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Discards sampling of the Dutch beam trawl fleet in 2004

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Summary

The Dutch beam trawl fishery is one of the main fisheries in the southern North Sea, targeting plaice and sole. It has been recognized that sampling of discards is an important element of fisheries statistics and therefore discards sampling schemes have been set up in a European context.

This report contains results of the discards sampling program on the Dutch beam trawl fishery in the North Sea in 2004, which was instigated as part of the EC regulations 1543/2000 and 1639/2001 on data collection in European fisheries. 10 trips with beam trawl vessels were sampled, of which eight were with vessels larger than 300 HP fishing with 80 mm mesh size, one vessel fishing with 100 mm mesh size and one with a vessel of 300 HP fishing with 80 mm mesh size. Samples of the discards and landings were counted and measured and raised to catches per hour, per trip, per quarter and per year. The sampling is carried out as a pilot-survey (see annex of EC 1639/2001, chapter III, E1c).

The sampled fleet segment (beam trawlers with engine power larger than 300 HP fishing with 80 mm mesh size) is responsible for most plaice and sole landings. This indicates that the most important fleet segment has been covered by the discard sampling program. The spatial distribution of fishing effort of the Dutch beam trawl fleet larger than 300 HP and fishing with 80 mm mesh size is similar to the effort distribution in the discard sampling, except for the north western part of the distribution area.

The major fish species in the discards were dab and plaice. The percentage plaice discards in 2004 was around 81% in numbers and 50% in weight (one trip extra included) for large vessels fishing with 80mm mesh. For the large vessel fishing with 100mm the percentage plaice discards was 8% in number and 3% in weight, while for the eurocutter this was 81% in number and 45% in weight. The percentage discards for sole in weight was around 17% for large vessels fishing with 80mm and 4% for eurocutters.

The percentage discarding of plaice in 2004 appeared to be as high as in previous years 1999-2003 (about 75%-80% in number, 50% in weight), which is higher compared to the period 1976-1990 (42%-53% in numbers, 18%-31% in weight). There was no apparent trend in discard percentage of sole in number (25%) compared to previous years, while the percentage in weight was slightly higher (17% in 2004 against 14% in 2003).

Length frequency distributions showed that smaller plaice were being caught in recent periods compared to the 1970s and 1980s. This could be caused by a shift in spatial distribution of small plaice to more offshore areas, whereby they become vulnerable to the beam trawl fleet. The relatively strong 2001 year class, in 2004 at the age of 3, was still apparent in the discards fraction.

Samenvatting

De Nederlandse boomkor visserij is één van de belangrijkste visserijen in de zuidelijke Noordzee. De belangrijkste doelsoorten zijn schol en tong. Jonge vissen die kleiner zijn dan de minimum aanvoermaat worden hierbij weer overboord gezet, hetgeen discarding genoemd wordt. Het is algemeen erkend dat het bemonsteren van discards een belangrijk onderdeel is de visserij statistiek en om die reden zijn programma's voor de bemonstering van discards in een Europese context opgezet.

Dit rapport bevat de resultaten van het discardsbemonsteringsprogramma van de Nederlandse boomkorvisserij in de Noordzee in 2004, dat is opgezet als invulling van EC regelingen 1543/2000 en 1639/2001 voor gegevensverzameling in Europese visserijen. 10 reizen aan boord van boomkorschepen werden bemonsterd; acht aan boord van schepen met een motorvermogen groter dan 300 PK vissend met 80 mm maaswijdte, één aan boord van een schip met een motorvermogen groter dan 300 PK vissend met 100 mm maaswijdte en één aan boord van een eurokotter met een motorvermogen van 300 PK vissend met 80 mm maaswijdte. De discards en de aanlandingen werden geteld en gemeten en vervolgens opgewerkt tot vangsten per visuur, per reis, per kwartaal en per jaar. De bemonstering werd uitgevoerd als een "pilot-survey" (zie annex van EC 1639/2001, hoofdstuk III, E1c)

Het bemonsterde vlootsegment (boomkorschepen met een motorvermogen groter dan 300 PK met 80 mm maaswijdte) is verantwoordelijk voor de meeste schol en tong aanlandingen. Dit geeft aan dat het belangrijkste Nederlandse vlootsegment is bemonsterd. De ruimtelijke verdeling van de visserij-inspanning van de boomkorvisserij groter dan 300 PK vissend met 80 mm maaswijdte is vergelijkbaar met de verdeling van de visserij-inspanning in het bemonsteringsprogramma, met uitzondering van het noordwestelijke gedeelte van het verspreidingsgebied.

De discards in de boomkorvisserij bestaan voornamelijk uit schar en schol. Het percentage discards van schol was in 2004 voor grote schepen vissend met 80 mm rond de 81% in aantallen en 50% in gewicht (een extra reis opgenomen bij berekening van gewichtspercentage). Voor het grote schip vissend met 100 mm maaswijdte was het discardspercentage van schol 8% in aantal en 3% in gewicht, terwijl dit voor de eurokotter 81% in aantal en 45% in gewicht was. Voor tong was het percentage discards in gewicht ongeveer 17% voor grote kotters met 80 mm maaswijdte en 4% voor eurokotters.

Het percentage discards van schol in 2004 lijkt even hoog te zijn als in de afgelopen jaren 1999-2003 (ongeveer 75%-80% in aantal, 50% in gewicht), wat hoger is in vergelijking met de periode 1976-1990 (42%-53% in aantal, 18%-31% in gewicht). Er was geen duidelijke trend in percentage discards van tong in aantal (25%) vergeleken met de afgelopen jaren, terwijl het percentage in gewicht wat hoger was (17% in 2004 tegen 14% in 2003).

De lengteverdelingen van schol laten zien dat in recente periodes gemiddeld kleinere schol werd bijgevangen dan in de periode 1976-1990. Deze verandering hangt mogelijk samen met een verandering in de ruimtelijke verspreiding van ondermaatse schol, waardoor deze nu verder uit de kust voorkomt en daarom beschikbaar is voor de visserij. De relatief sterke 2001 jaarklas, 3 jaar oud in 2004, was stil aanwezig in de discards.

1. Introduction

Most demersal fisheries are mixed fisheries, targeting a limited number of species and sizes. In general other catches will be thrown overboard, a practice called discarding (Van Beek, 1998). Worldwide the annual fish catch was estimated at 84 million tonnes for 1992-2001 with a discard rate of 8 percent in weight, resulting in an estimated 7.3 million tonnes of discards worldwide (FAO, 2004). This estimate was lower than the previous estimate for 1988-1990 (Alverson et al., 1994), when worldwide discarding was estimated between 17.9 en 39.5 million tonnes annually. This reduction in discarding was due to the use of more selective fishing gears, introduction of bycatch and discard regulations and increased retention of bycatch for human or animal food (FAO, 2004).

Discarding can be highly variable in space and time caused by changing economic, biological, environmental or social factors (ICES, 2004b; Catchpole et al., 2005). There are many reasons for discards:

- specimens of commercial species below the minimum legal landing size
- over-quota fish which is not allowed to be landed when this result to exceeding legal quota
- bycatch species of no commercial value
- fish with an undesired quality, high-grading

Discarding leads to lower profits from fish stocks, because a large part of the discards will not survive the sorting process (Van Beek et al., 1990; Jennings and Kaiser, 1998). However, discards also form an important food item for other organisms like birds (Camphuysen and Garthe, 2000) and benthic invertebrates (Lindeboom and De Groot, 1998). Discarding, and most important variation in discarding, may result in bias in fish stock assessments when these assessment are based only on landings numbers at age (Pastoors et al., 2000). To date discards are only incorporated into a few stock assessments (ICES, 2002, 2004c, a) but the intention is to incorporate discards estimates for all stocks where relevant information becomes available.

One of the main fisheries in the southern North Sea is the Dutch beam trawl fishery, targeting mainly sole (*Solea solea*) and plaice (*Pleuronectes platessa*). Trips made with beam trawl vessels between 1976 and 1990 showed great variation in the quantity of plaice discarded (18-31% by weight (Van Beek, 1998). Recent sampling suggested that the percentage of plaice discarded has increased to around 50% in weight (80% in numbers) (Van Keeken et al., 2003; Van Keeken and Pastoors, 2004). Since the end of the 1990's a change in the distribution of smaller plaice towards deeper water occurred (ICES, 1999; Grift et al., 2004) making plaice more susceptible to commercial fishing (Pastoors et al., 2000; Grift et al., 2004). The discard percentage did also increased because of declining biomass of marketable fish (Pastoors et al., 2000; ICES, 2002).

From 1999 to 2001 discarding practices of the Dutch beam trawl fleet in the North Sea were monitored within an EC funded international research project (Anon., 2002). From 2002 onwards discards data have been collected under the EC Data Collection Regulations 1543/2000 and 1639/2001 (EC., 2000, 2001; Anon., 2002; ICES, 2003). This report gives an overview of the Dutch demersal discard sampling program for 2004, which was carried out as a pilot-survey (see annex of EC 1639/2001, chapter III, E1c).

2. Methods

2.1 Sampling procedures

Selection of the vessels is quasi-random and based on co-operative sampling (ICES, 2000). This means that co-operation of a skipper with the project is on voluntarily basis. On forehand it is difficult to predict the sampling location, since this depends on the fishing strategy of the skipper. However vessels from different regions are selected during a quarter to obtain widespread coverage. During 2004 a total of 9 trips were made on board beam trawl vessels with engine power larger than 300 HP (221 kW), eight of which were fishing with 80 mm mesh size and one with 100 mm. In addition one trip was conducted with a eurocutter with engine power up to 300 HP.
For a discard sampling trip, two observers went onboard a vessel, sampling at least 60% of the hauls (Van Beek, 2001). For each sampled haul, a sub-sample of the discards was measured. All fish were counted and measured. Benthic invertebrates were only counted. Total and sampled volume of discards was recorded. A sub-sample of the fish landed was measured, and total and sampled landings weight was recorded. If possible, otoliths were collected from the major discarded fish species (plaice, sole, dab, cod, whiting) for age readings. All data was entered into a computer program on haul-by-haul basis and later transported into the central database.

2.2 Raising procedures

This paragraph gives a short description of the raising procedures used to work up the raw data to annual estimates of discards in the beam trawl fleet. The raising procedures are the same as applied in previous years. A more mathematical description is given in Appendix I.

Sampled numbers of fish per haul were raised to numbers at length and at age for both discards and landings. Different raising procedures were used for discards and landings because different sources of information were available for these catch components. For the landings the total landed weight per species was available, while such data was not available for discards.

Discards were raised from sampled numbers in a haul to total numbers in a haul with the ratio of estimated haul volume to sampled haul volume. Total numbers per haul were summed over all sampled hauls in a trip and divided by duration of the sampled hauls to obtain total numbers discarded per hour per trip. Numbers were converted to weight using length-weight relationships.

Landings were raised from sampled numbers per haul to total numbers per trip with the ration of total landings weight in the trip to sampled landings weight. Total numbers landed were calculated by dividing total numbers in the trip by the trip duration. Landed weight per hour was calculated by dividing total landings weight by trip duration.

Numbers landed and discarded at length were calculated per period (quarter or year) by multiplying total numbers at length in a trip over the trips in this period and dividing this by total duration of the trips in this period. Numbers at age were calculated from numbers at length using age-length keys, which calculates the proportion of fish at length (l) with age (a). Numbers at age landed and discarded by the fleet were calculated by multiplying total numbers at age in the sampled trips with the ratio of total fleet effort to effort of sampled trips, both measured in effort corrected for engine power.

3. Results

3.1 Sampling

In 2004 a total of 10 trips with beam trawl vessels were sampled for discards. One trip was carried out on a small beam trawler of 221 KW (300 HP) using 80 mm mesh size, eight trips were carried out on large vessels with engine power between 1324-2133 KW (1797-2895 HP) using 80 mm mesh and one trip on a vessel with engine power of 2398 KW (3255 HP) using 100 mm mesh (Table 3.1.1).

The total number of hauls in the trips varied between 29 and 42, with an average fishing duration of 73 hours per trip (Table 3.1.2.). 82% of the hauls were sampled for discards and 54% for landings. Otoliths were collected from the discards samples for plaice (310 otoliths) and sole (109 otoliths).

Per quarter between 0.06% and 0.21% of the Dutch beam trawl fleet with engine power larger than 300 HP was sampled in HP effort (Table 3.1.3a). Fleet coverage by year was 0.16% in HP effort for the beam trawl fleet larger than 300 HP (Table 3.1.3a) and 0.09% for the beam trawl fleet with engine power of 300 HP (Table 3.1.3b).

The spatial distribution of fishing effort of the Dutch beam trawl fleet larger than 300 HP is shown in Figure 3.1.1a for the segment fishing with 80mm mesh, and in Figure 3.1.2a for the segment fishing with 100mm mesh and larger. Figure 3.1.3a shows the spatial distribution for beam trawl vessels of 300 HP. Effort of the beam trawl fleet larger than 300 HP is mainly distributed off-shore from the Dutch coast, while the effort of the smaller vessels is mainly distributed along the Dutch coast. The beam trawl fleet larger than 300 HP fishing with 100 mm mesh and larger are distributed more North compared with the segment fishing with 80 mm mesh.

The distribution of the sampled vessels are presented in Figures 3.1.1b, 3.1.2b and 3.1.3b for vessels larger than 300 HP fishing with 80mm and 100mm and for a vessel of 300 HP respectively. The distribution of the sampled vessels can be compared with the spatial distribution of fleet effort. The comparison of the beam trawl fleet larger than 300 HP indicate that the effort distribution in the discard sampling covers the major areas for the whole fleet, with exception of the areas above 53.5 N and left of 4 E. Because only one vessel larger than 300 HP with 100 mm mesh and one vessel of 300 HP were sampled, effort distributions could only be compared for few rectangles.

3.2 Numbers and weight

The total landings weight by trip for vessels larger than 300 HP fishing with 80mm mesh varied for plaice between 644 and 7785 kg and for sole between 411 and 3537 kg (Table 3.2.1a). For the trip with the large beam trawler fishing with 100mm mesh the landings weight of plaice was 7778 kg, while for the vessel of 300 HP the landings weight was 778 kg for plaice and 772 kg for sole. Sampled landings weight varied for plaice between 30 and 197 kg and for sole between 48 and 126 kg (Table 3.2.1b).

