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Discard sampling of the Dutch beam trawl fleet in 2008

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Table of Contents

Summary

This report provides the results of the discards sampling program on the Dutch beam trawl fishery in the North Sea in 2008. The program was instigated in 2002 as part of the EC regulations 1543/2000 and 1639/2001 on data collection regulation (DCR) in European fisheries. In 2008 ten trips on commercial beam trawlers with an engine power larger than 300 HP fishing using 80 mm mesh size are observed. Samples of the discards and landings were counted and measured, and raised to catches per hour, per trip, per quarter and per year. Other commercial bottom trawling fleets were not sampled in this project.

In 2008, the average percentage discards for sole was estimated at 16% in numbers and 6% in weight for the sampled vessels. This is the lowest discard rate observed for sole since 2002. Higher discard rates in previous years were caused by the strong year class of 2005 (ICES, 2008). In 2008 this year class has reached marketable lengths and explains the drop in discard rates compared to the previous years, when year class 2005 was still abundant in the discarded part of the catch.

The estimated discard rate for plaice in the sampled trips in 2008 is estimated at 84% in numbers and 53% in weight. Although variation between observed trips is high, the average discard rate is within the range as previous years, between 76% en 86%. New studies on spatio-temporal distribution patterns of juvenile plaice will provide more insight in the discard behavior of this species in the near future.

Through time dab has been the most abundant species in the fish discards. Since 1976 the discard estimate of this species in numbers has varied between 91% and 99%. Also in 2008 the estimated discard rate, 95%, is within this range. The discard rates calculated for cod (35% in weight) and whiting (93% in weight), are based on low catch numbers. These rates are, therefore, considered highly uncertain.

A new Data Collection Framework (2008/949/EG) became effective in 2009. Compared to the previous regulation, a more intensified sampling strategy results in an increased number of metiers that are considered for discard sampling purposes. Consequently, almost all member states are required to increase the sampling effort of their discard monitoring programs. To meet these new standards within a reasonable budget, IMARES started a self-sampling program with 12 commercial vessels in April 2009

The discard observer program forms an important source of information to verify outcomes of newly developed sampling methods. Continuation of the observer program, parallel with the development of alternative methods, like the self-sampling program, is, therefore, strongly recommended.

Samenvatting

In dit rapport staan de resultaten van het discardsbemonsteringsprogramma van de Nederlandse boomkorvisserij in de Noordzee in 2008 beschreven. Het programma wordt sinds 2002 op deze wijze uitgevoerd als invulling van EC regelingen 1543/2000 en 1639/2001 voor verzameling van gegevens in Europese visserijen (DCR programma). In 2008 zijn tien reizen op de Nederlandse boomkorschepen met een motorvermogen groter dan 300 PK vissend met een maaswijdte van 80 mm bemonsterd. De discards en aanlandingen werden geteld en gemeten en vervolgens opgewerkt tot vangsten per vis uur, per reis, per kwartaal en per jaar. Andere commercial bodem trawlers zijn niet bemonsterd binnen dit project,

Het gemiddelde discard percentage voor tong voor de bemonsterde boomkorschepen in 2008 is geschat op 16% in aantallen en 6% in gewicht. Dit is het laagste discard percentage voor tong sinds 2002. Hoger discard percentages in voorgaande jaren zijn veroorzaakt door de sterke jaarklasse van 2005 (ICES, 2008). In 2008 heeft deze jaarklasse een marktwaardige lengte bereikt en verklaart het lager vastgestelde percentage discards in vergelijking met vorige jaren, toen de 2005 jaarklasse nog veel werd waargenomen was in de discard-fractie van de vangst.

Het gemiddelde discard percentage voor schol in 2008 is geschat op 84% in aantallen en 53% in gewicht. Hoewel de spreiding tussen de bemonsterde reizen hoog is valt het gemiddelde discardpercentage binnen de verwachte range van voorgaande jaren, tussen de 76% en 86%. Recent onderzoek op het gebied van de spreiding in ruimte en tijd voor juveniele schol gaat in de nabije toekomst ook meer inzicht verschaffen in de discardpatronen van ondermaatse schol.

Schar is de meest talrijke soort in de discard-fractie van de vangst in de boomkorvisserij (in aantallen 91% tot 99%). Ook in 2008 is het geschatte percentage discard, 95%, weer vergelijkbaar met voorgaande jaren. De discardschattingen voor kabeljauw, 35% in gewicht, en wijting, 93% in gewicht, zijn gebaseerd op lage aantallen in de monsters en worden daarom als onzeker beschouwd.

In 2009 is een nieuwe Data Verordening (2008/949/EG) van kracht gegaan. In vergelijking met de vorige verordening is hierin is een intensiever programma voor discardbemonstering vastgesteld. Als gevolg van deze nieuwe verordening moeten bijna alle lidstaten de bemonsteringsintensiteit drastisch verhogen. Om de gewenste intensiteit te kunnen bereiken binnen een toelaatbaar budget is Nederland in april 2009 gestart met een 'self-sampling' project.

Ondanks de ontwikkelingen van alternatieve bemonsteringsmethode zijn bemonsteringsprogramma's, zoals het discard programma van IMARES nog steeds erg belangrijk. Deze langlopende programma's vormen een betrouwbare basis waarop uitkomsten van nieuwe projecten getest en gevalideerd kunnen worden. Continuering van het discard waarnemingsprogramma wordt is daarom van belang.

1   Introduction

Discard is the part of the catch taken in a fishery that is not retained on board and, consequently, thrown back into the sea. In 2005, the Food and Agriculture Organization of the United Nations (FAO) estimated a weighted discard rate at 8 percent (portion of the catch discarded) in the world's marine fisheries in the 1992-2001 period. Based on this discard rate yearly average discards are estimated to be 7.3 million tonnes ((FAO, 2007)).

