less chance of the vessel losing its gear. Also, if the vessel does break away from its gear, there is an accurate record of the gears position for retrieval at a later date. This should have helped to decrease the occurrences of ghost fishing.

LINES



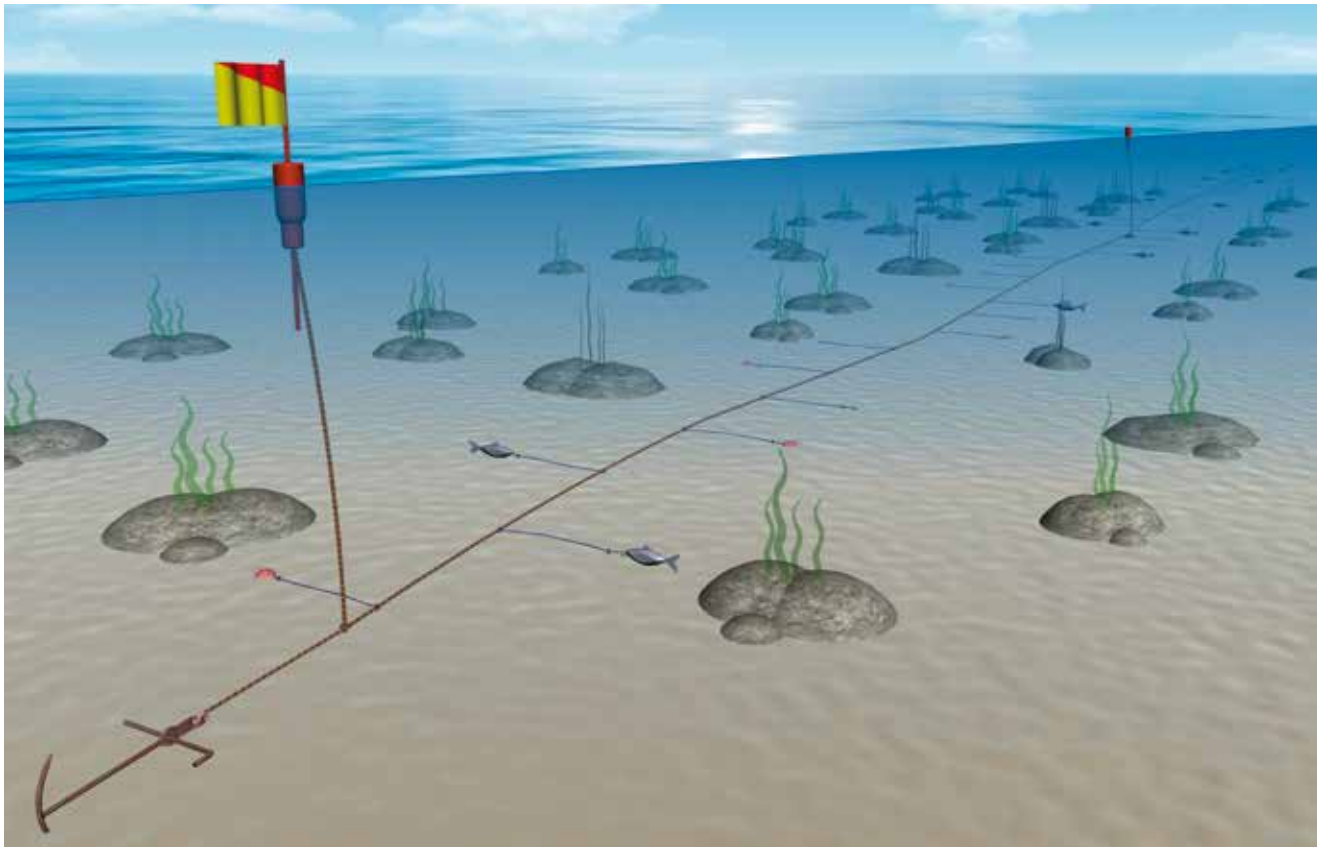


Fig 8.1 Demersal lines

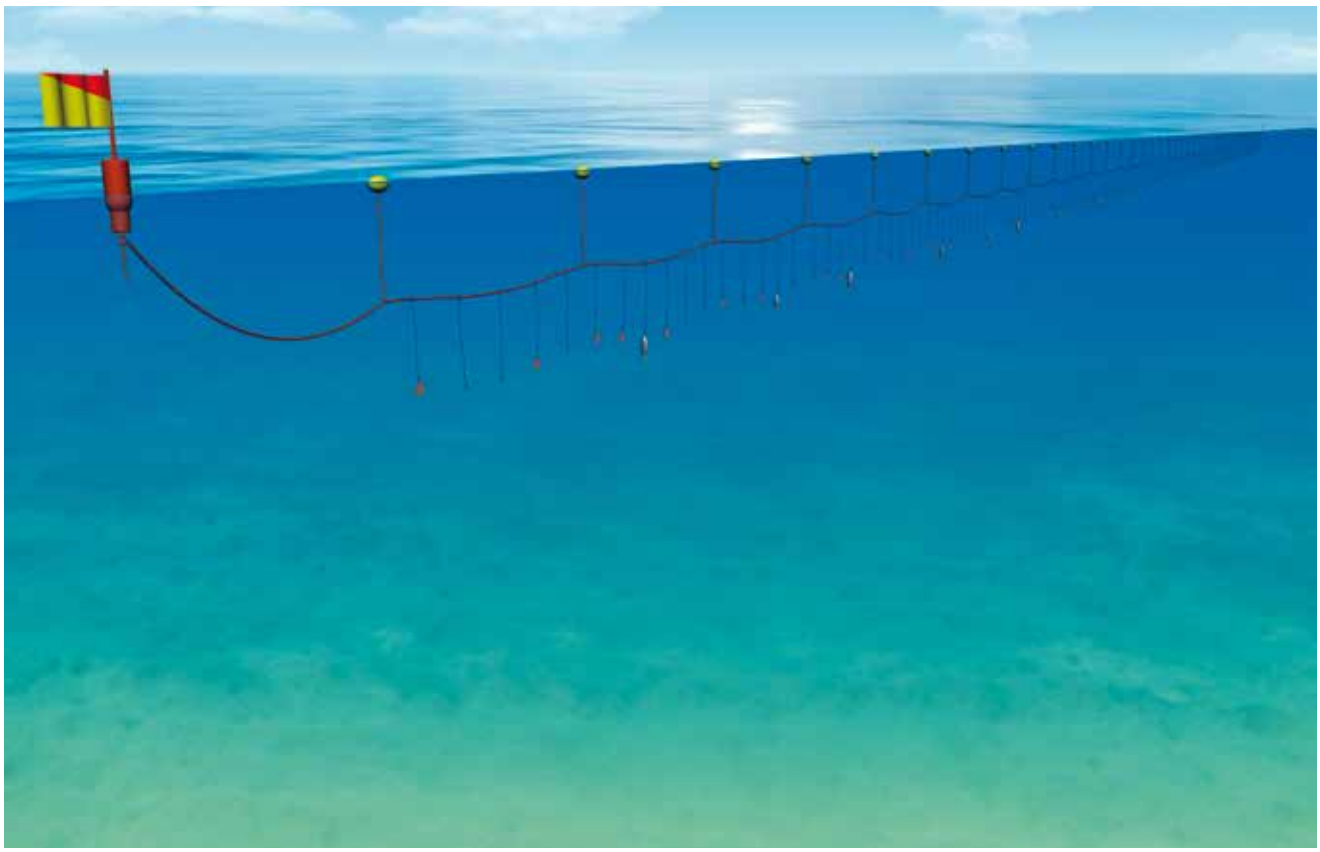


Fig 8.2 Pelagic lines

FISHING WITH LINES

LONGLINING

Catching fish on hook and line can be traced back to the days of the cave men when hooks were fashioned out of bone and line was fashioned from any twisted strands that were available. The use of multiple hooks on one line (longline) probably did not start to come into its own until the late 1800s when the construction of hooks became more mechanised. The next major step would have been in 1950 -1970 when automated line systems were introduced to bait, shoot, haul and stow the lines. Prior to this, every hook would have been baited by hand before shooting. Though these hand baiting techniques are still used in some fisheries today.

Longlining can be used to target both pelagic and demersal fish, with the lines being rigged and set at a position in the water column to suit the particular species. A basic longline consists of a long length of line, light rope or more common now is heavy nylon monofilament, with multiple branch lines with hooks on (snoods) attached at regular intervals. On smaller inshore vessels, where baiting and handling the gear is done by hand, they may use lines that are only a few hundred metres long with a few hundred hooks attached. The larger ocean-going longline vessel with modern automatic baiting and hauling systems will shoot lines that are several miles long with many thousands of hooks on. As in most fishing methods, the amount of gear used is dictated by the size of the vessel.

Fig 8.1 Demersal lines.

In common with many other static gears, the end of the line is shot away with an anchor to fix it to the seabed, and a bouy to mark where it is and aid retrieval. The anchor and bouy are shot away first, then as the boat steams forward, the line and baited hooks is paid out over the stern. The speed at which the vessel shoots its gear depends greatly on the set up they have on board. The smaller inshore boats pre-baiting the hooks by hand and shooting out of plastic tubs on the deck will have to shoot fairly slowly. The large auto liners, where the hooks are automatically baited as the line is shot from racks on deck, will be able to shoot at speeds in excess of six knots, or about five hooks per second.

Once all the line and baited hooks are shot away, the end of the line is marked with a dhan and prevented from drifting by a second anchor. The gear is then allowed to fish for a certain length of time, often over one change of tide or a full 24 hour period. After the specified soak time the dhan is picked up and the line is hauled using a hydraulic line hauler. As the line is hauled and the fish are unhooked and passed over for processing. On the large auto line vessels the line and hooks will lead straight onto the hook storage cassettes in preparation for baiting and shooting away again. On the smaller vessels, it will be fed into a tub and most likely taken ashore to be baited by hand.

There are two main types of longline fishing — demersal longline, where the lines are set on the seabed; and, pelagic or midwater longlines, where the lines are set at a specific position in the water column to suit the behaviour of target species.

Demersal longline is used to target the bottom feeding fish, in particular, cod, haddock, ling and some flatfish. It can be very size selective simply by variation in hook size and the species can be regulated by the skipper's experience in where he shoots his gear, the depth of water and the bait used. It is accepted as a very environmentally friendly method of fishing with very little by-catch or discards. Line caught fish is regarded as being of the highest quality.

In the UK, long line fishing is operated on a small scale by only a few inshore vessels in different parts of the country. Most of the larger demersal long line vessels that supply fish into the UK are based in Norway, Iceland, etc. However, demersal long line, in some form, is used by fishermen throughout the world.