The average weight of all discards (both fish and invertebrate discards) was 32 tonnes per trip (CV 36%, Table 3.2.2) for vessels larger than 300 HP with 80mm mesh. Total discards for the vessel larger than 300 HP with 100mm mesh was 18 tonnes, while for the vessel of 300 HP total discards was 9 tonnes. For the large vessels with 80 mm, 19% of the catch in weight consisted of fish landed and 21% of fish discards (Figure 3.2a). Dab and plaice were the most abundant species in the discards (Table 3.2.3a, Figure 3.2). Brittle stars, common starfish, swimming crab and hermit crab were the most abundant benthos species (Table 3.2.3b).

3.3 Species

On average 3650 kg of plaice were discarded per trip for beam trawl vessels larger than 300 HP with 80 mm mesh (CV 60%, Table 3.2.2), while this was lower for the vessel with 100 mm mesh (217 kg) and the vessels of 300 HP (917 kg). The average number per hour discarded was 692 to 162 individuals landed for vessels with engine power larger than 300 HP with 80 mm mesh. This resulted in an average discard percentage of 81% in numbers (no data from trip R59) and 50% in weight (including data from R59). The discard percentage for the large vessel with 100 mm mesh was 8% in numbers and 3% in weight while for the vessel of 300 HP this was 81% in numbers and 45% in weight (Table 3.3.1). The average discard percentage per quarter for large vessels varied between 87% and 74% in numbers and 67% and 36% in weight (Table 3.3.2, trip R59 data included in weight).
The number discarded per rectangle per hour varied for a vessel of 300 HP between 206-233 (only two rectangles sampled, Figure 3.3.1a), for vessels larger than 300 HP with 80 mm mesh between 0-1607 (Figure 3.3.1b), and for the vessel with 100mm between 3 and 111 individuals (Figure 3.3.1c).
The peak of the discard length distribution was around 17 cm for the vessel of 300 HP (Table 3.3.3, Figure 3.4.1) and the vessels larger than 300 HP with 80 mm mesh (Table 3.3.3, Figure 3.4.2), while for the vessel with 100 mm mesh plaice were discarded at length of 18 cm and larger (Table 3.3.3, Figure 3.4.3). Plaice were discarded up to 30 cm in the vessels larger than 300 HP, whereas the minimum landing size is 27 cm.
Most discards were between ages 1 to 4, with most of the discards being age 1. Plaice from the strong 2001 yearclass were still discarded in large quantities, while most landings consisted of plaice from this yearclass (Table 3.3.4).
Landings and discards in numbers at age were raised to fleet level for vessels larger than 300 HP and are presented in Table 3.3.5.

Sole
On average 400 kg of sole were discarded per trip for beam trawl vessels larger than 300 HP with 80 mm mesh (CV 89%, Table 3.2.2). For all trips, landings were higher than discards both in numbers and in weight per hour (Table 3.3.6). The average discard percentage was 25% in number and 17% in weight for vessels larger than 300 HP with 80 mm mesh, and 9% in number and 4% in weight for the vessel of 300 HP. The large vessel with 100 mm mesh had no discards and minor landings. Per quarter the discard percentage in number varied between 18 and 27% in number and 9% and 20% in weight for vessels larger than 300 HP with 80 mm mesh (Table 3.3.7).
The peak of the discard length distribution was around 22 cm for vessels larger than 300 HP with 80 mm mesh (Table 3.3.8, Figure 3.4.1) and 21 cm for the vessel of 300 HP (Table 3.3.8, Figure 3.4.2). Sole were discarded up to 28 cm.
Most sole discards were between ages 1 and 3, with most discards being age 2 (Table 3.3.9). Landings and discards in numbers at age were raised to fleet level for vessels larger than 300 HP (Table 3.3.10).

Dab
On average 3700 kg of dab were discarded per trip for beam trawl vessels larger than 300 HP with 80 mm mesh (CV 30%, Table 3.2.2). On average 51 kg were discarded to 7 kg landed per hour for vessels larger than 300 HP with 80 mm mesh while 34 kg was discarded to 11 landed for the vessel with 100 mm (Table 3.3.11). The average discard percentage was 95% and 88% in numbers and 87% and 76% in weight for large vessels with 80 mm and 100 mm mesh respectively. The discard percentage for the vessel of 300 HP was 97% in number and 82% in weight, but quantities were much less compared to the larger vessels. Per quarter the discard percentage varied in weight between 83% and 91% in weight for large vessels (Table 3.3.12).

Cod

On average 15 kg of cod were discarded per trip for beam trawl vessels larger than 300 HP with 80 mm mesh (CV 143%, Table 3.2.2) and per hour less than 1 kg cod was discarded (Table 3.3.13). The average discard percentage was 8% in weight. The estimate however is highly uncertain because of the low catches, expressed by the discard percentage in weight per quarter varying between 0% and 43% for large vessels (Table 3.3.14).

Whiting

On average 163 kg of whiting were discarded for beam trawl vessels larger than 300 HP with 80 mm mesh (CV 112%, Table 3.2.2). For large vessels discards were higher than landings with less than 1 kg whiting landed to 2 kg discarded per hour for vessels with 80 mm mesh (Table 3.3.15). Discards per hour for the vessel of 300 HP was lower than 1 kg per hour. The average discard percentage, taking discards from all trips into account, was 100% in number and 92% in weight for large vessels. Per quarter the discard percentage in weight varied between 64% and 100% (Table 3.3.16).

4. Discussion

The discards sampling programme for the Dutch beam trawl fleet in 2004 was instigated as part of the EC regulations 1543/2000 and 1639/2001 on data collection in European fisheries. Results of the discard sampling on Dutch beam trawl vessels in 2004 were presented. A total of 10 trips were sampled, of which nine were on vessels with engine power larger than 300 HP and one on a vessel of 300 HP. The mesh size used during the trips was 80 mm, except for one trip with a vessel larger than 300 HP, when 100 mm was used. The sampling was carried out as a pilot-survey (see annex of EC 1639/2001, chapter III, E1c).

The discard sampling program of vessels larger than 300 HP covers the most important fleet fishing for North Sea plaice and sole. The fleet of vessels larger than 300 HP fishing with 80 mm mesh size is responsible for most of the plaice and sole landings. The spatial distribution of fishing effort of the Dutch beam trawl fleet larger than 300 HP and fishing with 80 mm mesh size is similar to the effort distribution in the discard sampling, except for the area in the north-western part of the southern North Sea.

Plaice is one of the two most important target species of the Dutch beam trawl fishery next to sole. The average discard percentage of plaice in 2004 was around 81% in numbers and 50% in weight. In the calculation of the discard percentage in weight one trip was included which was excluded in the discards percentage in numbers, because landings were not measured in number during this trip. While high-grading was not observed in the sampled trips, high-grading of adult plaice was reported at the end of 2004, mostly of smaller plaice, While the discard percentage in 2004 was still as high as for 2002-2003, the actual numbers landed and discarded were lower. During 2002-2003 the strong 2001 yearclass dominated the discards fraction. In 2004 at the age of 3 this yearclass was apparent in the discard fraction, but at lower amounts, while most of the landings consisted of this yearclass. Landings were lower compared to previous years, which could be a trip effect, due to lower quota, or an effect of effort reduction through limiting the number of fishing days per month. Effort reduction has been instigated to decrease fishing mortality. Because of the limitation in the number of days that fishermen can go out to sea, they can either choose between fishing closer to shore and thereby limiting their steaming time, or go out further to sea and limiting their fishing time. With increasing fuel prices in the latter part of 2004 the incentive to remain closer to the coast, the area with higher abundance of juveniles has increased.

The discard percentage observed over the last years is higher than during 1976-1990 (51% in numbers and 27% in weight, Table 4.1). Since the late 1990's a shift in spatial distribution of plaice is apparent, whereby relatively small plaice move towards deeper, more offshore water (Pastoors et al., 2000; Grift et al., 2004; Van Keeken et al., 2004), making the fish more vulnerable to the fishery. The size of the smallest plaice caught in recent discards trips outside the plaice box corresponded to those lengths at which plaice in the 1970s and '80s were only caught inside the 12-mile zone and the plaice box (Rijnsdorp and Van Beek, 1991; ICES, 1999; Van Keeken and Pastoors, 2004). Changes in plaice discard rates in the recent period were also caused by the decrease in landings (Table 4.1).

The discard percentage of sole in 2004 was within the range of discard percentages in earlier periods (Table 4.2). However the amount of sole discarded and landed has increased, partly due to a fairly large 2001 yearclass. The catches of cod were very low, as seen in previous years. It is very clear that the absolute numbers caught per hour has decreased substantially compared to the 1970s and 1980s (Van Keeken and Pastoors, 2004).

Up to 2003 discards have only been included into the stock assessments of haddock and whiting (ICES, 2002), but in 2004 a discards time series has also been used in the stock assessment of North Sea plaice. This time series was based on reconstructed discard estimates for 1957-1998 and recent observations from discards trips during 1999-2003 (ICES,

2004c; Van Keeken et al., 2005). The numbers of reconstructed plaice discards at age were calculated from corrected fishing mortality estimates F, using a simulated population based on growth measurements and selection and distribution ogives (ICES, 2004c; Van Keeken et al., 2005). Recent observations were derived from the Dutch sampling programme.

In 2004 the Dutch fisheries sector through "Productschap Vis" instigated a discards self-sampling programme (plaice only), whereby plaice discards were measured weekly onboard of 17 commercial beam trawl vessels by fishermen themselves (detailed by week and area) (Dekker and Van Keeken, 2005; Grift et al., 2005). Twice a week the volume of both discards and landings were measured from a haul. Discards percentages from the fisheries sector were compared with observations from the RIVO sampling programme in the same week, which were converted from weight into volume. The discards percentages observed by the fisheries sector matched the RIVO sampling with 1% difference, which is well within the confidence limits. The fisheries sector discards sampling programme covers the spatial and temporal variation, while research sampling yields the required level of detail and ensures the quality of the data. The combination of both sampling programmes will achieve an adequate sampling programme.

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Appendix I

Table I. Explanation of the abbreviations used in the formulas in appendix I.

	explanation	sub-script	explanation
n	sampled number	l	length
N	total number	h	haul
w	sampled weight	o	hour
W	total weight	t	trip
v	sampled discards volume	p	period
V	total discards volume	y	year
u	sampled duration	s	species
U	total duration	f	fleet
wt	sampled landings weight		
WT	total landings weight		
e	sampled fleet effort		
E	total fleet effort		
T	Number of trips		
DN	total discard number		
LN	total landings number		
CN	total catch number (landings and discards combined)		

Raising discards per trip

The sampled number per length and haul were raised per species to total number per length and haul

$$DN_{l,h,s} = \frac{V_h}{v_h} Dn_{l,h,s}$$

where $DN_{l,h,s}$ is the total number discarded at length (l) in haul (h) for species (s), V_h is total volume of haul (h), v_h is sampled volume of haul (h) and $Dn_{l,h,s}$ sampled number discarded at length (l) in haul (h) for species (s).

The total number discarded at length per haul and species was summed over the sampled hauls to obtain the total sampled number discarded at length (l) for species (s) over all sampled hauls (h). The total number discarded ($DN_{l,t,s}$) at length (l) per trip (t) and species (s) was calculated by multiplying the total number discarded ($DN_{l,h,s}$) over all sampled hauls with the ratio of total trip duration (U_t) and duration of all sampled hauls ($\sum u_h$):

$$DN_{l,t,s} = \frac{U_t}{\sum u_h} \sum_{h=i}^{h} DN_{l,h,s}$$

The number discarded at length per hour and species ($DN_{l,o,t,s}$) was calculated by dividing the total number at length per trip ($DN_{l,t,s}$) by total trip duration (U_t).

$$DN_{l,o,t,s} = \frac{DN_{l,t,s}}{U_t}$$

The obtained number discarded at length per hour ($DN_{l,o,t,s}$) was summed over length to obtain the number discarded per hour ($DN_{o,t,s}$):

$$DN_{o,t,s} = \sum_{l=i} DN_{l,o,t,s}$$

Discarded weight per hour per species at length was calculated using length-weight relationships:

$$DW_{l,o,t,s} = \sum_{l} \left(\frac{DN_{l,o,t,s} * A_s * l^{Bs}}{U_t} \right)$$

where $DW_{l,o,t,s}$ is the weight per length, per hour and per species, $DN_{l,o,t,s}$ is the number discarded at length, per hour and per species and A_s and B_s species specific constants.

The variance over the total weight of all discards combined per trip $VAR(DW_y)$ was calculated per year (Anon. 2003):

$$Var(DW_y) = \sum_{t} VAR(DW_{t,y})$$

where $DW_{t,y}$ is the total weight of all discards in a trip.

Second the variance over the total weight per species per trip $VAR(DW_{y,s})$ was calculated per year:

$$Var(DW_{y,s}) = \sum_{t} VAR(DW_{t,y,s})$$

where $DW_{t,y,s}$ is the total weight of a species discarded in a trip.

Raising landings per trip

The sampled number landed at length per haul and species ($Ln_{l,h,s}$) were summed over all sampled hauls (h) to calculate the sampled number at length for the trip ($n_{l,t,s}$). The total number landed at length for the entire trip ($LN_{l,t,s}$) was calculated by multiplying the sampled number at length for the trip ($Ln_{l,t,s}$) with the ratio of total trip weight obtained from auction or VIRIS data ($WT_{t,s}$) to sampled landings weight of the trip ($wt_{t,s}$):

$$LN_{l,t,s} = \frac{WT_{t,s}}{wt_{t,s}} \left(\sum_{h=i}^{h} Ln_{l,h,s} \right)$$

Number landed at length per hour per species ($LN_{l,o,t,s}$) was calculated by dividing total number landed at length per trip ($LN_{l,t,s}$) by the trip duration (U_t).

$$LN_{l,o,t,s} = \frac{LN_{l,t,s}}{U_t}$$

The obtained total number at length per hour ($LN_{l,o,t,s}$) was summed to calculate number per hour per species ($LN_{o,t,s}$):

$$LN_{o,t,s} = \sum_{l=i} LN_{l,o,t,s}$$

Total landings weight per hour ($LW_{o,t,s}$) was calculated per species by dividing total landings weight ($WT_{t,s}$) per species by total trip duration (U_t).

$$LW_{o,t,s} = \frac{WT_{t,s}}{U_t}$$

Numbers at length, per quarter and year

The number of discards and landings ($CN_{l,o,p,s}$) at length per hour was calculated per quarter/year by summing the total number landings or discards at length per trip ($CN_{l,t,s}$) over all trips in that period (p) and then dividing this by the sum of the duration of all trips (U_t) in this period:

$$CN_{l,o,p,s} = (\sum_{p} CN_{l,t,s}) / \sum_{p} U_t$$

Confidence limits around length-frequency distributions show weighted standard deviation ($VAR(CN_{l,o,p,s})$):

$$VAR(CN_{l,o,p,s}) = \sqrt{\left[\left(T_t /(T_y - 1)\right) * \frac{\sum_{l} \left[(N_{l,o,t} - N_{l,o,y})^2 * (U_t)^2 \right]}{U_y} \right]}$$

where T_y is the number of trips per year, $N_{l,o,t}$ the number at length per hour and trip, $N_{l,o,y}$ the number at length per hour and year, U_t trip duration and U_y total duration over all sampled trips in the concerning year (Sokal & Rohlf, 1981).

