F. Delanghe

IMPACT-II The effects of different types of fisheries on North Sea and Irish Sea benthic ecosystems

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Subproject 1b - Collection and analysis of data on bottom trawling gears

Final report

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H. Polet, W. Blom and F. Delanghe

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RSZV Rijksstation voor Zeevisserij, Oostende, Belgium

RIVO-DLO Rijksinstituut voor Visserij Onderzoek, IJmuiden, the Netherlands

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2. Materials and methods

2.A Size of bottom trawl fleet in the study area

2.A.1 Historical review of fishing fleets and gears

The review of fishing fleets and gears for the past century was based on a high amount of historical data found in a wide variety of historical sources, cited in the bibliography. In order to make this review a tool easy to use, most of the data were gathered in graphs and figures accompanied by explanatory text. No freezing/factory trawlers, and for the Netherlands no shellfish trawlers, were included in the review.

2.A.2 Size of the bottom trawl fleet in the study area - present situation

Data on fleet sizes and total landings were collected from the national databases for the year 1994 for the three participating countries in sub-project 1-B and, also, for England & Wales, Scotland and the main fishing ports on the east coast of Ireland. Each national fishing fleet was divided into sub-fleets based on engine power classes.

2.B Fishing gears used by different fishing fleets

In order to gather detailed information on vessels, fishing gears, netting and operational parameters an inquiry has been carried out. Most of the vessel characteristics were available in the national databases. *Basic* data on fishing gear and netting have been collected from fishing gear and netting manufacturers. *Detailed* information on vessels, gears, netting and operational parameters have been gathered by interviewing skippers and vessel owners in situ, i.e. the fishing vessel.

For the inquiry a wide range of information is collected but special attention is given to items which relate to the impact of fishing gears, like the weight of the gear and its components, numbers of tickler chains, dimensions of chainmats, factors affecting selectivity, operational parameters like towing speed and warp length / depth ratios etc.

The minimum set of vessel and gear data to be included in the inquiry, which was agreed upon in the early stages of the project, is shown in Table 1. Depending on specific local situations extra information could be added to this list.

These data led to a definition of a "typical fishing gear" for each sub-fleet.

2.C Distribution of fleet activities

In order to obtain an idea about the geographical distribution of the activities of the fishing fleet, landings and effort data were extracted from the official statistics in the national databases for each ICES statistical rectangle. These data have been divided according to the previously defined sub-fleets and fishing gears and have been plotted as dots on a North Sea map. This will give an idea about the geographical distribution of the disturbance of the sea floor by different bottom trawling activities.

3. Results

3.A Size of bottom trawl fleets in the study area

3.A.1 Historical review

3.A.1.1Fishing fleets

Before the introduction of steam vessels in 1884, the Belgian, German and Dutch fleet consisted only of rowing boats and sailing vessels. The smaller coastal vessels, usually not decked and with a flat keel, operated within a 10 miles range from the coast. The medium coastal vessels, with a keel length between 9 and 12 m operated in a range of 25 miles from the coast. The larger Belgian vessels, with a length over all of 16 to 18 m, operated from the English south-east coast up to the Dutch coast (Terschelling). In summertime they fished for cod on the Doggerbank, the Faeroes and even up to Iceland. Also for the other North Sea countries a wide spread of the effort for the larger vessels is reported for the end of the 19th century. By then fishing was carried out in the whole North Sea, the Dogger bank, the Great Fisher bank towards the coast of Norway, Iceland, the Barents Sea etc.

The numbers of sailing vessels (figures 3A.1 to 3A.4) reached a maximum between 1910 and 1920, with over 600 for Belgium and over 5000 (of which 500 trawlers) for the Netherlands. Also for Germany the numbers of sailing vessels reached a maximum in this period, but the data presented in the graph only include herring drifters. These so called herring luggers had a length between 22 and 28 m, a breadth between 5 and 6 m and a tonnage between 60 and 100 BRT. In figure 3A.2 the numbers of "trawling" sailing vessels are shown and include 10 % of the sailing fleet. Though numbers of sailing vessels were high, the effort exerted was low and mainly passive fishing methods were applied. These numbers decreased drastically after 1920 when the diesel engine appeared on fishing vessels. As for the tonnage, the Dutch vessels had an average BRT of 6.1 in 1910 decreasing to 3.5 in 1965 whereas the trawling sailing vessels had an average BRT of 31 in 1910 decreasing to 18 in 1940.

Starting from 1884 the first steaming vessels (figure 3A.1 to 3) were introduced in the Belgian, the Dutch and the German fishery. This new type of fishing vessel caused the first boost in effort that, together with the introduction of the otter trawl, probably produced a much higher disturbance of the seafloor compared with non-motorised boats. The steamtrawlers knew their highest success by the end of the 1920's. Thereafter their numbers decreased to almost zero after the Second World War. The steamtrawlers were not limited in their choice for fishing grounds and were less dependent on weather conditions. They fished in the southern and central North Sea, the English Channel, Rockall and Moray-Firth but most of the effort was concentrated on Iceland, West of Scotland, northern North Sea and the Bristol Channel.

The first vessels equipped with a diesel engine (figure 3A.1 to 5) were introduced about 1901. They had an increasing success and were, after the 50's the only type of vessel active in the sea-fishery. This motorisation caused a second drastic increase in effort. The fishing grounds, which were mainly fished with otter trawls, depended very much on the vessels' engine power but fishing was soon carried out through the whole of the North Sea. As with steamtrawlers, the otter trawl was the most popular gear.

In the early 60's the beam trawl was re-introduced in the Belgian, Dutch and German fishery. Where this gear used to be a light wooden construction, at that time still used by German shrimp trawlers, it was now replaced by a double rig heavy steel gear often equipped with tickler chains and later sometimes chainmats. Since it was soon clear that the catchability of this gear increased with the number of tickler chains and higher towing speed had no negative effect on the catches, there was a continuing trend for increasing engine powers (figure 3A.4 & 5). Consequently the smaller vessels in this fleet almost disappeared in favour of larger vessel with engine powers up to 4000 hp. The maximum engine power has been legally limited to 1200 hp for Belgium and 2000 hp for the Netherlands. The number of otter trawlers went gradually down in favour of beam trawlers.

Figures 3A.6 to 8 illustrate the progress of the total landings. These landings have been split up in flatfish, roundfish, pelagic and shellfish and prawn catches. It is clear that the most important group for both countries is the demersal fish. Pelagic fish used to be important for Belgium, but is almost absent in the landings since the 80's. For the Netherlands the pelagic landings remain fairly constant, but these are landed especially by large freezer trawlers (which are not included in the figures). Nephrops and shrimp only take a small percentage of the total landings but are quite constant for both countries over the years. For Belgium it is clear that the total landings show a continuous decline since the early 60's. For the Netherlands, on the other hand, there was a peak in 1985 but the picture before and after are not really different.

Figures 3A.9 & 10 show the trend for engine power and tonnage since the beginning of this century. The total engine power has been increasing constantly, except for the last years.

3.A.1.2Fishing gears

Four types of fishing vessels, each using one or more typical fishing gears, can be distinguished: sailing vessels, steam vessels, otter trawlers and beam trawlers. The evolution of numbers, engine power and tonnage are shown in figures 3A1 to 5 and figures 3A.9 & 10.

Due to its restricted towing force and its dependence on wind speed, sailing vessels were not able to apply heavy gears or gears needing hydrodynamic forces to open. Consequently, mainly stationary gear or light weight trawls were used in this fishery. Following types of fishing gears were used aboard sailing vessels:

- Beam trawls with a wooden beam with a length up to 10 m, iron beam trawl shoes, 90 cm high. Since these gears were towed by sailing vessels they were quite light. The target species were flatfish and roundfish like cod and whiting. Most of the vessels stopped using these trawls by the end of the 19th century.

- Stownets (figure 3A.11): the stownets usually had a length between 25 and 35 m. The length of the beam, which opened the net horizontally, was about 7 m long. The gear had a stationary position on the seabed during fishing operation and was attached to an anchor with a weight of over 70 kg. The target species were herring and sprat.

- Driftnets (figures 3A.12 & 13), with a total length of about 900 m, consisting of individual nets with a length of 36 m and a depth of 7 m. While fishing, these nets were attached to the vessel. The target species was herring and other pelagics.

- Otter trawls (figures 3A.14 & 15): The first otter trawls appeared by the end of the 19th century. At that time the otter boards were directly attached at the wings of the net. They were seldom used by sailing vessels.

The appearance of steam boats and, later, vessels equipped with diesel engines, made it possible to make a profitable use of the otter trawl. At first the otter boards were directly attached to the netwings but later long bridles and sweeps were inserted between boards and wings in order to increase the fishing circle and swept area. Also new methods of rigging the gear, new types of groundgear and new types of otter boards increased catchability and gave the fishery access to new fishing grounds. These developments came gradually and appeared at different times in different countries or regions. It is impossible to give dates when the otter trawl's catchability took a big step forward. Otter trawls can be constructed to fish pelagic but in the cutter fishery mainly the demersal otter trawl has been used. In the 70's the Danish pair trawl (figure 3A.16) became increasingly popular. Driftnets were only still used on the smaller vessel till the 1940's.

In 1959 the first modern beam trawl (figure 3A.17) was introduced. It was based on the same principle as the wooden beam trawls, but now they were much heavier, completely constructed of steel. Also the use of tickler chains and chainmat increased the weight of the gear and increased the fishing efficiency. Soon many vessels switched to the beam trawl fishery, first on a seasonal basis and later continuously, as well for shrimp as for flatfish. By the end of the 80's over 80 % of the Belgian and Dutch fishing vessels merely fished with beam trawls.

In the beginning of this century the numbers of vessels in the Belgian, Dutch and German fishery were very high. These were, however, non-motorised vessels, applying mainly passive gear or light weight beam trawls. The impact of these fisheries on the seafloor were probably quite low. With the introduction of the steam engine (end 19th century), and later the diesel engine (1920's), the fishery soon changed from mainly passive to mainly active fishing, applying mostly bottom otter trawls. This probably had consequences for the fish stocks and bottom fauna, especially when new types of rigging and groundgear increased the catchability and gave the fishery access to new fishing grounds. The introduction of the beam-trawl (1960's) was the start of a continuous increase of engine powers. Vessels sizes increased as well as the weight of the gears.

The obvious conclusion of this review would be that during the past century fishing methods developed to a gradual increase in catchability and that vessel development lead to a continuous increase of the input of energy into the fishery.

3.A.2 Size of the bottom trawl fleets in the study area - present situation

The numbers of vessels, total landings and an up-to-date vessel list are given in Table 2 & Table 3.

The first step in the preparation to the fleet inventory was the division of the fishing fleets into sub-fleets. This was necessary because of the wide range in vessel sizes in the fleets considered, with engine powers ranging from less than 100 hp up to 4000 hp (Table 2). It was decided to apply *engine power* classes. The two main reasons for this were:

- engine power is the basis for the vessel classes in the national databases and a lot of data needed in this project will have to be extracted from these databases and

- engine power can be considered as an important factor in the impact of the fishery on the environment.

Since the goal of the study is to define an average vessel and fishing gear for each sub-fleet the variation of vessel and gear parameters within each sub-fleet should be as small as possible. Consequently sub-fleets were chosen such as to get vessel groups with similar characteristics.

Following classes were defined: class 1 : 70-191 kW; class 2 : 192-221 kW; class 3 : 222-800 kW; class 4 : 801-1100 kW; class 5 : 1101-1500 kW; class 6 : >1500 kW.

Class 1 contains coastal beam trawlers targeting shrimp. Class 2 consists mainly of the so called eurocutters fishing with beam trawls for shrimp but mainly for flatfish. Class 3 is the only sub-fleet with some importance for otter trawling (Belgium) and pair trawling (Netherlands). The other vessels are older beam trawlers, often former otter trawlers adapted for beam trawling. Class 4 contains mainly beam trawlers and is important for Belgium since it contains the distinct 1200 hp group which is the maximum hp-limit in Belgium. Class 5 and 6 consist mainly of Dutch vessels which merely are modern beam trawlers.

For each subgroup the numbers of vessels have been extracted together with the landings for each participating country according to the gear they were caught with (Table 2). This was the basis for the choice of gears to be included in the inquiry.

The total number of Belgian, Dutch, German, Irish and UK fishing vessels active in the North Sea and the Irish Sea is 3425 (Table 2). England & Wales and Scotland account for 1238 and 1057 vessels respectively. These consist, however, mainly of vessels with low engine powers. The Netherlands, Germany, Belgium and Ireland account for 482, 367, 149 and 132 vessels respectively. About 2000 of the vessels have an engine power below 221 kW, 1000 have an engine power between 222 and 800 kW and the rest lie above 800 kW.

From the landings in Table 2 it is clear that beam trawling is the most important fishery in Belgium and the Netherlands. Demersal otter and pair trawling is only marginally important. Other types of fisheries like longlining and gillnetting are almost absent. For England & Wales otter trawling is the most significant fishing method in the three lower engine power classes. In these classes, the beam trawl has a comparable importance as the demersal pair trawl, the seine net, gillnets and longlines. In engine power class 1, dredging is the most important fishing method as for the landed catch weight. The vessels with engine powers above 800 kW operate mainly the beam trawl. For Scotland, the demersal otter and pair trawl are the most significant gears. The beam trawl only accounts for a very small percentage of the total Scottish landings. In Ireland otter trawling is the most important fishing method. The beam trawl is only operated on a small number of vessels.

3.B Fishing gears used by different fishing fleets

Following sub-fleets were selected to be included in the vessel and gear inventory. Each were given an appreciation of their relative importance as a fishery (xx: high importance, x: medium importance, o: small importance):

Engine power class (kw)	Fishing method	Belgium	Germany	Netherlands
70-191	shrimp beam trawling	xx	xx	xx
	flatfish beam trawling	x	x	x
192-221	shrimp beam trawling	xx	xx	xx
	flatfish beam trawling	xx	x	xx
	demersal otter trawling	x	o	x
222-800	flatfish beam trawling	xx	o	xx
	demersal otter trawling	x	x	x
801-1100	flatfish beam trawling	xx	o	xx
1101-1500	flatfish beam trawling	o	o	xx
>1500	flatfish beam trawling	o	o	xx

For each of the sub-groups an inquiry form was made up with questions on vessel characteristics, fishing gear characteristics and operational parameters. The base list of parameters that was agreed upon by the three participants is given in Table 1.

It is important to keep in mind that the data presented hereafter have been collected in the period 1994 - 1996 and can vary in time due to changing fishing opportunities, new technologies and all kind of economical factors.

3.B.1 Shrimp beam trawling

Figure 3B.1 shows the basic type of beam trawl. This is a demersal fishing gear and is used to target flatfish and shrimps. The net is kept open horizontally by means of a steel beam, which is supported at both sides by the beam trawl shoes. The construction of the net is rather simple and consists of a top and a lower panel and a cod-end where the catch accumulates. The top panel is attached to the headline, which is rigged to the beam trawl shoes. The lower panel is attached to the bobbin rope, which has to be rather heavy in order to maintain the bottom contact. Although the basic construction of the beam trawl is rather simple, this gear often shows typical alterations to adapt the gear for certain fishing operations. A fishing vessel equipped for beam trawling tows two gears simultaneously, one at each side, by means of two outrigger beams (figure 3A.17).

Shrimp (*Crangon crangon*) are caught along the coasts, in estuaries and in the "Wadden Sea", usually on sandy fishing grounds, by the smaller type beam trawlers. These vessels with engine powers below 221 kW are allowed to fish within the 12 miles zone with beam trawls, according to the EU-regulation no. 55/87, if each beam length is below 4.5 m.. Beams over 4.5 m long are also allowed for shrimp trawling if the vessel appears on a specific list published by the European Commission. According to EU-regulation 3554/90 these vessels

can also catch sole within the 12 miles zone with a beam length over 4.5 m if, in a 12-month's period, 50% of the landings consist of shrimp. Every year, the list with the vessels matching this condition is adapted based on the vessel's catch.

The gear is a lightweight beam trawl without tickler chains or chainmat. The legal minimum mesh size is 20 mm and a large mesh cod-end cover protects the cod-end.

In the North Sea, 22 Danish, 247 German, 228 Dutch, 36 Belgian and 98 UK vessels target shrimp continuously or on a seasonal basis.

3.B.1.1 Technical and operational details - 70-191 kW

Vessel (table 3): The average engine power of a vessel in the 70-191 kW sub-fleet is 151 kW (206 hp). The average length over all (LOA) and breadth is 17 m and 5.1 m respectively. The tonnage of the vessels is given in two units: BRT and GT. BRT is an older unit, measured at the inside of the vessel, and is smaller than GT which is measured at the outside of the vessel. GT is a unit agreed upon in the Convention of Geneva in 1969 (active in 1982) and all recent measurements are done in this unit. Consequently there are two groups of vessels, one with an average tonnage of 32 BRT and one of 39 GT. 80% of the vessels have a kort nozzle with an average propeller diameter of 1.3 m. A controllable pitch does not occur in the shrimper fleet in Belgium but in the Netherlands a series of 6 shrimp beam trawlers (built in 1981) have been equipped with a controllable pitch. A GPS-system and a videoplotter have become standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back up.

Operational parameters (Table 4): The towing speed relative to the bottom is 2.5 - 3 knots. Warp depth ratio is 2 to 2.5/1, depending on seafloor condition and depth. All vessels use single warps with a diameter between 16 and 20 mm. Since the gears used are rather light, and the optimal towing speed for catching shrimp with the type of fishing gear used lies around 2.5 knots, the engine powers installed in the vessels can be rather low. Consequently none of the vessels have secondary engines to deliver power for non-propulsion activities.

In Belgium, the fishery in this sub-fleet is usually carried out during night-time. The vessels mainly stay at sea for only 12 hours. In wintertime one trip can take up to 36 hours. In the Netherlands a trip mostly takes 36 hours except for Zeeland and South-Holland where day-trips are common. In Germany the shrimp fishery in this sub-fleet takes usually daytrips. The catchability of shrimp highly depends on the light intensity, with lower catchability with increasing light intensity. Consequently, day-fishing will only be successful if the visibility in the water is poor and during daytime fishermen will select fishing grounds on this characteristic. The shrimp fishery is a coastal and estuarine fishery often carried out close to the homeport. The fishing grounds usually are sandy and free of large obstacles like stones and boulders. In the North Sea this fishery is carried out in the UK, in the Wash and the Humber estuary and from the Belgian coast up to the Danish coast.