Pelagic long lining is undertaken worldwide, to some degree, but tends to be concentrated in

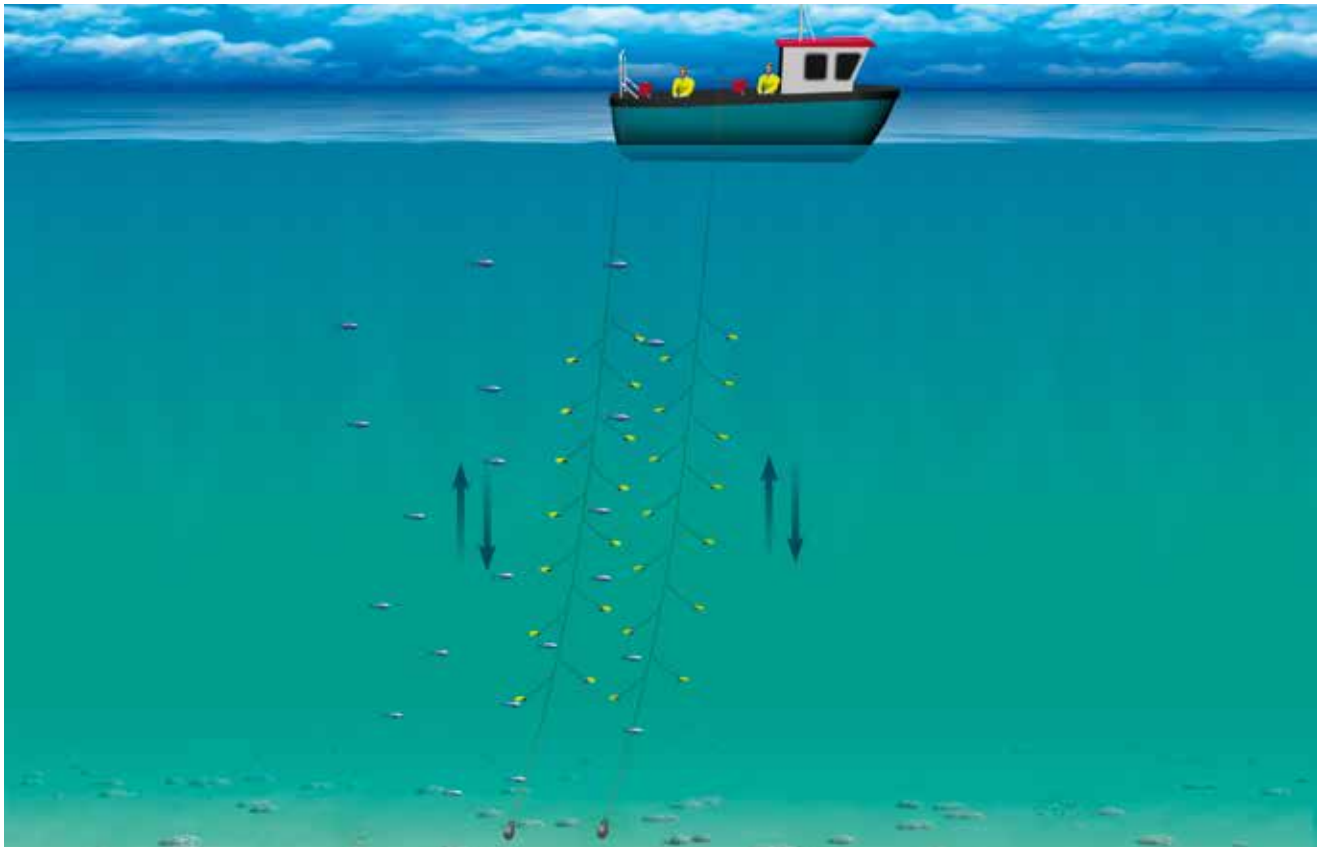


Fig 8.3 Jigging

Fig 8.4 Pole and line

tropical regions where there are concentrations of the large pelagic species. The main target species are, various species of tuna, billfish and swordfish. Fig 8.2 Pelagic lines.

The gear is very similar to the demersal longlines, but they are not usually anchored, and are allowed to drift below the surface being marked by large dhan flags at each end and at regular intervals along the line. In pelagic lining, the snoods are usually spaced further apart to suit the widely dispersed nature of the target species. The line is suspended below the surface by short lines with floats attached, spaced out along the main line. The length of these lines is set to hang the baited line at a suitable depth for the target species. There will be a certain amount of sag between the float lines but this allows the bait to be fished at slightly different depths on the same line. Although pelagic long lining, due to the various gear and hook configurations used, is considered as highly selective for the larger pelagic fish, there is concern in certain fisheries about the numbers of seabirds, turtles and marine mammals that may be caught or entangle in pelagic long lines. This problem of by-catch has been addressed in some areas with the adopting of bird scaring lines towed behind the vessel (tori lines) — weighted lines to ensure they sink quickly below the depth of the seabirds, and several other concepts to reduce accidental capture of seabirds. These include full redesign of the vessels to incorporate a moon pool to allow the lines to be shot away without any interference from birds.

The skipper can minimise the chances of by-catch by considering various characteristics of the gear such as the time of the year, the depth the lines are set to, the soak time, the type and size of bait and the hook type, when he deploys his gear. Although only two basic diagrams of lines are shown, throughout the world there are many different ways of rigging lines to suit the local conditions.

JIGGING

Jigging is a method of fishing that has evolved over many centuries, using hooks with artificial lures fitted to attract and capture fish. The lures are designed to resemble small fish that the target species would normally feed on. They are usually operated in a rhythmic up and down motion to simulate the movement of small fish, but often particularly if the fish are feeding well, the very movement of lowering the jig to the required depth is enough for the fish to take the jig and be caught.

Originally this method would be operated by one fisherman with only one line with a basic lure on it and some fisheries still operate in this way. However with the use of modern materials and computer-controlled jigging machines to handle the lines, enabling one person to operate several lines, jigging can develop into quite a lucrative commercial fishery. Fig 8.3 Jigging.

In some fisheries, there may be multiple jigs on each line enabling several fish to be caught at once.

In the UK, jigging is used commercially in several different areas. In SW England, it is used in the handline fishery for mackerel. This is a small boat fishery, usually under 10 metre boats operated on a single-handed basis. In this fishery, one man will use a single line with a weight and multiple hooks on it, often as many as 20 or 30 hooks. These hooks will have a small feather or piece of coloured plastic on them to act as a lure; sometimes the fish will go for a bare shiny hook alone, without the need for feathers or plastic strip. The lines will be hauled by hand and the fish shaken off as they come aboard, or the line may be hauled and stowed on a large reel known as a 'gurdy'. In this case the line is usually hauled through a device called a 'stripper' that strips the fish from the hooks as it comes on board. This enables the line to be shot away again as soon as the last hook has passed through the stripper. At certain times of the year, some of the boats will change their rig and move to jigging for pollack or squid.

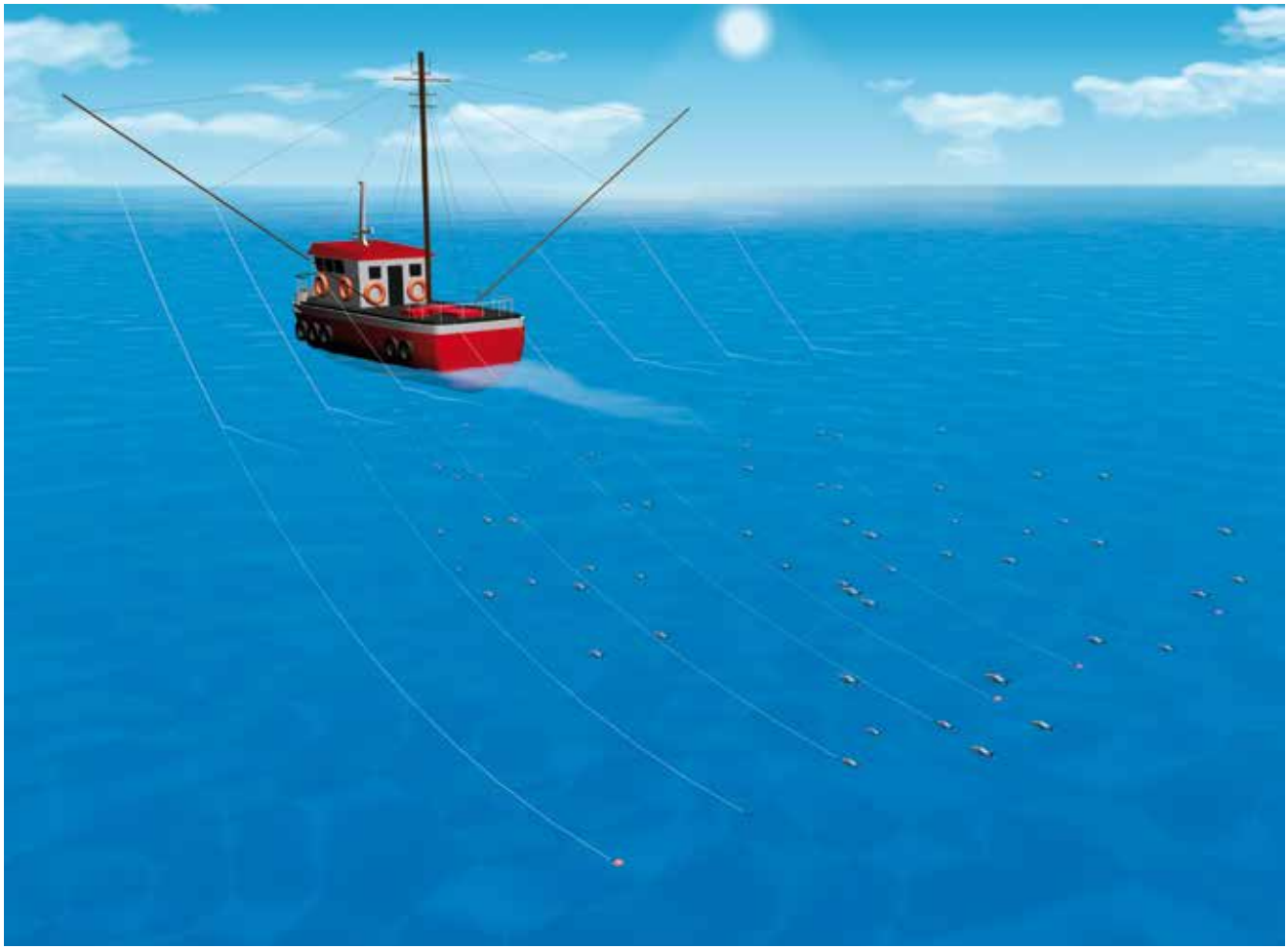


Fig 8.5 Trolling

In NE Scotland, where commercial 'handlining' for mackerel' has developed more recently, most fishermen have opted to use the electronic jigging machines. The lines are similar to that used in the SW, but they are operated using the computer-controlled electronic machines that can be programmed to drop the lures to a set depth, then retrieve them when a fish has taken the lure. On retrieval, the line is hauled through a 'stripper' that strips the fish off the line and channels them directly into a plastic box. Use of this system enables one man to operate as many as four machines, with up to 30 lures on each line. Although, in the Scottish fishery, the lines are hauled by a machine, the fish are still referred to as 'handline caught'

The handline fishery is seen as a very selective method of fishing with very little by-catch. If there is any unwanted by-catch it can usually be returned to the sea alive and unharmed giving an almost zero discard mortality. It is pursued by small low-powered boats using very little fuel, and as the gear is never in contact with the seabed, has minimum seabed impact. It is a well-managed fishery throughout the UK that produces a high-quality product.