Total numbers discards or landings ($CN_{o,p,s}$) were calculated by summing over length. Trip duration data was excluded from calculation numbers per hour per period if landings were not measured during a trip, but auction records existed for this species.

$$CN_{o,p,s} = \sum_{l=i} CN_{l,o,p,s}$$

Numbers at age, per quarter and year

The age structure of both plaice and sole discard and landings was calculated by distribution of numbers at length over age groups using age-length-keys (ALK). The number landed and discarded ($CN_{l,a,t,s}$) at length and age per trip and species was calculated by distribution of the proportion ($f_{l,a}$) of fish at length (l) with age (a) over the number ($CN_{l,t,s}$) at length per trip and species. Because $f_{l,a}$ is dependent on the period, ALK were taken from discards and market samples from the quarter were discards were sampled.

$$CN_{l,a,t,s} = f_{l,a} * CN_{l,t,s}$$

The number landed and discarded ($CN_{a,t,s}$) at age per trip and species was calculated by multiplying the number landed and discarded ($CN_{l,a,t,s}$) at length and age per trip and species over length:

$$CN_{a,t,s} = \sum_{l=i} CN_{l,a,t,s}$$

The number of discards and landings ($CN_{a,o,p,s}$) at age per hour was calculated per quarter/year by summing the total number landings or discards at age per trip ($CN_{a,t,s}$) over all trips in that period (p) and then dividing this by the sum of the duration of all trips (U_t) in this period:

$$CN_{a,o,p,s} = (\sum_{p} CN_{a,t,s}) / \sum_{p} U_t$$

The variance of the numbers at age per species per trip $VAR(DN_{a,y,,s})$ was calculated per year (for the major species) as:

$$Var(DN_{a,y,s}) = \sum_{t} VAR(DN_{a,y,s,t})$$

where $DN_{a,y,s,t}$ is the total weight of a species discarded in a trip.

Numbers at age, per quarter and year per fleet

Total landings en discards ($CN_{a,p,s,f}$) at age per quarter/year were calculated for the entire fleet by multiplying the total numbers of discards and landings ($N_{a,p,s}$) at age per quarter/year with the ratio effort of the entire fleet ($E_{p,f}$) per quarter/year measured in Hpeffort (proportion fishing duration per day multiplied with engine power) to the effort of the sampled part of the fleet in Hpeffort per quarter ($e_{p,f}$).

$$CN_{a,p,s,f} = \frac{E_{p,f}}{e_{p,f}} CN_{a,p,s}$$

Trip duration data was excluded from calculation numbers per hour per period if landings were not measured during a trip, but auction records existed for this species.

Tables and Figures

Table 3.1.1. Characteristics per trip. For each vessel the engine power in KW, the mesh size in mm and sampled ICES rectangles are presented.

Vessel	KW	Mesh	Quarter	Sampled ICES rectangles
R56	221	80	3	34/F4, 35/F4
R51	1324	80	1	32/F3, 33/F3, 34/F3,
R52	1681	80	2	34/F3, 34/F4, 35/F3,
R53	1471	80	2	33/F3, 33/F4, 34/F3, 34/F4
R54	1471	80	2	34/F3, 35/F2, 35/F3,
R57	1470	80	3	33/F3, 33/F4, 34/F3, 35/F3
R58	1467	80	4	34/F3, 34/F4, 35/F3, 35/F4
R59	1471	80	4	37/F4, 37/F5, 37/F6, 38/F4, 38/F6, 39/F5, 39/F6
R60	2133	80	4	34/F4, 35/F4, 36/F4, 37/F4, 37/F6, 37/F7, 38/F5, 38/F6, 39/F5, 39/F6
R55	2398	100	3	38/F1, 39/F1, 39/F2, 39/F4, 39/F5, 40/F2, 40/F3, 40/F4

Table 3.1.2. Sampling effort per trip. For each trip the duration and number of hauls sampled for landings and discards and total duration and number of hauls for the total trip are given, and the number of plaice and sole otoliths taken from the discard fraction.

HP		Number of hauls			Duration (hour)			Plaice	Sole
class	Vessel	Land	Disc	Tot	Land	Disc	Tot	Otolith	Otolith
300	R56	18	33	40	34	62	75	32	10
>300	R51	18	26	37	36	52	74	46	12
	R52	20	32	38	35	56	66	38	13
	R53	20	25	29	40	50	59	25	17
	R54	27	35	41	53	69	80	31	26
	R57	29	36	42	53	66	77	38	11
	R58	11	32	40	20	57	71	32	14
	R59	0	26	39	0	55	82	34	-
	R60	33	36	37	68	74	75	34	6
	R55	29	29	35	62	62	74	-	-
	Total	**205**	**310**	**378**	**401**	**603**	**733**	**310**	**109**
	% Total	**54%**	**82%**		**55%**	**82%**			

Table 3.1.3a. Sampling effort in days at sea (D.A.S.) and hp-effort (HPeff, days at sea corrected for engine power) per trip and per quarter for the sampled trips and for the fleet larger than 300 HP and fleet coverage by the sampled trips in 2004.

		Sampled effort		Fleet effort		Fleet coverage	
Quarter	**Vessel**	**D.A.S.**	**HPeff**	**D.A.S.**	**HPeff**	**D.A.S.**	**HPeff**
1	R51	4	7,200				
	Total	4	7,200	5,053	11,402,704	0.08%	0.06%
2	R52	4	9,144				
	R53	3	6,000				
	R54	4	8,000				
		11	23,144	5,472	12,412,577	0.20%	0.19%
3	R55	4	13,040				
	R57	4	7,996				
	Total	8	21,036	4,827	10,875,531	0.17%	0.19%
4	R58	3	5,985				
	R59	4	7,980				
	R60	4	11,600				
	Total	11	25,565	5,381	12,028,169	0.20%	0.21%
All	Total	34	76,945	20,733	46,718,981	0.16%	0.16%

Table 3.1.3b. Sampling effort in days at sea and hp-effort (days at sea corrected for engine power) per trip, and per quarter for the sampled trip and for the fleet of 300 HP and fleet coverage by the sampled trip in 2004.

		Sampled effort		Fleet effort		Fleet coverage	
Quarter	**Vessel**	**D.A.S.**	**HPeff**	**D.A.S.**	**HPeff**	**D.A.S.**	**HPeff**
1	Total			686	205,828		
2	Total			1,563	468,896		
3	R56	4	1,200				
	Total	4	1,200	1,260	378,054	0.32%	0.32%
4	Total			947	284,187		
All	Total	4	1,200	4,457	1,336,965	0.09%	0.09%

Table 3.2.1a. Total landings weight per trip for the plaice, sole, cod, whiting, dab, turbot and brill for a beam trawl vessel of 300 HP (vessel R56), beam trawl vessels larger than 300 HP with 80mm cod-end mesh size and a beam trawl vessel larger than 300 HP with 100mm cod-end mesh size (vessel R55).

HP	Mesh	Vessel	Quar	Plaice	Sole	Cod	Whiting	Dab	Turbot	Brill
300	80	R56	3	1184	837	0	0	57	68	22
>300	80	R51	1	4535	1789	711	18	400	117	102
		R52	2	1085	2495	7	21	389	193	109
		R53	2	644	1626	63	25	214	118	33
		R54	2	2855	1949	13	41	545	164	47
		R57	3	2443	3050	12	0	838	128	69
		R58	4	3410	3537	23	0	263	232	147
		R59	4	7785	411	175	0	686	315	146
		R60	4	6864	1249	403	7	1017	510	155
>300	**80**		**All**	**29621**	**16106**	**1407**	**112**	**4352**	**1777**	**808**
>300	100	R55	3	7778	30	11	0	798	172	67

Table 3.2.1b. Sampled landings weight per trip for the plaice, sole, cod, whiting, dab, turbot and brill for a beam trawl vessel of 300 HP (vessel R56), beam trawl vessels larger than 300 HP with 80mm cod-end mesh size and a beam trawl vessel larger than 300 HP with 100mm cod-end mesh size (vessel R55).

HP	Mesh	Vessel	Quar	Plaice	Sole	Cod	Whiting	Dab	Turbot	Brill
300	80	R56	3	82	73	0	0	3	0	0
>300	80	R51	1	78	126	0	0	28	0	0
		R52	2	66	48	0	0	23	9	4
		R53	2	110	94	45	0	0	0	0
		R54	2	147	116	0	0	67	0	0
		R57	3	171	59	0	0	0	0	0
		R58	4	30	62	0	0	0	0	0
		R59	4	0	0	0	0	0	0	0
		R60	4	159	118	0	0	25	0	0
>300	**80**		**All**	**760**	**623**	**45**	**0**	**143**	**9**	**4**
>300	100	R55	3	197	0	0	0	82	0	0

Table 3.2.2. Total weight (kg) of all discards (fish and benthos) and of plaice, sole, dab, cod and whiting for a beam trawl vessel of 300 HP and of vessels larger than 300 HP with 80mm and 100mm mesh by trip and summed over trips.

HP class	Mesh	Vessel	All discards	Plaice	Sole	Dab	Cod	Whiting
300	80	R56	9154	971	37	259	0	2
			9154	**971**	**37**	**259**	**0**	**2**
>300	80	R51	15512	5548	197	1978	2	32
		R52	24552	6330	540	5088	3	170
		R53	21607	1814	547	3903	59	505
		R54	40787	1083	320	3314	0	375
		R57	48046	4404	320	4987	0	24
		R58	29761	5959	1146	4560	6	129
		R59	31556	1133	12	2612	15	32
		R60	44975	2966	107	3361	36	38
		Mean	**32099**	**3654**	**399**	**3725**	**15**	**163**
		CV (%)	**36.17**	**60**	**89**	**30**	**143**	**112**
>300	100	R55	17752	217	0	2504	8	3
		Mean	**17752**	**217**	**0**	**2504**	**8**	**3**

Table 3.2.3a. Numbers of fish discarded per hour in 2004 for a beam trawl vessel of 300 HP and larger than 300 HP fishing with 80mm and 100mm mesh size.

English name	Dutch name	300 HP 80mm	>300 HP 80mm	>300HP 100mm
Ammodytes sp.	Ammodytes	0.21	11.7	11.2
Bib	Steenbolk		1.7	
Brill	Griet	0.35	0.42	
Bull-rout	Zeedonderpad	3.5	1.4	0.4
Cod	Kabeljauw		2.7	0.9
Dab	Schar	64.8	1036.7	512.4
Dragonet	Pitvis	6.9	70.5	8.0
Flounder	Bot	0.37	2.0	
Four-bearded rockling	Vierdradige meun		7.2	
Garfish	Geep		0.15	
Greater pipefish	Grote zeenaald	0.21		
Greater sand-eel	Smelt	5.4	10.1	0.24
Grey gurnard	Grauwe poon	1.0	18.3	38.6
Hake	Heek			0.30
Herring	Haring		1.0	
Hooknose	Harnasmannetje	0.6	8.1	3.0
Horse mackerel	Horsmakreel		4.3	
John Dory	Zonnevis		0.07	
Lemon sole	Tongschar	0.7	3.0	27.7
Lesser spotted dogfish	Hondshaai		0.19	
Lesser weever	Kleine pieterman	2.7	41.7	0.6
Long rough dab	Lange schar		2.4	2.7
Mackerel	Makreel		0.11	
Norway pout	Kever		0.22	
Norwegian topknot	Dwergbot		0.12	
Plaice	Schol	230.4	692.2	23.2
Pomatoschistus sp.	Grondel		0.32	
Poor cod	Dwergbolk	0.18	0.26	
Red gurnard	Engelse poon		0.11	
Reticulated dragonet	Rasterpitvis		0.80	0.50
Roker	Stekelrog		0.24	6.7
Sand goby	Dikkopje		0.92	
Scaldfish	Schurftvis	14.4	116.5	21.2
Sole	Tong	5.7	57.8	
Solenette	Dwergtong	34.9	115.5	28.5
Spotted dragonet	Gevlekte pitvis			0.13
Sprat	Sprot		1.3	
Starry ray	Sterrog			9.4
Striped red mullet	Mul	0.55	1.8	
Tub gurnard	Rode poon	2.8	8.5	
Turbot	Tarbot	0.92	0.3	
Twaite shad	Fint		0.06	
Whiting	Wijting	0.63	45.9	1.2
Witch	Witje		0.03	

Table 3.2.3b. Numbers of benthic species discarded per hour in 2004 for a beam trawl vessel of 300 HP and larger than 300 HP fishing with 80mm and 100mm mesh size.