Discarding is caused by economic, biological, environmental or social factors or a combination of these factors (ICES, 2004a; Catchpole *et al.*, 2005). During commercial fishing practices four different types of discarding can be recognized:
1)   specimens of commercial species do not com[ply to the minimum legal landing size;
2)   surplus to quota: species which is not allowed to be landed when this results to exceeding legal quota;
3)   bycatch species of no commercial value;
4)   commercial fish with an undesired quality (low value); this type of discarding is commonly referred to as high-grading.

Discarding leads to lower profits from fish stocks, because generally a large part of the discards will not survive the catching and sorting process ((Beek *et al.*, 1990; Jennings and Kaiser, 1998).Correct estimates are, therefore, of importance to fisheries management. Conversely, due to large spatial heterogeneity in the distribution of fish, seasonal variability and differences in fishing gear used, discard estimates of single hauls can be very variable, and may lead to imprecise discard estimates (Aarts and Helmond, 2007). Increasing sampling effort of discards on commercial fleets will increase the precision level. However, increasing sampling effort through increasing the number of observed trips in discard monitoring programs is time consuming and very expensive. In an attempt to increase the precision level in discard sampling programs, alternative monitoring methods are tested and studied in several member states of the EU. In the Netherlands, a self-sampling program started in 2009 to increase sampling effort in space and time within a reasonable budget.

To date, in North Sea fisheries, discards are only incorporated into a few stock assessments such as haddock, cod, whiting and plaice (ICES, 2005; 2006). The intention is to incorporate discards estimates in the assessments for all stocks where it is significant and where relevant information becomes available. However, including discard data might also increase the noise in the assessment because the high variability in the data (Dickey-Collas *et al.*, 2007). Alternative sampling methods may increase the data quality in the near future (Helmond, 2009).

The Dutch beam-trawl fishery is a bottom trawling mixed fishery, fishing with 80-89 mm mesh size in the cod-end, targeting a limited number of demersal species that are of commercial interest, in particular sole (*Solea solea*) in the southern part of the North Sea and plaice (*Pleuronectes platessa*) in the northern fishing grounds. Consequently, a major part of the catch consists of other species that live on or near the seabed. In general this part of the catch is of no commercial interest and is thrown overboard (discarded).

Discard data collected during an observer program on beam trawl vessels between 1976 and 1990 showed great variation in the quantity of plaice discarded (18-31% by weight (Beek, 1998)). Recent sampling (between 1999 - 2007) indicate that the percentage of plaice discarded has increased to 54% in weight (82% in numbers) (Keeken *et al.*, 2003); (Keeken and Pastoors, 2004; 2005; Keeken, 2006; Helmond and Overzee, 2007).

From 2002 onwards discards data have been collected under the DCR[1]. This report gives an overview of the results of the Dutch demersal discard sampling program for 2008, which focuses on beam trawl vessels larger than 300 HP fishing with 80 mm mesh size.

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[1] EC Data Collection Regulations 1543/2000 and 1639/2001 (EC., 2000, 2001; Anon., 2002; ICES, 2003).

2 Methods

2.1 General information

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 2008 a total of ten trips were made on board of Dutch beam trawl vessels with an engine power between 1379-1839 KW (HP = 1.34*KW). All vessels fished with an 80 mm[1] cod-end mesh size (Table 2.1.1).

2.2 Sampling procedures

For each discard sampling trip, two observers go onboard a vessel, sampling at least 60% of the hauls (Beek, 2001). After each haul, the marketable fish is sorted from the catch by the crew of the vessel on a conveyer-belt. From each sampled haul, a representative sub-sample of the discards was taken from the conveyer belt by the observers. All fish in the sub-sample were counted and measured. Benthic invertebrates were only counted. Total and sampled volume of discards was recorded. In addition, sub-samples of the landed fish were measured, and total and sampled landings weight were recorded. If possible, otoliths were collected from the commercial important discarded fish species (plaice, sole, dab) for age readings. All data was entered into a computer program on haul-by-haul basis and later transferred into a central database.

Sampling protocol per haul:
1) Estimation total catch per haul. Registration of total catch in volume.
2) Take sample of discards.
    a. The sample consists of one basket (35 kg). To get a representative sample, discards are taken at different moments from the conveyer belt when processing the haul.
3) Measuring discard sample:
    a. Sort all fish species, take length measurements and register total number by species and length class.
    b. Sort all benthos and register total number by species.
4) Measuring landings sample:
    a. Sample landings from target species (sole and plaice), 10-15 kg. Register total number by species and length class.
    b. Sample landings from non-target species (e.g. dab, turbot, brill, whiting, cod) 10-15 kg. Register total number by species and length class.
5) Age estimations of discards:
    a. Sample otoliths from most discarded commercial species (plaice, sole and dab).
    b. The sample of age analysis consists of undersized fish. A sample consists of minimal 3 individuals per length class per area (ICES quadrant).
6) Information on position, haul duration, wind direction, fishing depth en landed catch is collected in cooperation with the skipper for each haul.
7) Registration of total landings:
    c. Information on total landings is collected at the end of the trip.

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[1] In this report a mesh size of 80-99 mm is referred to as 80mm cod-end mesh size

2.3 Raising procedures

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

Sampled numbers of fish per haul were raised to numbers at length, and for some species at age, for both discards and landings. Different raising procedures were used for discards and landings because different sources of information were used for these catch components. For the landings the total landed weight per species by trip was available from the auction, 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 standard 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.

An average of numbers landed and discarded at length per hour were calculated per period (quarter or year) by multiplying total numbers at length in a trip over the trips in this period dividing this by total duration of trips in this period. Numbers at age were calculated from numbers at length using age-length keys, which calculate the proportion of fish at length (l) with age (a). Numbers at age landed and discarded are raised to fleet level by effort-ratio: multiplying total numbers at age in the sampled trips with the ratio of hpeffort (effort in days at sea multiplied by the engine power of the vessel in HP) of the fleet to hpeffort of the sampled trips.