World wide, probably the largest commercial jig fishery is that for squid. In this fishery powerful lights are used to congregate the squid beneath the vessel. The vessel will operate multiple lines with jigs on, either by hand or using automated jigging machines. The squid jigs have a ring of barbless hooks on them that allow the squid to drop off the jig once they are onboard the vessel and the line goes slack.

POLE AND LINE

One of the main fisheries using pole and line fishing is the tuna fishery in tropical waters where the individual fish have a high value. It can be a fairly basic type of fishing, with a minimum of gear, that consists of a long pole usually made of bamboo, wood or nowadays fibreglass, with a short line attached. On the line is a single barbless hook. This can be just a bare shiny hook or a simple feathered lure. Combining their experience with modern technology, the skipper will locate a school of tuna, or any other target species. They will then attract the fish close to the boat by scattering some form of small fish, such as small sardines or pilchard, on the surface as bait. This is called 'chumming' and is done in conjunction with spraying water on the surface to create the illusion that there is a large shoal of small bait fish just below the surface. This will send the tuna into a feeding frenzy and they will go for anything shiny that they see, such as a barbless hook.

There will be several fishermen, each with a pole, casting their lines into the feeding frenzy at the same time. Once a fish is hooked it is flicked up, over their heads, to land on the deck behind them. Once the strain comes off the line, the fish releases itself from the barbless hook and the fisherman casts his line into the shoal of fish again. Once the feeding frenzy ceases, the fish will be stowed below decks on ice to keep them in prime condition, and the skipper will try to line up another shoal of fish. **Fig 8.4 Pole and line.**

TROLLING

These are basic lines that are towed behind a boat, close to the surface or at a set depth to suit the target species. Each line will have one or more hooks with natural bait, or what is more common, an artificial lure. Trolling can be used by small open boats using one or two lines, while many of the larger vessels will be fitted with lightweight out-rigger style booms to enable them to tow multiple lines behind one vessel. These are rigged in such a way to allow each line to be hauled individually when a fish is caught. It is usually a daylight fishing operation used mainly by French and Spanish vessels and occasionally by some vessels from SW England for targeting tuna along the Atlantic coasts. Some of the smaller vessels in southern England will use this method, but with fewer lines to target bass.
Fig 8.5 Trolling.

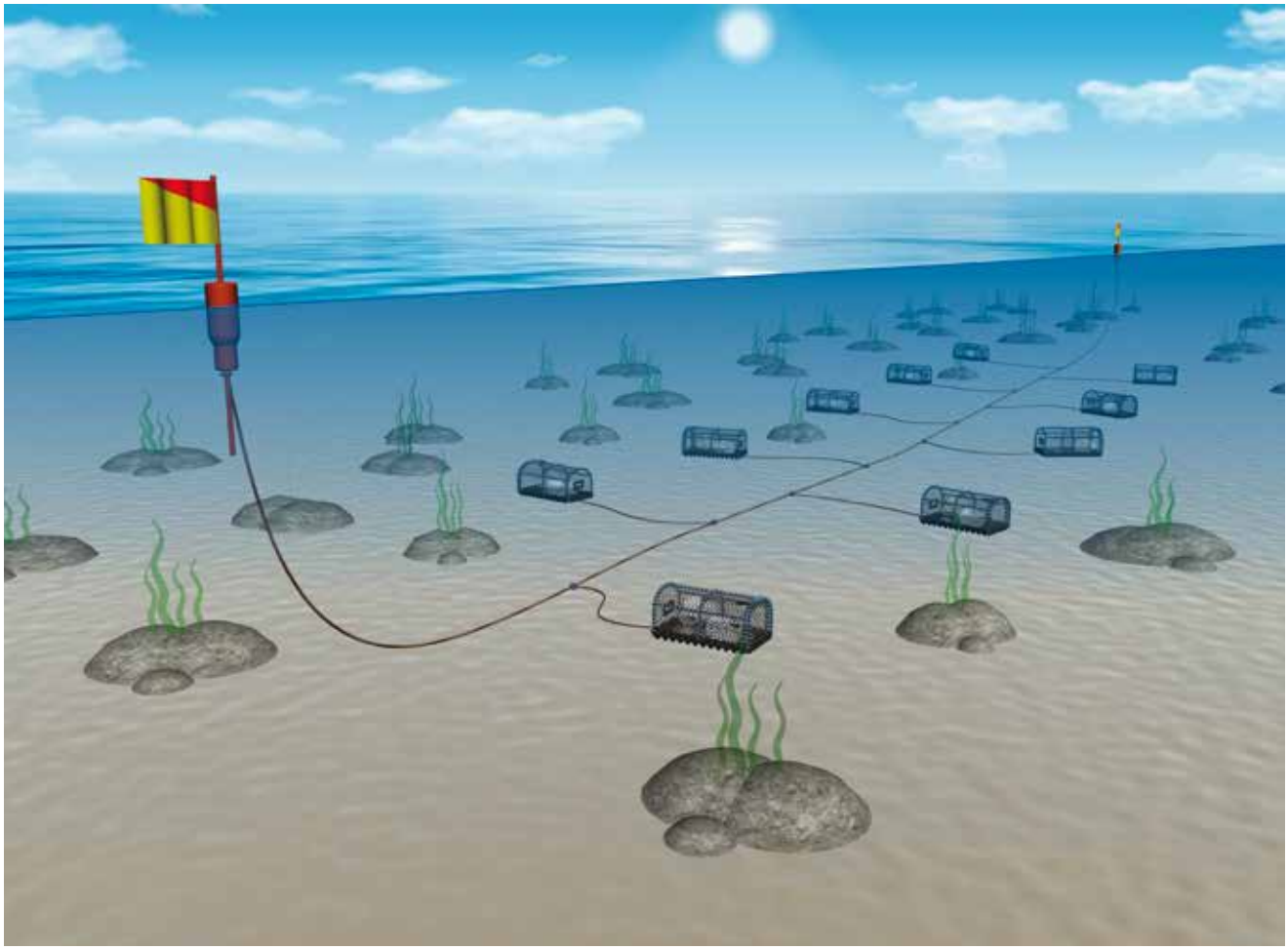


Fig 8.6 Fleet of pots

POTS AND TRAPS

Traps, in various forms of cages or baskets, have been used throughout the world for thousands of years to catch a wide variety of fish and shellfish. The basic design has not changed much over the years; the major changes have been in the materials that are used to make the gear. Early gear would have been made with wicker or willow, woven into a basket-form with a tapered entrance in the top, and stones inside to weight them down on the seabed. Nowadays, the pots and traps are made, along similar lines to the old wicker ones, but using modern materials such as wood, steel, plastic, etc. for the frame; this being covered with nylon and polyethylene netting.

Modern pots and traps tend to differ in shape, size and construction materials according to the behaviour of the target species, and local fishing practices. However, they will all be similar in that they will have at least one tapered entrance that makes it easy for the shellfish to enter, but very difficult for them to find their way out again.

There is a big variation in the names of the different traps in different fisheries, with them being referred to most commonly as pots, creels, traps — but there will be numerous different local names for the different styles of pot. The pots are baited, usually with some type of fish. As with the pot construction, the choice of bait varies greatly with the locality and the target species, with some baits proving much more suitable for certain species than others. Despite this, it often comes down to what type of bait is readily available, and at a reasonable price.

The traps can either by shot individually or more commonly in strings (fleets), where a number of pots are attached to one long rope and laid on the seabed, with a dhan or bouy to mark the location of each end of the fleet. If the pots are very light weight, as in Nephrops creels, an anchor or weight may be added at both ends of the fleet. **Fig 8.6 Fleet of pots.**

The number of pots in a fleet depends on many factors, such as the type of pot used, the target species, the size and design of vessel, the area they are shot in, the type of seabed, and the personal preference of the skipper and crew. The numbers in a fleet can vary from five in some inshore lobster fisheries to over 100 in offshore crab fisheries and Nephrops fisheries. The pots are baited and shot away from the vessel as it steams slowly ahead and, are left on the seabed to fish for a period of, usually, 24 hours. If left much more than overnight, there can be a tendency for some of the shellfish that are already in the traps to escape, thereby creating a loss of revenue for the vessel.

The pots are hauled by firstly picking up the dhan at the end of the fleet of pots and leading the rope to the creel hauler. The hauler is usually mounted forward, to one side of the vessel. As the pots are hauled up to the vessel, the creel hauler will be slowed down as the pots approach the vessel side. They will then be hauled, or manhandled, over the side of the vessel and onto a flat working table where the catch is removed and placed in a container for onboard sorting and processing before storage. As the catch is being taken out of the trap, any by-catch or undersized crabs and lobster will be immediately returned to the sea and the traps will be re-baited. The re-baited pots are passed across the deck and stowed in correct order so that they are all ready to be shot away again. In the meantime, the hauler will have been engaged again to haul in the rope until the next pot is at the side of the vessel, and the whole process is repeated and continues like this until the whole fleet is onboard the vessel. The skipper will manoeuvre the vessel into position and start to shoot the fleet again. This is usually done by shooting away the dhan and rope and probably manhandling the first trap into the water. After this, the rest of the fleet should be 'towed of the stern of the boat in turn as each length of rope comes tight. However, if there has not been a good catch the skipper may opt to keep the fleet onboard and move fishing grounds a short way in an attempt to improve the next day's catch. This routine and layout is fairly standard on all UK vessels, and many overseas vessels fishing with traps and pots.