Latin name	Dutch name	300 HP 80mm	>300 HP 80mm	>300HP 100mm
Acanthocardia echinata	Gedoornde Hartschelp		72.6	10.0
Aequipecten opercularis	Wijde mantel		0.79	11.5
Alcyonidium diaphanum	Hanenkam		0.39	24.3
Alcyonium digitatum	Dodemansduim		0.29	3.6
Alloteuthis subulata	Dwergpijlinktvis		0.06	0.25
Anthozoa	Zeeanemonen	7.7	0.20	0.38
Aphrodita aculeata	Fluwelen zeemuis		107.8	159.3
Arctica islandica	Noordkromp		8.5	9.3
Ascidiacea	Zakpijp			0.32
Asterias rubens	Zeester	1600.0	2205.5	240.2
Astropecten irregularis	Kamster	93.7	3487.0	3086.0
Buccinum undatum	Wulk		34.5	146.7
Callinectes sapidus	Blauwe zwemkrab		0.13	
Cancer pagurus	Noordzeekrab	18.6	5.1	10.3
Carcinus maenas	Strandkrab	36.4	0.51	
Chamelea galena	Venusschelp	32.0		
Corystes cassivelaunus	Helmkrab	117.6	409.5	122.7
Crangon crangon	Gewone garnaal		7.9	
Crangon sp.	Garnaal	3.3	21.7	
Cyanea lamarckii	Blauwe haarkwal	41.2		
Donax vittatus	Zaagje			0.22
Echinidae	Zeeegels	2.3	390.4	0.61
Echinocardium cordatum	E. cordatum		274.9	71.7
Ensis ensis	Kleine zwaardschede		0.69	0.24
Ensis sp.	Ensis	24.9	1.9	
Gele spons	Gele spons		2.0	2.6
Goneplax rhomboids	G. rhomboides		0.35	
Hyas sp.	Spinkrab		0.04	2.0
Liocarcinus depurator	Blauwpootzwemkrab		1.3	2.4
Liocarcinus holsatus	Gewone zwemkrab	638.6	2950.6	236.8
Liocarcinus marmoreus	Gemarmerde zwemkrab	8.7	8.3	
Lithodes maja	Augustinuskrab		0.95	
Loligo sp.	Loligo		1.5	0.34
Luidia ciliaris	L. ciliaris		7.7	0.18
Luidia sarsi	L. sarsi			0.20
Luidia sp.	Luidia			9.1
Lunatia alderi	Glanzende tepelhoorn		4.7	4.3
Macoma balthica	Nonnetje		0.14	
Macropipus sp.	Zwemkrabben			7.7
Macropodia rostrata	Hooiwagenkrab		0.43	
Mytilus edulis	Mossel		1.6	
Necora puber	Fluwelen zwemkrab	37.6	4.7	0.10
Nephrops norvegicus	Noorse kreeft		52.1	
Neptunea antiqua	Noordhoorn		0.23	2.3
Octopus vulgaris	Octopus			0.43

Table 3.2.2b. Continued

Latin name	Dutch name	300 HP 80mm	>300 HP 80mm	>300HP 100mm
Ophiotrhix fragilis	Brokkelster		0.16	
Ophiura ophiura	Slangster	3070.8	2343.5	12.3
Pagurus bernhardus	P. bernhardus		76.3	
Pagurus sp.	Heremietkreeft	384.6	501.8	210.3
Pandalus montagui	Ringsprietgarnaal		0.09	
Pecten maximus	St. Jacobsschelp		0.40	
Pilumnus hirtellus	Ruig krabbetje		0.65	
Psammechinus miliaris	Zeeappel		23.9	223.6
Scrobicularia plana	Platte slijkgaper		0.04	
Sepia officinalis	Zeekat		0.13	
Spisula sp.	Spisula		2.9	
Venerupis pullastra	Tapijtschelp		0.23	

Table 3.3.1. Plaice. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for a beam trawl vessels of 300 HP and beam trawl vessels larger than 300 HP with 80mm or 100mm mesh size.

				Numbers			Weight		
HP class	**Mesh**	**Vessel**	**Quart**	**L**	**D**	**%D**	**L**	**D**	**%D**
300	80	R56	3	56	230	81	16	13	45
			all	**56**	**230**	**81**	**16**	**13**	**45**
>300	80	R51	1	318	895	74	61	75	55
		R52	2	106	1266	92	16	96	85
		R53	2	41	644	94	11	31	74
		R54	2	132	169	56	36	13	27
		R57	3	115	750	87	32	57	64
		R58	4	158	1180	88	48	84	64
		R59	4		159		96	14	13
		R60	4	237	642	73	91	39	30
			all	**162**	**692**	**81**	**51**	**50**	**50**
	100	R55	2	269	23	8	105	3	3
			all	**269**	**23**	**8**	**105**	**3**	**3**

Table 3.3.2. Plaice. Landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessel larger than 300 HP. In quarter 4 numbers were available for 2 trips, weight for 3 trips.

	Numbers			Weight		
Quarter	**L**	**D**	**%D**	**L**	**D**	**%D**
1	318	895	74	61	75	55
2	98	658	87	22	45	67
3	115	750	87	32	57	64
4	199	637	76	79	44	36

Table 3.3.3. Plaice. Number landed and discarded per hour per length class (with weighted standard deviation in *italics*) for a beam trawl vessel of 300 HP with 80mm mesh, for beam trawl vessels larger than 300HP with 80mm mesh and for a beam trawl vessel lager than 300HP with 100mm mesh.

Length	300HP, 80mm		>300 HP, 80mm				>300HP, 100mm	
(cm)	Disc	Land	Disc	Std	Land	Std	Disc	Land
10	0.2		0.7	*0.4*				
11	0.5		2.1	*1.1*				
12	0.5		5.7	*3.0*				
13	0.4		20.6	*9.0*				
14	0.5		25.3	*10.9*				
15	1.1		37.0	*11.1*				
16	6.0		51.4	*12.0*				
17	21.8		72.8	*19.4*				
18	41.3		72.4	*23.1*			0.2	
19	52.0		63.9	*17.1*			0.3	
20	32.6		69.3	*16.6*			0.8	
21	19.8		56.5	*14.6*			1.1	
22	11.8		56.9	*17.2*			2.7	
23	9.5		50.4	*12.2*	<0.1	*<0.1*	3.4	1.1
24	6.0		43.7	*11.4*	<0.1	*<0.1*	3.7	0.5
25	7.6	0.2	36.6	*9.9*	0.2	*0.2*	6.2	1.6
26	8.9	2.9	18.9	*6.6*	3.1	*1.1*	3.1	2.7
27	6.5	8.7	5.8	*2.3*	19.3	*4.8*	0.7	10.1
28		9.9	1.1	*0.4*	23.5	*6.3*	0.8	15.5
29		7.2	0.3	*0.1*	23.4	*6.5*		19.7
30		7.0	0.2	*0.2*	18.1	*4.8*	0.2	33.6
31		4.8	0.1	*0.1*	11.5	*3.1*		24.6
32		5.2			10.1	*3.1*		24.6
33		3.1			8.0	*2.6*		20.3
34		2.7			7.4	*2.6*		25.1
35		1.2			3.7	*1.2*		21.3
36		0.8			3.2	*1.3*		14.4
37		1.2			1.9	*0.6*		19.2
38		0.4			1.8	*0.7*		8.5
39		0.2			1.0	*0.4*		6.4
40		0.2			0.8	*0.3*		2.1

Table 3.3.3. Continued.

Length	300HP, 80mm		>300HP, 80mm				>300HP, 100mm	
(cm)	Disc	Land	Disc	Std	Land	Std	Disc	Land
41		0.2			0.9	*0.4*		6.4
42					0.4	*0.2*		2.1
43					0.6	*0.4*		3.2
44					0.1	*0.1*		2.1
45					0.3	*0.2*		1.6
46					<0.1	*<0.1*		0.5
47					<0.1	*<0.1*		
48								
49					<0.1	*<0.1*		0.5
50					0.9	*0.4*		0.5
53					0.1	*0.1*		
56								0.5

Table 3.3.4. Plaice. Numbers landed (L) and discarded (D) at age per hour and per quarter and year, and discard coefficient of variation (CV) at age per year.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Year	
Age	D	L	D	L	D	L	D	L	D	L
0			1.9		1.0		0.6		1.1	
1	318.5		217.5		339.0		503.1	0.6	357.9	0.2
2	321.4	19.0	247.7	6.5	327.0	42.4	61.4	17.2	194.7	17.0
3	253.0	98.4	188.5	52.5	82.0	61.1	69.4	85.7	136.1	72.4
4	1.3	104.8	4.1	14.4	0.8	7.6		9.8	1.7	23.1
5	0.4	43.4	0.3	11.9		3.4	2.7	8.3	1.2	13.4
6	0.2	26.3	0.1	6.9				3.9	0.1	7.3
7		10.8		1.8				0.8		2.3
8		14.4		2.4		0.4		1.0		3.1
9		0.2		0.2				0.2		0.2
10		0.8		0.9				0.2		0.5

Table 3.3.5. Plaice. Landings (L) and discards D) raised estimates of total fleet numbers (*1000) and mean length (left), total weight (*1000) and mean weight (right) at age per quarter.

		Numbers (*1000)		Mean length		Weight (*1000)		Mean_weight	
Quarter	age	D	L	D	L	D	L	D	L
1	0								
	1	37087		16.70		1566		0.042	
	2	37429	2215	21.85	27.44	3554	410	0.095	0.185
	3	29458	11458	23.70	28.99	3560	2551	0.121	0.223
	4	154	12204	29.00	30.06	34	3039	0.219	0.249
	5	47	5057	30.00	32.14	11	1550	0.242	0.306
	6	26	3061	28.00	31.38	5	891	0.196	0.291
	7		1259		34.75		486		0.386
	8		1682		33.71		598		0.356
	9		27		41.00		17		0.622
	10		91		53.00		124		1.354
	all	104200	37054	20.55	30.35	8731	9664	0.084	0.261
2	1	198		9.71		2		0.008	
	2	22117		14.72		650		0.029	
	3	25183	665	19.41	28.23	1752	135	0.070	0.202
	4	19165	5341	23.00	29.12	2114	1202	0.110	0.225
	5	420	1459	24.57	30.91	56	399	0.134	0.273
	6	27	1211	28.09	31.57	5	351	0.200	0.290
	7	7	706	29.38	32.41	1	227	0.229	0.321
	8		182		36.25		80		0.439
	9		243		34.18		92		0.378
	10		23		40.07		14		0.600
	all	67116	9921	18.90	30.19	4581	2533	0.068	0.255
3	1	102		7.23		1		0.008	
	2	34431		17.56		1670		0.049	
	3	33215	4309	21.94	28.31	3187	882	0.096	0.205
	4	8329	6202	23.35	29.44	954	1455	0.115	0.235
	5	86	768	27.00	27.28	15	141	0.176	0.184
	6		344		34.58		129		0.375
	7								
	8								
	9		38		45.00		31		0.826
	10								

Table 3.3.5. Continued.

	all	76163	11662	20.10	29.08	5828	2639	0.077	0.226
4	0	65		9.43		0		0.007	
	1	53380	63	18.19	26.00	2972	10	0.056	0.157
	2	6517	1824	23.04	29.12	714	409	0.110	0.224
	3	7364	9093	24.27	30.34	949	2324	0.129	0.256
	4		1035		34.68		398		0.385
	5	286	882	26.00	34.92	45	355	0.157	0.402
	6		414		31.83		126		0.306
	7		87		40.96		54		0.621
	8		102		42.31		70		0.689
	9		18		43.00		13		0.719
	10		20		45.00		17		0.825
	all	67612	13539	19.35	31.03	4680	3776	0.069	0.279
all	0	364		9.33		3		0.008	
	1	147015	63	17.20	26.00	6859	10	0.048	0.157
	2	102344	9014	20.93	28.50	9207	1836	0.086	0.209
	3	64317	32094	23.45	29.70	7578	7532	0.117	0.240
	4	659	15466	25.15	30.88	105	3977	0.145	0.274
	5	359	7494	26.33	32.72	61	2384	0.164	0.327
	6	32	4180	28.62	31.82	7	1244	0.211	0.304
	7		1528		36.02		620		0.433
	8		2065		35.06		792		0.409
	9		67		41.34		43		0.649
	10		203		39.88		175		0.648
	all	315092	72175	19.50	30.42	23819	18613	0.072	0.262

Table 3.3.6. Sole. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for a beam trawl vessels of 300 HP and beam trawl vessels larger than 300 HP with 80mm or 100mm mesh size.

				Numbers			Weight		
HP class	**Mesh**	**Vessel**	**Quart**	**L**	**D**	**%D**	**L**	**D**	**%D**
300	80	R56	3	60	6	9	11	<1	4
			all	**60**	**6**	**9**	**11**	**<1**	**4**
>300	80	R51	1	144	40	22	24	3	10
		R52	2	271	89	25	38	8	18
		R53	2	140	84	37	28	9	25
		R54	2	155	40	20	24	4	14
		R57	3	187	41	18	40	4	9
		R58	4	270	169	39	50	16	24
		R59	4		2		5	<1	3
		R60	4	61	20	24	17	1	8
			all	**174**	**58**	**25**	**28**	**5**	**17**
	100	R55	2		0		<1	0	0
			all		**0**		**<1**	**0**	**0**

Table 3.3.7. Sole. Landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for large vessels.

	Numbers			Weight		
Quarter	**L**	**D**	**%D**	**L**	**D**	**%D**
1	144	40	22	24	3	10
2	188	68	27	30	7	19
3	187	41	18	40	4	9
4	163	60	27	23	6	20

Table 3.3.8. Sole. Number landed and discarded per hour per length class (with weighted standard deviation in *italics*) for a beam trawl vessel of 300 HP with 80mm mesh and for beam trawl vessels larger than 300HP with 80mm mesh.

Length	300HP, 80mm		>300 HP, 80mm			
(cm)	Disc	Land	Disc	Std	Land	Std
10			0.3	*0.3*		
11			0.1	*0.1*		
12						
13			0.2	*0.2*		
14			0.3	*0.3*		
15			0.8	*0.6*		
16			1.3	*0.7*		
17			0.9	*0.6*		
18	0.5		1.5	*0.3*		
19	0.2		3.1	*1.4*		
20	0.4		5.9	*2.4*		
21	2.4		11.2	*4.9*	0.2	*0.1*
22	2.1	0.6	16.4	*6.4*	0.2	*0.1*
23	0.2	4.0	9.3	*3.8*	2.5	*1.0*
24		7.4	3.9	*1.5*	18.0	*5.8*
25		10.5	1.3	*0.4*	27.4	*6.9*
26		8.3	0.8	*0.5*	22.2	*5.4*
27		7.1	0.2	*0.1*	21.8	*4.9*
28		5.4	0.1	*0.1*	22.9	*5.8*
29		5.5			17.5	*3.9*
30		4.2			13.7	*3.3*
31		3.1			9.0	*2.5*
32		1.5			6.7	*1.9*
33		0.9			4.3	*1.4*
34		0.2			2.8	*0.8*
35		0.5			1.2	*0.3*
36		0.3			0.5	*0.2*
37					1.0	*0.3*
38		0.2			0.8	*0.3*
39		0.5			0.6	*0.2*
40					0.3	*0.1*

Table 3.3.8 Continued.

Length	300HP, 80mm		>300HP, 80mm			
(cm)	Disc	Land	Disc	Std	Land	Std
41		0.2				
42		0.2			0.2	*0.1*
43					0.2	*0.1*
44					<0.1	*<0.1*
45						
46		0.2			0.1	*0.1*
47						
48						
49						
50						

Table 3.3.9. Sole. Numbers landed (L) and discarded (D) at age per hour and per quarter and year, and discard coefficient of variation (CV) at age per year.