With an average speed of 2.75 knots and an average beam length of 7.65 m a typical fishing vessel of this fleet will fish a surface of 0.08 km² in 1 fishing hours. Knowing that about 15 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.07 km² in one fishing hour.

Catch handling (figure 3B.1): The cod-ends are emptied in a hopper, where a continuous waterflow leads the catch onto a conveyer belt. This belt ends in the shaking or rotating riddle where large shrimp are separated from small shrimp and by-catch and trash (In Belgium and the Netherlands mainly rotating riddle, in Germany 80% shaking and 20% rotating riddle). These three fractions are collected in baskets. Fish to be landed are picked out manually, in the hopper and/or at the end of the rotary sieve. By-catch and small shrimp are usually thrown overboard manually (surface disposal). Large shrimp are poured in the boiler. Shrimps for the local market are boiled in seawater, with the addition of salt. Shrimps to be processed in peeling factories are boiled in seawater without extra salt. After boiling the shrimp, which sometimes contain small fish, are manually scooped and put in a washing drum, which speeds up the cooling process and washes out the small fish. Shrimps are then filled in cooling trays, which are placed outboard of the vessel. After this the shrimp are stored in baskets or boxes, on the deck, until landed. In the Netherlands the shrimps are cooled in water and stored in plastic bags in the fishhold, on ice.

Fishing gear (Table 5): Two thirds of the shrimp beam trawls have a beam length of 8 meter. The other one third have a width of 7 meter. The vertical netopening is 0.5 to 0.65 m. The surface of the sole plate is on average 270 cm^2. All data on the dimensions of the gear are gathered in figure 3B.19. Average dimensions are given in mm and minima and maxima are given between brackets.

The average weight, in air, of the shoe, the beam and the bobbins are 200 kg, 260 kg and 300 kg respectively. The whole gear has an average weight, in air, of about 1.1 ton. On average, the Dutch shrimp beam trawls have a 200kg higher weight compared to the Belgian and the German fleet. Tickler chains are never used when targeting shrimp. The weight of the net in water is negligible. Due to the design, the net will usually not touch the seafloor while fishing, except for the cod-end when the catch accumulates.

It is important to keep in mind that the weights of the gears and the gearparts mentioned in this report are weighed above water. The weight on the bottom is quite smaller because of the upward pull in the warps, the upward force exerted by the hydrodynamic forces on the netting and the weight reduction of steel in water compared to air.

The length of the headline is mostly 20 cm shorter than the beam. Diameter of the headline is 16 mm. Headline material is PA, PE or "Atlas". The groundrope length depends on the length of the beam (Table 5). It's diameter is 14 or 16 mm and the material is mixed PE with steel wire. The bobbins consist of rubber cilinders, with a diameter of 18 to 22cm, which are mounted on rigid steel axes which allow the cilinders to roll. The net-design usually depends on the skipper and is quite standard for all vessels. Only two vessels use a net provided by the netting industry. Netting material usually is single braided PA, sometimes PP or PE. The cod-end usually is 200 meshes long and 200 on the circumference and made of 22 mm single braided PA. Numbers of meshes in the selvedge is 4 to 6. All nets are equipped with a large mesh cover, 50 meshes round and 50 meshes on the circumference, sometimes provided with chafers.

Many vessels use a sieve net for some period in the year to reduce by-catches. It is made of 50 to 70 mm PE. It leads to a reduction of the by-catch.

3.B.1.2 Technical and operational details - 191-221 kW

The fishing vessels in this fleet will usually not only target shrimp. They are so called multi-purpose vessels which will switch between shrimp beam trawling, flatfish beam trawling (see section 3.B.2.2.) and otter trawling (see section 3.B.3.1.) depending on the season, quota and catch opportunities. Time allocated to each of the fisheries is with the available data impossible to determine and is also very variable from vessel to vessel and year tot year. For the Belgian and Dutch vessels flatfish beam trawling can be considered as the main fishery, whereas for the German fleet shrimp beam trawling would be the main activity.

Vessel (Table 4): The average engine power of a shrimp trawler in the 192-221 kW sub-fleet (so-called eurocutters) is 215 kW (292 hp). The average LOA and breadth is 20.5 m and 5.5 m respectively. The tonnage of the vessels is given in two units: BRT and GT (see section 3.B.2.1.1.1). The average tonnage for this sub-fleet is 39.5 BRT and 66.5 GT. The average propeller diameter is 1.4 m. Also for these shrimp trawlers, controllable pitch does not occur. A GPS-system and a videoplotter are standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back-up.

Operational parameters (Table 4): In this fleet there are two distinct groups of trawlers: the more traditional shrimpers which carry out a comparable fishery to the previous group and the modern vessels which land shrimps for industrial processing. The latter fish at towing speeds relative to the bottom of 3 knots. Warp depth ratio is 2.5/1 to 3/1, depending on sea-floor condition and depth. All vessels use single warps with a diameter between 16 and 20 mm.

The fishery in this sub-fleet is usually carried out during nighttime for the traditional shrimpers. The vessels mainly stay at sea for only 12 to 18 hours, except in wintertime when a trip can last up to 50 hours. The modern shrimp trawlers, which have a refrigerated fish hold often stay at sea for a longer period, up to five days (Monday till Friday). This is a coastal and estuarine fishery. Due to the larger size of the vessels compared to the previous sub-fleet, the range of these vessels is quite larger. The fishing grounds usually are sandy and free of large obstacles like stones and boulders.

With an average speed of 2.7 knots and an average beam length of 7.9 m a typical fishing vessel of this fleet will fish a surface of 0.08 km^2 in 1 fishing hours. Knowing that about 15 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.067 km^2 in one fishing hour.

Catch handling (figure 3B.1): Catch handling is similar to the vessels in sub-fleet 70-191 kW, be it that the new technology is mainly installed on the larger and more recently built vessels. Contrary to the sub-fleet 70-191 kW, the by-catch is discarded through a tube which leads straight from the rotary sieve to an opening in the hull of the vessel which discards the trash sub-surface. The transfer of large shrimp from the rotary sieve to the boiler is, in a few cases, done by means of a tube that leads the shrimp. Scooping the shrimp out of the boiler and transfer to the cooling device is also automated. On the eurocutters the shrimps are stored on ice in plastic bags or boxes in a refrigerated fish hold. Fishing trips often take two up to five days.

Fishing gear (Table 5): The fishing gear for shrimps used in this sub-fleet is similar to the one used in the 70-191 kW sub-fleet.

3.B.2 Flatfish beam trawling

Flatfish beam trawlers usually are larger vessels with engine powers over 221 kW operating in the open sea (this is excluded the vessels with engine powers below 221 kW which are specialised to fish flatfish within the 12 miles zone and the plaice box). These vessels are not allowed to fish within the 12 miles zone. The length of the beams ranges from 4 to 12 m. Beamlengths over 12 m, and over 9.5m in the 12-miles-zone, are prohibited by law.

The gear (figure 3B.2) is a rather heavy beam trawl equipped with tickler chains to disturb the flatfishes from the seabed. The tickler chains are attached between the beam trawl shoes. Additional net-tickler chains often are included in the gear and are rigged to the groundrope. It is a main advantage of beam trawling that the number of tickler chains, and consequently the catching power, is only limited by the engine power of the vessel's main engine whereas the number of tickler chains that can be used in otter trawling is limited by the fishing method itself, because the drag exerted by the chains reduces the opening between the otter boards. In order to allow a large number of chains to be used the belly of the net is cut far backwards. These nets are called V-nets because of the shape of this cut. Its diameter (weight) and the bottom type mainly determine the resistance of a tickler chain during fishing operation. A heavy chain will penetrate too much in a soft bottom and will consequently increase the towing resistance to an unacceptable level. Accordingly, soft bottoms will demand gears with light chains and hard bottoms will permit heavy chains.

For operation on rough grounds beam trawls can be equipped with chain matrices (figure 3B.2). Chain matrices are rigged between the beam and the groundrope and prevent boulders from being caught by the net. The belly in this type of beam nets is cut less far backwards than in a V-net. Therefore chainmats are also called round nets (R-nets).

The largest vessels combine the chainmat configuration with some extra chains.

Both V-nets and R-nets may be equipped with so-called flip-up ropes to prevent large stones from entering the trawl.

Flatfish beam trawl nets are of the same construction as the shrimp nets, but they are made of heavier netting yarns and have bigger meshes. V-nets have much slack netting in the belly in order to permit a good bottom contact of the groundrope. The legal minimum mesh size for sole is 80 mm (in the North Sea below 54° N) and for plaice is 100 mm.

In Belgium the most important fishing gear is the chainmat beam trawl. Tickler chain gear is used as the main gear on a minority of the vessels. Many skippers will, however, use this gear as an alternative. In the Netherlands, the main fishing gear is the tickler chain beam trawl and two distinct beam trawler groups appear, the "gears west" and the "gears east". The gears west comprise the fishery in Zeeland, Zuid-Holland and IJmuiden. These gears are used mostly on hard sandy bottoms, west of 4°E and on grounds with small stones and sanddunes in the southern North Sea. The gears east comprise the vessels operating from the harbours north of Den Helder. These are operated on softer grounds, sometimes silty, east of 4° E. Flatfish beam trawling is of minor importance in Germany, compared to shrimp beam trawling.

3.B.2.1 Technical and operational details - 70-191 kW

For most of the vessels in this engine power class shrimping is the main fishing activity (see section 3.B.1.1.). Flatfish beam trawling is of minor importance in this engine power range and is carried out by some vessels, on a seasonal basis, e.g. in May-June when good sole-catch opportunities occur. Still, since catch opportunities are very variable, the fishing effort in the two types of fishery (shrimp or flatfish beam trawling) as well as the exact periods and time spans can change dramatically from year to year.

The details on vessels are comparable to the ones in the sub-fleet "shrimp beam trawling, 70 - 191 kW". The details on operational parameters and fishing gear are comparable to the next sub-fleet, be it that the fishing gear is of a lighter type.

3.B.2.2 Technical and operational details - 191-221 kW

Of the 55 Belgian vessels in this engine power class, 36 fish with chainmat beam trawls and 10 with tickler chain beam trawls. Most of the chainmat beam trawlers will, depending on the season and the quota, switch to tickler chain gear for shorter periods. Shrimp trawling can be a seasonal fishery for some of these vessels. The other 9 vessels are otter trawlers. Of the 129 Dutch vessels active in this fleet, over 30 will only target shrimp, 15 switch from shrimp beam trawling to flatfish beam trawling and otter trawling, 25 switch from shrimp beam trawling to flatfish beam trawling and Danish pair trawling, 30 use the flatfish beam trawl and the otter trawl and 25 only target flatfish with the beam trawl. For the flatfish beam trawls, a chainmat is only rigged to a minority of the fishing gears. Of the 75 German vessels active in this sub-fleet only 6 are otter trawlers. The others are shrimp beam trawlers that will seasonally switch to flatfish beam trawling.

Vessel (Table 4): The average engine power of a vessel in the 191-221 kW sub-fleet is 219 kW (297 hp). The average length and breadth is 23 m and 5.8 m respectively. The tonnage of the vessels is 67 BRT and 77 GT. 90% of the vessels have a kort nozzle with an average propeller diameter of 1.5 m. The most recently built 221kW vessels have a propeller of 2.5m. Note that the kort nozzle and the propeller diameter have an important influence on the pulling force of the vessel. A rule of thumb is that a kort nozzle increases the pulling force with 30% and that a 20% increase in propeller diameter gives an increase of 10% to the pulling force of the vessel. A controllable pitch does not occur in this fleet. A GPS-system and a videoplotter are standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back up. None of the vessels are equipped with an automatic warpload-measuring-safety-system. Looking at the age structure of this fleet, two separate groups appear: one half with an age of over 25 years and one half younger than 12 years. The same groups occur for the type of secondary engines on board. The older vessels have low powered (< 40 kW) secondary engines which are only used as a back-up in case of a breakdown of the main engine. The more recently built vessels have secondary engines of up to 150 kW engine power. These are used constantly for non-propulsion activities (like for electricity, hauling and veering...) in order to be able to use the power of the main engine solely for propulsion. This is important because these types of vessels have an upper limit of 221 kW for the main engine (EC-regulation no. 55/87).

Operational parameters (Table 4): The average towing speed relative to the bottom of a chainmat and a tickler chain beam trawler is 3.6 and 4.5 knots respectively. Warp depth ratio is 2.5 to 4/1. Dutch vessels using tickler chain gear will often use a depth/warplength ratio of

1/5 on harder bottoms. 60 % of the vessels use single warps with a diameter between 20 and 24 mm. The other 40 % use double warps with a diameter between 20 and 22 mm. The double warp system is used to reduce the tension in the warps and on the winches but has the disadvantage that veering and hauling time is longer.

The duration of a fishing trip in this sub-fleet is quite variable. Due to the size, these vessels are rather dependent on weather conditions. The distance to the fishing ground, and consequently the duration of one seatrip, also depends upon the season. A standard seatrip will take 3 to 7 days for Belgian vessels and 4 to 5 days for the Dutch vessels. The fishing grounds are often within the 12 miles zone. Rough grounds are fished with chainmat beam trawls but for grounds which are free from stones and boulders the tickler chain beam trawl is preferred.

With an average speed of 3.6 knots and an average beam length of 5.2 m a typical chainmat beam trawler of this fleet will fish a surface of 0.07 km² in 1 fishing hours. Knowing that about 10 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.063 km² in one fishing hour. The vessels fishing with tickler chains tow a less wide beam trawl (4.4 m) but at a higher speed (4.6 knots) and will fish a surface of 0.067 km² in one fishing hour.

Catch handling (3B.3): One third of the Belgian vessels and 90% of the Dutch vessels have a conveyor belt installed to handle the catch. In this case the cod-ends are emptied into a hopper, where a continuous waterflow leads the catch onto the conveyer belt. The marketable fish are sorted out on this belt and the discards are disposed immediately, through a tube, above or sub-surface (for the younger vessels). The other two thirds of the vessels empty the cod-ends on the deck of the vessel and pick out the fish manually. After sorting, the discards are shovelled over board or washed through the port-holes with water. It is obvious that the time that discards are on board of the vessel is substantially longer than with a conveyor belt. Many skippers made the remark that the quality of the marketable fish and the condition of the discards had improved since the installation of the belt.

Fishing gear (Table 5):

- Chainmat beam trawl (figures 3B.2 & 3):

The main parts of a chainmat beam trawl are the beam, the shoes, the chainmat, the bobbins and the net. Fishing operation will be such as to ensure a continuous bottom contact of the shoes, the bobbins and part of the chainmat (about 2/3's) in order to optimise the fishing efficiency. The rigging of the net is designed to minimise the bottom contact of the netting material and only the cod-end will touch the seafloor as catch accumulates. The weight of a typical 4m beam trawl is 1800 kg. The beam (inclusive bridles), the shoes, the bobbins and the chainmat weigh 300kg, 500kg, 170kg and 550kg respectively. The weight of a typical 8m beam trawl used by the eurocutters is 2200 kg. The beam (inclusive bridles), the shoes, the bobbins and the chainmat weigh 390kg, 600kg, 177kg and 570kg respectively. Notwithstanding the double size of this 8m beam trawl, the weight is only slightly higher compared to the 4m trawl. This is due to the use of lighter chains and larger quadrants in the chainmat and lighter material for the beam and the shoes. A 300hp vessel would not be able to tow an 8m beam trawl with a normal weight at the necessary towing speed.

In this sub-fleet, the beamlength of a chainmat beam trawl is 4, 4.5 or 8m with an average beam length of 5.1 m. The surface of the sole plate of the beam trawl shoe is on average 300

cm^2. The vertical netopening is 0.55 m. The length of the groundrope is 9.2m for a 4m beam and 12.5m for an 8m beam. The bobbins consist of rubber cylinders with a diameter of 25cm mounted on a steel wire. The chainmat consists of a flexible grid of chains, with a shackle diameter of 14mm or 18mm, with quadrants of 5 on 5 or 3 on 3 shackles respectively. The larger quadrants and lighter chains are used to construct a light chainmat and thus a lighter fishing gear. This has the advantage that with the same engine power, a wider beam can be used and that fishing can be carried out on softer grounds. A flip-up rope, rigged to reduce the amount of boulders entering the net, is of minor importance in this sub-fleet.

The mesh size in the net is 120mm throughout the net, made of single braided PE and on half of the vessels double braided in the belly of the net. The cod-end mesh size in the North Sea is legally set at 80mm for sole fishery and 100mm for plaice fishery. The netting material usually is double braided PE. One quarter of the Belgian and almost all Dutch vessels use a cod-end cover.

- Tickler chain beam trawl (figures 3B.2 & 3):

The weight of the beam, the shoes, the groundrope and the tickler chains is 350, 510 kg, 200kg and 370kg respectively. The whole gear weighs on average 1500 kg. This weight is lower than the weight of the chainmat beam trawls used in this sub-fleet. This is why the towing speed with tickler chain gear is higher. The weight of a typical Dutch tickler chain beam trawl is 1200kg for the beam + shoes and 350 to 600kg for the tickler chains.

In this sub-fleet, the beamlength of a tickler chain beam trawl is 4 or 6m with an average beam length of 4.5 m. The surface of the sole plate of the beam trawl shoe is on average 260 cm^2. The vertical netopening is 0.53 m. The length of the groundrope is 10.5m for a circular shaped groundrope and 17m for a V-shaped groundrope. The deeper cutting in the belly of the net to obtain the V-shape is used to be able to insert a larger amount of tickler chains, which enlarge the fishing efficiency of the trawl. The groundrope consists of bare chain (diameter 18 mm) with a central rubber roller, ± 4m long, made of rubber discs with a diameter between 200 and 300 mm. The gear is rigged with 4 to 7 tickler chains and 4 to 7 net-tickler chains. The diameter of the tickler chains is on average 16mm. For the net tickler chains the diameter usually increases from 10mm for the longest chain to 14mm for the shortest one. A flip-up rope is of minor importance in this sub-fleet.