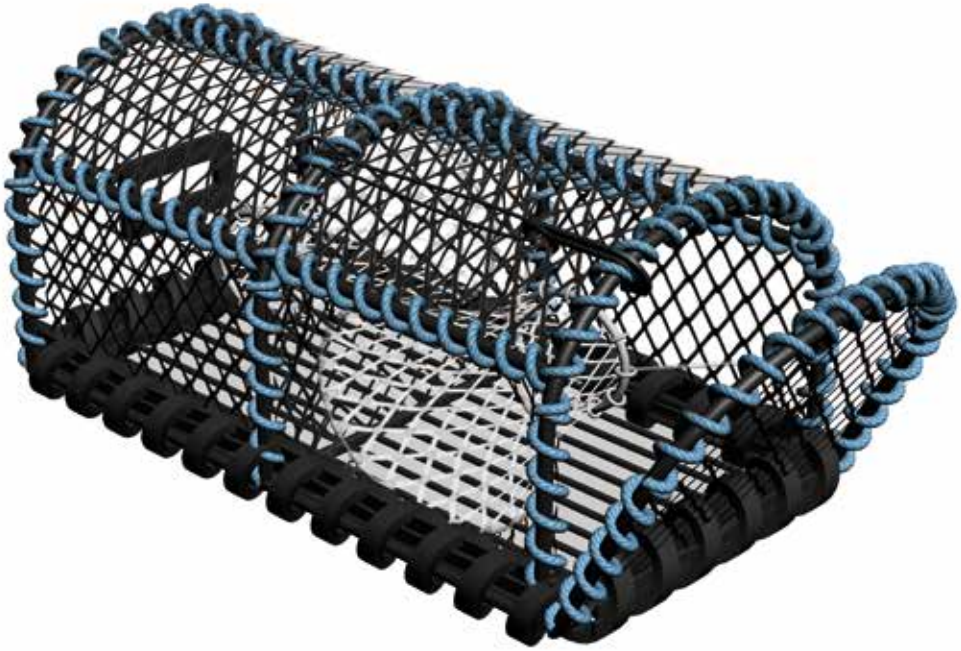


Fig 8.7 Lobster creel

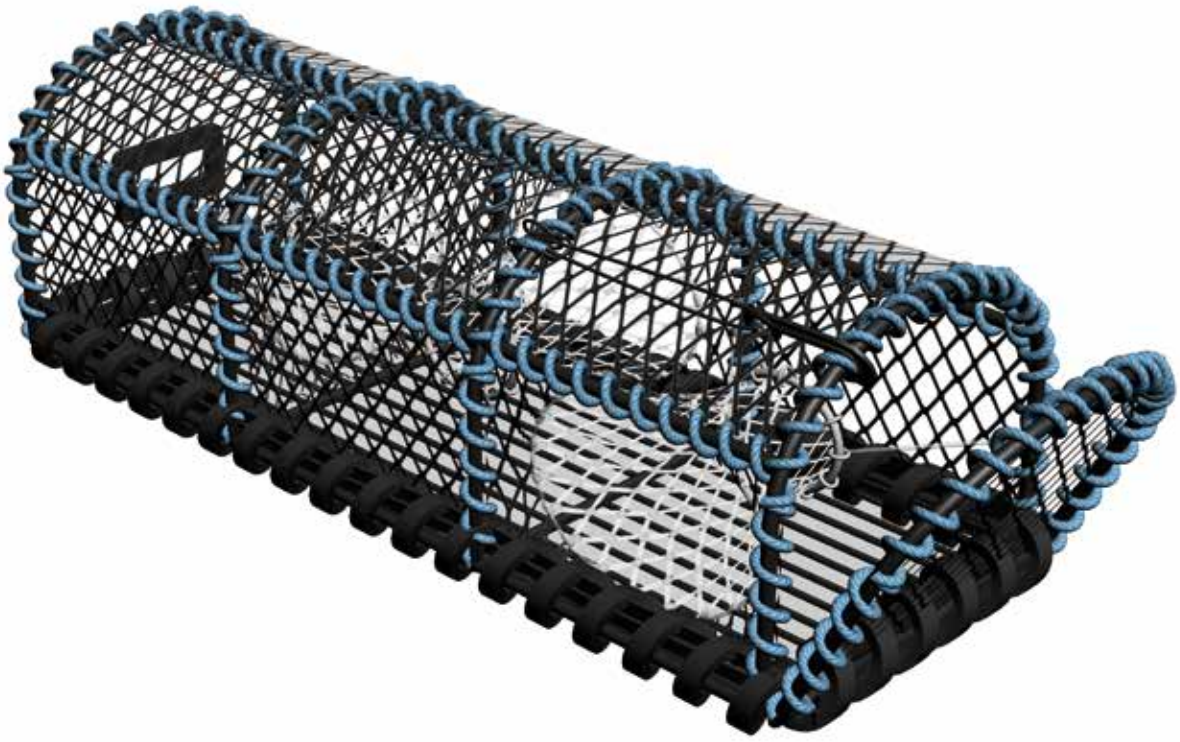


Fig 8.8 Parlour creel

All sizes of vessels can fish with traps, with small inshore open boats often operating with a few traps shot individually instead of in fleets and hauled by hand, right up to 20 - 30 metre vessels operating several thousand pots in fleets of around 100. The smaller vessels will store their catch in boxes and land them daily, or put them into storage cages left underwater until the shellfish buyer is in port to collect them. The larger vessels will store their catch in vivier tanks to keep them alive onboard the vessel and land their catch after several days of fishing. A vivier tank is a tank built into the hull of the vessel with a pump system to circulate fresh seawater to keep the animals alive. Once put ashore, many shellfish buyers will transport the catch in lorries fitted with vivier tanks to ensure the shellfish are still alive and fresh when they reach the end user. Shellfish can be transported long distances in this way, with much of the UK catch being shipped to France and Spain while it is still alive.

Traps and pots, of some description, are used all around the shores of the UK with fishermen concentrating on species such as crabs, lobsters, crayfish, Nephrops, whelks, spider crabs, velvet crabs, cuttlefish and several other species but in lesser numbers. The gear will be designed taking into consideration the behaviour of target species and fished on grounds where they are known to frequent. This helps to make pots and traps very efficient in species selectivity. However, in some cases there may be a small by-catch of other shellfish. Almost all of this will be retained and sold, with any undersize or unwanted animals being returned to the water alive.

LOBSTER / CRAB CREEL

One of the most common styles of pots used throughout the UK is the 'D' creel. It is used to target lobster and crab by inshore vessels and some of the larger vessels working further offshore. These creels will be seen in many ports piled up on the quay ready for use when the shellfish season starts. Originally, this style of creel would have been made with a wooden base and frame that was then covered in netting. Creels of this style would use a stone or lump of concrete to weight them down, and pots like this are still used by some fishermen today. **Fig 8.7 Lobster creel.**

Plastic-coated steel is more commonly used to construct both the base and the framework of modern creels then this is covered with netting. This netting is very often black in colour as in many areas black netting has been found to make the creel catch shellfish more effectively than creels made with other colours of netting. Once the netting is fitted, the outside edges of the framework will be bound with old rope or strips of rubber cut from old tyres to protect the creel from damage through abrasion on the seabed. In each side of this creel, there is a tapered netting entrance with a plastic ring in the end to keep it open, referred to as a 'hard eye'. The entrance has a slope up into the creel where the animals, attracted by the bait inside, can easily crawl up and drop into the creel. Although the plastic ring keeps the entrance open the lobsters and crab have difficulty finding the entrance from inside the pot to make their way out again. Some of these pots do not have a plastic ring in the entrance, but just have the inner end of the entrance as the cut edge of the netting, this is called a 'soft eye'. Both crabs and lobster will have more difficulty escaping again from the soft eye as the upper edge of the entrance tends to hang down, and is quite effective at closing the entrance from inside the creel. The end of this creel is hinged to allow easy removal of the catch and replacement of bait. The bait is fixed to a vertical length of twine or small netting bag fixed in the centre of the creel. The hinged end is held closed by a hook attached to the creel by a rubber cord. Some traps will have this doorway for removing the catch in the top netting of the trap.

The gaps between the bars in the base are generally set at a suitable spacing to allow the release of any crab or lobster below the minimum landing size (MLS). In the illustration, there is an additional rectangular plastic release panel fitted in the end to allow animals of a certain size to escape easily. In some fisheries, the use of these

Fig 8.9 Inkwell pot

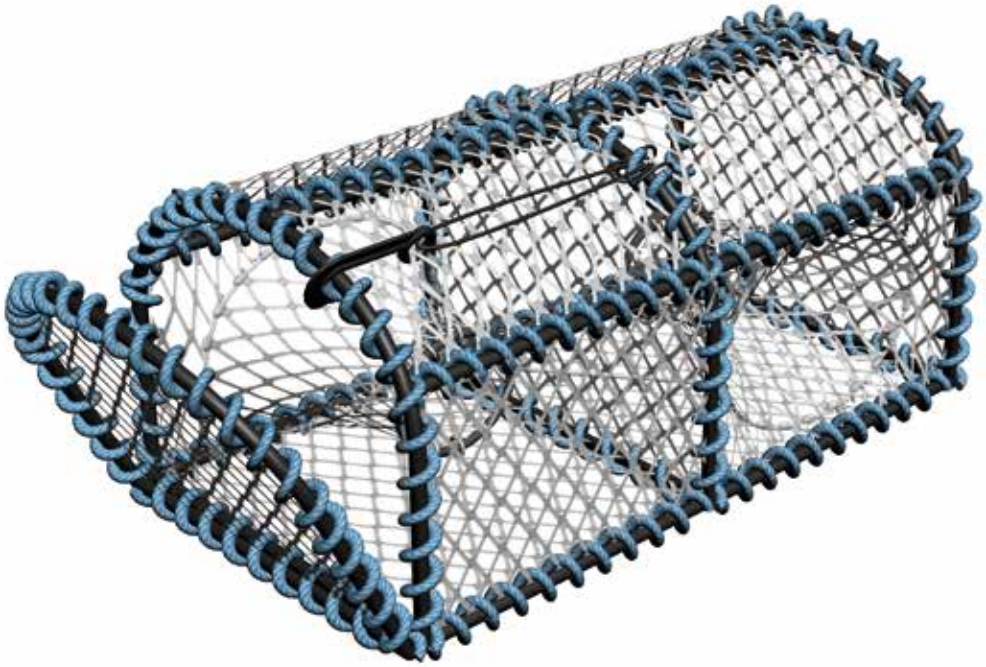


Fig 8.10 Nephrops creel

release panels of a certain size is mandatory, whereas in others they are used by fishermen on a voluntary basis.

PARLOUR CREEL

Some of these D shaped creels are constructed with an extra 'parlour' section to help retain the catch, enabling them to be left on the seabed fishing for several days without hauling. This allows the vessel to operate with a greater number of pots or enables the gear to continue fishing when the boat cannot get to the gear due to poor weather. **Fig 8.8 Parlour creel.**

In this style of creel the animals will enter the creel through the two side entrances as normal, then, once it has eaten enough of the bait, and tries to get out of the creel again, the easiest exit for it to find is through the entrance from the main chamber of the creel into the parlour section. This is usually a soft eye to minimise the chances of it escaping from the parlour section of the creel. The end of the parlour section will be hinged as in a standard creel for easy removal of the catch. When using parlour creels the fisherman can haul the creels every second or even third day without any noticeable loss of catch. This enables the fisherman to operate much more gear by only hauling half or a third of the creels each day.

INKWELL POT.

The other common type of pot for targeting crab is the inkwell pot. **Fig 8.9 Inkwell pot.**

The shape of this is exactly the same as that of the early wicker work traps but it is constructed in either steel rod or plastic, with a plastic spout entrance in the top. This plastic entrance resembles a plastic bucket without a bottom in it. Once the crabs enter the pot through the plastic entrance, the crabs will have difficulty getting out again. The position and design of the entrance requires the crabs to 'swim' directly upwards to escape, and due to the smooth plastic in the entrance, without anything for the crabs to grip onto, they have great difficulty in escaping again. However, if not hauled every day, catch rates will drop considerably as the crabs will eventually manage to escape from an inkwell pot with a plastic spout entrance. As with the 'D' creel, these are covered in netting, bound with rubber strips and weighted to keep them in position on the seabed. Sometimes they will have a double layer of netting to tolerate the abrasion on the seabed. There is no need for an opening door on this type of trap as the catch can be removed and the pot re-baited through the plastic entrance. This is the favoured pot by many of the large crab vessels (crabbers) in SW England, working deeper waters further offshore. They will be shot and handled in the usual way, with fleets of up to 100 being used and some vessels operating with over 2,000 pots in the water at one time.

NEPHROPS CREEL.