3 Results

3.1 Sampling

During the ten sampled trips the total number of hauls in the trips varied between 29 and 54, with an average fishing duration of 80 hours per trip (Table 3.1.1). 67% of all hauls were sampled for discards and 58% for landings. Otoliths of plaice (279 otoliths), dab (262 otoliths) and sole (15 otoliths) were collected from the discards samples.

The sampling occurred during quarters 1, 2, 3 and 4. Per quarter between 0.18% and 0.43% of the effort (in days at sea) of the Dutch beam trawl fleet with engine power larger than 300 HP fishing with 80 mm cod-end mesh size was sampled (Table 3.1.2). Fleet coverage by year was 0.30% in hpeffort for this fleet segment (Table 3.1.2).

The spatial distribution of fishing effort in the Dutch beam trawl fleet larger than 300 HP fishing with 80 mm cod-end mesh size was extracted from VIRIS and is shown in Figure 3.1.1a. The fleet is mainly distributed offshore from the Dutch coast. The distribution of all sampled vessels is presented in Figure 3.1.1b. This shows that the spatial distribution of sampling efforts covers the major areas for the whole fleet.

3.2 Numbers and weight

The total landings weight by trip for the observed vessels varied between 1016 and 8458 kg for plaice and between 957 and 2612 for sole (Table 3.2.1a). Sampled landings weight for all trips varied between 66 and 276 kg for plaice and between 34 and 402 kg for sole (Table 3.2.1b).

The average weight of all discards on the observed beam trawl vessels (both fish and invertebrate discards) was estimated to be around 28.6 tonnes per trip (CV 35%, Table 3.2.2a). About 32% of the catch weight consisted of fish landings and 25% consisted of fish discards, while about 1% of the catch numbers consisted of fish landings and 3% consisted of fish discards (Figure 3.2a). Dab and plaice were the most abundant fish species in the discards (Table 3.2.3a, Figure 3.2b). The sand star, common starfish, helmet crab, swimming crab and brittle star were the most abundant benthos species (Table 3.2.3b).

3.3 Species

Plaice
On average 72,897 plaice individuals (CV 89%) weighing 5,571 kg (CV 75%) were discarded per trip by the beam trawl vessels (Tables 3.2.2a,b). The average number per hour discarded was 902 compared to 169 individuals landed. This resulted in an average discard percentage of 84% in numbers and 53% in weight (Table 3.3.1). The average discard percentage per quarter varied between 63% and 94% in numbers and 30% and 72% in weight (Table 3.3.2). Between rectangles, the number discarded per hour varied between 311 and 2,188 (Figure 3.3.1).

Plaice were caught from 9 cm onwards during the beam trawl trips (Table 3.3.3). The peak of the discards length distribution was around 20 cm (Table 3.3.3, Figure 3.4.1). Plaice were discarded up to 39 cm whereas the minimum landing size is 27 cm. Most discards during the beam trawl trips were between ages 1 and 3, with the highest number at the age of 2 (2006 year class). Most landings were between ages 2 and 5 (Table 3.3.4)

Landings and discards in numbers at age were raised to fleet level for beam trawl vessels larger than 300 HP and are presented in Table 3.3.5.

Sole

On average 1,216 sole individuals (CV 97%) weighing 115 kg (CV 101%) were discarded per trip by the beam trawlers (Tables 3.2.2a,b). In all trips landings were higher than discards (Table 3.3.6). The average discard percentage was 16% in number and 6% in weight. The variation per quarter was between 4% and 27% in numbers and 2% and 9% in weight (Table 3.3.7).

Sole was discarded up to 31 cm during the beam trawl trips. The peak of the discard length distribution was around 21 cm (Table 3.3.8, Figure 3.4.1). The highest number of landings were from the strong 2005 year class at the age of 3 while the highest number of discards was at age 2 (Table 3.3.9).

Landings and discards in numbers at age were raised to fleet level for beam trawl vessels larger than 300 HP (Table 3.3.10).

Dab

On average 70,618 dab individuals (CV 58%) weighing 3,894 kg (CV 58%) were discarded per trip by the beam trawl vessels (Tables 3.2.2a,b). Per hour on average 49 kg was discarded compared to 8 kg landed (Table 3.3.11). The average discard percentage was 95% in numbers and 87% in weight. Per quarter the discard percentage varied in weight between 77% and 94% (Table 3.3.12).

Cod

On average 464 cod individuals (CV 187%) weighing 78 kg (CV 180%) were discarded per trip by the beam trawl vessels (Tables 3.2.2a,b). Per hour on average less than 1 kg cod was discarded (Table 3.3.13). The average discard percentage was 35% in weight. This estimate is however highly uncertain because of the low catches. Per quarter the discard percentage varied in weight between 0% and 81% (Table 3.3.14).

Whiting

On average 2,757 whiting individuals (CV 72%) weighing 219 kg (CV 86%) were discarded per trip by the beam trawl vessels (Tables 3.2.2a,b). Discards in weight were higher than landings with less than 1 kg whiting landed compared to 3 kg discarded per hour (Table 3.3.15). The average discard percentage was 93% in weight. Per quarter the discard percentage in weight varied between 88% and 94% (Table 3.3.16).

4   Discussion

The discard estimates presented in this paper are obtained by an observer sampling program. Similar to previous years the sampling program does not entirely cover the fishing effort of the North Sea fleet. Due to limited resources, only the largest métier of Dutch beam vessels with an engine power larger than 300 HP and using a mesh-size of 80-99 mm, is covered by the program. Beam trawlers using mesh size of 100 mm and larger and vessels with an engine power less than 300 HP (so called Eurocutters) are not included. Also vessels using chain mats instead of tickler chains are not included.