The mesh size in the net is 120mm throughout the net, made of single braided PE or single braided PA. The cod-end mesh size is 80mm (sole) or 100mm (plaice). The cod-end netting material usually is double braided PE. Ten percent of the vessels use a cod-end cover.

3.B.2.3Technical and operational details - 222-800 kW

This sub-fleet contains in Belgium 37 vessels, of which 5 otter trawlers. The other 32 are beam trawlers operating the chainmat beam trawl as the main gear. About 30% of these beam trawlers operate the tickler chain beam trawl as an alternative, depending on the season and the quota. For the Netherlands, 24 of the vessels in this engine power class operate the tickler chain beam trawl for one quarter of their total effort. The average age of these vessels is over 20 years and their number is decreasing (from 40 in 1991 to 24 in 1994). The main fishery for this fleet is Danish pair trawling which is carried out north of Hoek van Holland. The German vessels in this engine power class do not operate the beam trawl.

Vessel (Table 4): The average engine power of a vessel in the 222-800 kW sub-fleet is 588 kW (799 hp). The average length and breadth is 32 m and 7.5 m respectively. The tonnage of the vessels is 147 BRT and 221 GT. 80% of the Belgian vessels have a kort nozzle with an average propeller diameter of 2.4 m. The Dutch trawlers are mainly older vessels without kort nozzle. A controllable pitch does not occur in this fleet. A GPS-system and a videoplotter are standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back up. About $1/5^{th}$ of the vessels are equipped with an automatic warpload measuring safety system. Some of the older vessels have low powered (< 40 kW) secondary engines which are only used as a back up in case of a breakdown of the main engine. But the majority have secondary engines of up to 250 kW engine power. These are used for non-propulsion activities in order to be able to use the power of the main engine solely for propulsion.

Operational parameters (Table 4): The average towing speed relative to the bottom is 4.1 knots. Warp depth ratio is 3/1 if the vessel is towing a chainmat gear and 4.5/1 for tickler chain gear. 65 % of the Belgian vessels use single warps with a diameter of 32mm. The other 35 % use double warps with a diameter of 28mm. In the Netherlands single warps have a diameter of 28mm and double warps have a diameter of 20mm.

The duration of a fishing trip will be between 5 and 12 days. All fishing grounds within the North Sea are within the range of these vessels. Rough grounds are fished with chainmat beam trawls but for grounds that are free from stones and boulders, the tickler chain beam trawl is preferred.

With an average speed of 4.1 knots and an average beam length of 9.6m a typical chainmat beam trawler of this fleet will fish a surface of 0.15 km^2 in 1 fishing hours. Knowing that about 10 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.13 km^2 in one fishing hour. In the same fleet, occasionally, also tickler chain gear is used. In this case the beamlength is larger, 11m, and towing speed 4.1 knots. The surface fished in one fishing hour is 0.15 km^2.

Catch handling (figure 3B.4): About 90% of the vessels have a conveyor belt installed to handle the catch. In this case the cod-ends are emptied into a hopper, where a continuous waterflow leads the catch onto the conveyer belt. The marketable fish are sorted out on this belt and the discards are disposed immediately, through a tube, sub-surface. On board of the other vessels the cod-ends are emptied on the deck of the vessel and fish is picked out manually. After sorting, the discards are shovelled over board or washed through the port-holes with water.

Fishing gear (Table 5):

- Chainmat beam trawl (figure 3B.2 & 4):

The weight of a typical 9m beam trawl is 3900kg. The beam (inclusive bridles), the shoes, the bobbins and the chainmat weigh 810kg, 490kg, 350kg and 1450kg respectively. The weight of a typical 10.5m beam trawl is 5000kg. The beam (inclusive bridles), the shoes, the bobbins and the chainmat weigh 930kg, 800kg, 360kg and 2210kg respectively.

In this sub-fleet, the average beam length of a chainmat beam trawl is 9.6m. In the Netherlands the western fleet operates 8.5m and the eastern fleet 10m beams. The surface of the sole

plate of the beam trawl shoe is on average 360 cm². The vertical netopening is 0.58 m. The length of the groundrope is on average 16m. The bobbins consist of rubber cylinders with a diameter of 25cm mounted on a steel wire. The chainmat consists of a flexible grid of chains with a shackle diameter of 18mm and with quadrants of 5 on 3 shackles. A flip-up rope is used on 70% of the vessels.

The mesh size in the net is 120mm throughout the net, made of single braided PE in the top panel and double braided PE in the belly of the net. Occasionally netting material with a mesh size of 150mm is used if sole is not the target species. The cod-end mesh size in the North Sea is 80mm for sole and 100mm for plaice. The cod-end netting material is double braided PE. Almost half of the Belgian and all Dutch vessels use a cod-end cover.

- Tickler chain beam trawl (figure 3B.2 & 4):

The weight of the beam, the shoes, the groundrope and the tickler chains is 1600, 1270 kg, 500kg and 1000kg respectively. The whole gear weighs on average 4800 kg.

In this sub-fleet, the beamlength of a tickler chain beam trawl is 11m. The surface of the sole plate of the beam trawl shoe is on average 530 cm². This surface is rather high compared to the chainmat beam trawl in this same sub-fleet. The reason is that tickler chain gear is often used on softer grounds and a larger sole plat will prevent the gear from digging in the sea-floor. The vertical netopening is 0.53 m. The length of the groundrope is 28m. The groun-drope consists of bare chain (diameter 22 mm) with a central rubber roller, ± 6m long, made of rubber discs with a diameter between 230 and 300 mm. The gear is rigged with 7 tickler chains and 6 to 10 net-tickler chains. The shackle diameter of the tickler chains is 18mm. For the net tickler chains the diameter usually increases from 11 for the longest chain to 22 for the shortest one. None of the vessels use a flip-up rope.

The mesh size in the net is 120mm throughout the net, made of single braided PA in the top panel and double braided PA in the belly of the net. The cod-end mesh size is 80mm (sole) or 100mm (plaice). The cod-end netting material is double braided PA. Thirty percent of the vessels use a cod-end cover.

3.B.2.4Technical and operational details - 801-1100 kW

This sub-fleet contains in Belgium 32 vessels, all beam trawlers. 5 of these vessels use the tickler chain beam trawl continuously and 27 operate the chainmat beam trawl. Of these 27 vessels, 22 use the chainmat continuously and 5 also operate the tickler chain beam trawl as an alternative depending on the season and the quota. In the Netherlands 25 tickler chain and 1 chainmat beam trawlers are active in this engine power class, of which 7 in the western fleet. In Germany 2 tickler chain beam trawlers are active in this fleet.

Vessel (Table 4): The average engine power of a vessel in the 801-1100 kW sub-fleet is 884 kW (1203 hp). The average length and breadth is 36 m and 8 m respectively. The tonnage of the vessels is 307GT. All vessels have a kort nozzle with an average propeller diameter of 2.6m. A controllable pitch was installed on 10% of this sub-fleet. A GPS-system and a video-plotter are standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back-up. About 1/4th of the Bel-gian and none of the Dutch vessels are equipped with an automatic warpload measuring safety system. All vessels have secondary engines installed with engine power of up to 250

kW. These are used for non-propulsion activities in order to be able to use the power of the main engine solely for propulsion.

Operational parameters (Table 4): The average towing speed relative to the bottom is 4.5 knots with chainmat gears and 6 knots with tickler chain gears. Warp depth ratio is 3/1 if the vessel is towing a chainmat gear and 4.5/1 for tickler chain gear. 30 % of the vessels use single warps with a diameter of 32mm. The other 70 % use double warps with a diameter of 28mm.

The duration of a fishing trip lies between 7 and 18 days in the Belgian and 4 to 5 days in the Dutch fleet. The operational range of these vessels is very large and often fishing grounds outside of the North Sea are visited (Irish Sea, Bay of Biscay...). Rough grounds are fished with chainmat beam trawls but for grounds that are free from stones and boulders the tickler chain beam trawl is preferred.

With an average speed of 4.5 knots and an average beam length of 10.6m a typical chainmat beam trawler of this fleet will fish a surface of 0.18 km^2 in 1 fishing hours. Knowing that about 10 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.16 km^2 in one fishing hour. In the same fleet also tickler chain gear is used. In this case the beamlength is larger, 11.4m, and towing speed 6 knots. The surface fished in one fishing hour is 0.23 km^2.

Catch handling (figure 3B.4): All vessels have a conveyor belt installed to handle the catch. The cod-ends are emptied into a hopper, where a continuous waterflow leads the catch onto the conveyer belt. The marketable fish are sorted out on this belt and the discards are disposed immediately, through a tube, sub-surface.

Fishing gear (Table 5):

- Chainmat beam trawl (figure 3B.2 & 4):

The weight of a typical 11m beam trawl is 5600 kg. The beam (inclusive bridles), the shoes, the bobbins and the chainmat weigh 1100kg, 900kg, 430kg and 2000kg respectively.

In this sub-fleet, the average beamlength of a chainmat beam trawl is 10.6m. The surface of the sole plate of the beam trawl shoe is on average 475 cm^2.The vertical netopening is 0.61 m. The length of the groundrope is on average 18.5m. The bobbins consist of rubber cylinders with a diameter of 25cm mounted on a steel wire. The chainmat consists of a flexible grid of chains, with a shackle diameter of 18mm, with quadrants of 5 on 3 shackles. A flip-up rope is used on 90% of the vessels.

The mesh size in the net is 120mm throughout the net, made of single braided PE in the top panel and double braided PE in the belly of the net. Occasionally netting material with a mesh size of 150mm is used if sole is not the target species. The cod-end mesh size in the North Sea is 80mm for sole and 100mm for plaice. The cod-end netting material is double braided PE. Almost half of the vessels use a cod-end cover.

- Tickler chain beam trawl (figure 3B.2 & 4):

The weight of the beam, the shoes, the groundrope and the tickler chains is 1850, 1600 kg, 600kg and 1150kg respectively. The whole gear weighs on average 6000 kg.

In this sub-fleet, the beamlength of a tickler chain beam trawl is 11.4m. The surface of the sole plate of the beam trawl shoe is on average 635 cm^2. Again, this surface is rather high compared to the chainmat beam trawl in this same sub-fleet. The reason is that tickler chain gear is often used on softer grounds and a larger sole plat will prevent the gear from digging in the seafloor. The vertical netopening is 0.43 m. The length of the groundrope is 32m. The groundrope consists of bare chain (diameter 22 mm) with a central rubber roller, ± 6.5m long, made of rubber discs with a diameter between 320 and 400 mm. The gear is rigged with 7 tickler chains and 11 net-tickler chains. The shackle diameter of the tickler chains is 18mm. For the net tickler chains the diameter usually increases from 10 for the longest chain to 22 for the shortest one. About $1/5^{th}$ of the vessels use a flip-up rope.

The mesh size in the net is 120mm throughout the net, made of single braided PA in the top panel and single or double braided PA in the belly of the net. A minority of the nets is made of polypropylene (PP) or PE. The cod-end mesh size is 80mm (sole) or 100mm (plaice). The cod-end netting material is double braided PE. Twenty percent of the Belgian and all Dutch vessels use a cod-end cover.

3.B.2.5Technical and operational details - >1101kW

This sub-fleet is only of importance for the Netherlands with a total of 174 vessels. Beam trawlers with engine powers above 1100kW do not occur in Belgium and in Germany only one such vessel is active. In the Netherlands, new building during the last 15 years has been divided between the so-called eurocutters (engine power < 221kW) for fishing within the 12-miles-zone and large high powered vessels (> 1400kW). Only a few vessels with were built with engine power between 221 and 1400kW. The design of the larger vessels does not differ strongly from the smaller ones, as described in the previous chapters.

Vessel (Table 4): The vessels are 40-45m long and 8.8-10m wide. All vessels have a kort nozzle of which some have a controllable pitch. About one third of the vessels are equipped with an automatic warpload-measuring-safety-system. In the 1101-1800kW engine power class, 70 vessels are active in the Dutch eastern fishery and 33 in the western fishery. In the engine power class >1500kW 44 vessels are active in the eastern and 27 in the western fishery.

Operational parameters: The warps are usually double but for vessels with an engine power above 1470kW a triple warp system is used (diameter 28 to 32mm) because of the high tensions in the warps. Towing speed is 6 to 7 knots. Usually one fishing trip takes 4 to 5 days and sometimes (5 to 10% of the trips) 11 to 12 days.

Catch handling: All vessels have a conveyor belt installed to handle the catch. The cod-ends are emptied into a hopper, where a continuous waterflow leads the catch onto the conveyer belt. The marketable fish are sorted out on this belt and the discards are disposed immediately, through a tube, sub-surface.

Fishing gear (figure 3B.2 & 4): About 15 vessels operate the chainmat beam trawl, all others use tickler chain beam trawls. The chainmat beam trawls usually are of the type where the chainmat is rigged in combination with tickler chains. These gears have a somewhat higher weight compared to the tickler chain gear. The tickler chain beam trawls used in the eastern Dutch fishery are rigged with lighter chains (but equal or higher in number) compared to the ones in the western Dutch fleet. The maximum beam length is 12m since 1989. A conse-

quence of this is that the towing speed is about 0.5knots higher compared to before 1989. All vessels use a cod-end cover.

For the 1101-1500kW engine power class, the weight of the beam+shoes and the groundrope is 3800kg and 700kg respectively. The tickler chains weigh 2000kg for the "gears-west" and 3000kg for "gears-east". The total weight of the gear is on average 6500kg. A chainmat beam trawl in this fleet weighs about 7000kg. For the >1500kW engine power class, the weight of the beam+shoes and the groundrope is 4500kg and 950kg respectively. The tickler chains weigh 2500kg for the "gears-west" and 5000kg for "gears-east". The total weight of the gear is on average 8000kg for the "gears east" and 11.000 to 12.000kg for the "gears west". A chainmat beam trawl in this fleet weighs about 7000kg.

3.B.3 Demersal otter trawling

The most developed method for keeping towed trawls open horizontally is the use of otter boards. These are large boards of steel or wood and iron, weighted on their base by a protective iron shoe, designed for a firm contact with the bottom, and fitted with brackets, or becketts, to which is attached the Kelly's eye assembly. The otter board is designed to be towed over the bottom at such an angle that the pair of doors constantly try to "swim away" from each other, thus spreading the wings of the net and holding the trawl mouth open. The contact of the otter board with the bottom and the water turbulence behind the board can generate a sand cloud which, together with the noise, leads to a herding effect for the fish. At the trawl mouth the groundrope assures good contact with the bottom and the square prevent fish from escaping.

Otter trawls used in the North and Irish Sea exist in a wide variety and mainly have *Nephrops* and roundfish like cod, haddock and whiting as target species.

3.B.3.1 Technical and operational details - 191-221 kW

The main target species in the Belgian fishery for this sub-fleet, which comprises 9 vessels, is *Nephrops*. Skippers may, however, decide to switch to roundfish trawling in certain periods of the year or even during some part of a seatrip because of good catch opportunities or low *Nephrops* catches. In the Netherlands otter trawlers exert only 1 to 2% of the fishing effort in this sub-fleet. Also in Germany this fishery is of minor importance with a total of 8 vessels operating otter trawls.

The typical net in the Irish Sea *Nephrops* fishery is a 25-fathom single trawl. Many boats also use a twin trawl arrangement. The mesh size used with twin trawls is similar to that used by single trawls, but the net size of each trawl is somewhat smaller c. 18-20 fathoms. All trawlers operating in the Irish Sea since 1 January 1994 must include a square mesh escape panel in the net.

Vessel (Table 4): The average engine power of a vessel in the 191-221 kW otter trawler subfleet is 221 kW (300 hp). The average length and breadth is 24.8 m and 6.1 m respectively. The tonnage of the vessels is 78 BRT and 94 GT. None of the vessels have a kort nozzle. The average propeller diameter is 1.9 m. A controllable pitch does not occur in this fleet. A GPS-system and a videoplotter have become standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back up.

Operational parameters (Table 4): The towing speed relative to the bottom is 3.5 knots. While the towing speed in beam trawling has no important effect on the dimensions of the fishing gear, in otter trawling it is one of the main factors influencing the vertical and horizontal opening of the trawl. Each gear has an optimum speed in relation to the dimension envisaged by the fishermen. Only low powered secondary engines are installed on board of these otter trawlers. Warp depth ratio is 3/1. All vessels use single warps with a diameter between 18 and 24 mm. The duration of a fishing trip is very variable and can vary between a few days and 2 weeks.

With an average speed of 3.5 knots and an average horizontal opening between the otter boards of 18m, a typical fishing vessel of this fleet will fish a surface of 0.12 km² in 1 fishing hours. Knowing that about 15 % of the fishing time is used for hauling and setting the gear, this vessel will, in practice, fish a surface of 0.1 km² in one fishing hour.

Catch handling (figure 3B.5): After emptying the cod-end in a box on the deck of the vessel the catch is being sorted. The catch is shovelled on a sorting table and hand-sorted by the crew. While sorting the catch it is graded in *Nephrops* to be landed whole, *Nephrops* to be tailed and fish. The discards are collected in baskets and then returned to the sea or washed overboard by a constant flow of water from a hose laying on the deck. None of the Belgian otter trawlers are equipped with a conveyer belt to process the catch.

Fishing gear (Table 5 & figure 3B.5): The fishing gear used in this sub-fleet is the otter trawl. Some attempts have been made to introduce twin and triple gears but the traditional two-panel single otter trawl is still the standard. The gear described hereafter is the single otter *Nephrops* otter trawl.

The *Nephrops* trawl is a traditional two-panel bottom trawl. The otter boards used are wooden rectangular boards with a weight of 340kg, 2.2m long and 1.2m high. The vertical netopening is 1m. The horizontal opening between the otter boards lies between 15 and 20m. The headline length is 28m and consists of mixed rope. The groundrope is 35m long. The central part of the groundrope (± 20m) consists of wire rounded with netting and rope. The rest, together with the lower bridle is made of chain. The upper bridle consists of wire or mixed rope. Both bridles usually have a length of about 6m.