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Year	
Age	**D**	**L**	**D**	**L**	**D**	**L**	**D**	**L**	**D**	**L**
0					0.5		0.7		0.3	
1	9.2		2.0		4.7	8.3	5.7	0.6	4.7	1.4
2	18.6	2.4	46.4	8.2	19.0	19.3	51.3	55.4	41.2	22.8
3	11.6	99.2	14.5	106.9	10.6	122.4	2.1	84.2	8.8	101.5
4		6.5	2.5	31.5	3.9	13.9		11.9	1.4	19.4
5	0.4	33.9	2.7	21.5	2.7	21.1		5.2	1.4	18.5
6		0.2		4.4		1.2		2.2		2.7
7		1.5	0.0	10.1		0.6		0.9	0.0	4.7
8		0.2		4.0				1.4		2.1
9		0.2		1.0		0.3				0.5
10		0.1		0.3		0.3		0.9		0.5

Table 3.3.10. Sole. Landings (L) and discards D) raised estimates of total fleet numbers (*1000) and mean length (left), total weight (*1000) and mean weight (right) at age per quarter.

		Numbers (*1000)		Mean length		Weight (*1000)		Mean_weight	
Quarter	age	D	L	D	L	D	L	D	L
1	0								
	1	1075		14.80		30		0.028	
	2	2166	284	17.68	24.00	111	38	0.051	0.135
	3	1350	11554	22.99	27.56	160	2523	0.119	0.218
	4		758		31.88		263		0.347
	5	51	3949	25.94	28.74	9	1027	0.175	0.260
	6		26		39.43		18		0.700
	7		180		37.13		104		0.577
	8		26		39.43		18		0.700
	9		18		40.00		13		0.732
	10		7		42.00		6		0.860
	all	4642	16802	18.65	28.13	310	4011	0.067	0.239
2	0								
	1	201		15.45		6		0.032	
	2	4721	830	21.48	24.65	447	124	0.095	0.150
	3	1471	10868	23.07	27.46	178	2334	0.121	0.215
	4	250	3198	23.03	28.17	29	768	0.118	0.240
	5	272	2186	24.15	27.85	37	523	0.138	0.239
	6		451		28.68		123		0.273
	7	2	1025	27.00	27.41	0	230	0.199	0.225
	8		404		31.29		136		0.336
	9		97		29.27		26		0.266
	10		32		37.74		20		0.640
	all	6918	19091	21.80	27.64	698	4284	0.101	0.224
3	0	48		3.00		0		0.000	
	1	475	840	18.60	24.57	30	123	0.062	0.146
	2	1931	1956	21.11	27.18	173	400	0.090	0.204
	3	1077	12432	23.40	27.65	136	2756	0.126	0.222
	4	399	1414	23.22	27.50	48	312	0.121	0.220
	5	276	2141	23.68	28.49	36	544	0.130	0.254
	6		118		32.00		41		0.349
	7		58		33.00		23		0.387
	8								

Table 3.3.10. Continued.

	9		34		46.00		40		1.163
	10		34		46.00		40		1.163
	all	4207	19026	21.57	27.66	423	4277	0.101	0.225
4	0	74		10.00		1		0.007	
	1	607	58	18.90	23.95	39	8	0.065	0.134
	2	5441	5491	21.54	27.43	518	1186	0.095	0.216
	3	227	8340	24.15	27.10	31	1782	0.138	0.214
	4		1180		28.55		303		0.257
	5		515		31.19		179		0.348
	6		217		28.95		61		0.283
	7		94		37.39		56		0.603
	8		142		33.35		64		0.451
	9								
	10		89		38.87		61		0.688
	all	6349	16127	21.25	27.64	589	3702	0.093	0.230
all	0	122		8.70		1		0.006	
	1	2358	898	17.34	24.49	105	131	0.050	0.145
	2	14260	8561	21.27	26.94	1249	1749	0.092	0.204
	3	4126	43194	23.21	27.42	505	9395	0.123	0.216
	4	650	6549	23.10	28.35	78	1646	0.119	0.246
	5	599	8791	24.10	28.47	82	2273	0.137	0.256
	6		812		29.10		244		0.286
	7	2	1357	27.00	28.57	0	413	0.199	0.267
	8		572		31.83		218		0.365
	9		149		31.65		79		0.388
	10		162		39.43		128		0.732
	all	22116	71046	21.28	27.70	2021	16274	0.095	0.228

Table 3.3.11 Dab. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for a beam trawl vessels of 300 HP and beam trawl vessels larger than 300 HP with 80mm or 100mm mesh size.

				Numbers			Weight		
HP class	**Mesh**	**Vessel**	**Quart**	**L**	**D**	**%D**	**L**	**D**	**%D**
300	80	R56	3	2	65	97	<1	3	82
			all	**2**	**65**	**97**	**<1**	**3**	**82**
>300	80	R51	1	34	466	93	5	27	83
		R52	2	49	1354	96	6	77	93
		R53	2		1459		4	67	95
		R54	2	47	906	95	7	41	86
		R57	3		1333		11	65	86
		R58	4		1624		4	64	95
		R59	4		520		8	32	79
		R60	4	86	832	91	13	45	77
			all	**54**	**1037**	**95**	**7**	**51**	**87**
	100	R55	2	73	512	88	11	34	76
			all	**73**	**512**	**88**	**11**	**34**	**76**

Table 3.3.12. Dab. Landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for large vessels.

	Numbers			Weight		
Quarter	**L**	**D**	**%D**	**L**	**D**	**%D**
1	34	466	93	5	27	83
2	48	1209	96	6	60	91
3		1333		11	65	86
4	86	967	92	9	46	84

Table 3.3.13. Cod. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for a beam trawl vessels of 300 HP and beam trawl vessels larger than 300 HP with 80mm or 100mm mesh size.

				Numbers			Weight		
HP class	**Mesh**	**Vessel**	**Quart**	**L**	**D**	**%D**	**L**	**D**	**%D**
300	80	R56	3	0	0	0	0	0	0
			all	**0**	**0**		**0**	**0**	
>300	80	R51	1		<1		10	<1	0
		R52	2		<1		<1	<1	29
		R53	2	<1	3	93	1	1	48
		R54	2		0		<1	0	0
		R57	3		0		<1	0	0
		R58	4		2		<1	<1	19
		R59	4		5		2	<1	8
		R60	4		10		5	<1	8
			all	**<1**	**3**	**91**	**2**	**<1**	**8**
	100	R55	2		<1		<1	<1	43
			all		**<1**		**<1**	**<1**	**43**

Table 3.3.14. Cod. Landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for large vessels.

	Numbers			Weight		
Quarter	**L**	**D**	**%D**	**L**	**D**	**%D**
1	<1	<1	81	10	<1	0
2		1		<1	<1	43
3		0		<1	0	0
4		6		3	<1	9

Table 3.3.15. Whiting. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for a beam trawl vessels of 300 HP and beam trawl vessels larger than 300 HP with 80mm or 100mm mesh size.

				Numbers			Weight		
HP class	**Mesh**	**Vessel**	**Quart**	**L**	**D**	**%D**	**L**	**D**	**%D**
300	80	R56	3	0	<1	100	0	<1	100
			all	**0**	**<1**	**100**	**0**	**<1**	**100**
>300	80	R51	1		5		<1	<1	64
		R52	2		35		<1	3	89
		R53	2		124		<1	9	95
		R54	2		92		<1	5	90
		R57	3	0	6	100	0	<1	100
		R58	4	0	79	100	0	2	100
		R59	4	0	18	100	0	<1	100
		R60	4		25		<1	<1	84
			all	**0**	**46**	**100**	**<1**	**2**	**92**
	100	R55	2	0	1	100	0	<1	100
			all	**0**	**1**	**100**	**0**	**<1**	**100**

Table 3.3.16. Whiting. Landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for large vessels.

	Numbers			Weight		
Quarter	**L**	**D**	**%D**	**L**	**D**	**%D**
1		5		<1	<1	64
2		82		<1	5	92
3	0	6	100	0	<1	100
4	0	40	100	<1	<1	97

Table 4.1. Plaice. Landings (L), discards (D) and percentage discards (%D) per hour and per period in numbers (left) and weight (right). Results over 1976-1983 and 1989-1990 from Van Beek (1998), 1999-2001 from Netherlands Institute for Fisheries Research unpublished data.

		Numbers			Weight		
Period	**N trips**	**L**	**D**	**%D**	**L**	**D**	**%D**
1976-1979	21	253	185	42%	104	24	18%
1980-1983	22	336	380	53%	107	49	31%
1989-1990	6	392	330	46%	136	40	23%
1999-2001	20	214	575	73%	56	47	46%
2002	6	241	816	77%	63	66	51%
2003	9	189	936	83%	50	70	58%
2004	8	162	692	81%	51	50	50%

Table 4.2. Sole. Landings (L), discards (D) and percentage discards (%D) per hour and per period in numbers (left) and weight (right). Results over 1976-1983 and 1989-1990 from Van Beek (1998), 1999-2001 from Netherlands Institute for Fisheries Research unpublished data.

		Numbers			Weight		
Period	**N trips**	**L**	**D**	**%D**	**L**	**D**	**%D**
1976-1979	21	116	8	6%	38	1	3%
1980-1983	22	84	23	21%	27	3	9%
1989-1990	6	286	83	22%	72	11	13%
1999-2001	20	92	21	19%	22	2	8%
2002	6	124	37	24%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	174	58	25%	28	5	17%

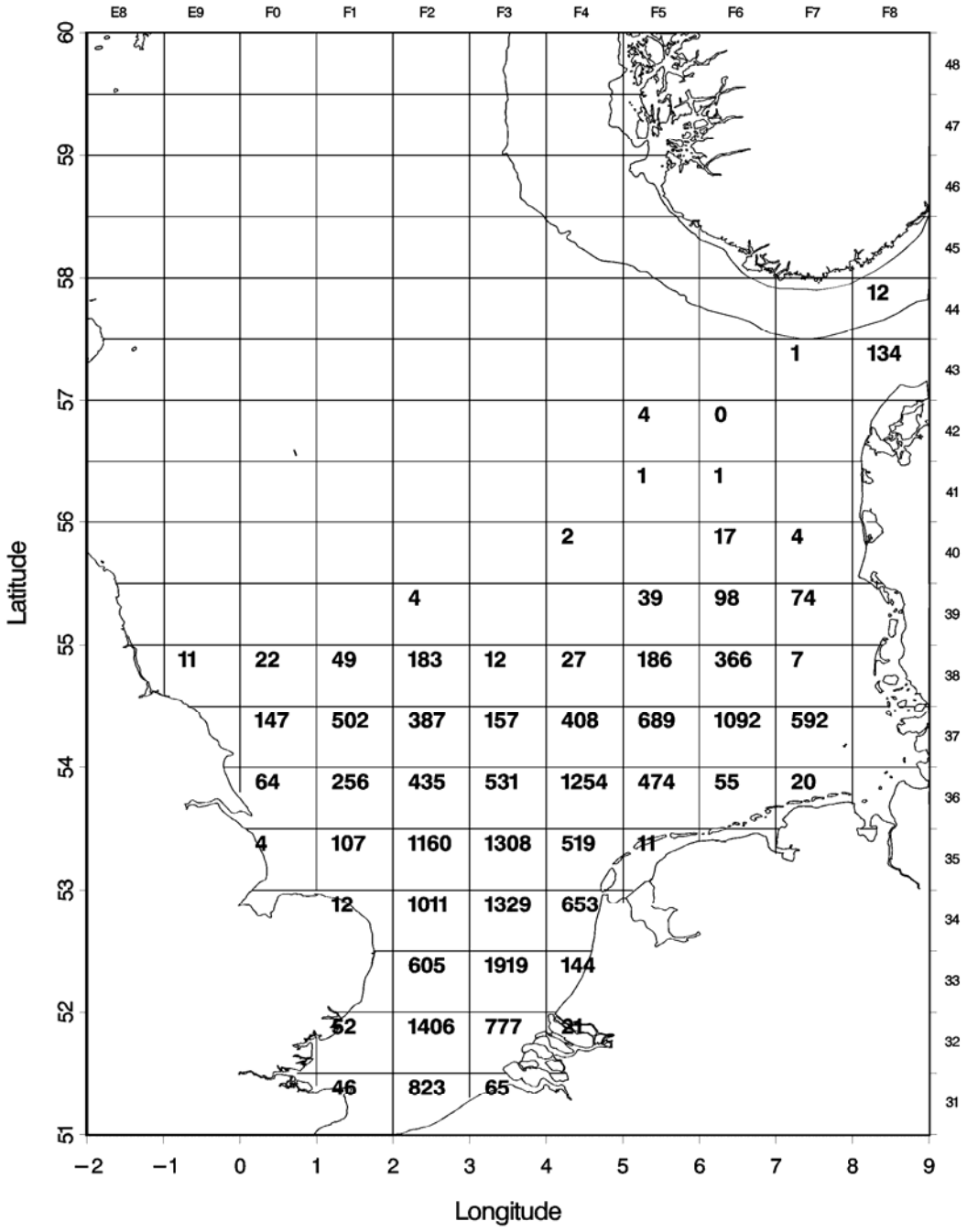

Figure 3.1.1a. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels larger than 300 HP with 80mm mesh size. Data from VIRIS database.