Due to the limited number of observations (10 trips with 440 sampled hauls), sampling-effort in 2008 was, like previous years, less than 1%. Consequently, temporal and spatial distribution of the sampled fishing effort of this fleet are poorly covered. Estimates of total discards for less abundant species, especially those which show large seasonal and spatial differences in discarding, must therefore be considered as very uncertain.

The discard percentage of sole in 2008, 16% in number and 6% in weight, is the lowest observed since 2002 (Table 4.1). Over the last 6 years the discard rate of sole have varied between 23% and 29% in numbers and between 13% and 17% in weight. Higher discard rates in previous years were caused by the strong year class of 2005 (ICES, 2008). This year the 2005 year class reached the marketable size (MLS = 24 cm) are were not observed in the discard fraction of the catch. However, this year class is now abundant in the landings at age 3 (Table 3.3.10).This contributed to the lower discard rates for sole in 2008.

The estimated discard rate of plaice was 84% in numbers and 53% in weight is within the line of expectation for the last 10 years (Table 4.2).. Discard rates between trips was high and varied, between 24% and 94% (in weight) (Table 3.3.1.). Age 1 and 2 were the most abundant age-groups discarded over the year (Table 3.3.5), with the exception of the first quarter, where age 3 is also abundant in the discarded fraction of the catch (Table 3.3.5). During this period of the year, age 3 is still below the minimum landing size (MLS= 27cm), which results in higher discard rates during this period. The estimated number of discards of age 1 in quarter 1 (Table 3.3.4 and 3.3.5) is high compared to the numbers of previous years (Keeken, 2006; Helmond and Overzee, 2007).However, numbers are based on only two trips during this period, of which one trip, R95, has very high discard rate for plaice, 98% in number and 94% In weight (Table 3.3.1).With the help of an new approach, where statistical modeling is applied to estimate the spatio-temporal distribution of juvenile plaice, we are able to provide a more comprehensive analysis on age-groups during different periods in the year. The first results of this research, based on data of this sampling program, will be published in 2010.

As in previous years, the catches of cod in the beam trawl fishery were very low. The main reason for the low cod catches is the low stock size in the North Sea. It is clear that the absolute numbers caught have decreased substantially in comparison with the 1970s and 1980s (Keeken and Pastoors, 2004). The discard rate for cod in 2008 is estimated at 35%, but due to low sampling effort in combination with the low observed numbers, considered to be very uncertain. The discard rates have a low precision are, therefore, not very representative for the fleet. A comparison with data available from the Belgian sampling program revealed that catches of cod in beam trawl fisheries using chain mats are higher than for vessels using tickler chains (STECF, 2008). Beam trawlers using chain mats fish in areas with rocky bottom structures, where cod is more abundant. Unfortunately, beam trawlers using chain mats are not included in the Dutch sampling programs. Although the estimated discard rate is already considered uncertain, missing chain mats in the program can also result in an under estimation of cod discard rates.

Dab is the most abundant discarded species since the start of this monitoring program. The discard percentage of dab in 2008 was 95% in numbers and 87% in weight and is considered to be representative for the métier. These values are comparable with the estimates observed in previous years (Table 4.3).

Whiting is a bycatch species in the beam trawl fishery. A decreasing trend over time in numbers and weight of catches per hour (Table 4.4) was observed In the analysis of 2007 data (Van Helmond & van Overzee, 2008). This trend is persistent and continued in the data of 2008. It is still under discussion of this trend may reflect a decline in stock size or a change in distribution of the stock outside the area where beam trawlers operate. The percentages of discarding observed in the whole time period are high but has not be estimated with high precision due to the low numbers of whiting in the samples of landings and discards.

From 2009 onwards, a new Data Collection Regulation (2008/949/EG) obligates member states to increase the sampling effort of their discard monitoring programs in order to achieve a sampling coverage of 90% of their métiers. Constrained by high costs and lack of trained observers, the Netherlands choose to expand her monitoring program with a self-sampling project together with the help of the Dutch fishery industry. This resulted in co-operative pilot project between IMARES and the fishing industry which started in April 2009. This pilot project will it make possible to expand the sampling to more métiers and increase the number of observations on discarding. The new sampling program will also provide information on the spatio-temporal distribution of discards, which allows more sophisticated analyses of the data.. Although it is expected that the information provided by the new program eventually will improve estimates on discard rates for a large number of métiers, continuation of a discard observer program will remain important to validate the discard estimates of the new sampling methods.

Acknowledgements

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Appendix I: Raising procedures

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		hour
		o	
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 in number of trips		
E	total fleet effort in number of trips		
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 (Σu_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.

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

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

Total numbers discards or landings ($CN_{o,p,s}$) were calculated by summing over length. Trips were 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 number of landings or discards at age per hour per trip ($CN_{a,o,t,s}$) over all trips in that period (p) and then dividing this by the total number of trips (U_t) in this period:

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

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 ($e_{p,f}$).

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

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

Appendix II: Tables and Figures

Table 2.1.1. Characteristics per trip sampled in 2008. For each vessel the gear (TBB=beam trawl), the engine power in KW, the mesh size in mm and sampled ICES rectangles are represented.

Mesh	Gear	Vessel	KW	Quarter	Sampled ICES rectangles
80	TBB	R94	1467	1	33/F3, 34/F3, 35/F3, 36/F3
		R95	1471	1	32/F2, 32/F3, 33/F2, 33/F3
		R96	1397	2	36/F4, 36/F5, 36/F6, 37/F5, 37/F6, 38/F7, 39/F6, 39/F7, 40/F7
		R97	1471	2	34/F3, 34/F4, 35/F3
		R98	1471	2	33/F2, 33/F3, 33/F4, 34/F2, 34/F3, 34/F4, 35/F2
		R102	1839	3	36/F2, 37/F1
		R103	1471	3	34/F3, 35/F2, 35/F3
		R104	1469	4	34/F4, 35/F2, 35/F3, 35/F4, 36/F3
		R105	1469	4	35/F1, 35/F2, 36/F2
		R106	1467	4	33/F2, 33/F3

Table 3.1.1. Sampling effort per trip sampled in 2008. For each trip the duration and number of hauls sampled for landings and discards and total duration and number of hauls for the total trips are given, and the number of plaice, dab and sole otoliths taken from the discard fraction.