The netting material of the net is always PE with a mesh size of 100mm throughout the net. The cod-end is made of double braided PE or single braided PA.

The *Nephrops* trawl used in the Irish Sea single or twin arrangements. For the twin gears, a two- or a three-winch arrangement is possible. The former is used mainly on smaller vessels and the latter is typical for larger vessels. The mesh size throughout the net is 70mm. In order to reduce by-catches, mainly whiting and haddock, in the *Nephrops* fishery all net are provided with a square mesh escape panel in the top panel, just in front of the cod-end.

3.B.3.2 Technical and operational details - 222-800 kW

In the North Sea there is a high variability in vessel types and fishing gear types in this sub-fleet. Side trawlers as well as stern trawlers occur. The fishing gears can be demersal or semi-pelagic and single, twin or triple gear arrangements. This fleet comprises 4 Belgian and 24 German vessel. In the Netherlands otter trawlers only carry out 2 to 3% of the effort in this engine power class.

The typical net in the Irish Sea *Nephrops* fishery is a 25-fathom single trawl. Many boats also use a twin trawl arrangement. The mesh size used with twin trawls is similar to that used by single trawls, but the net size of each trawl is somewhat smaller c. 18-20 fathoms. All trawlers operating in the Irish Sea since 1 January 1994 must include a square mesh escape panel in the net.

Vessel (Table 4): The average engine power of a vessel in the 222-800 kW otter trawler sub-fleet is 407 kW (553 hp). The average length and breadth is 24.8 m and 7.2 m respectively. The tonnage of the vessels is 184 GT. None of the vessels have a kort nozzle. A controllable pitch does not occur in this fleet. A GPS-system and a videoplotter have become standard navigation equipment aboard these vessels for navigation and storage of fishtracks. Decca navigation systems are only on board as a back up.

Operational parameters, catch handling and fishing gear are comparable to the 191-221 kW otter trawler sub-fleet but the variability in characteristics is much higher.

3.C Distribution of fleet activities

In order to get an idea of the areas where the different fishing gears are used, data on the geographical spread of the activities of the different sub-fleets have been collected. Fishing effort data as well as total landings per ICES statistical rectangle have been collected. These have been divided for each sub-fleet and fishing gear defined in the inventory. The year 1994 was chosen as a reference, since during phase 2 no more recent data were available. In addition to the three participating countries (Belgium, Germany and the Netherlands) the participants from England, Scotland and Ireland voluntarily gave their co-operation in providing data on the effort and landings of their fleets. The data are presented as circles proportional to the effort or landings for each sub-fleet and each participating country (figures 3C.1 to).

To be completed

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Table 3A : Vessel and operational data for the Belgian fishing fleet

	70-191 kW		192-221 kW			222-800 kW		801-1100 kW
	shrimp beam trawling	flatfish beam trawling	shrimp beam trawling	flatfish beam trawling	demersal otter trawling	flatfish beam trawling	demersal otter trawling	flatfish beam trawling
Engine power (kW)	151 (88-191) *		215 (191-221)	219 (193-221)	221 (219-221)	588 (368 - 795)	407 (265-551)	884 (817 - 1067)
LOA (m)	17 (14-21)		20.5 (17.5-24)	22 (17.5-28)	24.8 (16.5-28)	32 (27 - 38)	28.4 (25.9-32.3)	36 (30.5 - 40.5)
Breadth (m)	5.1 (4.2-5.8)		5.5 (5-6)	5.8 (4.8-6.8)	6.1 (5-6.5)	7.5 (6.3 - 8.5)	7.2 (6.5-7.8)	8 (6.5 - 9)
Tonnage	32 BRT-39GT		39.5 BRT-66.5GT	67 BRT-77GT	78BRT-94GT	147BRT-221GT	184GT	307GT
Kort nozzle	80%		90%	90%	0%	80%	0%	100%
Propeller diameter (m)	1.3 (1.2-1.6)		1.4 (1.3-1.8)	1.5 (1.3-1.8)	1.9	2.4 (1.8 - 3.2)		2.6 (2.1 - 4.3)
Controllable pitch	none		none	none	none	none	none	10%
Positioning system	GPS (Decca)		GPS (Decca)	GPS (Decca)	GDS(Decca)	GPS (Decca)	GPS(Decca)	GPS (Decca)
Warp depth ratio	2 to 2.5/1		2 to 2.5/1	2.5 to 4/1	3/1	3 (C), 4.5 (T) **	3/1	3 (C), 4.5 (T) **
Average towing speed (knots)	2.5		2.5	3.5 (C), 4.6(T)**	3.5	4.1	4	4.5 (C), 6(T)**
Single - double warp system	single		60% - 40%	60% - 40%	all single	65% - 35%	all single	30% - 70%
Diameter of the warps (mm)	18 - 20		20 - 24	20 - 24	18-24	32(sngl) - 28(dbl)	21	32(sngl) - 28(dbl)
Duration of one seatrip	1/2 to 2 days		1/2 to 5 days	3 to 7 days	5 to 15 days	5 to 12 days	5 to 12 days	7 to 18 days
Surface trawled in 1 hour (km²)	0.06		0.06	0.063(C), 0.067(T) **		0.13(C), 0.15(T) **		0.16(C), 0.23(T) **

* : average (minimum - maximum)

** : C stands for chainmat beam trawls and T for tickler chain beam trawls

Table 3B : Vessel and operational data for the Dutch fishing fleet

*PART 1 - GEARS WEST**	70-191 kW	192-221 kW	222-800 kW	801-1100 kW	1101-1500 kW	> 1500 kW (1)	Comments
No. of vessels (1991 - 1994)	20 - 15 (2)	57 - 53	17 - 4	25 - 7	25 - 33	31 - 27	(1): after 1988, new built max = 1470kW
LOA (m)	18.5 (14-23)	23 (18-25)	28 (22-35)	35 (29-38)	37 (33-42)	42 (36-46)	(2): mainly shrimp fishing in the Wadden Sea
Breadth (m)	4-6	5-6.5	6-8	7-8.5	7.5-9.5	8.5-10	
Tonnage (GT)	50 (20-70)	80 (32-140)	130 (60-210)	200 (150-270)	305 (260-450)	410 (300-550)	
Kort nozzle	90%(except older vessels)	90%	90%	99%	99%	99%	
Propeller diameter (mm)	1200	1200 (shrimp) 2500 (flatfish)	2000 (1500-2500	2450 (2000-2900)	3000 (2400-360	3200 (3000-3400)	
Controllable pitch	1 series of 6 shrimpers (built 1981) and 2 flatfish beam trawlers						
Positioning system	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)	DGPS on recent vessels
Warp depth ratio	3/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1	3/1 in areas with steep sanddunes
Average towing speed (knots)	2.5-3 (shrimp) 4 (otter trawl)	2.5-5	4-5.5	6-7	6-7.5	6.5-8	

* : Harbours west of IJmuiden. Mostly hard sandy bottom, west of 4° E, small stones and sanddunes in the South

Table 3C : Vessel and operational data for the Dutch fishing fleet

*PART 2 - GEARS EAST**	70-191 kW	192-221 kW	222-800 kW	801-1100 kW	1101-1500 kW	> 1500 kW
No. of vessels (1991 - 1994)	108 - 103	61 - 75	23 - 20	28 - 19	52 - 70	46 - 44
LOA (m)	18.5 (14-23)	23 (18-25)	28 (22-35)	35 (29-38)	37 (33-42)	42 (36-46)
Breadth (m)	4-6	5-6.5	6-8	7-8.5	7.5-9.5	8.5-10
Tonnage (GT)	50 (20-70)	80 (32-140)	130 (60-210)	200 (150-270)	305 (260-450)	410 (300-550)
Kort nozzle	90%(except older vessels)	90%	90%	99%	99%	99%
Propeller diameter (mm)	800**	1200 (shrimp) 2500 (flatfish)	2000 (1500-2500)	2450 (2000-2900)	3000 (2400-3600)	3200 (3000-3400)
Controllable pitch	s (built 1981) and 2 flatfish beam trawlers					
Positioning system	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)	GDS(Decca)
Warp depth ratio	3/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1	3.5/1 to 5/1
Average towing speed (knots)	3-4.5	4-5	4-5.5	5-7	6-7.5	6.5-8

* : Softer grounds east of 4° E, sometimes silty. In summertime often softer: less ticklers

Table 3D : Vessel and operational data for the German fishing fleet

	<70 kW	70-191 kW		192-221 kW	
	shrimp beam trawling	shrimp beam trawling	demersal otter trawling	shrimp beam trawling	demersal otter trawling
Engine power (kW)	35.4 (5-68)*	159 (74-191)	162 (159-165)	217 (197-221)	219 (206-221)
LOA (m)	8.4 (5-13)*	16.1 (9-25)	16 (15-17)	20.3 (15-25)	22 (19-26)
Tonnage	3.7 (12-113)*	30.5 (5-90)	23 (23-23)	102 (41-167)	107 (107-107)
	222-800 kW	801-1100 kW		1101-1500 kW	>1500 kW
	demersal otter trawling	flatfish beam trawling	demersal otter trawling	flatfish beam trawling	demersal otter trawling
Engine power (kW)	516 (243-784)	910 (908-912)	1007 (993-102	1104 (1104-11	2909 (1620-3530)
LOA (m)	30 (24-36)	37 (34-39)	36 (35-36)	38 (38-38)	74 (44-92)
Tonnage	240 (100-425)	260 (249-271)	347 (269-425)	244 (244-244)	2140 (671-3071)

* : average (minimum - maximum)

Table 4A : Gear data for the Belgian fishing fleet

	70-191 kW	192-221 kW		222-800 kW		801-1100 kW	
	shrimp beam trawling	shrimp beam trawling	flatfish beam trawling		flatfish beam trawling		flatfish beam trawling	
			chain mat gear ***	tickler chain gear ***	chain mat gear	tickler chain gear	chain mat gear	tickler chain gear
Beam length (m)	7 (35%) - 8 (65	7 (35%) - 8 (65	5.1 (4 - 8) *	4.4 (4 - 6) *	9.6 (7.5 - 11.8)	11	10.6 (9.4 - 11.5)	11.4 (10.5 - 12)
Weight beam (kg)	260	260	300 (4m beam) 390 (8m beam)	350	810 (9m beam) 930 (10.5m beam)	1600	1100 (11m beam)	1850
Weight 1 shoe (kg)	200	200	250 (4m beam) 300 (8m beam)	255	245 (9m beam) 400 (10.5m beam)	635	450 (11m beam)	800
Weight bobbins (kg)	300	300	170 (4m beam) 175 (8m beam)	200	350 (9m beam) 360 (10.5m beam)	500	430 (11m beam)	600
Weight of the chain mat (kg)	N/A.	N/A.	550 (4m beam) 570 (8m beam)	N/A	1450 (9m beam) 2210 (10.5m beam)	N/A	2000 (11m beam)	N/A
Weight of the tickler chains (kg)	N/A.	N/A.	N/A.	370	N/A	1000	N/A	1150
Weight gear (kg)	1100	1100	1800 (4m beam) 2200 (8m beam)	1500	3900 (9m beam) 5000 (10.5m beam)	4800	5600 (11m beam)	6000
Weight gear (kg/kW)	7.3	7.3	8.2 (4m beam) 10.0 (8m beam)	6.8	7.1 (9m beam) 4.7 (10.5m beam)	8.2	4.7 (11m beam)	6.8
Surface of the sole plate (cm²)	270	270	300.0	260.0	360	530	475	635
Vertical netopening (c.l. beam) (m)	0.65	0.65	0.55 (0.42 - 0.70) *	0.53 (0.42 - 0.70)	0.58	0.53	0.61	0.43
Length groundrope (m)	8.6 (7m beam) ; 10 (8m beam)	8.6 (7m beam) ; 10 (8m beam)	9.2 (4 m beam) ; 12.5 (8 m beam)	10.5 or 17	16	28	18.5	32
Diameter groundrope (mm)	Ø bobbins: 210 ; Ø axes: 20	Ø bobbins: 210 ; Ø axes: 20	Ø bobbins: 250 ; Ø steel wire: 24 - 32	Ø chain: 18 Ø roller: 200 to 300	Ø bobbins: 250 ; Ø steel wire: 28 - 32	Ø chain: 22 Ø roller: 230 to 300	Ø bobbins: 250 ; Ø steel wire: 30 - 34	Ø chain: 22 Ø roller: 320 to 400
Material groundrope	steel axes + rubber bobbins	steel axes + rubber bobbins	steel wire + rubber bobbins	chain + central rubber roller	steel wire + rubber bobbins	chain + central rubber roller	steel wire + rubber bobbins	chain + central rubber roller
Flip-up rope	none	none	15%	10%	70%	none	90%	20%
Vessels with tickler chain gear	none	none	65%	100%	35%	100%	20%	100%
Diameter of the shackles (mm)			N/A.	ticklers: 16 net ticklers: 10 to 14	N/A	ticklers: 18 net ticklers: 11 to 22	N/A	ticklers: 18 net ticklers: 11 to 22
Vessels with chainmat gear	none	none	100%	0%	100%	0%	100%	0%
Diameter of the shackles (mm)	N/A	N/A	14 or 18	N/A	18	N/A	18	N/A
Dimension of the quadrants (mm)	N/A	N/A	25 long on 25 wide or 35 long on 35 wide	N/A	35 long on 25 wide	N/A	35 long on 25 wide	N/A
Mesh size net (mm)	32 to 24 **	32 to 24 **	120	120	120 - few 150	120	120 - few 150	120
Netting material net	PA-sngl	PA-sngl	top panel: PE-sngl ; belly: PE-sngl or dbl	PE-sngl (67%), PA-sngl (33%)	top panel: PE-sngl ; belly: PE-dbl few sngl	top panel: PA-sngl ; belly: PA-dbl	top panel: PE-sngl ; belly: PE-dbl few sngl	top panel: PA-sngl ; belly: PA-sngl or dbl
Mesh size cod-end (mm)	22	22	80 or 100	80 or 100	80 or 100	80 or 100	80 or 100	80 or 100
Netting material cod-end	PA-single	PA-single	PE-dbl	PE-dbl	PE-dbl	PA-dbl	PE-dbl	PE-dbl
cod-end cover	yes (100%)	yes (100%)	25%	10%	45%	30%	45%	20%

* : average (minimum - maximum)

** : from trawlmouth to trawlend

*** : vessels which operate a chainmat beam trawl or a tickler chain beam trawl as the main gear.

Table 4B : Gear data for the Belgian fishing fleet

	192-221 kW	222-800 kW
	demersal otter trawling	demersal otter trawling
Target species	*Nephrops*	*Nephrops*
Type otter board	wooden rectangular	wooden rectangular
Weight otter board (kg)	340	420
Dimensions otter board (m)	2.2 on 1.2	2.4 on 1.2
Vertical netopening (c.l. beam) (m)	1	
Length groundrope (m)	35	35
Diameter groundrope (mm)	chain: 16 bobbins: 120	chain: 18 bobbins: 120
Length headline (m)	28	28
Diameter headline (mm)	18	18
Material headline	mixed rope	mixed rope
Lower bridles, length (m)	6	4.3
Lower bridles, diameter (mm)	16	16
Lower bridles, material	chain	chain
Upper bridles, length (m)	6	4.3
Upper bridles, diameter (mm)	16	14
Upper bridles, material	mixed PE and steel	steel wire
Mesh size net (mm)	100	100
Netting material net	PE	PE
Mesh size cod-end (mm)	70	70
Netting material cod-end	PE or PA	PE
cod-end cover	no	no

Table 4C : Gear data for the Dutch fishing fleet

PART 1 - GEARS WEST*	70-191 kW	192-221 kW	222-800 kW	801-1100 kW	1101-1500 kW	> 1500 kW	Comments
Beam length (m)	6-9	4.5-6	5-8		11-12	12	
Weight beam + shoes (kg)	900	1200	1700		3750	4500	
Weight beam + shoes (kg/kW)	4.5-5.5	5.5	4.5-5.5		2.2-3	1.4-2.5	
Weight of the chain mat (kg/kW)	N/A	1.8	1.8		1.4-1.8	1.4-1.8	
Weight of the tickler chains (kg/kW)	N/A	1.5-2.8	1.5-2.5		1.3-2.0	1.0-1.9	
Weight of the net tickler chains (kg/kW	N/A	0.3-0.6			0.3-0.35	0.2-0.35	
Weight tickler chain beam trawl (kg/kW)		8-10			4.1-5.8	3.0-5.0	
Weight chainmat beam trawl (kg/kW)		8-9.7			3.1-3.3	2.5-3.6	
Vertical netopening (c.l. beam) (m)	0.6-0.9	0.4-0.5	0.4-0.5	0.4-0.5	0.32-0.5	0.3-0.5	+ 0.15m for chainmat beam trawl
Length groundrope (m)	1.3 x beam length	13-18	17-23		30-35	35-37	
Length of the roller (m)	N/A	3	3		6-8	8	
Second groundrope diameter (mm)		22			24-26	26-28	= steel chain, 3 to 6m just in front of roller
Diameter groundrope (mm)	Ø bobbins: 180-220	Ø chain: 22 Ø roller: 50 to 100	Ø chain: 22 Ø roller: 50 to 100		Ø chain: 26 Ø roller: 200 to 350	Ø chain: 26-30 Ø roller: 200 to 400	
Material groundrope	steel axes + rubber bobbins	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	
Flip-up rope	struction, most nylon rope, sometimes with floats - occasionally used						
Tickler chain gear							
No. of tickler chains	N/A	5	5 to 6		6 to 10	10	
Diameter of the shackles (mm)	N/A	20	22		22 to 26	24 to 28	shortest chains have largest diameters
Length of tickler chains (m)	N/A	7 to 14	10 to 16		14 to 27	15 to 28	
No. of net tickler chains	N/A	5 to 6	5 to 6		8 to 11	9 to 12	
Diameter of the shackles (mm)	N/A	10 to 13	10 to 13		12 to 16	13 to 16	
Chainmat gear							
Diameter of the shackles (mm)	N/A	14 (l) & 10 (w)			18 (l) & 14 (w) or 16 (l) & 26 (w)	26 (l) & 18 (w)	
Dimension of the quadrants (mm)	N/A	25 to 30 long 20 to 25 wide			30 to 35 long 25 to 30 wide	30 to 35 long 25 to 30 wide	
Mesh size net (mm)	24 to 20	120 to 80 (sole) 120 to 100 (plaice)	120 to 80 (sole) 120 to 100 (plaice)		240 to 80 (sole) 240 to 100 (plaice)	240 to 80 (sole) 300 to 100 (plaice)	
Netting material net	PP	PA	PA		PA	PA	belly and cod-end double braided