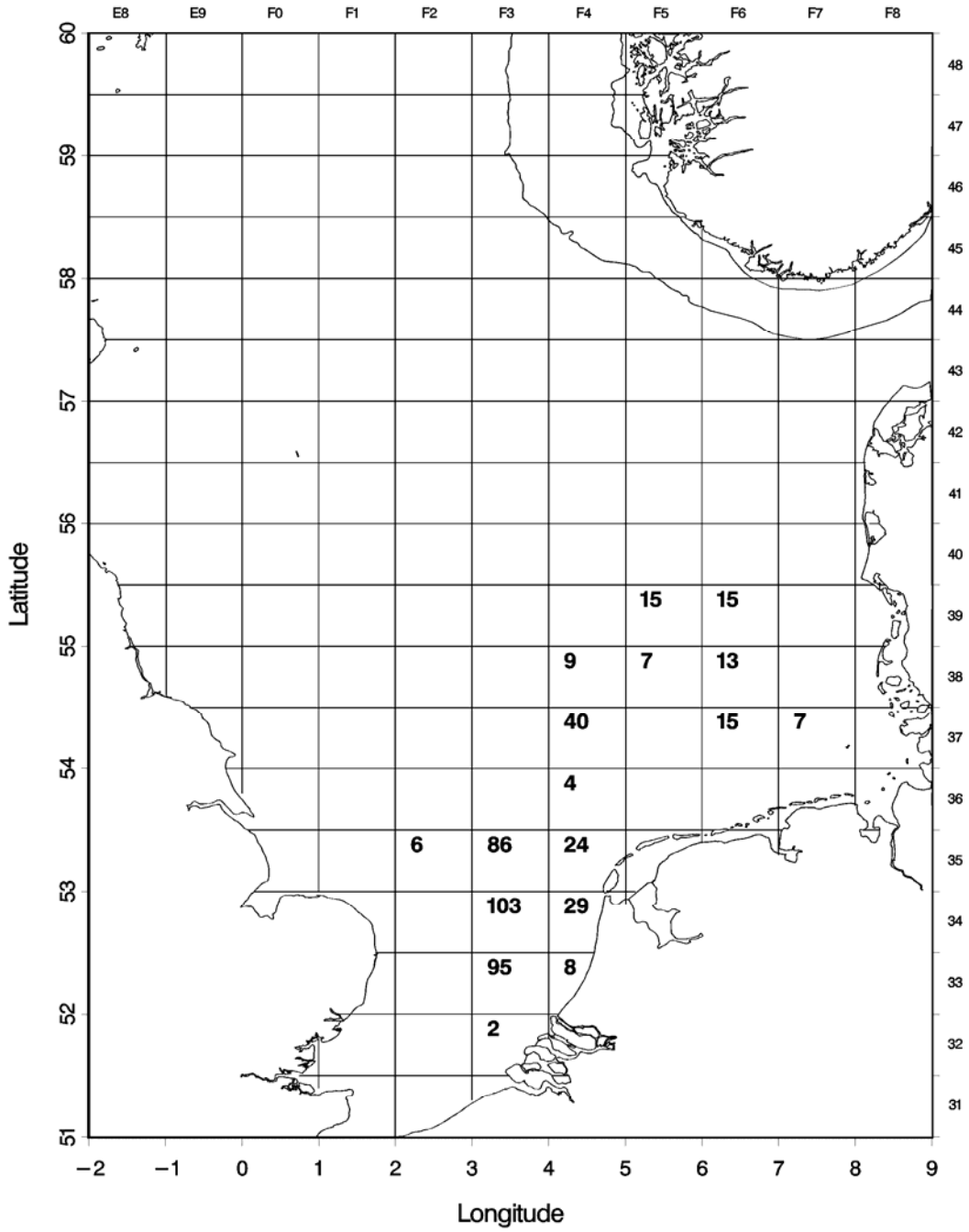

Figure 3.1.1b. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels larger than 300 HP with 80mm mesh size.

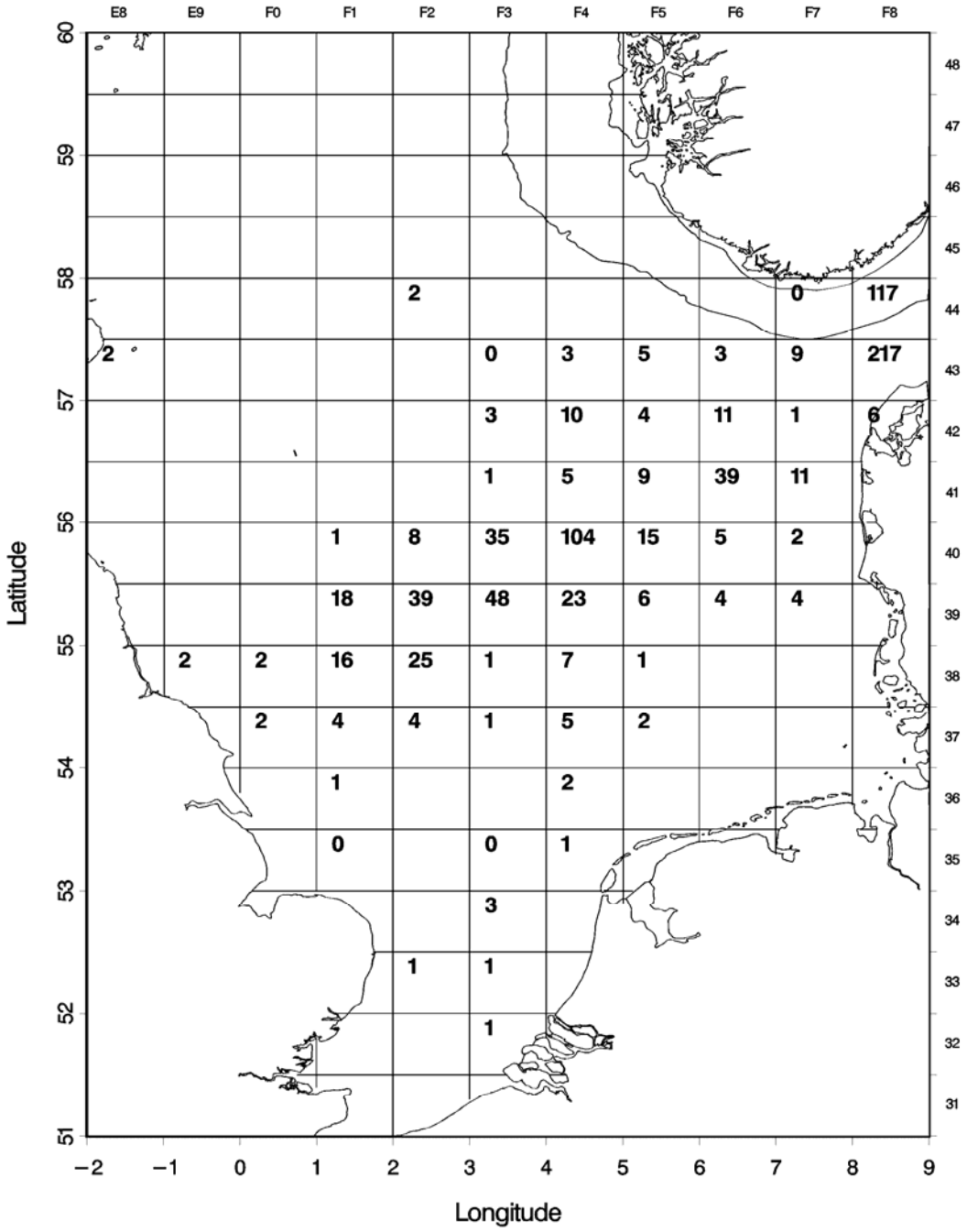

Figure 3.1.2a. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels larger than 300 HP with 100mm mesh size and larger. Data from VIRIS database.

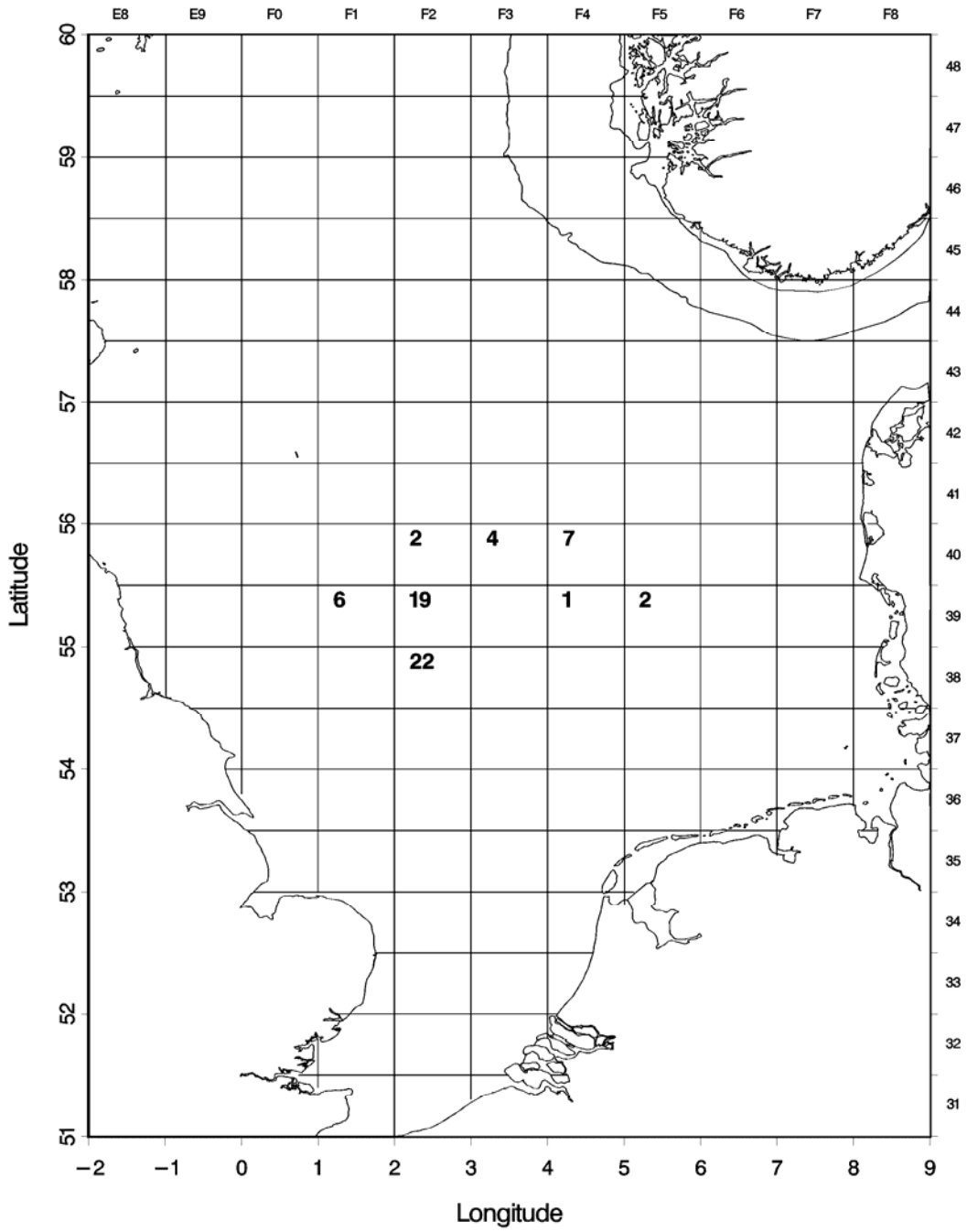

Figure 3.1.2b. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels larger than 300 HP with 100mm mesh size and larger.

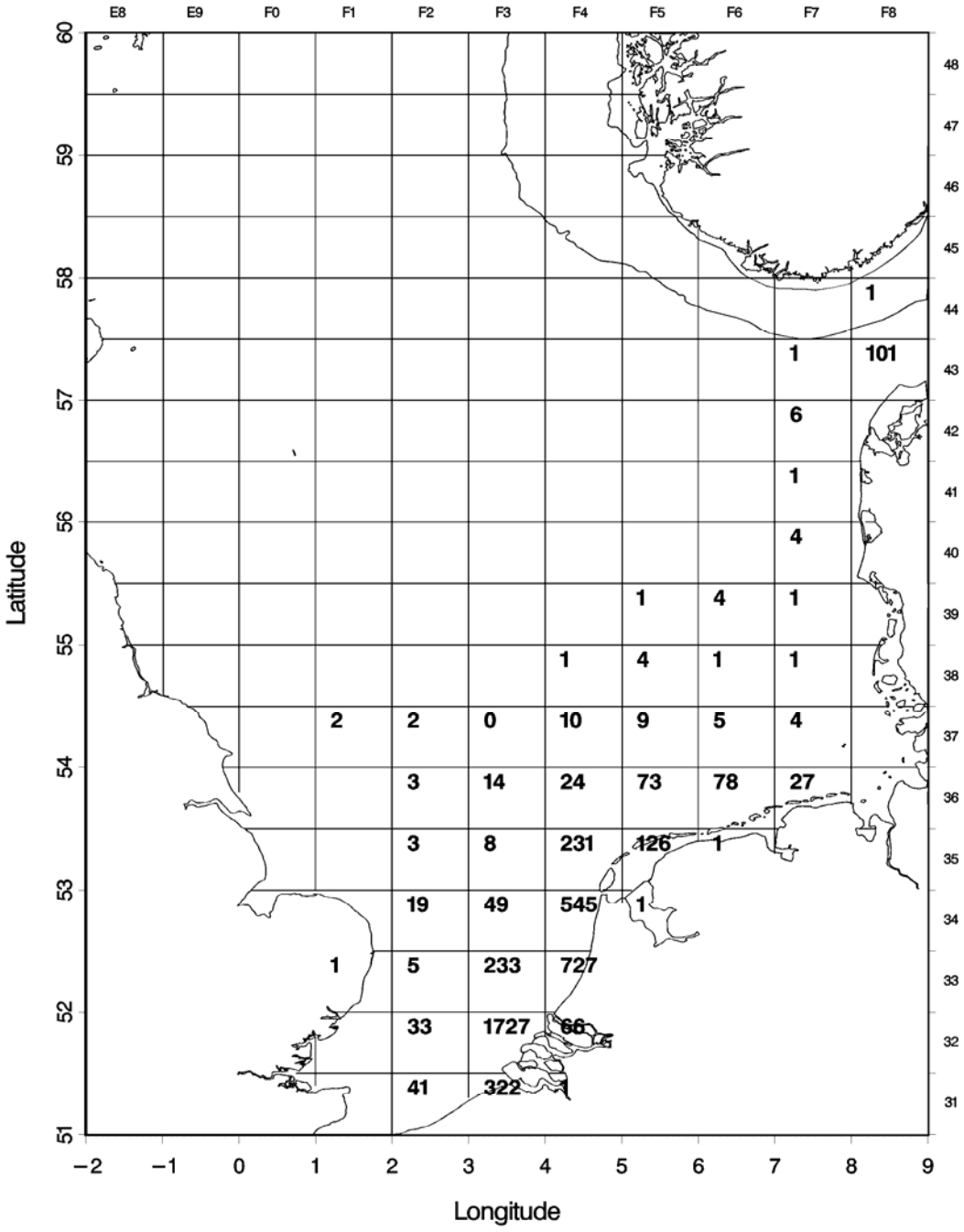

Figure 3.1.3a. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels of 300 HP with 80mm mesh size and larger. Data from VIRIS database.