Mesh size	Gear	Vessel	Number of hauls			Duration (hours)			Plaice Otolith	Dab Otolith	Sole Otolith
			Land	Disc	Tot	Land	Disc	Tot			
80	TBB	R95	13	33	42	26	65	83	37	37	
		R98	36	37	50	63	65	86	47	58	
		R106	28	29	39	56	58	77	34	33	15
		R103	16	17	50	30	32	96			
		R96	28	38	54	41	56	79	33	28	
		R97	29	30	48	52	54	88	35	25	
		R104	31	31	43	54	54	75			
		R105	26	26	40	46	46	72			
		R102	27	30	45	47	52	75	53	40	
		R94	21	22	29	47	49	66	40	41	
		Total	**255**	**293**	**440**	**462**	**531**	**797**	**279**	**262**	**15**
		%Total	**58%**	**67%**		**58%**	**67%**				

Table 3.1.2. Sampling effort in 2008 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 using 80 mm mesh size and using beam trawl (fleet data from VIRIS), and fleet coverage by the sampled trips.

Quarter	Vessel	Sampled effort		Fleet effort		Fleet coverage	
		D.A.S.	HPeff	D.A.S.	HPeff	D.A.S.	HPeff
1	R95	4	7892				
	R94	3	5901				
	Total	7	13793	3807	7698084	0.18%	0.18%
2	R98	4	7892				
	R97	5	9865				
	R96	5	9500				
	Total	14	27257	3266	6548953	0.43%	0.42%
3	R103	4	7884				
	R102	4	9864				
	Total	8	17748	3236	6453192	0.25%	0.28%
4	R106	4	7868				
	R104	5	9850				
	R105	5	9850				
	Total	14	27568	3901	7802827	0.36%	0.35%
All	**Total**	**43**	**86366**	**14210**	**28503056**	**0.30%**	**0.30%**

Table 3.2.1a. Total landings weight per trip in 2008 for plaice, sole, cod, whiting, dab, turbot and brill for the beam trawl (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh size.

HP	Mesh	Gear	Vessel	Quar	Plaice	Sole	Cod	Whiting	Dab	Turbot	Brill
>300	80	TBB	R94	1	4282	1601	40	7	604	199	34
			R95	1	1016	2084	50	49	830	203	150
			R96	2	4336	957	38	4	2413	684	553
			R97	2	3411	1330	92	25	545	282	117
			R98	2	2516	1212	189	40	468	387	186
			R102	3	5951	1524	544	14	286	65	119
			R103	3	5983	2509	41	0	229	350	146
			R104	4	4666	2612	39	0	175	272	157
			R105	4	7099	2190	26	3	202	233	93
			R106	4	8458	2335	278	40	206	248	296
				Mean	**4772**	**1835**	**134**	**18**	**596**	**292**	**185**

Table 3.2.1b. Sampled landings weight per trip in 2008 for plaice, sole, cod, whiting, dab, turbot and brill for the beam trawl (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh size.

HP	Mesh	Gear	Vessel	Quar	Plaice	Sole	Cod	Whiting	Dab	Turbot	Brill
>300	80	TBB	R94	1	205	134	0	0	12	0	0
			R95	1	66	81	0	0	6	0	0
			R96	2	116	91	0	0	76	19	20
			R97	2	151	129	0	0	0	0	0
			R98	2	200	135	0	0	0	0	0
			R102	3	123	120	0	0	0	0	0
			R103	3	95	34	0	0	13	0	0
			R104	4	276	286	0	0	84	22	19
			R105	4	226	402	0	0	31	0	0
			R106	4	143	148	0	0	0	0	0
				Mean	**160**	**156**	**0**	**0**	**22**	**4**	**4**

Table 3.2.2a. Total weight (kg) in 2008 of all discards per trip (fish and benthos) and of plaice, sole, dab, cod and whiting for the beam trawl (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh size.

HP	Mesh	Gear	Vessel	All Discards	Plaice	Sole	Dab	Cod	Whiting
>300	80	TBB	R94	9488	1353	44	1128	1	150
			R95	28643	14770	76	8633	420	682
			R96	30941	3946	47	5671	16	140
			R97	26156	10262	60	2906	220	142
			R98	26242	2970	96	3111	112	215
			R102	38881	2594	18	5998	0	110
			R103	18348	2486	46	2533	0	51
			R104	27266	4463	194	2313	0	70
			R105	43664	5327	165	4374	0	267
			R106	36279	7540	404	2276	8	360
			Mean	**28591**	**5571**	**115**	**3894**	**78**	**219**
			CV	**35%**	**75%**	**101%**	**58%**	**180%**	**86%**

Table 3.2.2b. Total number in 2008 of plaice, sole, dab, cod and whiting discards for the beam trawl (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh size.

HP	Mesh	Gear	Vessel	Plaice	Sole	Dab	Cod	Whiting
>300	80	TBB	R94	22453	567	21978	25	1979
			R95	223248	1061	151048	2648	7659
			R96	61178	551	92070	111	2294
			R97	150583	733	50107	1306	1897
			R98	38891	834	72214	456	2349
			R102	27250	157	121954	0	1143
			R103	24057	385	53501	0	1296
			R104	55580	1973	44986	73	1264
			R105	54241	1760	67362	0	3603
			R106	71487	4138	30958	23	4082
			Mean	**72897**	**1216**	**70618**	**464**	**2757**
			CV	**89%**	**97%**	**58%**	**187%**	**72%**

Table 3.2.3a. Numbers of fish discarded per hour in 2008 for the beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size.