* : mostly hard sandy bottom, west of 4° E, small stones and sanddunes in the South

** : from trawlmouth to trawlend

Table 4D : Gear data for the Dutch fishing fleet

PART 2 - GEARS EAST*	70-191 kW	192-221 kW	222-800 kW	801-1100 kW	1101-1500 kW	> 1500 kW	Comment
Beam length (m)	6-9	4.5 or 9	7-11	10-12	12	12	
Weight beam + shoes (kg)	900	950 to 1200	1400 to 2600	2000 to 3000	3400 to 5000	4000 to 6000	
Weight beam + shoes (kg/kW)		4.5-5.5	3.2	3.1	2.9-3.4	1.9-3.3	
Weight of the chain mat (kg/kW)	N/A	N/A	N/A	N/A	N/A	N/A	
Weight of the tickler chains (kg/kW)	N/A	0.6-1.4	0.8-1.2	0.8-1.0	0.8-1.0	0.5-1.0	
Weight of the net tickler chains (kg/kW)	N/A	0.3-0.6			0.27-0.35	0.20-0.35	
Weight tickler chain beam trawl (kg/kW)		6.0-7.8	4.4-5.4		3.8-5	3.0-4.0	
Weight chainmat beam trawl (kg/kW)	N/A	N/A	N/A	N/A	N/A	N/A	
Vertical netopening (c.l. beam) (m)	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5	0.32-0.5	0.3-0.5	
Length groundrope (m)	7-12	16-20	18-32	26-35	33-36	36-38	
Length of the roller (m)	N/A	3	3-6	6	8	8	
Second groundrope diameter (mm)	N/A	N/A	N/A	N/A	N/A	N/A	
Diameter groundrope (mm)	Ø bobbins: 180-220	Ø chain: 14-18 Ø roller: 100 to 200	Ø chain: 14 to 18 Ø roller: 200 to 300	Ø chain: 17 to 20 Ø roller: 250 to 400	Ø chain: 18 to 22 Ø roller: 300 to 400	Ø chain: 36-38 Ø roller: 400 to 500	
Material groundrope	steel axes + rubber bobbins	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	chain + central rubber roller	
Flip-up rope	Not often used						
Tickler chain gear							
No. of tickler chains	N/A	5-6	5-7	5-10	5-10	6-11	less tickler chains if more net tickler chains
Diameter of the shackles (mm)	N/A	12-16	12-16	14-20	19-22	19-24	shortest tickler chains have +5mm diameter
Length of tickler chains (m)	N/A	7 to 11	10 to 14		16 to 26	15 to 28	
No. of net tickler chains	N/A	5 to 7	6 to 10	12 to 13	10 to 16	10 to 16	
Diameter of the shackles (mm)	N/A	8 to 13	10 to 12	8 to 11	12 to 14	10 to 14	
Chainmat gear	N/A	N/A	N/A	N/A	N/A	N/A	
Diameter of the shackles (mm)							
Dimension of the quadrants (mm)							
Mesh size net (mm)	24 to 20	120 to 80 (sole) 120 100 (plaice)	120 or 160 to 80 (sole) 120 or 160 to 100 (plaice)	160 or 240 to 80 (sole) 120 or 240 to 100 (plaice)	260 to 80 (sole) 260 to 100 (plaice)	260 to 80 (sole) 260 to 100 (plaice)	
Netting material net	PP	PA	PA		PA	PA	cod-end double braided

* : Den Helder and east of Den HelderSofter grounds east of 4°E, sometimes silty. In summertime often softer, less ticklers.