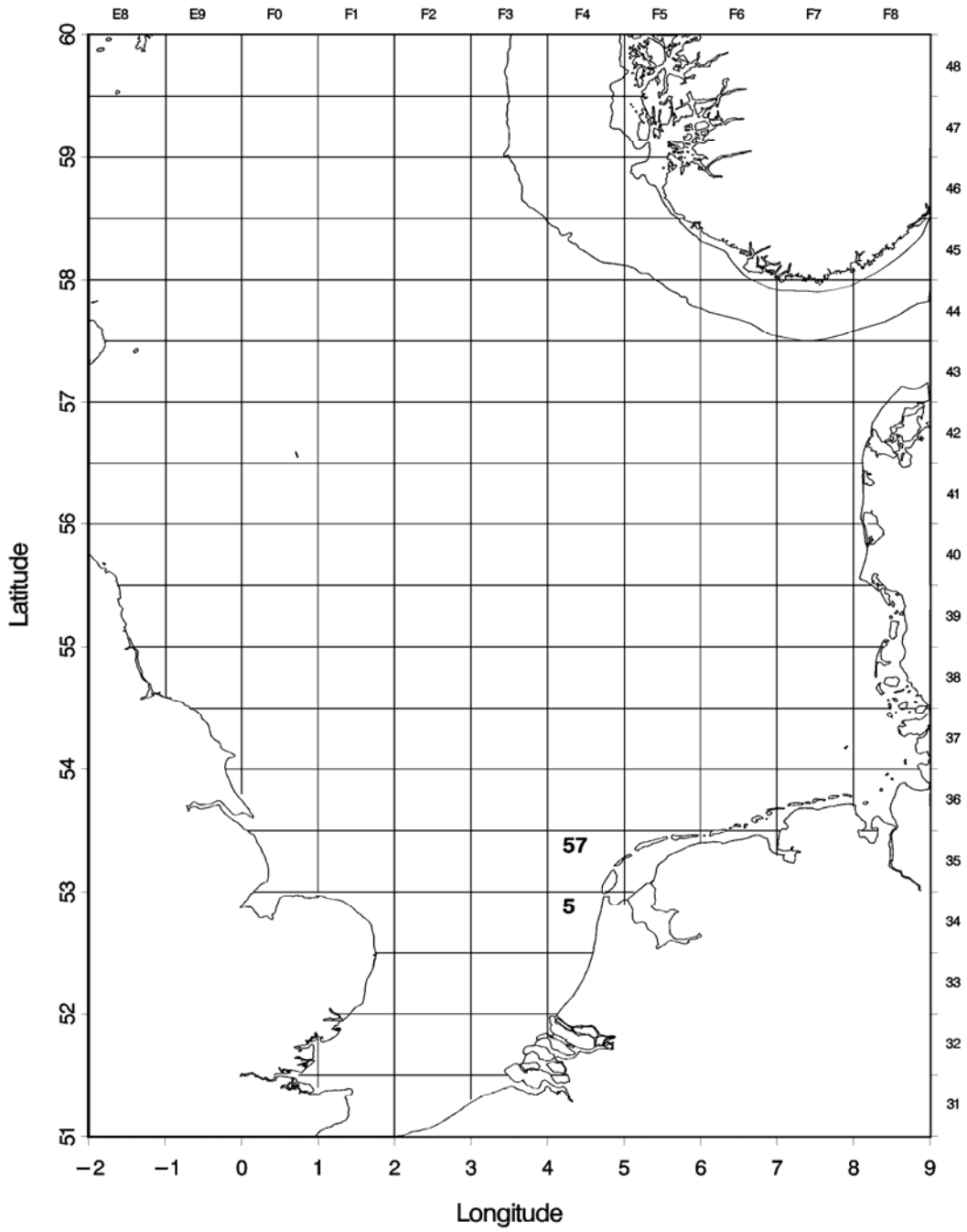

Figure 3.1.3b. Effort distribution of the Dutch beam trawl fleet in 2004, for vessels of 300 HP with 80mm mesh size and larger.

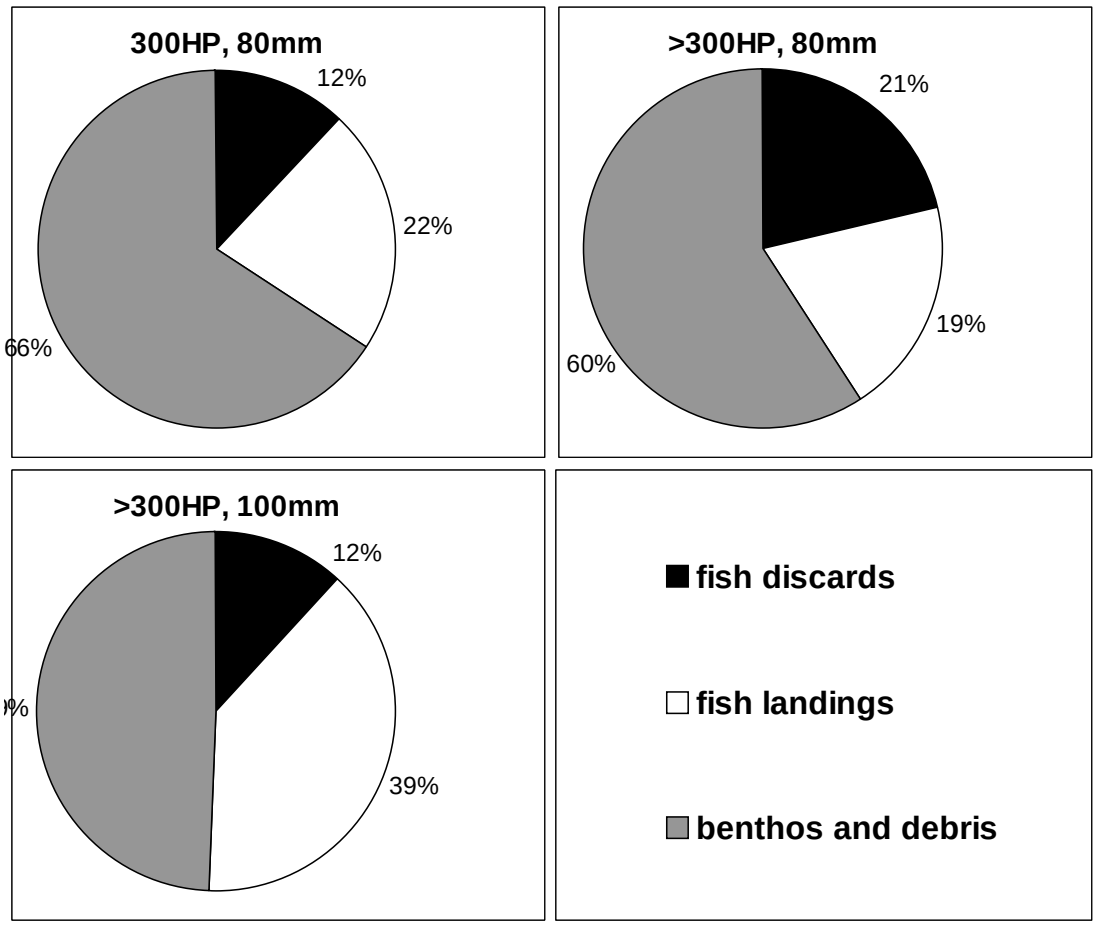

Figure 3.2a. Composition of the catch in weight for a vessel of 300 HP (upper left panel) and vessels >300 HP with 80mm (upper right panel) and 100mm mesh (lower left panel).

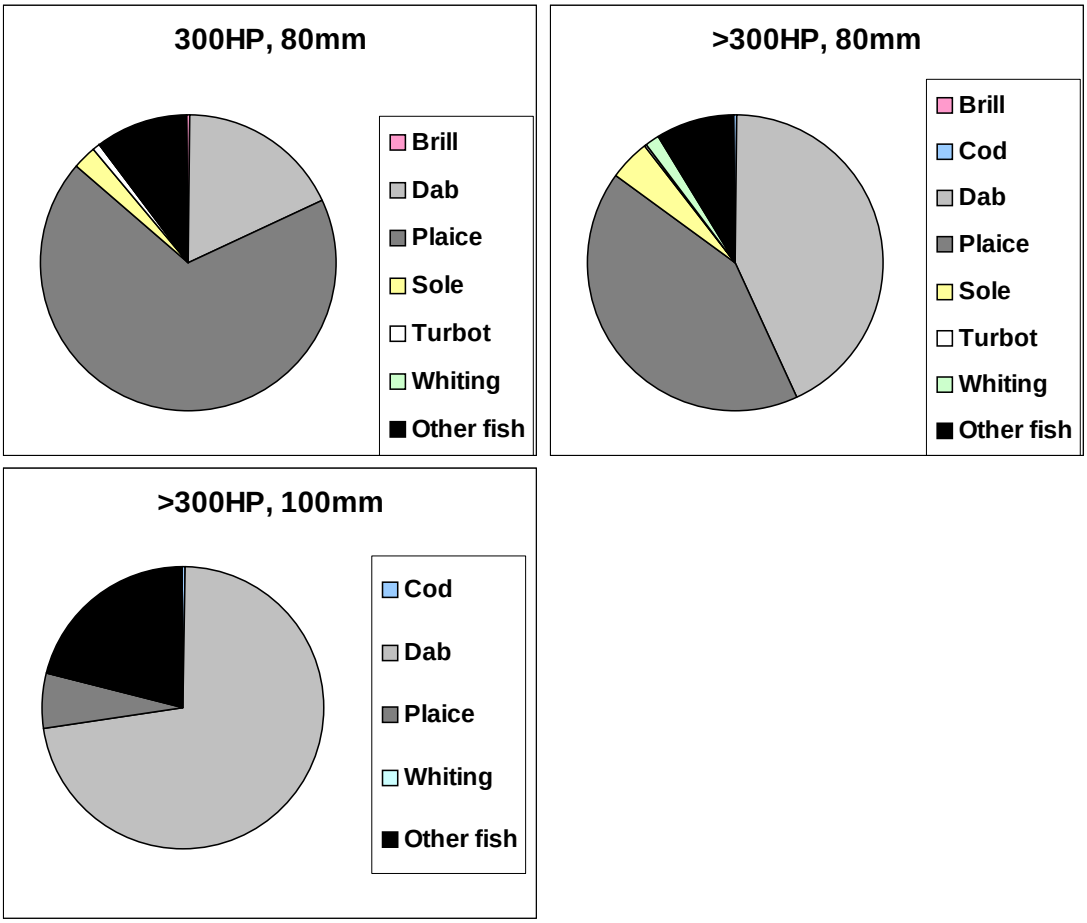

Figure 3.2b. Composition of the fish discards in weight for a vessel of 300 HP (upper left panel) and vessels >300 HP with 80mm (upper right panel) and 100mm mesh (lower left panel).

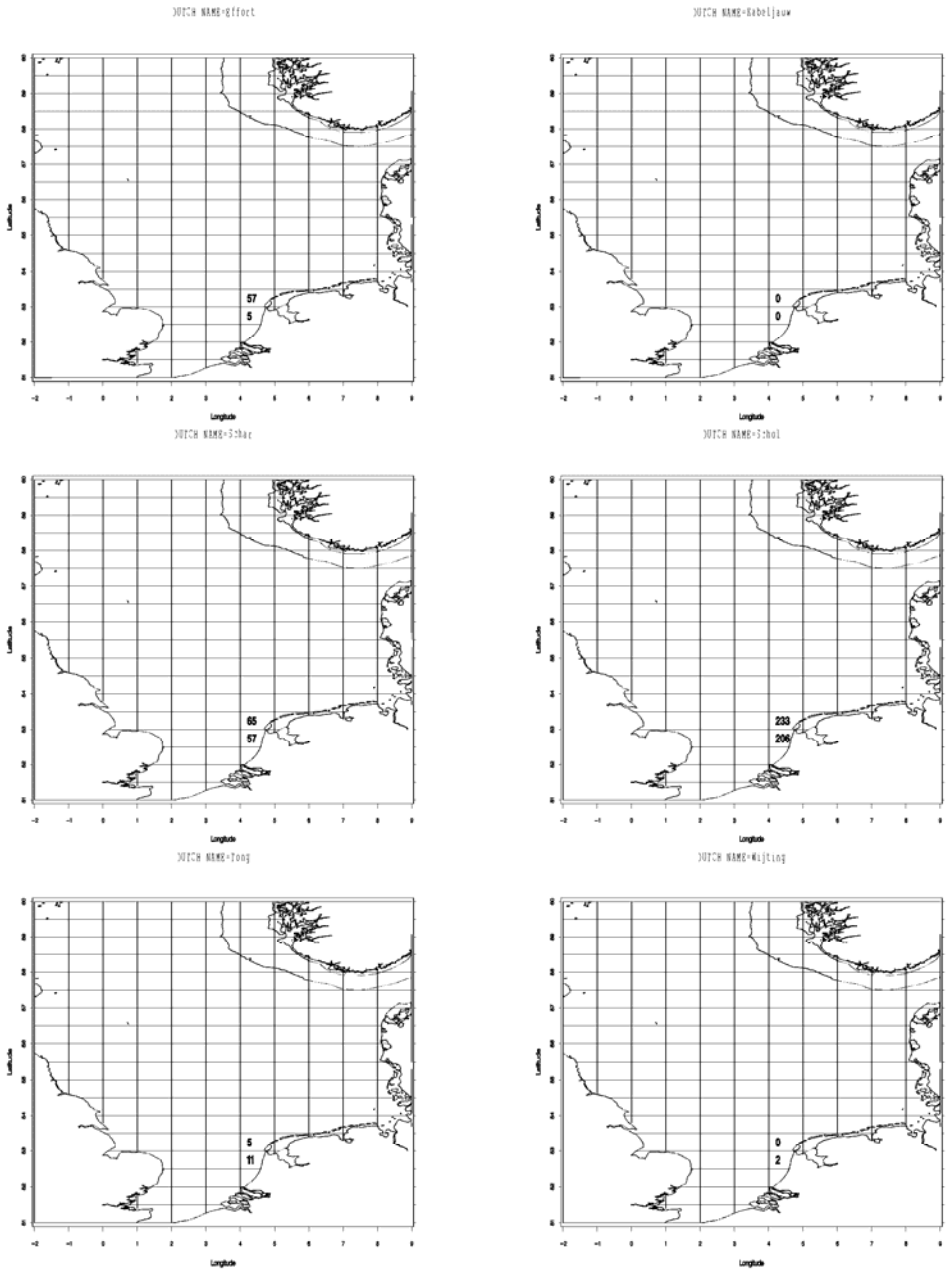

Figure 3.3.1a. Effort as sampled hours for discards (upper left) and number of discards per hour per ICES area in 2004 for cod (upper right), dab (middle left), plaice (middle right left), sole (lower left) and whiting (lower right) for a beam trawl vessel of 300 HP.