In some areas of the UK, particularly the West coast of Scotland, Nephrops (langoustine), referred to by the fishermen as 'prawns', are caught using creels. These prawn creels, as they are generally called, are of the basic D creel design but of much lighter construction than that of a lobster or crab pot. They usually have the standard two entrances in the side and almost always have hard eyes to make entry into the creel easy for the Nephrops. As with any hard eyed creel, if not hauled daily, many of the creatures will soon escape. These creels are generally set in deeper water on soft seabeds of mud and sand where the Nephrops live in burrows. In these areas, there is much less chance of the creels moving and getting abraded by contact with rocks and stones, therefore, there is need for only a lightweight rope to be wrapped around the frame of the creel to prevent damage. **Fig 8.10 Nephrops creel.**

Most skippers using Nephrops creels, even on the smaller vessels, use large fleets often around 100 creels. There will usually be some form of anchor or weight at each end of the fleet to help prevent the fleet being moved by strong tides and rough seas. The gear will be hauled and shot on a daily basis in the usual way. The mesh size of these creels will be chosen to allow the release

Fig 8.11 Whelk pot

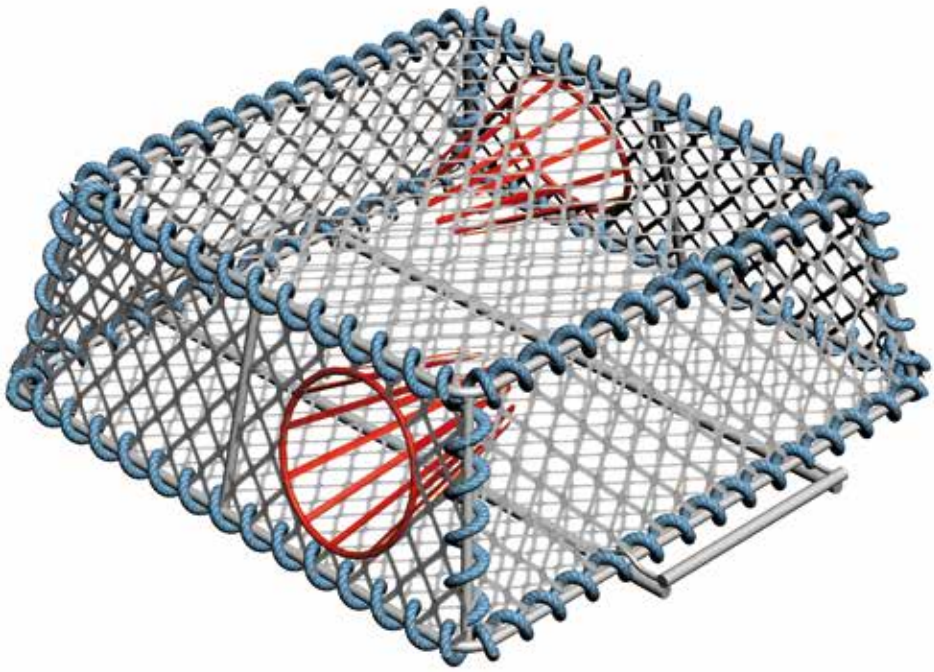


Fig 8.12 Cuttlefish trap

of the very small Nephrops and any small fish. When the gear is hauled and the catch removed, the retained Nephrops are usually selected by size and placed in individual sections or 'tubes' in a box that is then immersed in a tank of sea water to keep them alive and in prime condition. Most of the prime quality Nephrops will be transported, still alive, to the lucrative markets in France and Spain either by vivier lorry or by air freight. There is negligible by-catch or discarding in the creel Nephrops creel fishery. Due to the type of seabed the gear is worked on, and the lightweight gear used, the impact on the seabed should be minimal.

WHELK POTS

In several ports in the UK, some trap fishermen have changed their efforts to target whelks using pots. The pots used for this fishery are small, but heavy, and often made up from discarded 25 litre plastic containers, although purpose built ones are available nowadays. **Fig 8.11 Whelk pot.**

One side of the plastic container is removed and replaced with a section of netting with a hole in the centre to act as an entrance. This entrance forms the top of the trap. As with other pots, this allows the whelks an easy entry to the pot, but then it is almost impossible to get out. The bottom of the plastic pot is weighted with a block of cement to ensure that the pot lands upright on the seabed and remains this way when it's fishing. Inside, there will be some method of fixing the bait and numerous holes are made around the pot to allow the water to drain from it as the pot is hauled.

Whelk pots are handled in fleets, exactly the same as most other pots. Due to their relatively small size, although they do tend to be heavy, many vessels will operate fleets with a greater number of pots in them. By-catch is negligible as, due to the design of the pots, most other fish and shellfish can easily escape before the gear is hauled. Any unwanted by-catch will be returned to the sea alive.

CUTTLEFISH TRAPS

In SE of England, some inshore vessels use traps to target cuttlefish. This is similar to a cuttlefish fishery on the French side of the English Channel. It is a seasonal fishery when the cuttlefish come close inshore to mate and spawn. The pots are quite large, with some being over one metre in diameter and 600mm high, but they are very light in both construction and weight. They are similar to fish traps that are used in some other countries to target round-fish. The traps are either square or round, made from thin steel bars covered with lightweight netting. They will have two or three cone-shaped entrances fitted around the sides. Originally, these were made from netting or wire netting, but often now they are purpose made plastic entrances that have a series of flexible plastic fingers on them. These fingers are not fixed at their inner end and are free to bend outwards easily as the cuttlefish enters the trap, but then they will spring back to shape and make it very difficult for the cuttlefish to escape again. **Fig 8.12 Cuttlefish trap.**

Some fishermen use a simple plastic disc hung inside the trap, as bait, to attract cuttlefish in. Others may actually use a live female cuttlefish put into the trap before shooting, using the mating instinct to attract others into the trap.

There has been criticism directed at certain pot and creel fisheries in respect of 'ghost fishing'. This is where the fishing gear is lost and carries on catching fish or shellfish that may just die in the gear as they cannot escape or be released because the gear is not getting hauled regularly. As stated previously, most traps can only efficiently retain the catch for a period in the region of 24 - 36 hours, therefore, if the gear is lost, any shellfish or fish entering them should be able to escape from the trap fairly easily. The exception to this is where soft eyes are used either into the main chamber of the gear or into a parlour section. Escape through these entrances is difficult. However, many skippers will use some form of release device to allow the door of any lost pot or creel to open after a certain period