English name	Dutch name	TBB
Ammodytes sp.	Ammodytes	6.0
Black seabream	Zeekarper	<0.1
Blonde ray	Blonde rog	0.1
Brill	Griet	0.2
Bull-rout	Zeedonderpad	2.8
Cod	Kabeljauw	5.5
Dab	Schar	886.3
Dragonet	Pitvis	43.6
Five-bearded rockling	Vijfdradige meun	<0.1
Flounder	Bot	2.7
Four-bearded rockling	Vierdradige meun	0.2
Garfish	Geep	0.1
Greater pipefish	Grote zeenaald	0.1
Greater sand-eel	Smelt	7.7
Grey gurnard	Grauwe poon	34.3
Hake	Heek	<0.1
Herring	Haring	0.5
Hooknose	Harnasmannetje	2.9
Horse mackerel	Horsmakreel	0.1
John Dory	Zonnevis	0.5
Lemon sole	Tongschar	5.7
Lesser spotted dogfish	Hondshaai	2.2
Lesser weever	Kleine pieterman	15.8
Long rough dab	Lange schar	1.6
Lumpsucker	Snotolf	<0.1
Plaice	Schol	902.3
Pollack	Witte koolvis	<0.1
Pomatoschistus sp.	Grondel	0.9
Poor cod	Dwergbolk	0.5
Red gurnard	Engelse poon	<0.1
Reticulated dragonet	Rasterpitvis	0.1
Roker	Stekelrog	0.4
Sand sole	Franse tong	<0.1
Scaldfish	Schurftvis	48.9
Sea scorpion	Groene zeedonderpad	0.2
Smoothhound	Gladde haai	<0.1
Snake pipefish	Adderzeenaald	<0.1
Sole	Tong	15.7
Solenette	Dwergtong	57.5
Spotted ray	Gevlekte rog	1.1
Sprat	Sprot	0.1
Starry ray	Sterrog	0.2
Striped red mullet	Mul	0.1
Three-bearded rockling	Driedradige meun	0.2
Tub gurnard	Rode poon	6.1
Turbot	Tarbot	0.5
Twaite shad	Fint	0.2
Whiting	Wijting	34.9
bib	Steenbolk	2.2

Table 3.2.3b. Numbers of benthic species discarded per hour in 2008 for the beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size.

Latin name	Dutch name	TBB
Abra alba	Witte Dunschaal	0.2
Acanthocardia echinata	Gedoornde Hartschelp	7.1
Aequipecten opercularis	Wijde mantel	0.1
Alcyonium digitatum	Dodemansduim	30.8
Anthozoa	Zeeanemonen	8.1
Aphrodita aculeate	Fluwelen zeemuis	66.6
Arctica islandica	Noordkromp	0.6
Ascidiacea	Zakpijp	1.7
Asterias rubens	Zeester	1961.4
Astropecten irregularis	Kamster	2852.3
Aurelia aurita	Oorkwal	0.3
Buccinum undatum	Wulk	4.6
Cancer pagurus	Noordzeekrab	6.0
Cephalopoda	Cephalopoda	0.0
Common mussel	Mossel	0.7
Corystes cassivelaunus	Helmkrab	961.7
Crangon crangon	Gewone garnaal	3.8
Cyanea sp.	Haarkwal	0.1
Ebalia cranchi	Kleine kiezelkrab	0.0
Echinidae	Zeeegels	7.4
Echinocardium cordatum	E. cordatum	504.6
Echinocardium sp.	Hartegels	259.0
Eledone cirrhosa	Eledone	0.3
Ensis sp.	Ensis	0.1
Flustra foliacea	Bladachtig hoornwier	0.1
Goneplax rhomboids	G. rhomboides	1.1
Halichondria panacea	Broodspons	0.2
Hydrozoa	Hydroidpoliepen	0.2
Leander serratus	Gezaagde steurgarnaal	0.2
Liocarcinus depurator	Blauwpootzwemkrab	16.5
Liocarcinus holsatus	Gewone zwemkrab	891.9
Liocarcinus marmoreus	Gemarmerde zwemkrab	5.1
Loligo forbesi	L. forbesi	0.2
Loligo sp.	Loligo	0.8
Loligo subulata	Dwergpijlinktvis	3.3
Lunatia alderi	Glanzende tepelhoorn	0.1
Lunatia catena	Grote tepelhoorn	0.0
Macoma balthica	Nonnetje	1.8
Mactra coralline	Grote strandschelp	0.7
Necora puber	Fluwelen zwemkrab	3.4
Norway lobster	Noorse kreeft	0.5
Octopus vulgaris	Octopus	0.0
Ophiura albida	Kleine Slangster	0.6
Ophiura ophiura	Slangster	858.1
Pagurus bernhardus	P. bernhardus	213.1
Pagurus sp.	Pagurus sp.	51.7
Pecten maximus	St. Jacobsschelp	6.7
Pinnotheres pisum	Erwtenkrabbetje	0.8
Pleurobrachia pileus	Ribkwal	0.2
Psammechinus miliaris	Zeeappel	9.7
Sepia officinalis	Zeekat	1.0
Sepiola sp.	Sepiola	0.7
Thia scutellata	Nagelkrab	0.1

Table 3.3.1. Plaice. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for beam trawl (TBB) with an engine power larger than 300 HP using 80 mm mm cod-end mesh size in 2008.

HP	Mesh	Gear	Vessel	Quart	Numbers			Weight		
					L	D	%D	L	D	%D
>300	80	TBB	R94	1	131	340	72%	65	20	24%
			R95	1	48	2701	98%	12	179	94%
			R96	2	169	777	82%	55	50	48%
			R97	2	129	1713	93%	39	117	75%
			R98	2	89	454	84%	29	35	54%
			R102	2	224	361	62%	79	34	30%
			R103	3	142	252	64%	63	26	29%
			R104	3	169	745	81%	63	60	49%
			R105	4	276	756	73%	99	74	43%
			R106	4	313	923	75%	109	97	47%
				Mean	**169**	**902**	**84%**	**61**	**69**	**53%**

Table 3.3.2. Plaice. Average landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Numbers			Weight		
	L	D	%D	L	D	%D
1	90	1520	94%	39	100	72%
2	129	981	88%	41	67	62%
3	183	307	63%	71	30	30%
4	190	793	81%	83	73	47%

Table 3.3.3. Plaice. Number landed and discarded per hour per length class for beam trawl vessels (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh in 2008.