** : from trawlmouth to trawlend

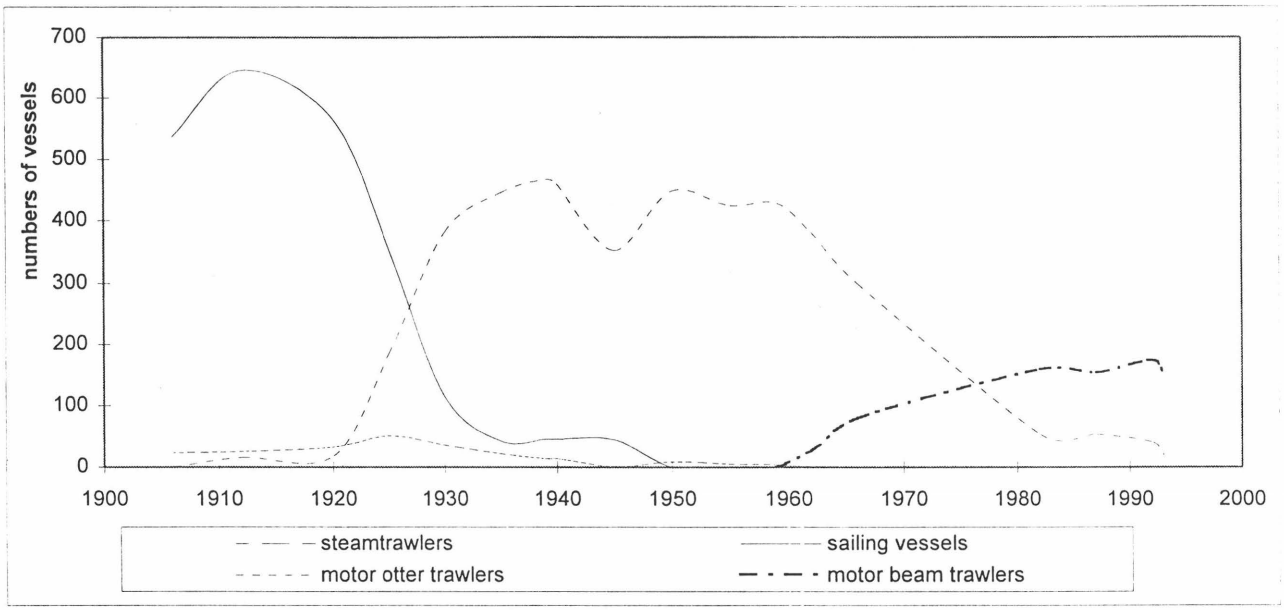


Figure 3A.1 - Vesselnumbers in the Belgian fleet

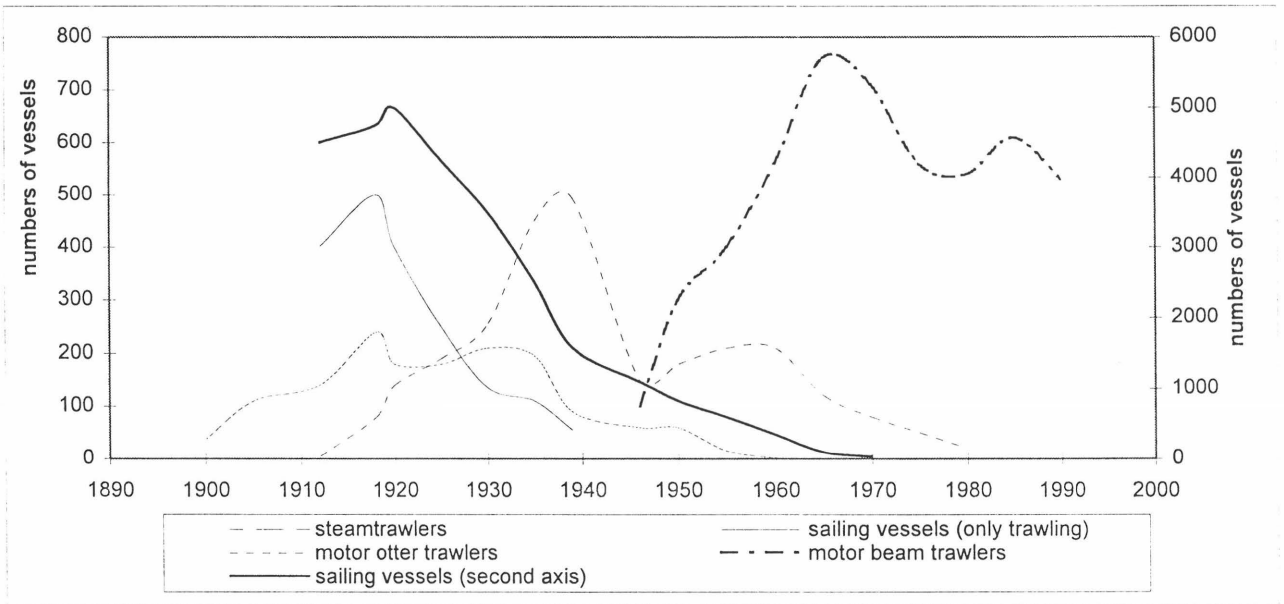


Figure 3A.2 - Vesselnumbers in the Dutch fleet*

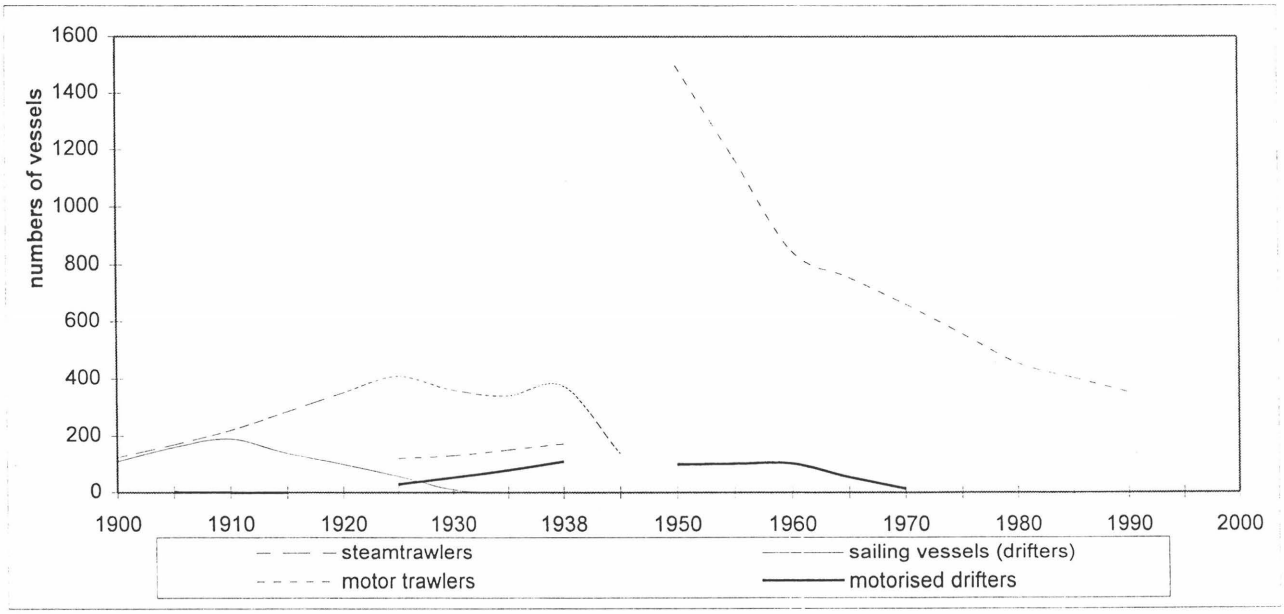


Figure 3A.3 - Vesselnumbers in the German fleet

*: The Netherlands: exclusive large stern trawlers and mollusc dredgers

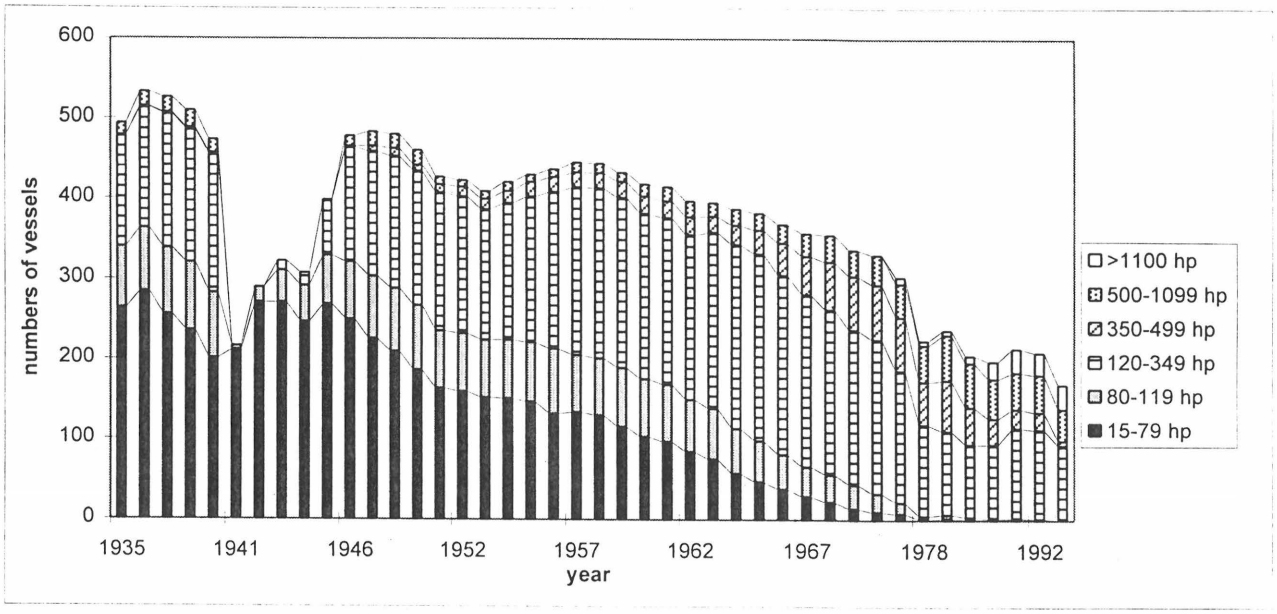


Figure 3A.4 - Numbers of trawlers per engine power class - Belgium

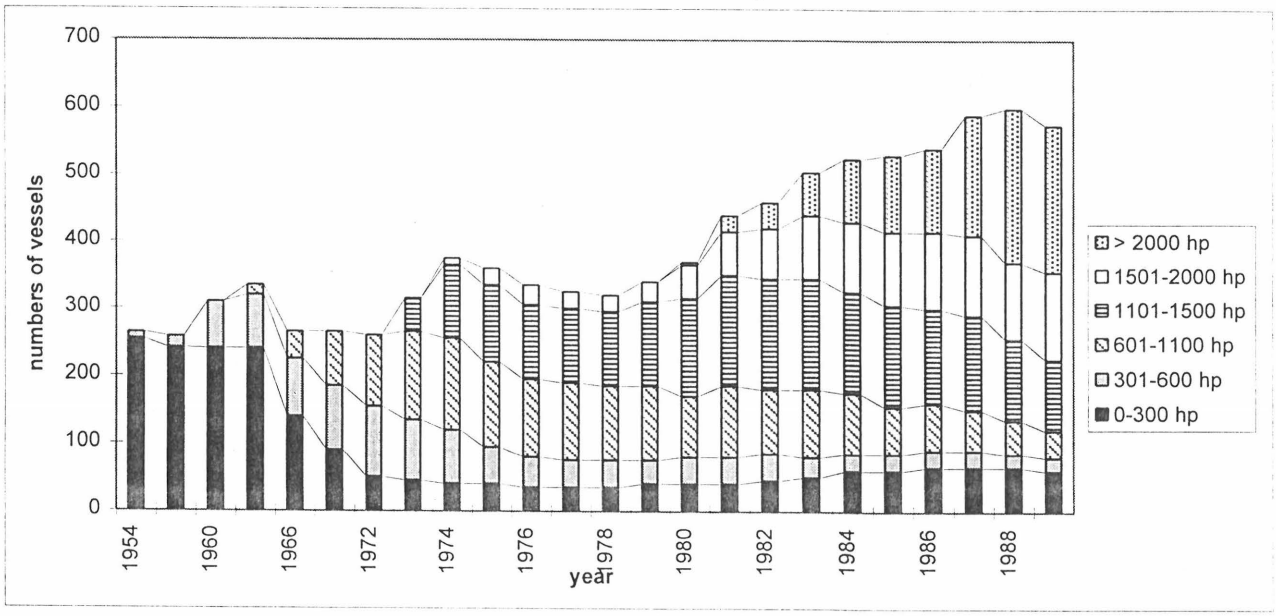


Figure 3A.5 - Numbers of trawlers per engine power class - Netherlands*

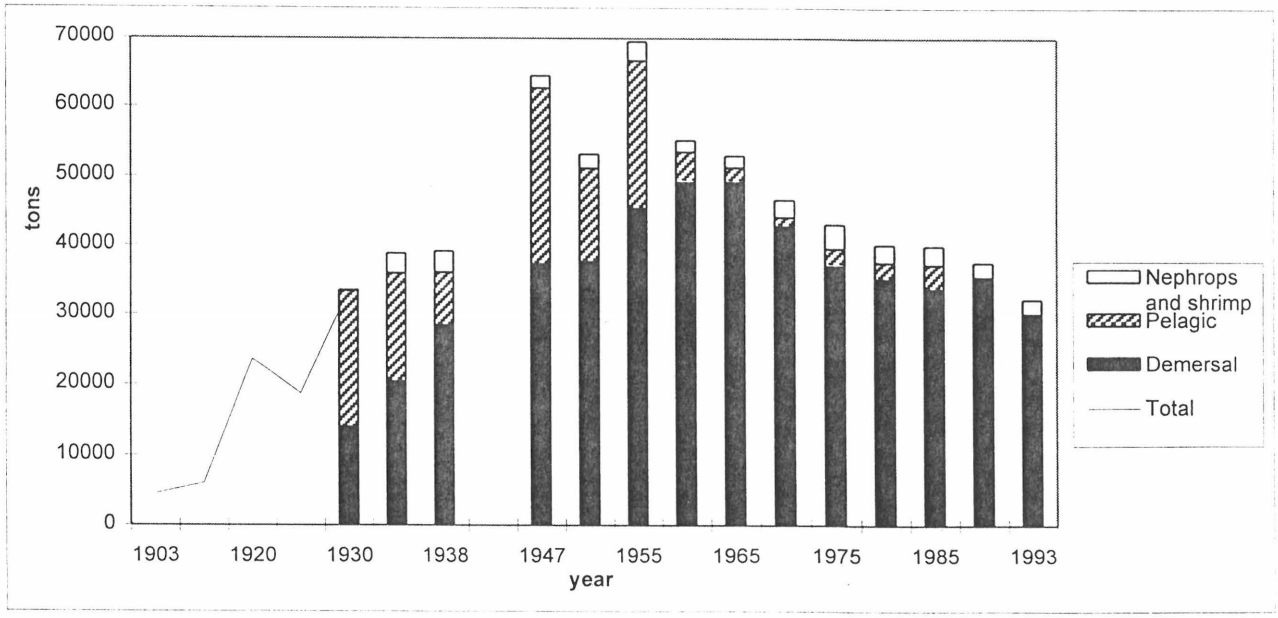


Figure 3A.6 - Fish landed by Belgian fishing fleet

*: The Netherlands: exclusive large stern trawlers and mollusc dredgers

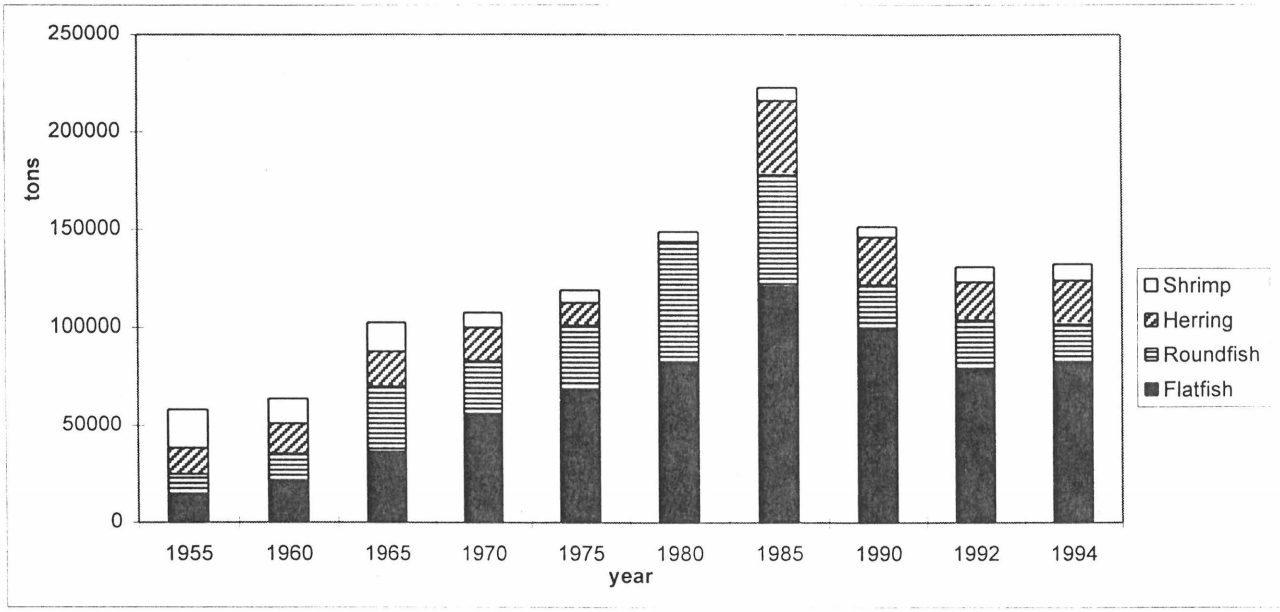


Figure 3A.7 - Fish landed by Dutch fishing fleet*

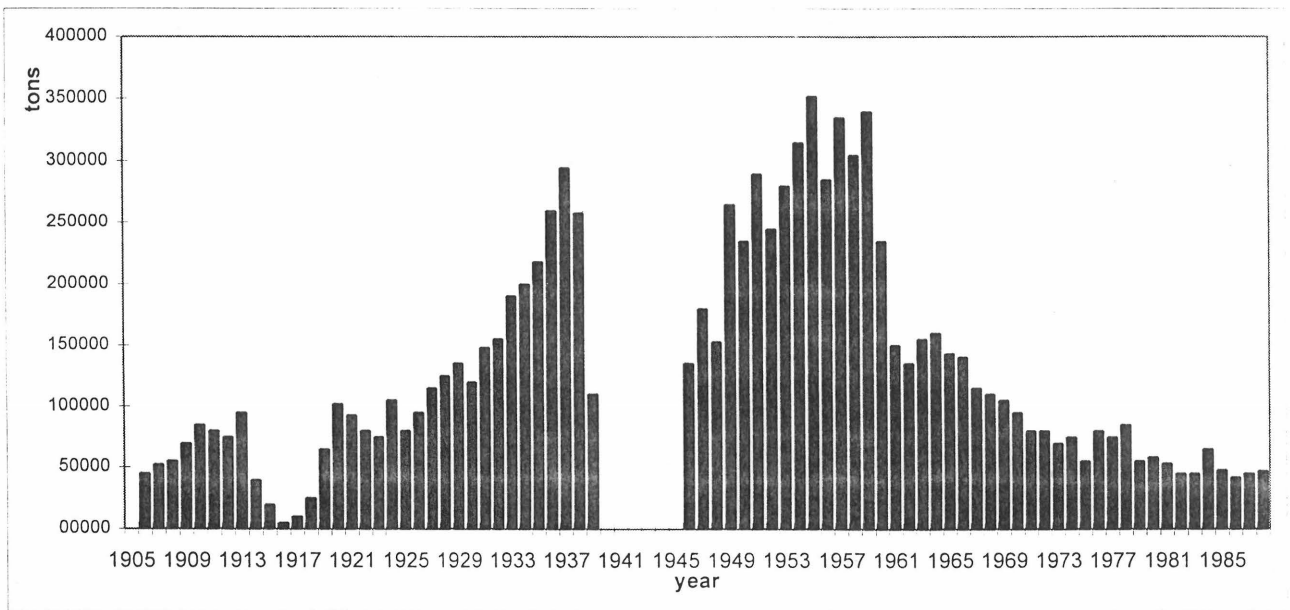


Figure 3A.8 - Fish landed by the German fishing fleet - total landings

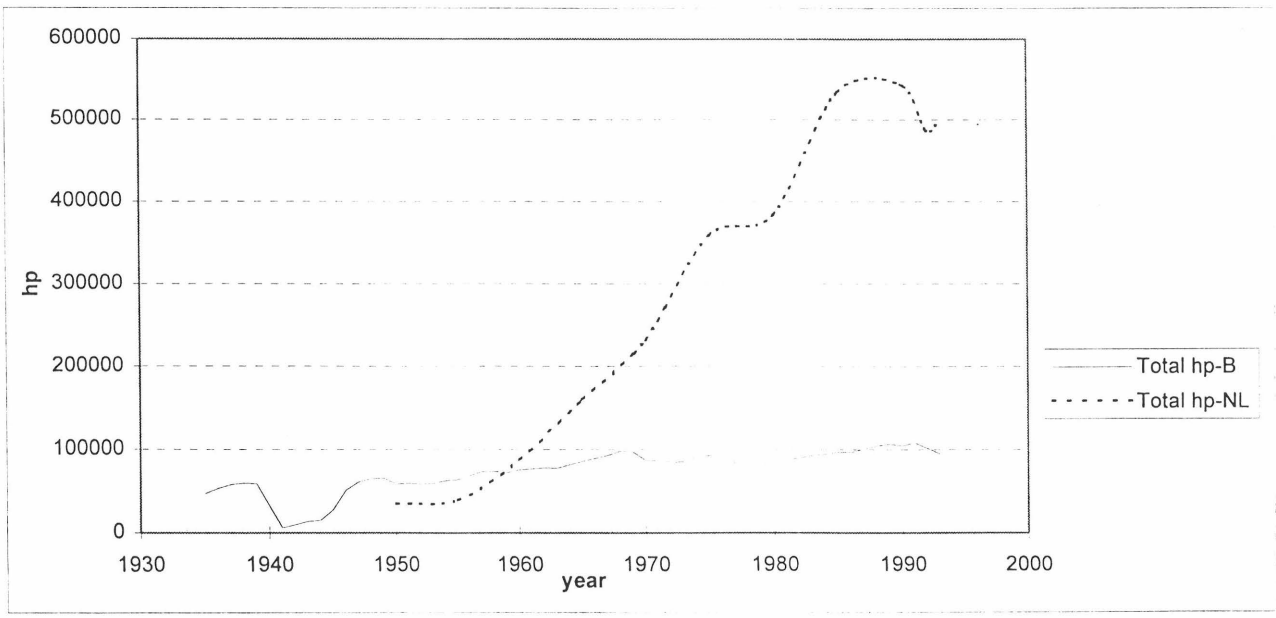


Figure 3A.9 - Total engine power of fishing fleet (excl. wind power)

*: The Netherlands: exclusive large stern trawlers and mollusc dredgers

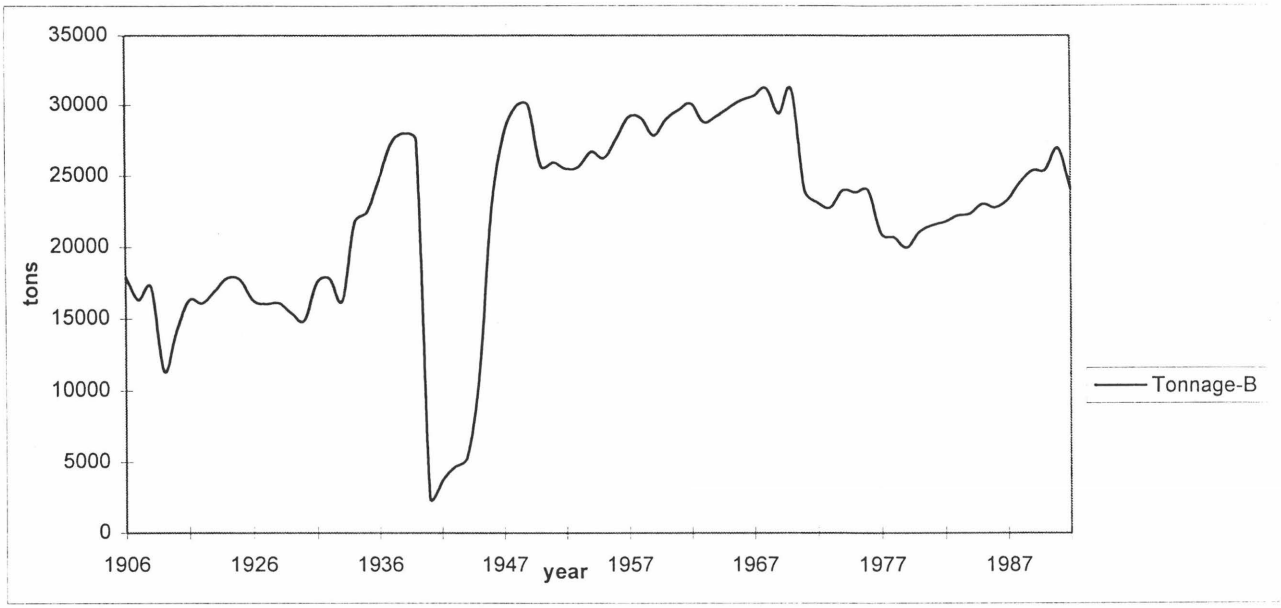


Figure 3A.10 - Tonnage of Belgian fishing vessels

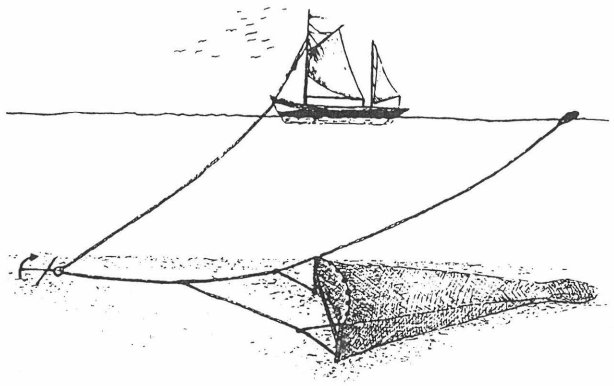


Figure 3A.11

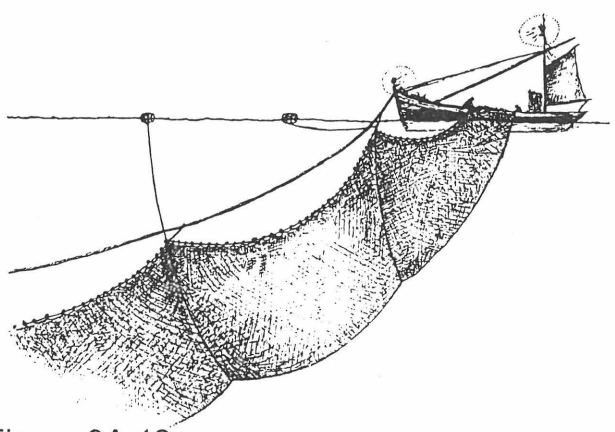


Figure 3A.12

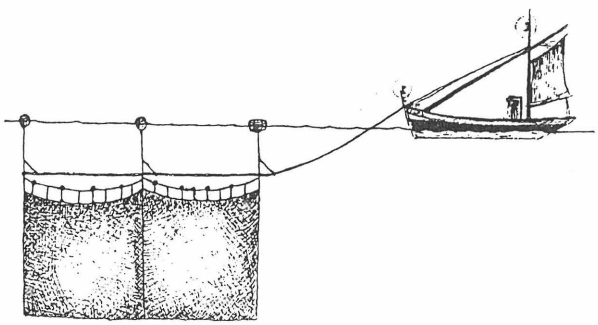


Figure 3A.13

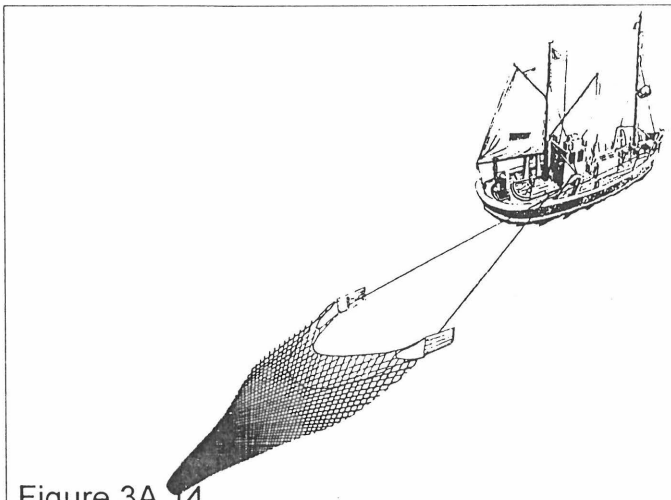


Figure 3A.14

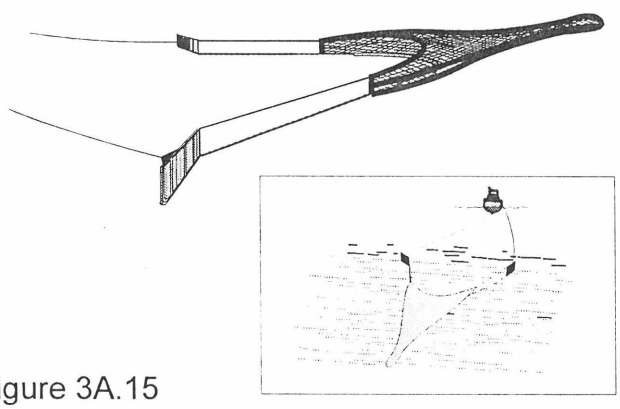


Figure 3A.15

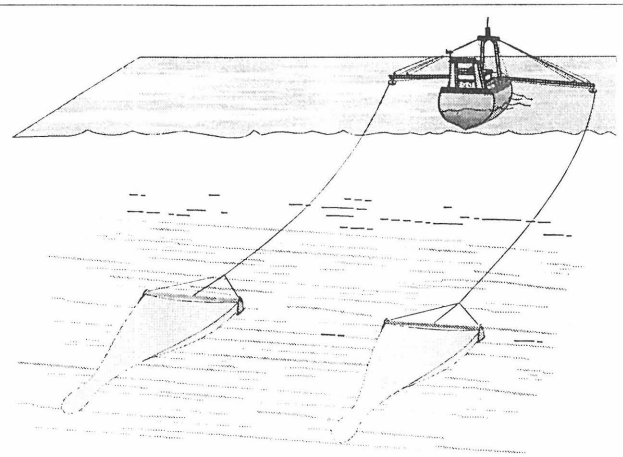


Figure 3A.17

Figure 3A.11 - Stownet, used by sailing vessels
Figure 3A.12 - Driftnet, used by sailing vessels
Figure 3A.13 - Driftnet, used by sailing vessels and later also by motorvessels
Figure 3A.14 - Early otter trawl
Figure 3A.15 - Otter trawling
Figure 3A.16 - Demersal pair trawling
Figure 3A.17 - Beam trawling