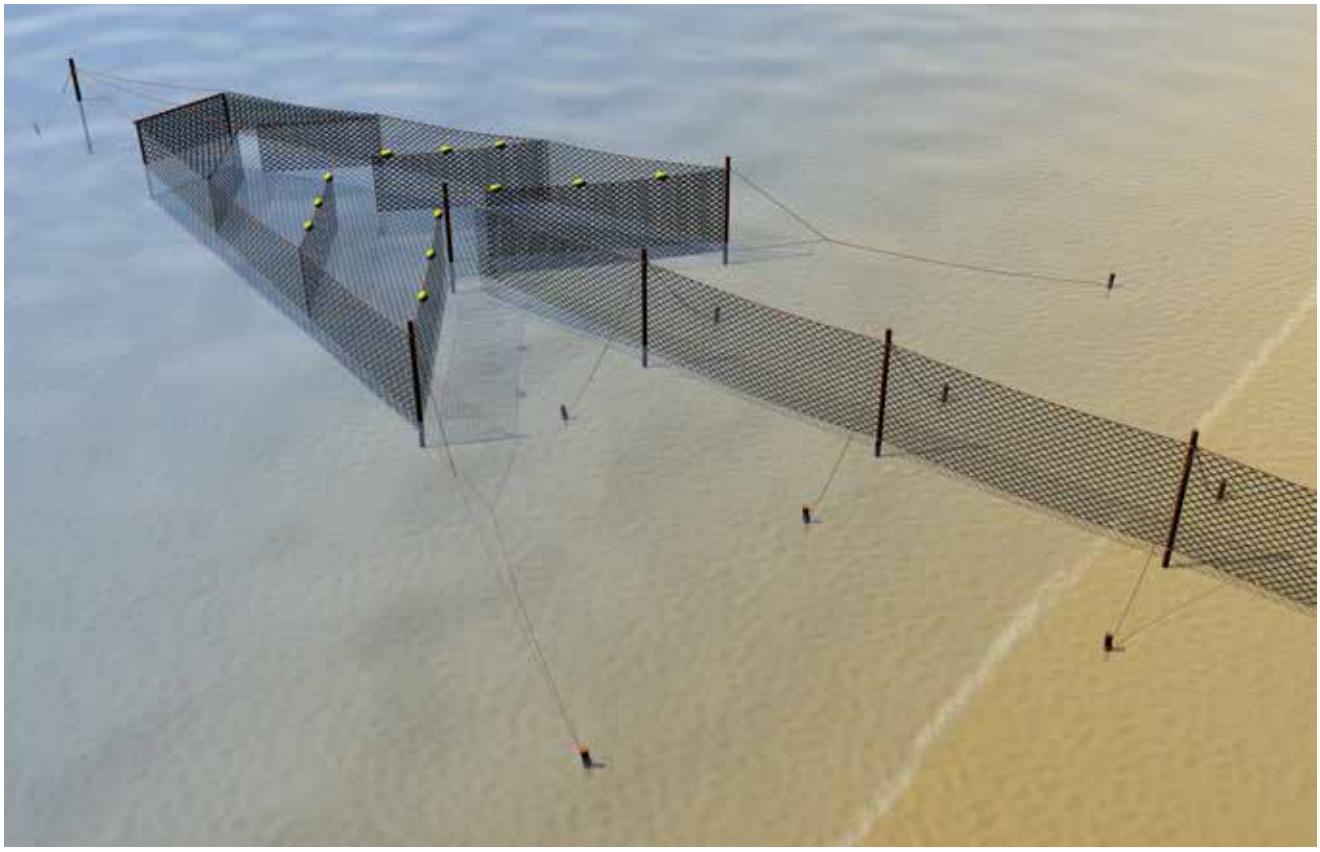


Fig 8.13 Stake net

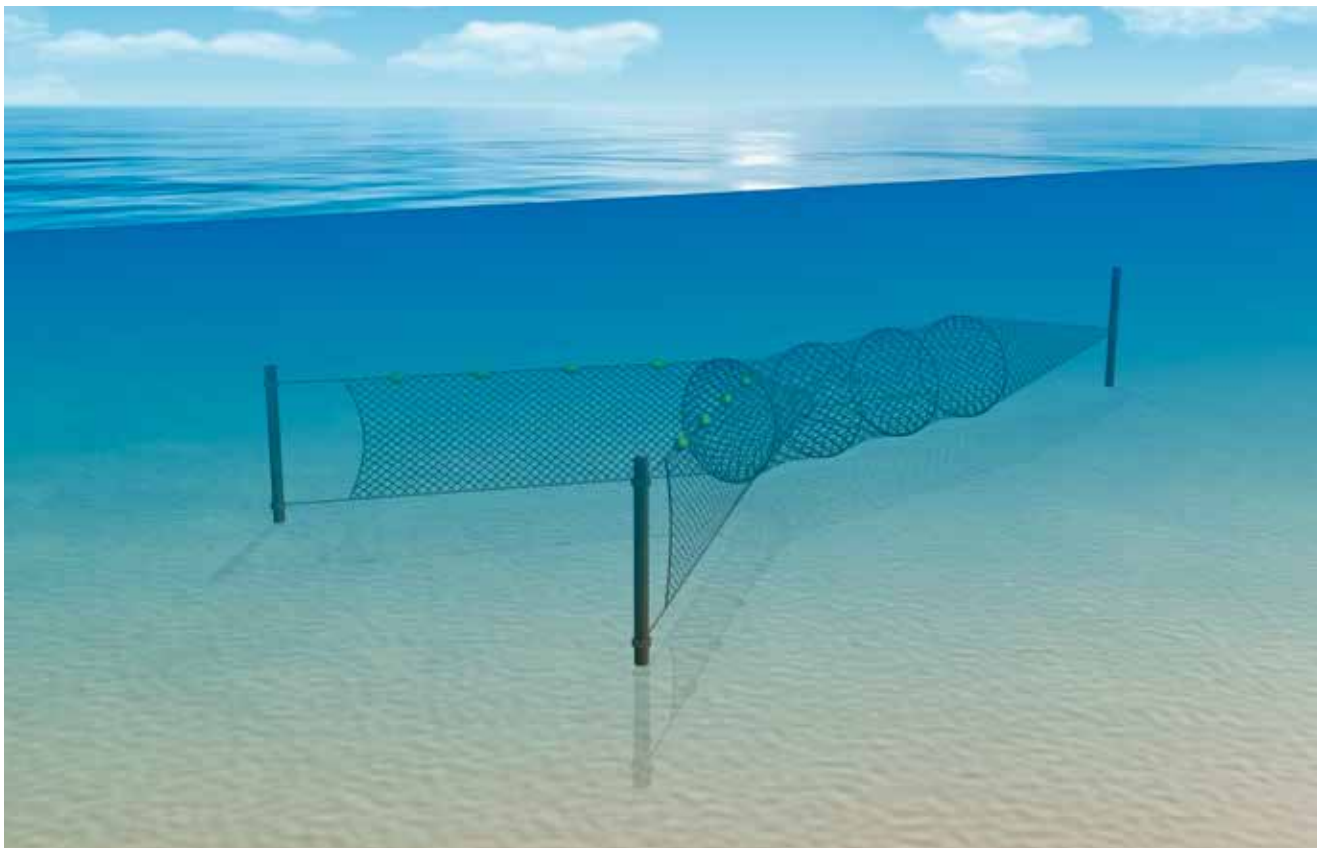


Fig 8.14 Fyke nets

of time in the water and release any trapped shellfish or fish. This can be done by using bio-degradable twine or a galvanic release device on the hook for keeping the door closed.

Many shellfish traps have built into them some form of release mechanism to allow immature animals to escape easily. This can be as simple as, during construction, ensuring the bar spacing in the base or the mesh size of the netting cover is of a suitable size to allow the immature shellfish to escape, but retain the marketable ones. Plastic escape gaps are also available that can be fitted into the netting of the traps to allow release of small shellfish.

In some areas, the vessels are restricted in the number of pots or creels that they can use in an attempt to prevent any increase in fishing effort in that area.

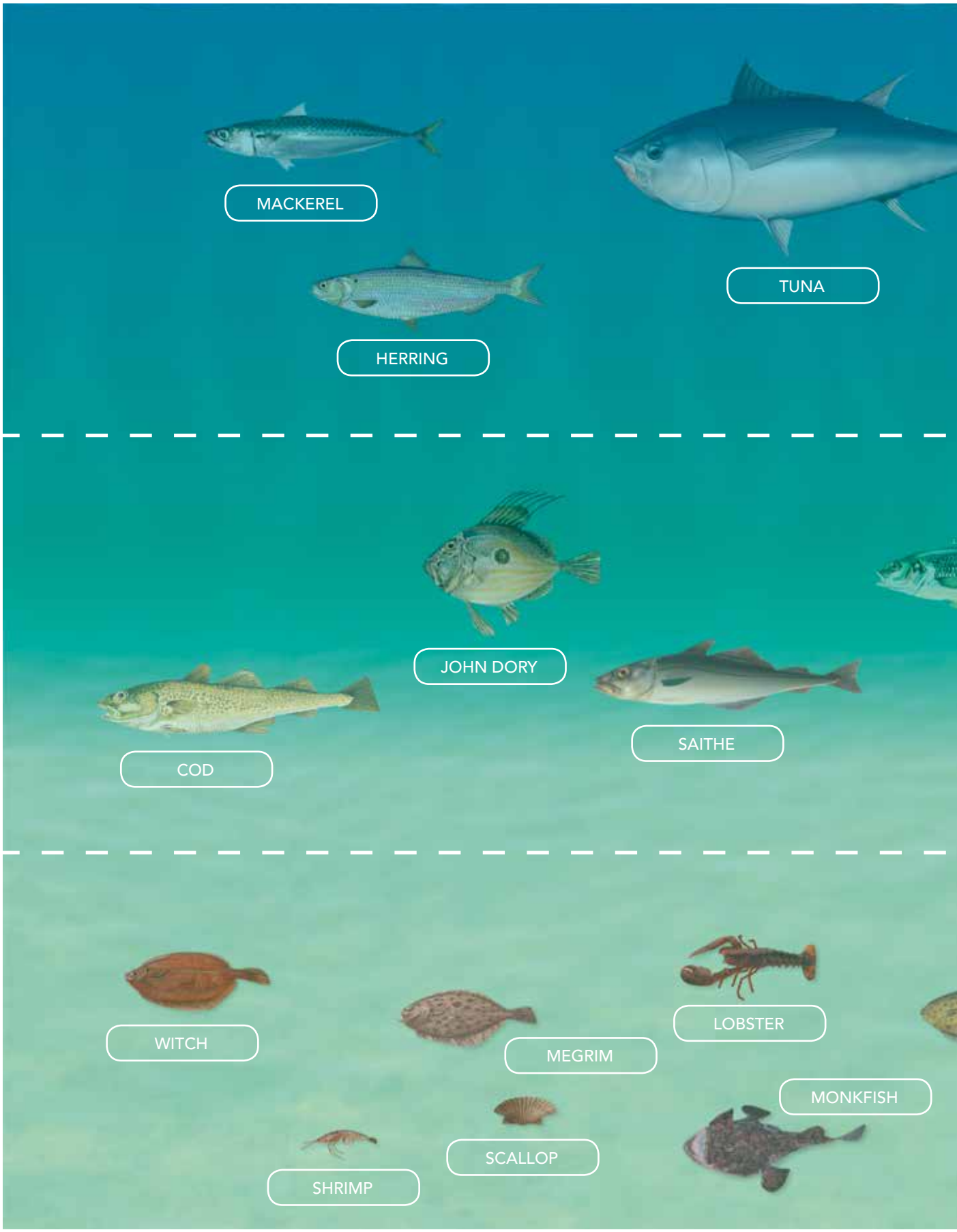
FIXED NETS OR FISH TRAPS.

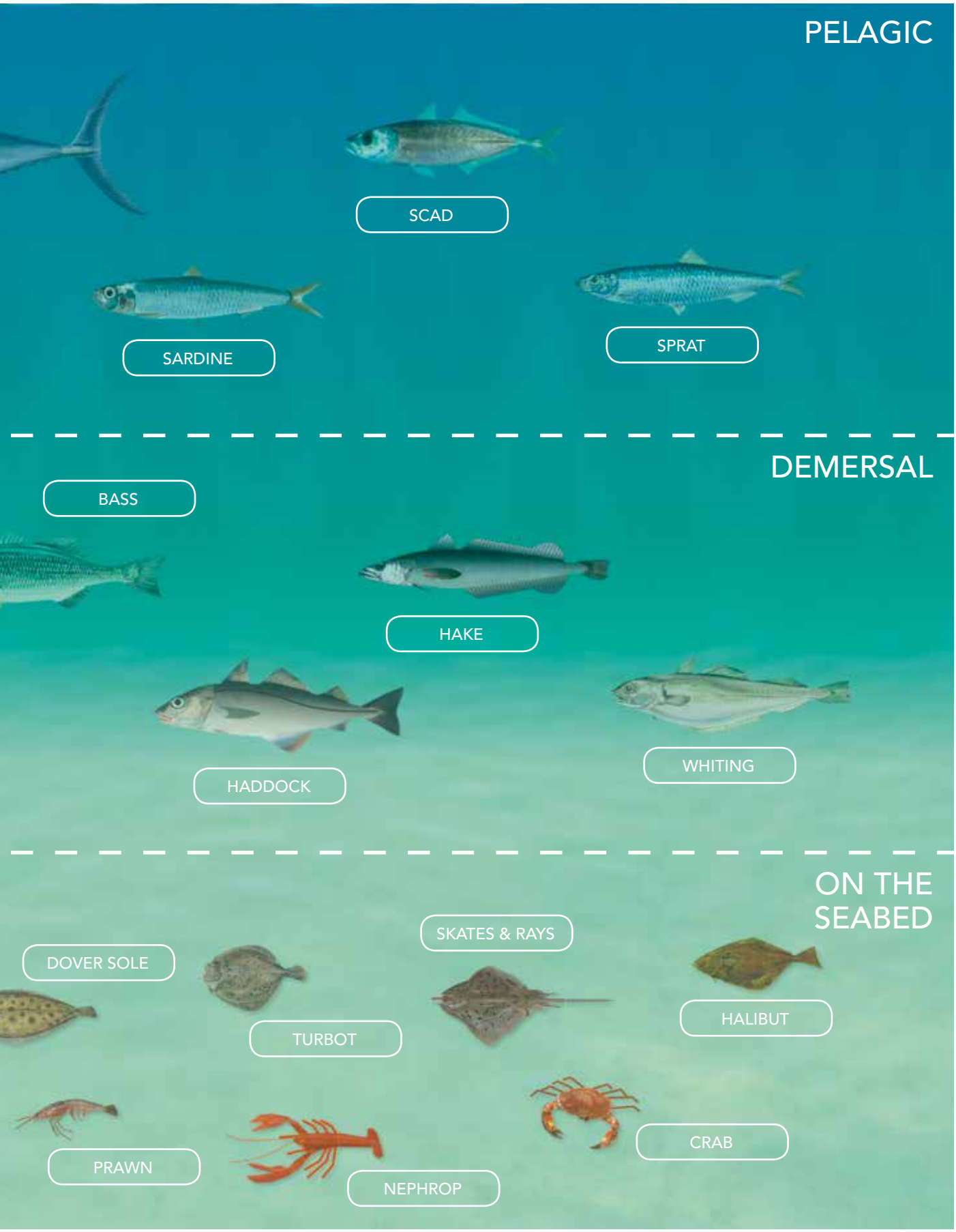
These are nets that are designed to be fixed to a beach or seabed to catch fish by guiding them into a trap section. They work on a similar principle to the entrances to other pots and traps, but on a larger scale. They are often used to capture fish as they migrate along a shoreline or up an estuary. Examples of these can be seen on some shorelines in Scotland targeting migrating salmon and sea trout. They have a long vertical wall of netting, often several hundred metres long, running at right angles to the shoreline that is intended to interrupt the natural swim of the fish along the coastline, and direct them along the netting away from the shore and into a series of traps. Just as in pots, these all have an easy entrance for the fish but a difficult exit, so the fish are retained until removed by the fisherman each day. There are two main types used in Scotland — 'bag nets' that are set in deeper water just offshore and fixed with anchors, and 'stake nets' that are set on stakes fixed into the beach; but both gears work on the same basic principle.
Fig 8.13 Stake net.