Length	TBB>300 HP, 80 mm	
(cm)	Discards	Landings
8		
9	0.2	
10	1.0	
11	4.1	
12	7.6	
13	20.9	
14	28.5	
15	40.6	
16	48.5	
17	79.5	
18	96.5	<0.1
19	97.9	
20	106.0	
21	82.6	
22	77.7	<0.1
23	53.6	0.1
24	60.6	0.1
25	43.7	0.8
26	30.3	4.5
27	11.9	20.3
28	4.8	26.8
29	1.9	23.0
30	0.2	20.3
31	0.3	16.2
32	0.7	12.9
33	0.2	8.7
34	0.4	8.1
35	0.5	6.4
36	0.3	4.3
37	0.7	3.7
38	0.4	3.8
39	0.1	2.9
40		1.9
41	0.0	0.9
42		1.1
43		0.4
44		0.3
45		0.3
46		0.4
47		<0.1
48		0.4
49		0.1
50		0.1

Table 3.3.4. Plaice. Average numbers landed (L) and discarded (D) calculated at age per hour per quarter and per year for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Age	Quarter 1 D	Quarter 1 L	Quarter 2 D	Quarter 2 L	Quarter 3 D	Quarter 3 L	Quarter 4 D	Quarter 4 L	Year D	Year L
0	0.8		4.5				1.8		2.4	
1	537.0		237.2	0.2	16.6	12.1	293.9	7.1	270.1	7.6
2	813.1	1.1	662.1	23.0	254.1	61.3	461.3	50.5	550.5	34.5
3	140.1	33.0	74.2	46.4	35.1	39.4	48.7	73.4	71.9	50.4
4	16.3	30.5	3.7	23.6	0.6	23.4	1.9	44.9	5.5	31.3
5	6.5	14.8	0.5	17.6	0.5	19.7	1.5	35.6	2.2	22.9
6	1.2	1.7	0.4	5.0	0.1	8.1	0.0	9.4	0.4	6.3
7	5.7	7.3	0.5	7.2	0.2	9.1	0.3	16.8	1.7	10.5
8	0.6	0.9		1.3	0.1	3.9		1.3	0.4	1.7
9		0.5		1.0	0.2	3.0		5.8	0.2	3.0
10		0.2		3.9		3.2		8.0	0.2	4.7

Table 3.3.5. Plaice. Landings (L) and discards D) raised estimates of total fleet numbers (*1000) and mean length at age (cm), total weight (*1000) tonnes and mean weight at age (kg) per quarter and at age per year for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Age	Numbers (*1000) D	Numbers (*1000) L	Mean Length D	Mean Length L	Weight (*1000) D	Weight (*1000) L	Mean Weight D	Mean Weight L
1	0	68		9.9		0.6		0.008	
	1	48904		16.1		1931.6		0.039	
	2	73149	85	19.3	25.7	4907.1	12.9	0.067	0.152
	3	12431	2519	23.1	29.9	1449.9	615.5	0.117	0.244
	4	1393	2326	28.8	30.7	327.1	621.0	0.235	0.267
	5	583	1120	32.4	32.2	188.4	352.3	0.323	0.315
	6	55	125	35.2	36.8	21.6	57.7	0.393	0.461
	7	521	553	31.8	33.3	161.2	199.8	0.310	0.362
	8	26	67	35.2	37.8	10.5	33.9	0.398	0.502
	9		18		46.7		17.1		0.936
	10		6		51		7.0		1.205
2	0	11		10.0		0.10		0.009	
	1	14882	6	15.9	18	552.0	0.3	0.037	0.052
	2	51291	1546	20.0	28.3	3787.6	318.6	0.074	0.206
	3	3316	3051	25.1	29.2	474.4	693.1	0.143	0.227
	4	326	1174	25.8	32.5	53.0	375.7	0.162	0.320
	5	30	697	31.1	33.2	8.5	243.9	0.279	0.350
	6	11	137	28.2	31.6	2.3	41.1	0.200	0.301
	7	12	202	28.2	32.5	2.4	66.1	0.201	0.327
	8		40		38.1		20.6		0.518
	9		31		36.4		13.9		0.453
	10		108		34.2		41.2		0.380
3	0								
	1	998	788	20.7	27.3	79.5	143.5	0.080	0.182
	2	15456	3947	21.9	29.4	1496.2	911.1	0.097	0.231
	3	2157	2349	23.5	32.3	261.3	730.2	0.121	0.311
	4	15	1358	29.3	32.9	3.4	447.6	0.228	0.330
	5	13	1113	29.4	33.0	3.0	375.0	0.228	0.337
	6	3	460	30.0	34.2	0.6	173.3	0.242	0.377
	7	5	513	31.0	35.2	1.3	212.4	0.267	0.414
	8	4	217	30.6	34.0	0.9	83.0	0.258	0.382
	9	5	164	28.0	33.8	0.9	66.2	0.196	0.405
	10		185		38.4		100.0		0.542
4	0	36		10.0		0.3		0.009	
	1	18633	453	20.1	27.7	1359.5	86.7	0.073	0.191
	2	29300	3209	22.2	29.0	3018.7	712.6	0.103	0.222
	3	3101	4658	25.8	30.0	476.6	1170.3	0.154	0.251
	4	118	2844	28.1	31.0	23.4	794.7	0.199	0.279
	5	98	2257	28.1	31.5	19.7	672.2	0.200	0.298
	6	1	593	30.0	34.3	0.2	227.4	0.242	0.383
	7	20	1064	29.0	33.2	4.4	373.6	0.219	0.351
	8		80		42.5		56.6		0.706

9		366		35.0		149.6		0.409
10	11	507	29.1	33.3	2.3	193.8	0.220	0.382

Table 3.3.6. Sole. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for beam trawl (TBB) with an engine power larger than 300 HP using 80 mm mm cod-end mesh size in 2008.