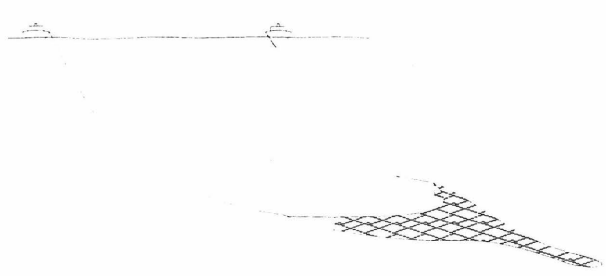
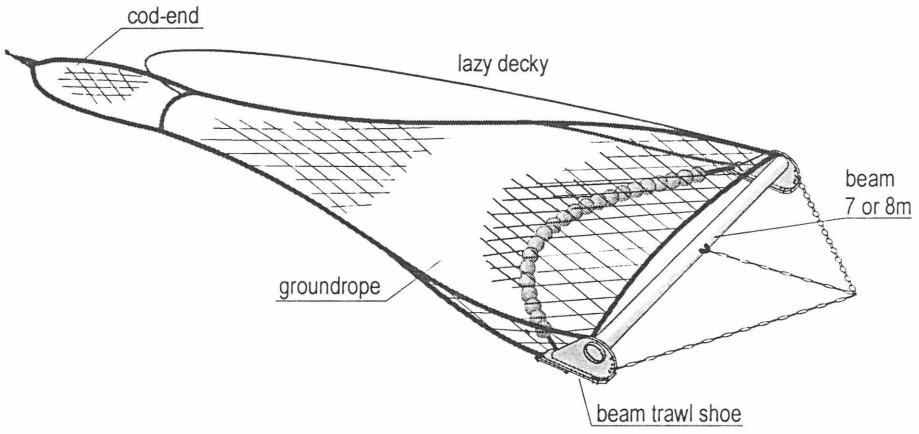


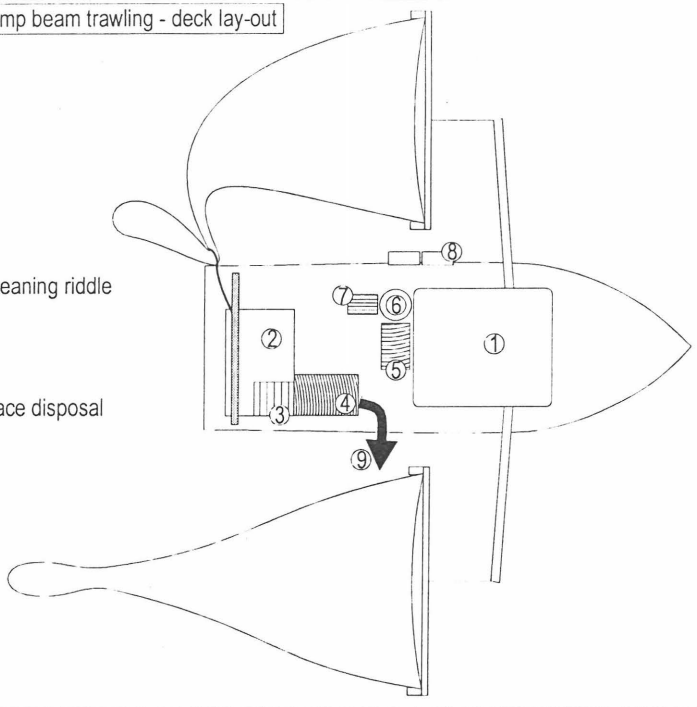
Figure 3A.16

Sub-fleet 70-191kW - shrimp beam trawling - the shrimp beam trawl

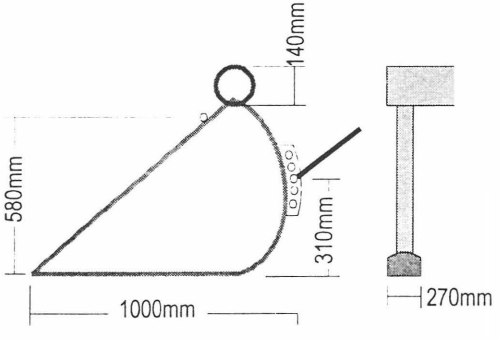


Sub-fleet 70-191kW - shrimp beam trawling - deck lay-out

1: wheelhouse
2: catch collector box
3: conveyor belt
4: rotating shrimp riddle
5: rotating cooling and cleaning riddle
6: shrimp boiler
7: shaking riddle
8: cooling trays
9: discards: manual surface disposal



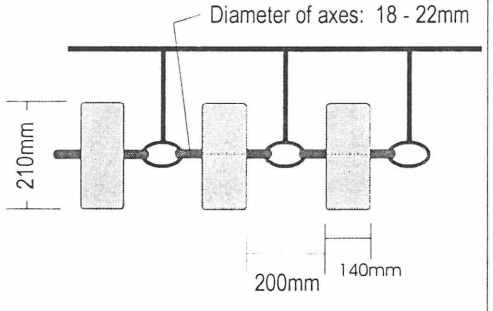
Sub-fleet 70-191kW - shrimp beam trawling - the beam trawl shoe



Sub-fleet 70-191kW - shrimp beam trawling - the bobbin rope

No. of bobbins: shrimpers: 30 or 32
eurocutters: 37

Material bobbins: modified rubber



Sub-fleet 70-191kW - shrimp beam trawling - rotating shrimp riddle

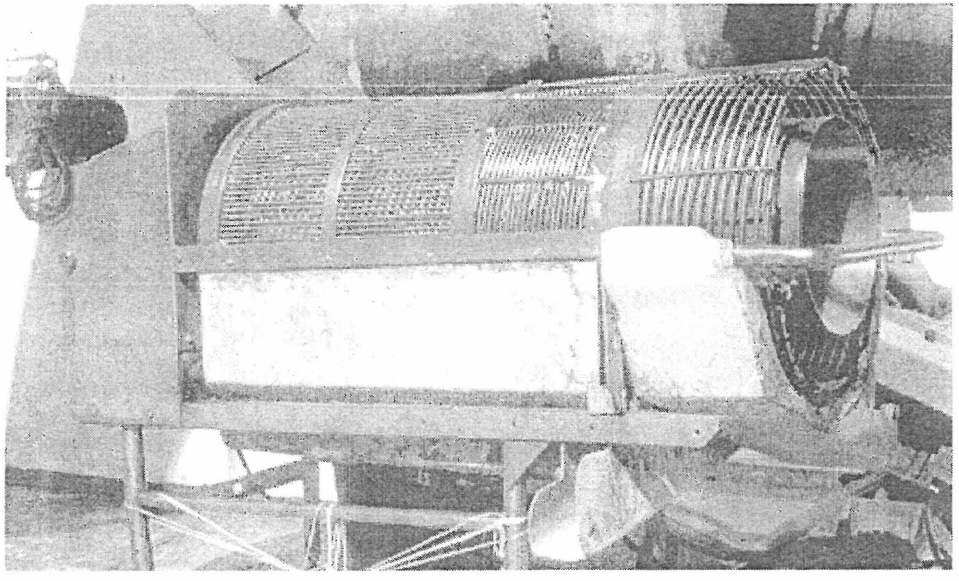
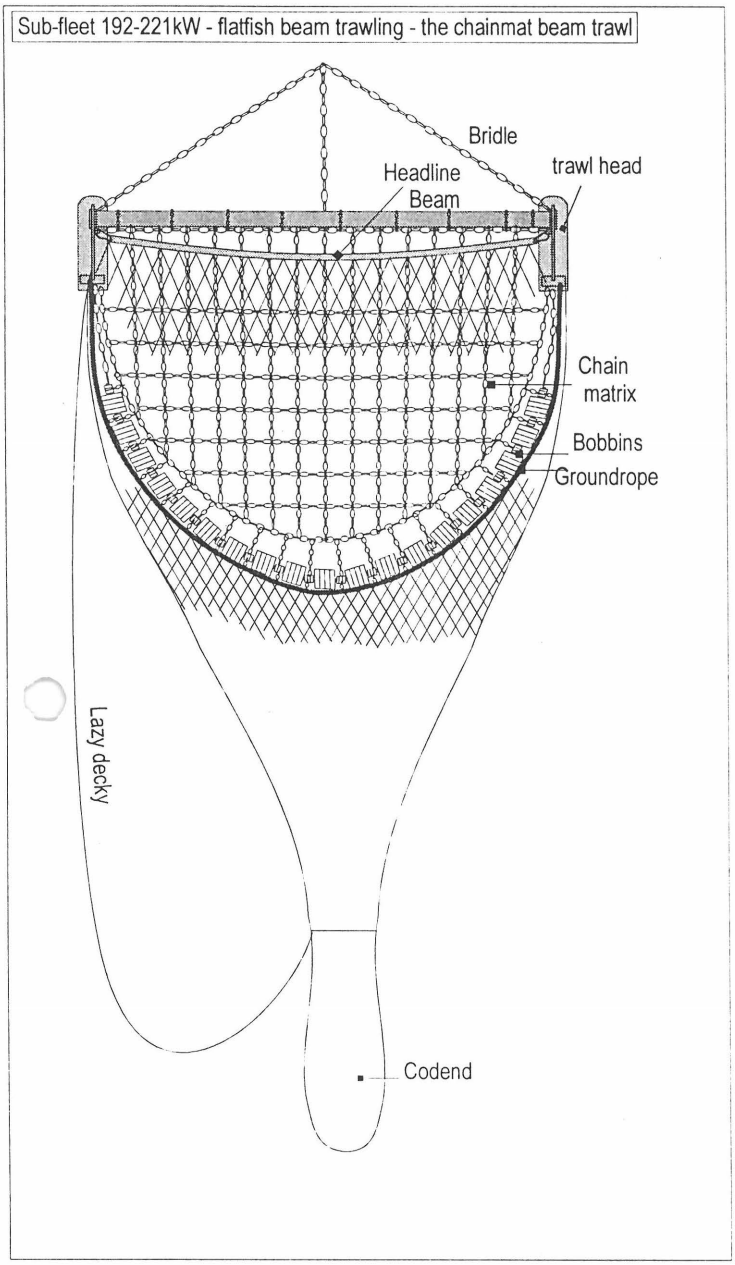
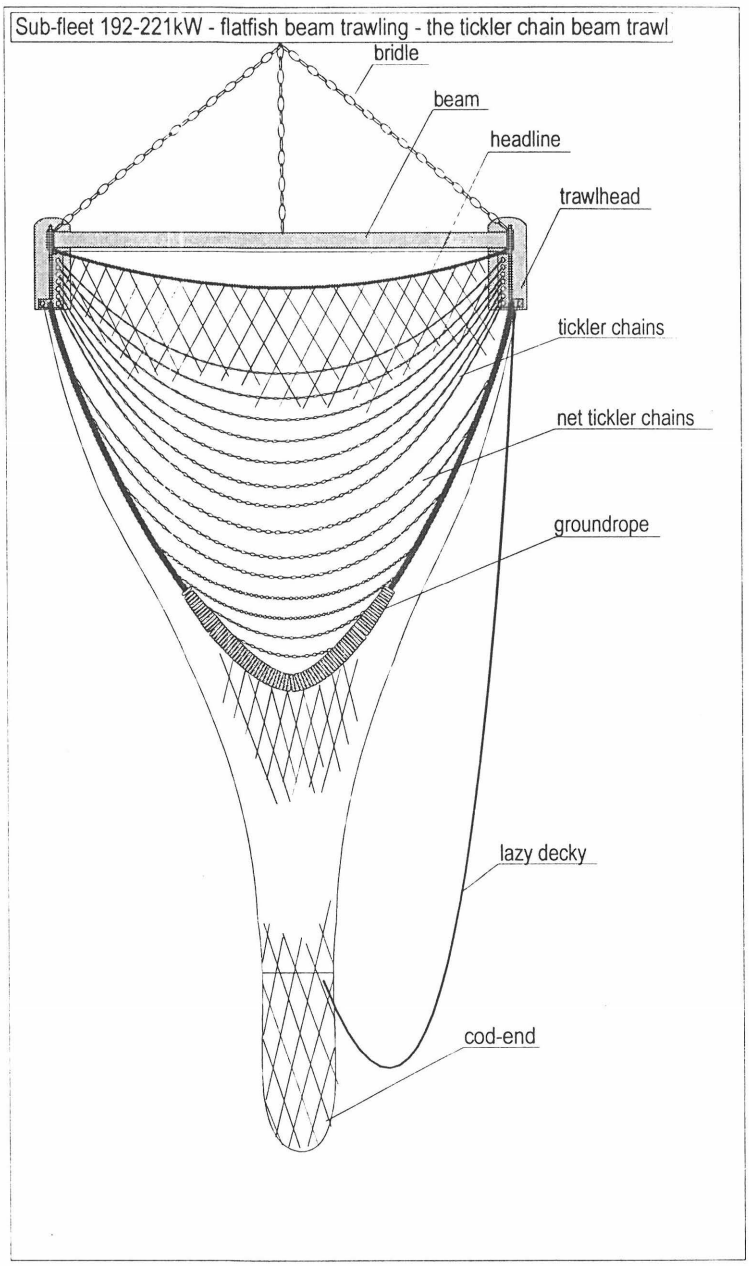
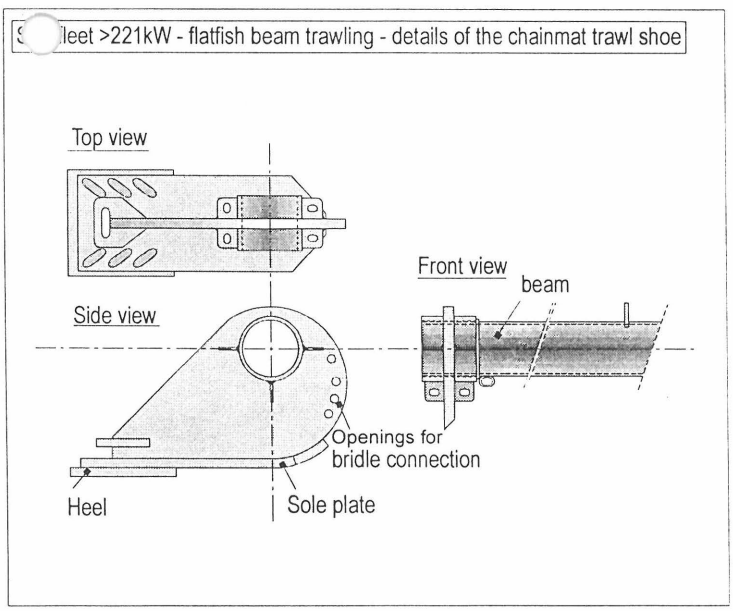


Figure 3B.1 - Shrimp beam trawling, sub-fleet <191kW







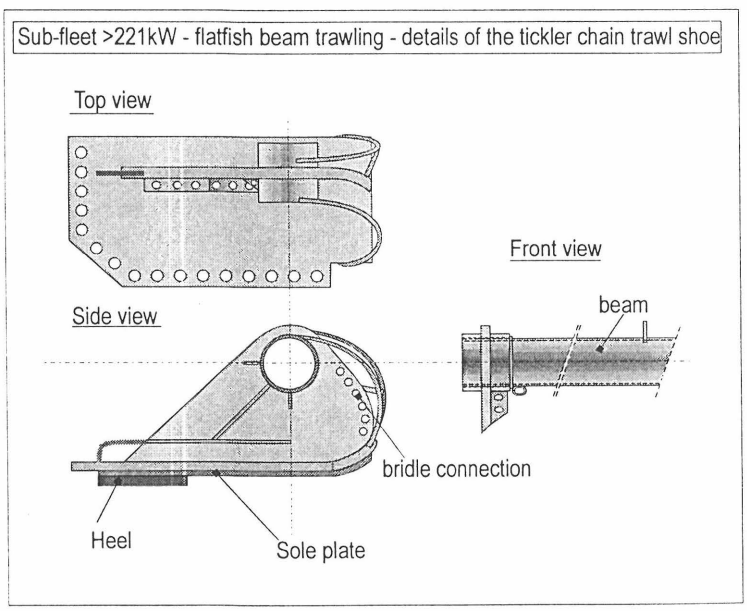
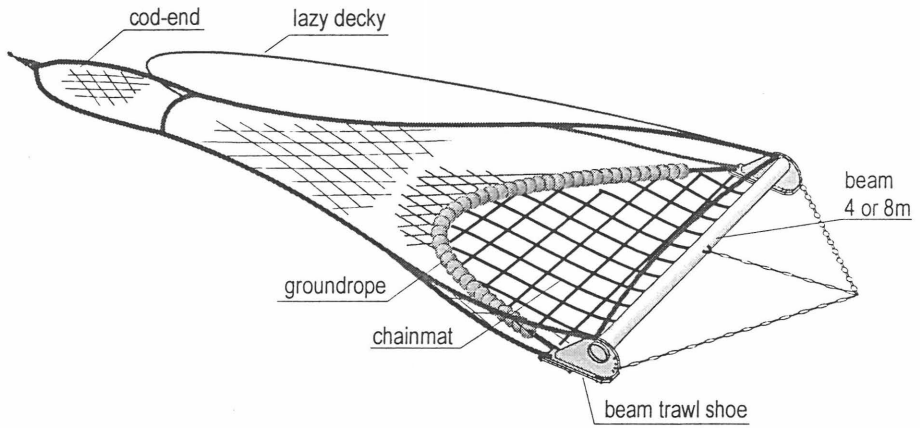
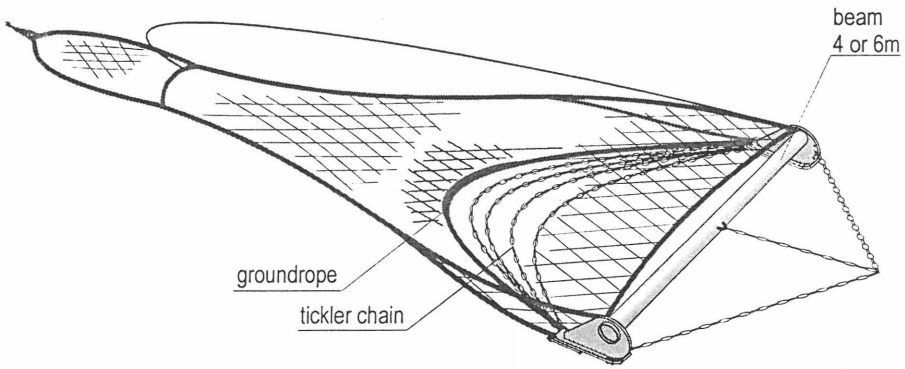