The other type of fish trap commonly used is a 'fyke net'. This is a cylinder of netting, sealed at one end, anywhere between 200mm to 750mm diameter and about 2 - 3 metres long, fitted with multiple cones inside the cylinder. These cones again resemble the entrances to shellfish traps in that they encourage easy entry but limit escape opportunity for the fish. The fyke net will usually have two long 'wings', one at each side, to direct fish into the cylinder and, hopefully, capture. Fyke nets are a favourite for targeting eels in some estuaries. They can be set out staked to the seabed at low tide, or shot from a small boat using small anchors to lay them out. Fig 8.14 Fyke nets.

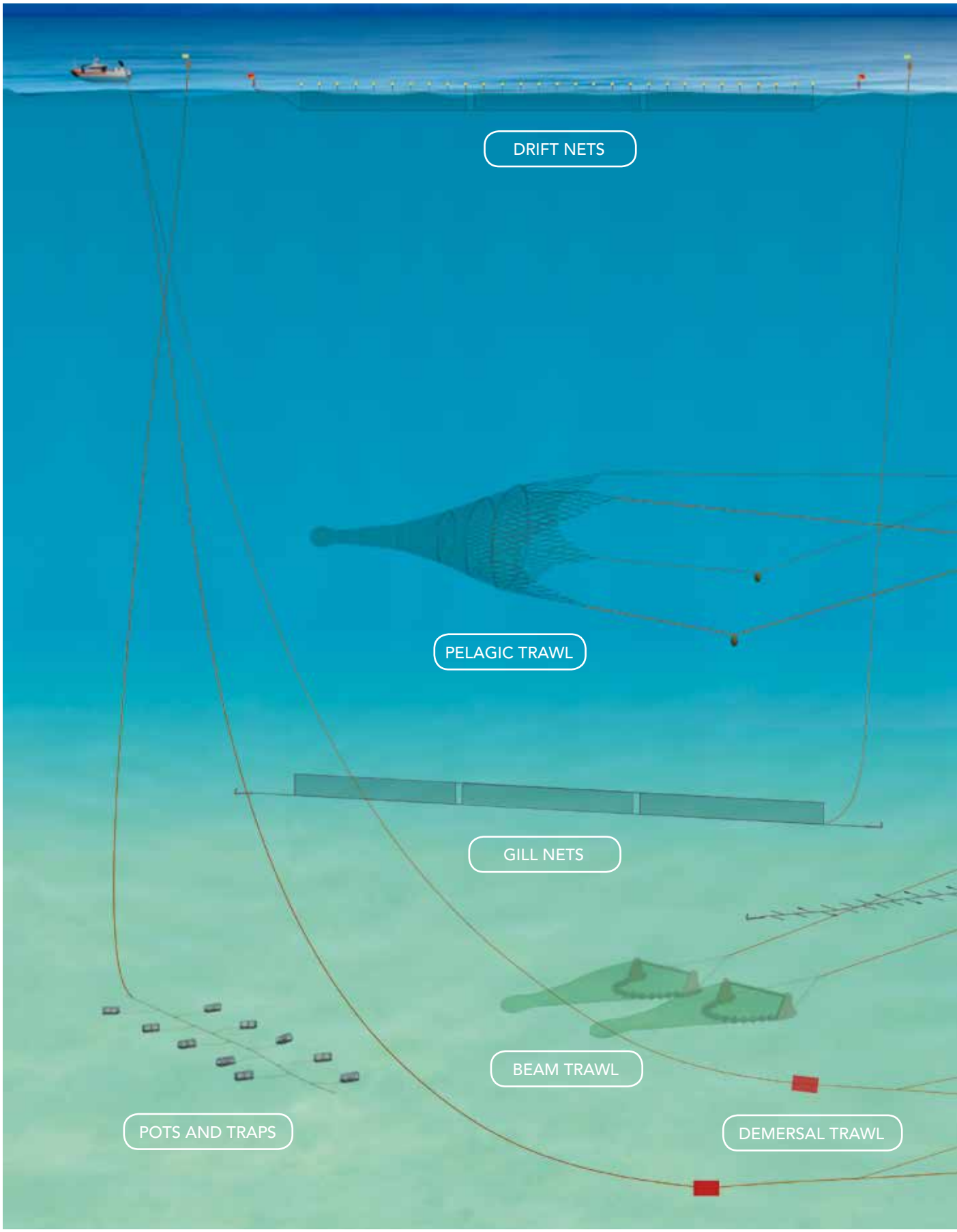
There are many different designs, styles and sizes of both fyke and stake nets used throughout the UK, and the rest of the world, to target a wide variety of fish species that swim in close proximity with the shore.

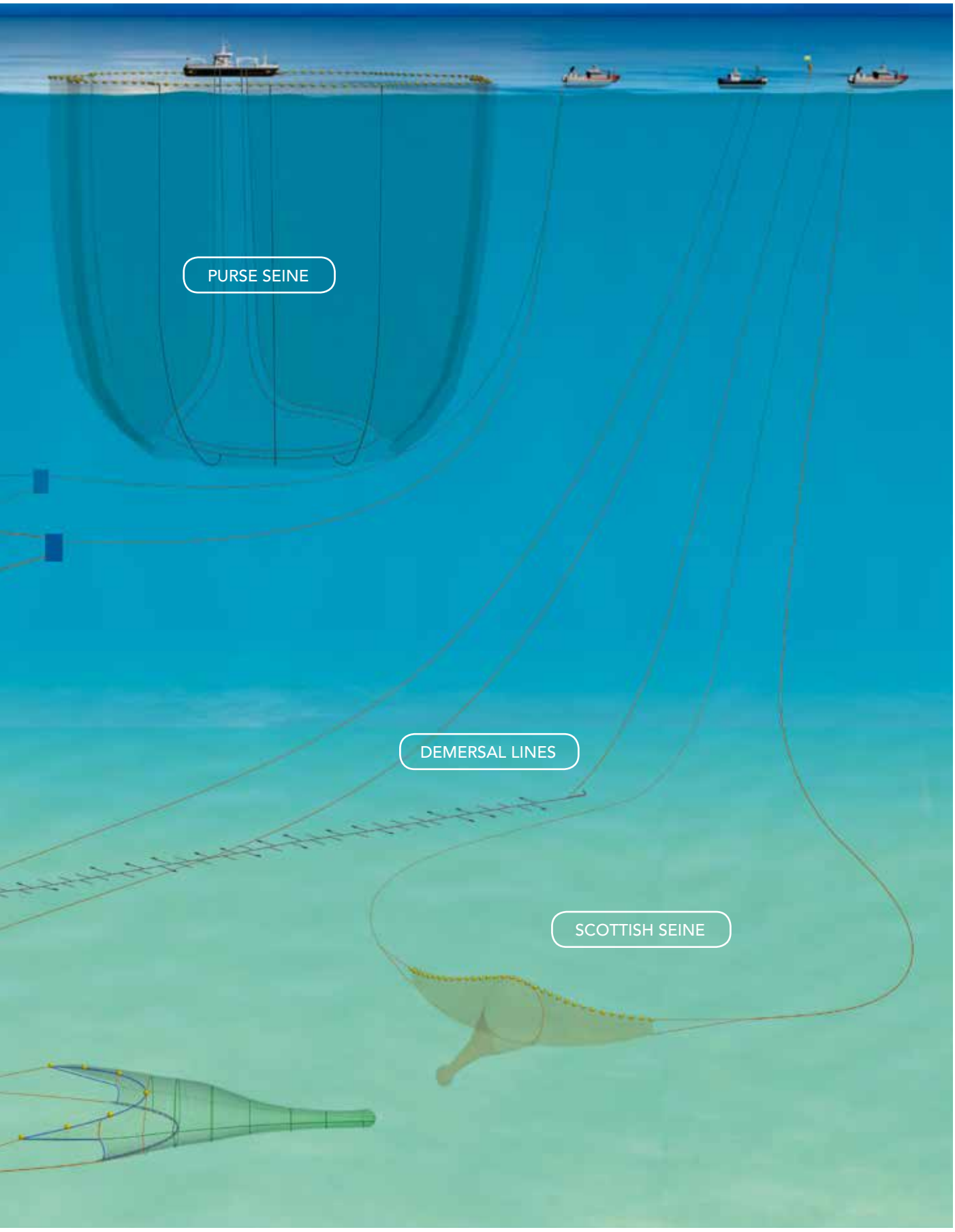
Fish species in the water column




PELAGIC
SCAD
SARDINE
SPRAT
DEMERSAL
BASS
HAKE
HADDOCK
WHITING
ON THE SEABED
SKATES & RAYS
DOVER SOLE
TURBOT
HALIBUT
CRAB
PRAWN
NEPHROP

Fishing gear in the water column




PURSE SEINE
DEMERSAL LINES
SCOTTISH SEINE

Anchor seining	Seine net fishing with the vessel at anchor to haul the gear.
Astern	Vessel going backwards.
Beach seine	An encircling fishing method operated from the shoreline.
Beam	Steel bar used to keep abeam trawl open.
Beam trawl	A towed fishing method using beam to hold the gear open.
Benthic panels	Panels fitted in the belly of a trawl, usually a beam trawl to release small seabed-living organisms.
Bights	Loops of rope, wire or chain.
Bobbins	Solid rubber wheels used as ground gear on some trawls.
Bosum	Centre section of a net.
Bottom trawl	Trawl towed along the seabed.
Brail	Large netting basket used for lifting fish.
Bridle angle	Angle of the bridles compared to the direction of towing (sweep angle).
Bridles	Wires connecting trawl doors to the net (sweeps).
Buoy	Float for marking the position of fishing gear.
By-catch	Anything caught that is not of the target species or target size.
Cast nets	A net that's thrown (cast) across the surface of the water to catch fish as it sinks down.
Chain bridle	Chains on the leading edge of a beam trawl for towing it by.
Chain mat	Network of chains to prevent stones entering the net. Usually used in beam trawls (stone mat).
Clean ground	Soft sand and muddy seabed's with no stones to damage the nets.
Clump weight	Chain weight used in multi-rig and pelagic trawling.
Cod end	End of a towed net where the catch collects.
Coil	Measure used for rope that is equal to 120 fathoms (220 metres).
Combination	Rope made by twisting fibre and wire strands together.
Commercial diving	Diving for profit rather than recreational.
Corkline	Rope along the top edge of a net to hold the floats. Usually refers to a purse net.
Creel hauler	Small winch for hauling ropes.