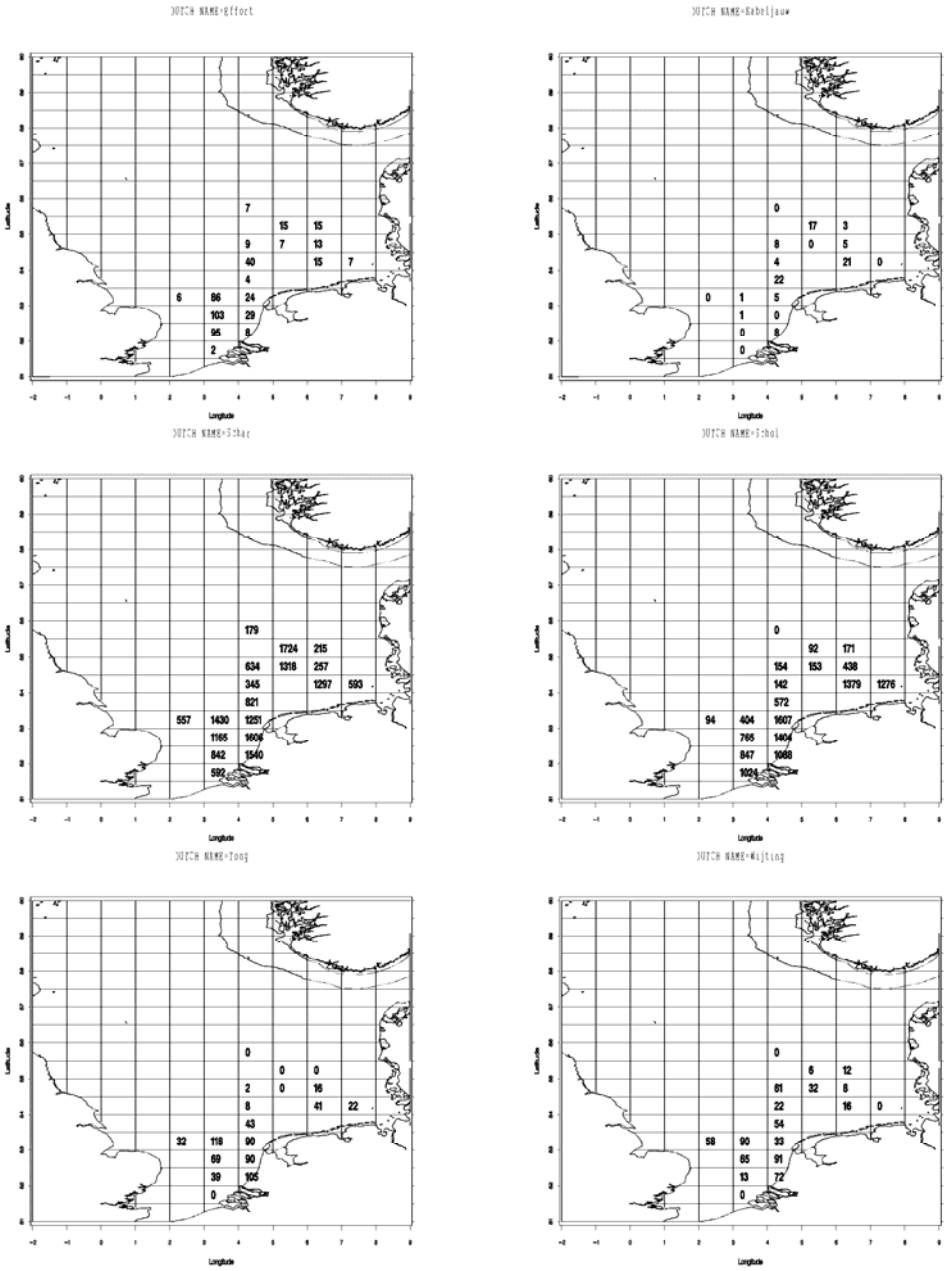

Figure 3.3.1b. Effort as sampled hours for discards (upper left) and number of discards per hour per ICES area in 2004 for cod (upper right), dab (middle left), plaice (middle right left), sole (lower left) and whiting (lower right) for beam trawl vessels with engine power >300 HP with 80mm mesh.

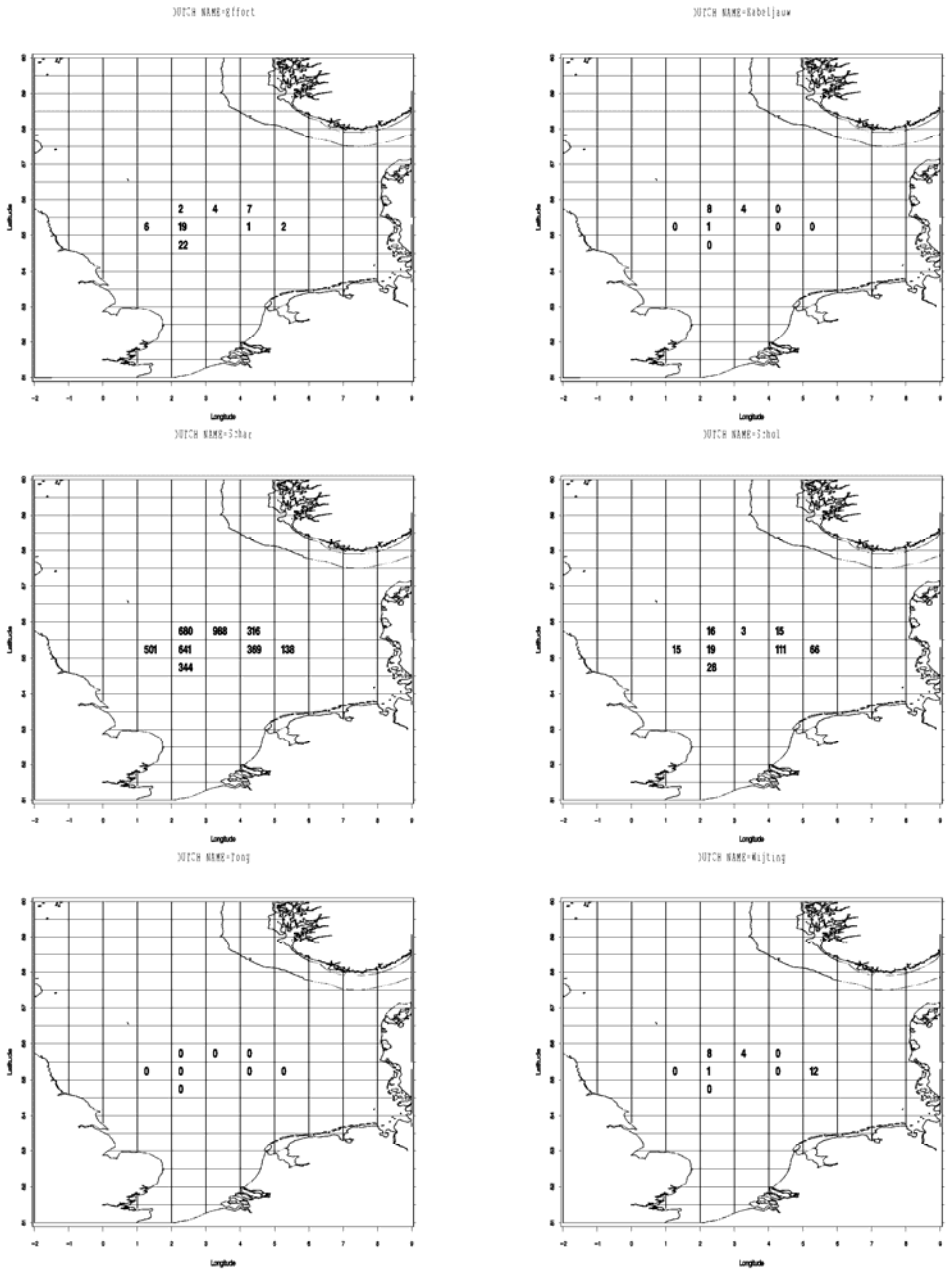

Figure 3.3.1c. Effort as sampled hours for discards (upper left) and number of discards per hour per ICES area in 2004 for cod (upper right), dab (middle left), plaice (middle right left), sole (lower left) and whiting (lower right) for a beam trawl vessel with engine power >300 HP with 100mm mesh.

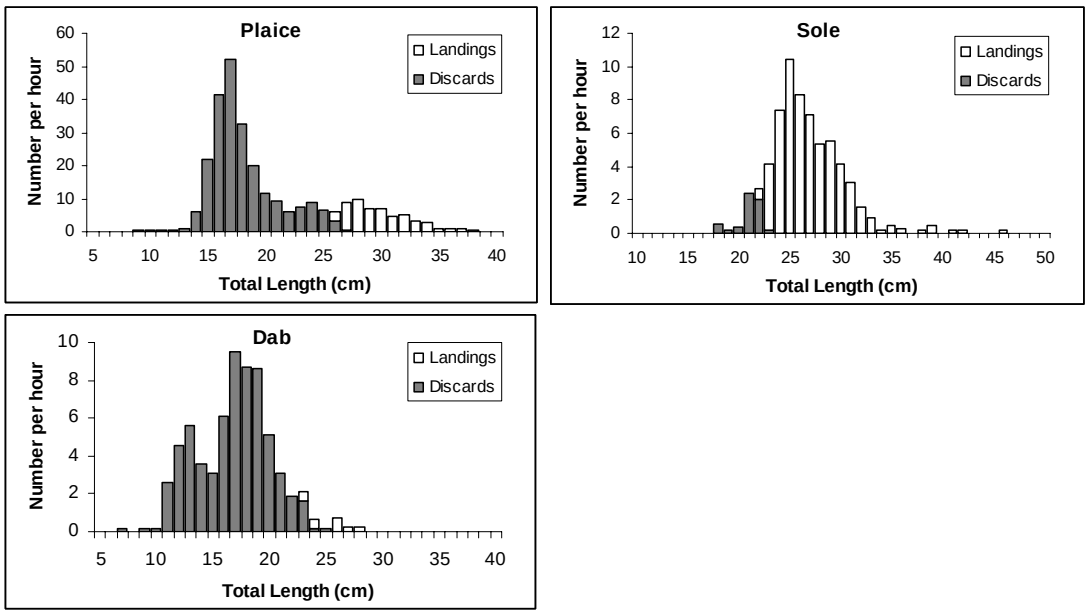

Figure 3.4.1. Length frequency distribution of plaice, sole and dab in 2004, caught with a beam trawl vessel of 300 HP. Black bars show discards, white landings.

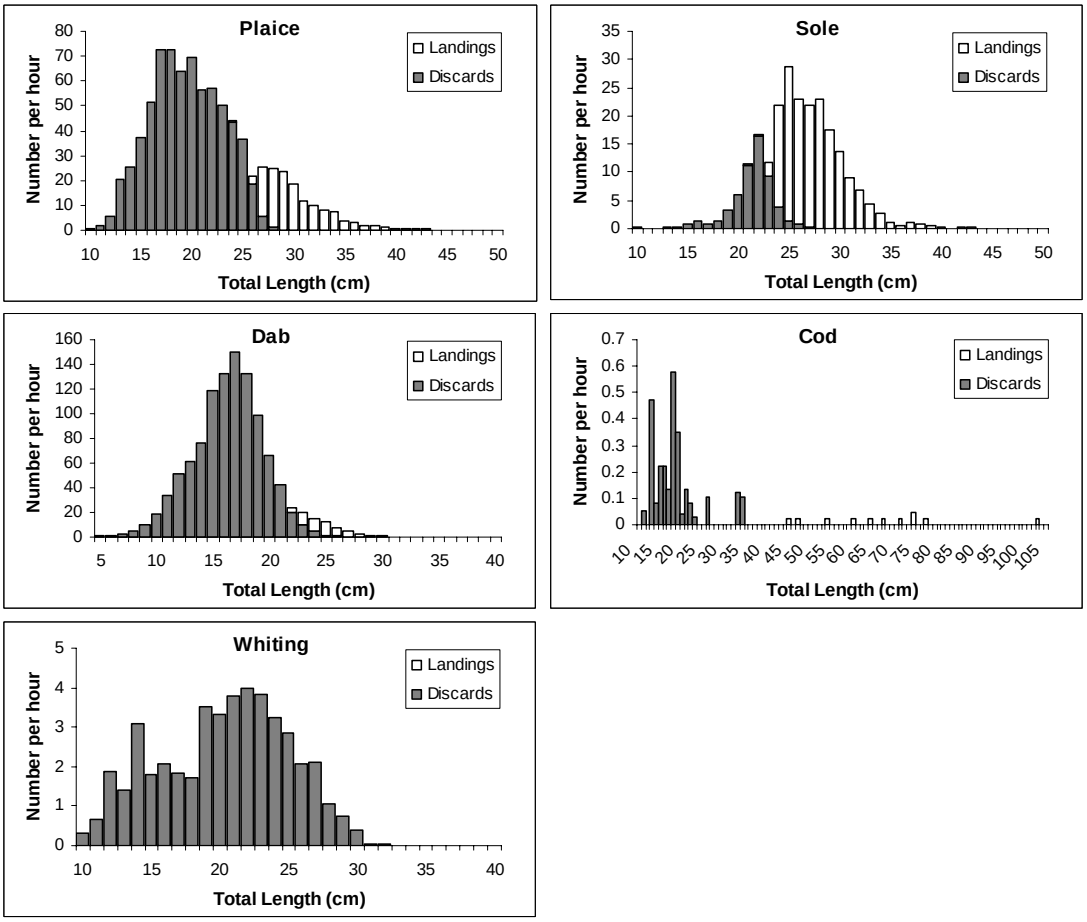

Figure 3.4.2. Length frequency distribution of plaice, sole, dab, cod and whiting in 2004, caught with beam trawl vessels larger than 300 HP, with 80mm mesh. Black bars show discards, white landings.

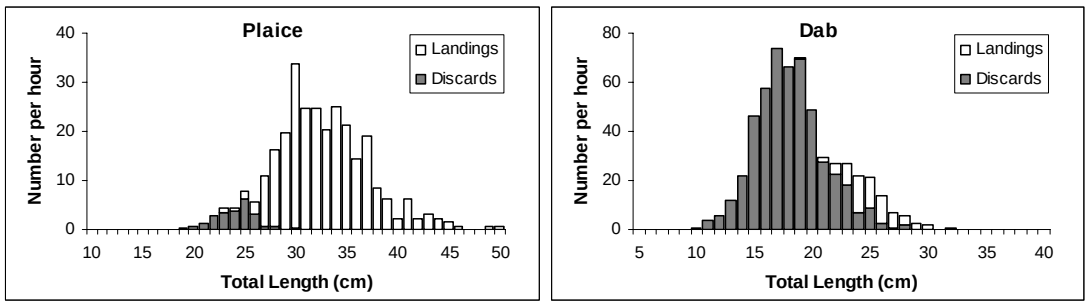

Figure 3.4.3. Length frequency distribution of plaice and dab in 2004, caught with a beam trawl vessel larger than 300 HP, with 100mm mesh. Black bars show discards, white landings.