Figure 3B.2 - Flatfish beam trawls, equipped with chainmat and with tickler chains, sub-fleets >221 kW

Sub-fleet 192-221kW - flatfish beam trawling - the flatfish beam trawl rigged with a chainmat

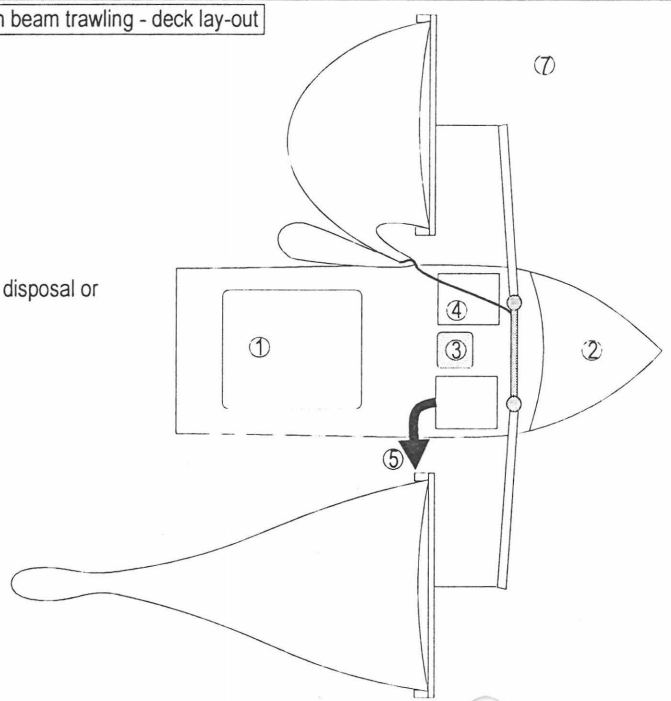


Sub-fleet 192-221kW - flatfish beam trawling - the flatfish beam trawl rigged with tickler chains

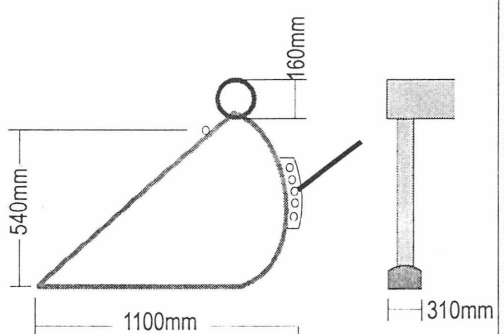


Sub-fleet 192-221kW - flatfish beam trawling - deck lay-out

1: wheelhouse
2: covered front area
3: entrance to fish hold
4: catch collector box
5: discards, manual surface disposal or by a waterflow on deck



Sub-fleet 192-221kW - flatfish beam trawling - the beam trawl shoe (chainmat beam trawl)



Sub-fleet 192-221kW - flatfish beam trawling - the beam trawl shoe (tickler chain beam trawl)

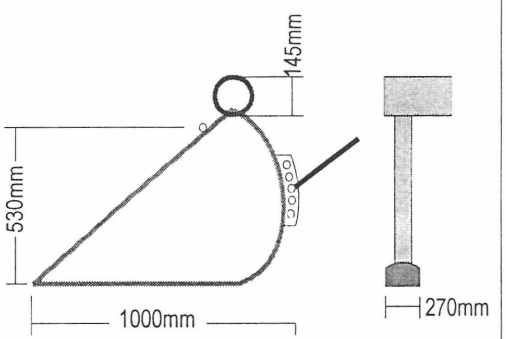
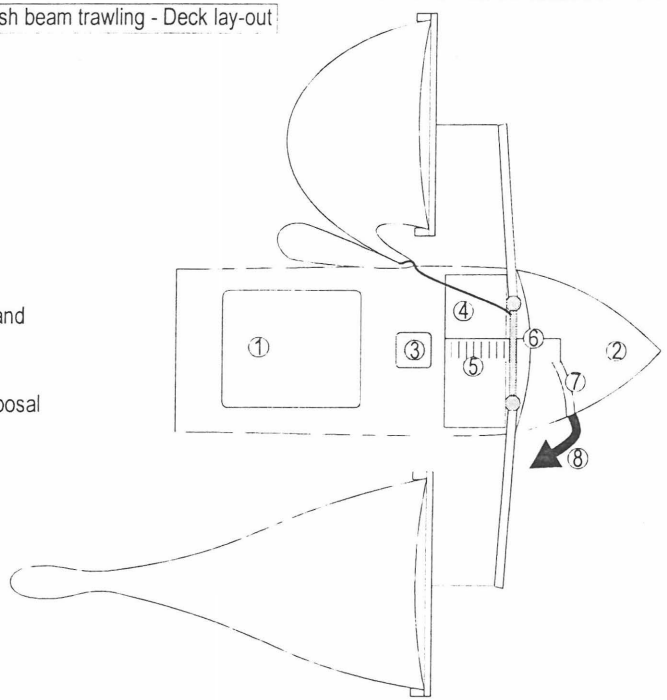
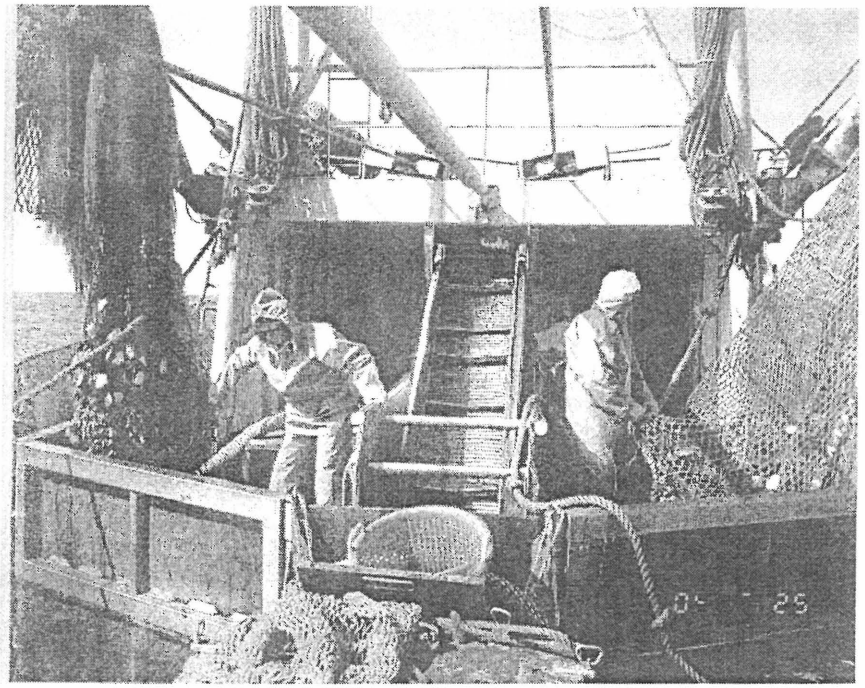


Figure 3B.3 - Flatfish beam trawling, sub-fleet 192 - 221kW

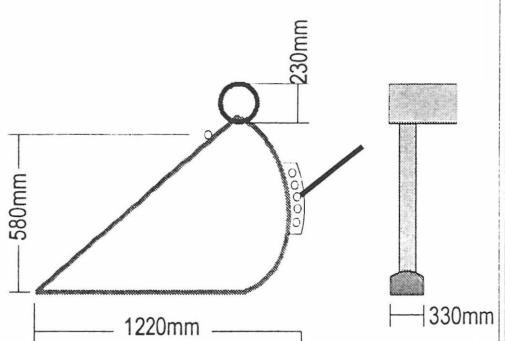
Sub-fleet 222-1100kW - flatfish beam trawling - Deck lay-out

1: wheelhouse
2: covered front area
3: entrance to fish hold
4: catch collector box
5: conveyor belt
6: conveyor belt for sorting and processing
7: tube for discards disposal
8: discards, sub-surface disposal

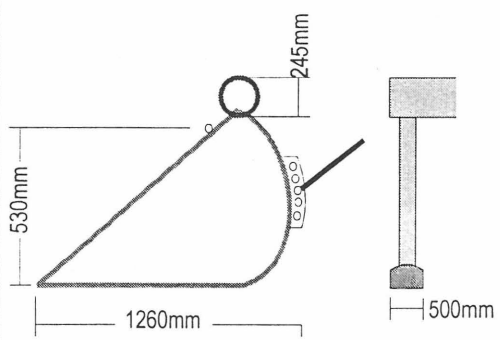




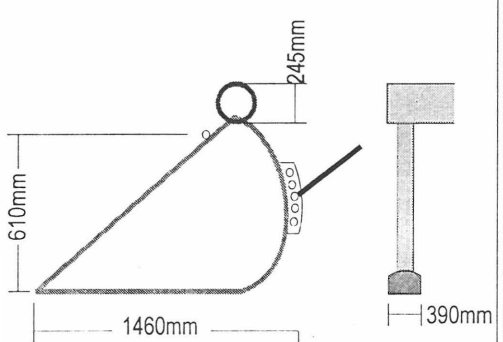
Sub-fleet 222-800kW - flatfish beam trawling - the beam trawl shoe (chainmat beam trawl)



Sub-fleet 222-800kW - flatfish beam trawling - the beam trawl shoe (tickler chain beam trawl)



Sub-fleet 801-1100kW - flatfish beam trawling - the beam trawl shoe (chainmat beam trawl)



Sub-fleet 801-1100kW - flatfish beam trawling - the beam trawl shoe (tickler chain beam trawl)

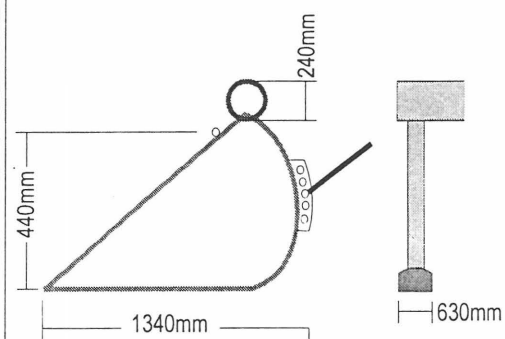
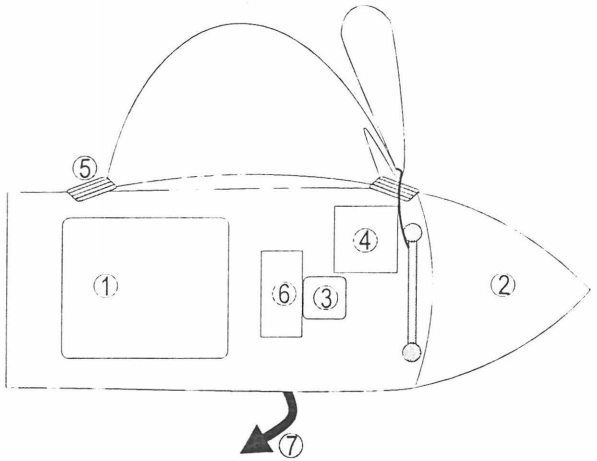


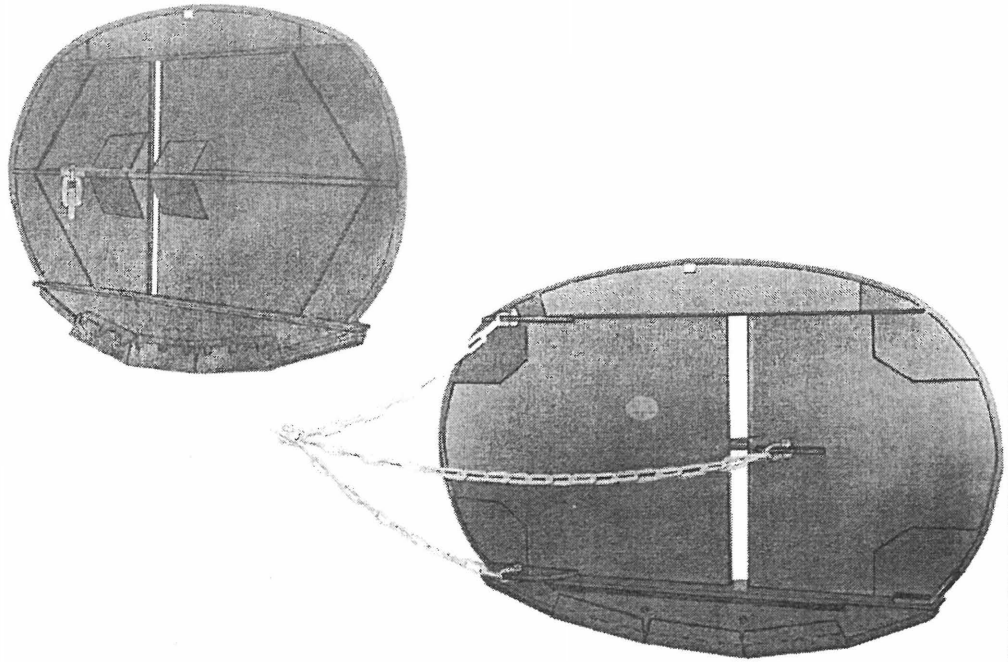
Figure 3B.4 - Flatfish beam trawling, sub-fleet 192 - 221kW

Sub-fleet 191-800kW -otter trawling - Deck lay-out side trawler

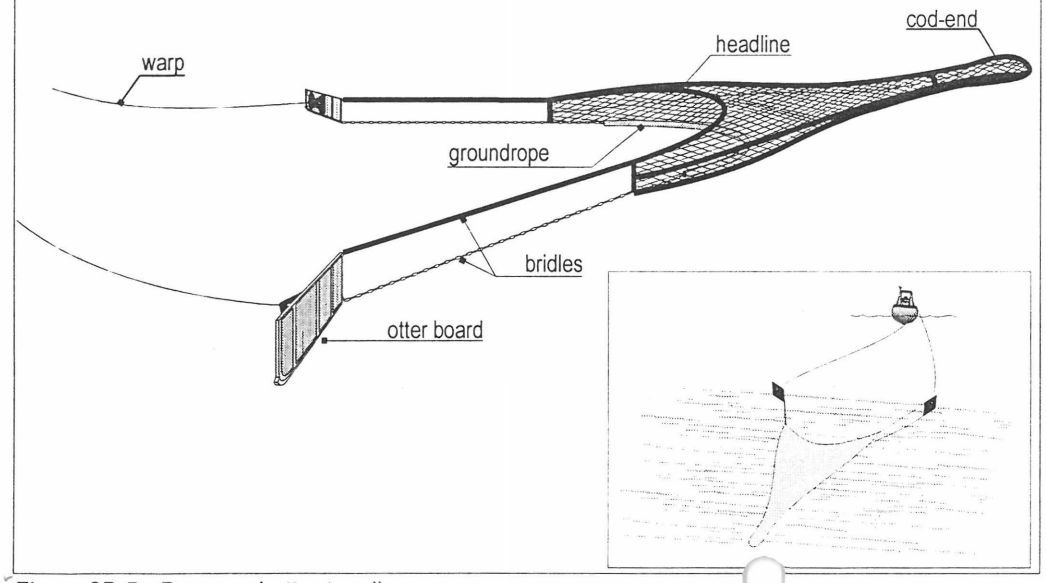
1: wheelhouse
2: covered front area
3: entrance to fish hold
4: catch collector box
5: otter board
6: sorting table
7: discards, manual surface disposal



Sub-fleet 191-800kW -otter trawling - example of an otter board



Sub-fleet 191-800kW -otter trawling - the *Nephrops single* otter trawl



Sub-fleet 191-800kW -otter trawling - the *Nephrops* twin otter trawl

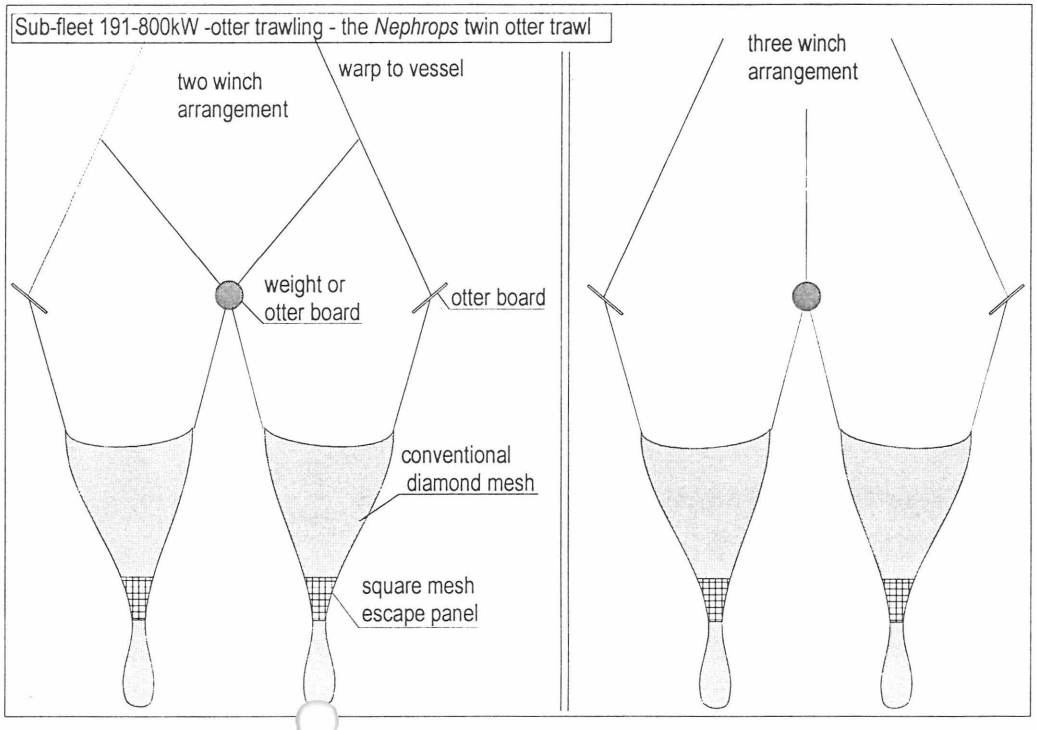


Figure 3B.5 - Demersal otter trawling