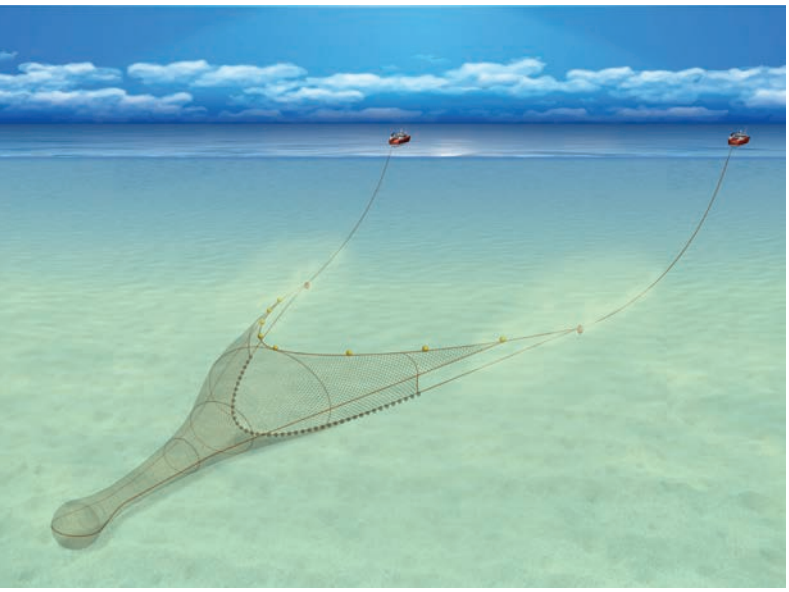
CSW	Chilled sea water.
D creel	A trap shaped like a letter 'D'.
Danish seine	Anchor seining.
Deck pound	Area on a vessel with built up sides for emptying the catch into.
Demersal fish	Fish living on or near the seabed.
Demersal gear	Fishing gear that is operated on or close to the seabed.
Dhan	Bouy with a flag on it.
Dredge	A rigid structure that is towed over the seabed to catch shellfish.
Drift net	A net (usually a gill net) that is allowed to drift with the tide to catch fish by them swimming into it.
Dublin Bay prawn	A Nephrop or langoustine.
Echo sounder	Electronic instrument that uses sound waves to measure the water depth below boat and can also be used to detect fish shoals below the boat.
Encircling gear	Fishing gear that forms a circle with nets or ropes to catch fish enclosed by the circle.
FAD	Fish aggregation device.
Fathom	Unit of length equal to six feet. Used by seafarers.
Fish pump	A pump used to transfer fish from the net onboard the vessel causing no damage to the fish.
Fish room	Area on a fishing vessel for storing the catch (fish hold).
Fishing line	Lower frame rope of a net (footrope, ground rope).
Fixed net	A net that is anchored to the seabed, or shore, to catch fish by them swimming into it.
Flip up ropes	Framework of ropes across the mouth of a net to prevent stones entering the net.
Floats	Plastic spheres attached to the headline of a net.
Fly dragging	Scottish seine netting (fly dragging).
Fly shooting	Scottish seine netting (fly shooting).
Frame ropes	Ropes to which sheets of netting are attached to form the shape of a net.
Fyke net	A conical shaped net with an entrance at one end.
Gill net	A sheet of thin netting, hung vertically in the water, to capture fish by enmeshing them, usually by their gills.

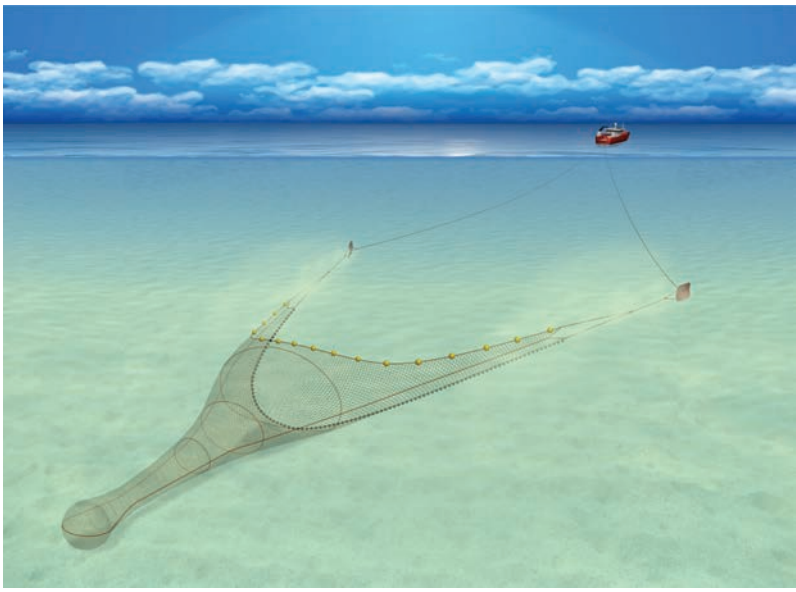
GPS plotters	Screens that accurately display the vessels position overlaid on a chart using information from the Global Positioning System.
Grass rope	Type of footrope used on trawls and seine nets to work the gear on soft seabeds.
Ground gear	Part of a net designed to be in contact with the seabed, to which the fishing line is attached.
Ground rope	General term for the lower frame rope of a net (fishing line, footrope).
Hand gathering	A method of collecting shellfish (usually cockles) by raking them from the beach.
Handline	A line, with hooks on, operated without machinery.
Hard ground	Seabed made up of stones and rock.
Harpoon	A spear used to catch fish.
Head rope	General term for the upper frame rope of a net (headline).
Headline	Term for upper frame of a net (head rope).
Hopper	Large 'box' on the deck of a boat for receiving the catch.
Jig	An artificial lure used to attract and catch fish.
Jigging machine	A mechanical device that operates a jig.
King scallop	The larger of the commonly caught scallops with shells in the region of 100mm across, targeted by dredges and hand-picked by diving.
Langoustine	A Dublin Bay prawn or Nephrop.
Lead line	Term for the lower frame rope of a net, usually refers to purse nets.
Lift net	A net that is hung in the water and lifted up towards the surface to catch the fish above it.
Mesh	One of the closed spaces bounded by twine in a piece of netting.
Mesh size	The distance between two opposite knots in the same mesh.
Mid-water	Between the seabed and surface (pelagic).
Mid-water pair trawl	A mid-water trawl towed between two vessels (pelagic pair trawl).
Mid-water trawl	Trawl that is towed somewhere between the seabed and surface, but not touching the seabed (pelagic trawl).
Mobile gear	Fishing gear that is moved through the water to catch fish and shellfish.
Multi-rig trawling	Towing more than one net behind one vessel.
Nephrop	A langoustine or Dublin Bay prawn.

Net drum	Large capacity winch for hauling nets.
Net stacking system	Combination of powered rollers and chutes for stowing the net on large purse seiners.
Open gear	A type of beam trawl without a chain mat.
Otter trawl	A trawl that is spread horizontally by otter boards (trawl doors).
Otter boards	Shearing device, two of which horizontally hold open the mouth of a trawl. (trawl doors, boards).
Outrigger boom	Booms on either side of a beam trawler to tow the nets from.
Pair seine	A net that is towed between two vessel using long lengths of rope or wire on the seabed.
Pair trawl	A trawl that is towed between two vessels.
Parlour creel	A lobster creel with an extra chamber in it.
Passive gear	Fishing gear that catches fish without any movement of the gear.
Pelagic fish	Fish living in mid-water.
Pelagic pair trawl	A mid-water trawl towed between two vessels.
Pelagic trawl	Trawl designed to catch pelagic fish.
Pelagic trawl	Trawl that is towed somewhere between the seabed and surface but not touching the seabed.
Pots	Types of traps.
Power block	Large rubber covered roller, powered by hydraulics, for hauling nets.
Prawns	Fisherman's slang for Nephrops (Norwegian lobsters).
Purse seine	A large net that catches fish by encircling a shoal with a wall of netting.
Queen scallop	The smaller of the commonly caught scallops, targeted using small trawls and dredges.
RSW	Refrigerated seawater tanks.
Recreational angling	Angling for recreation, rather than profit.
Ring net	Smaller version of a purse seine but without the running purse wire to close up the gear.
Rock hopper discs	Large rubber discs made from discarded tyres.
Rope reels	Reels used for storing seine net ropes on the deck of the vessel.
Round fish	Collective term for cod, haddock, whiting, etc.

Rubber discs	Discs, cut from old vehicle tyres, used for making ground gear of nets.
Sailing smacks	Early sail powered fishing vessels.
Sand clouds	Seabed disturbances created by trawl doors, sweeps, ground gear, etc. forming clouds of sand in the water.
Scallop	A type of shellfish that is targeted by dredge and by diving. (See queen scallop and king scallop.)
Scottish seine	An encircling fishing method using long ropes (fly dragging, fly shooting).
Seine ropes	Ropes made from hard abrasion resistant fibres with a strand of lead through it for seine net fishing.
Selectivity	How selective gear is at catching only the targeted species.
Semi pelagic trawl	A trawl that is towed very close to the seabed with either the trawl doors or the net in contact with the seabed.
Shelter decks	Lightweight cover over the deck of a fishing vessel to protect the fishermen from the weather.
Shoes	Steel frame used to support the beam on a beam trawl.
Side thrusters	Propellers within the hull of a boat to provide sideways motion.
Sonar	Electronic instrument that uses sound waves to locate and track fish shoals around the vessel.
Split-links	Specially designed chain links that are made so that they can be easily and quickly clipped together.
Static gear	Fishing gear that is set in the water to wait for fish to swim into it. In some static gear the fish are enticed into the gear using bait.
Stern ramp	Ramp set into the stern of a vessel for pulling heavy nets up.
Stern trawler	Trawler that handles its gear over the stern.
Sumwing	Hydro dynamically shaped beam trawl beam.
Sweep angle	Angle of sweep compared to the direction of towing (bridle angle).
Sweeps	Wires connecting trawl doors to the net (bridles).
T45	Diamond mesh turned through 45 degrees to make it into an open square shape.
T90	Diamond mesh that is turned through 90 degrees.
TAC	Total Allowable Catch.
Target species	Specific type of fish that gear is designed to catch.
Tickler chain	Chain towed ahead of the ground gear to disturb fish on the seabed.

Towed gear	Fishing gear that is dragged through the water to catch fish.
Trawl door	Otter boards.
Trawl rig	Term used to cover all the components in a trawl net rig. Doors, sweeps, bridles and net.
Vivier tanks	Tanks onboard shellfish boats to keep the catch alive.
Warp	Wire used for towing fishing gear.
Water separator	Container used for separating the water and fish in fish pumping systems.
Winch	Machine for hauling and storing trawl warp.
Wing ends	Ends of the net nearest to the boat.





Written by: Mike Montgomerie, Seafish
Edited by: Roger Forbes, Seafish

SEAFISH
the authority on seafood

Seafish 18 Logie Mill, Logie Green Road, Edinburgh EH7 4HS
T: +44 (0)131 558 3331 F: +44 (0)131 558 1442 E: seafish@seafish.co.uk

Seafish Origin Way, Europarc, Grimsby, N.E. Lincs DN37 9TZ
T: +44 (0)1472 252 300 F: +44 (0)1472 268 792 E: seafish@seafish.co.uk

© August 2015