HP	Mesh	Gear	Vessel	Quart	Numbers			Weight		
					L	D	%D	L	D	%D
>300	80	TBB	R94	1	94	9	8%	24	<1	3%
			R95	1	77	13	14%	25	<1	4%
			R96	2	42	7	14%	12	<1	5%
			R97	2	63	8	12%	15	<1	4%
			R98	2	63	10	13%	14	1	7%
			R102	3	78	2	3%	20	<1	1%
			R103	3	73	4	5%	26	<1	2%
			R104	4	133	26	17%	35	3	7%
			R105	4	107	25	19%	31	2	7%
			R106	4	122	53	30%	30	5	15%
				Mean	**95**	**16**	**16%**	**23**	**1**	**6%**

Table 3.3.7. Sole. Average landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Numbers			Weight		
	L	D	%D	L	D	%D
1	85	11	11%	25	<1	3%
2	56	8	13%	14	<1	5%
3	75	3	4%	23	<1	2%
4	90	33	27%	33	3	9%

Table 3.3.8. Sole. Number landed and discarded per hour per length class for beam trawl vessels (TBB) and otter bottom trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh in 2008.

Length (cm)	TBB > 300 HP, 80 mm	
	Discards	Landings
8		
9		
10		
11	0.2	
12		
13	<0.1	
14	<0.1	
15	0.5	
16	0.2	
17	0.4	
18	0.4	
19	0.9	
20	1.9	<0.1
21	3.6	0.2
22	2.8	0.7
23	2.6	2.4
24	1.4	7.4
25	0.3	9.7
26	0.1	9.8

27	0.2	9.4
28	<0.1	8.8
29		8.2
30	<0.1	6.6
31	<0.1	5.8
32		4.9
33		3.5
34		2.5
35		1.6
36		1.0
37		0.9
38		0.5
39		0.4
40		0.2
41		0.2
42		0.1
43		<0.1
44		
45		<0.1
46		<0.1
47		<0.1
48		
49		
50		

Table 3.3.9. Sole. Average numbers landed (L) and discarded (D) calculated at age per hour per quarter and per year for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Age	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Year	
	D	L	D	L	D	L	D	L	D	L
0					0.2				0.2	
1	2.4		1.1		0.6	0.9	27.4	19.2	9.1	11.9
2	4.2	6.8	3.2	3.6	0.8	8.9	2.9	14.2	2.8	8.5
3	4.0	61.8	2.6	22.4	1.4	42.4	4.0	65.3	3.1	47.1
4	<0.1	5.3	1.1	7.2	0.1	11.3	0.3	10.8	0.6	8.7
5		6.2	0.3	7.6	0.1	3.4		4.1	0.2	5.5
6		0.6	0.2	4.1	0.1	3.0	0.5	3.9	0.3	3.4
7	<0.1	3.8	0.2	7.0		3.2		2.0	0.1	4.1
8		0.9	0.1	1.8		0.2		0.1	0.1	0.8
9		0.2	<0.1	0.9		1.2		0.6	<0.1	0.8
10		0.2	<0.1	1.7		0.7		1.9	<0.1	1.2

Table 3.3.10. Sole. Landings (L) and discards D) raised estimates of total fleet numbers (*1000) and mean length at age (cm), total weight (*1000) tonnes and mean weight at age (kg) per quarter and at age per year for beam trawl vessels with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Age	Numbers (*1000)		Mean Length		Weight (*1000)		Mean Weight	
		D	L	D	L	D	L	D	L
1	0								
	1	208		16.9		9.4		0.045	
	2	361	584	18.9	26.0	23.7	106.3	0.066	0.182
	3	337	5292	21.7	27.4	33.4	1153.1	0.099	0.218
	4	1	478	26.0	29.4	0.2	133.0	0.176	0.278
	5		549		30.4		172.8		0.315
	6		30		40.0		22.2		0.734
	7	1	337	26.0	31.4	0.2	124.1	0.176	0.369
	8		92		32.0		32.1		0.349
	9		8		42.0		6.9		0.860
	10		11		41.0		8.4		0.794
2	0								
	1	74		18.4		4.1		0.056	
	2	220	256	20.5	24.4	18.3	37.5	0.083	0.147
	3	171	1654	22.3	27.2	19.1	343.9	0.112	0.208
	4	71	510	23.0	27.8	8.4	120.3	0.119	0.236
	5	23	598	24.8	27.0	3.5	128.2	0.153	0.214
	6	7	249	27.0	30.3	1.4	77.1	0.201	0.310
	7	7	546	27.1	29.2	1.4	154.3	0.205	0.282
	8	4	97	27.7	29.8	0.9	28.3	0.218	0.292
	9	<1	46	28.0	32.0	0.1	17.1	0.224	0.370
	10	1	80	26.0	31.2	0.1	28.9	0.176	0.361
3	0	5		14.0		0.1		0.023	
	1	38	53	17.5	26.0	1.9	9.4	0.052	0.176
	2	49	532	22.4	26.0	5.6	95.0	0.113	0.178
	3	97	2691	24.3	28.3	14.0	652.0	0.144	0.242
	4	3	711	29.5	30.9	0.7	229.6	0.272	0.323
	5	3	196	24.5	31.0	0.5	65.8	0.145	0.336
	6	2	168	29.1	31.2	0.6	58.1	0.263	0.346
	7		184		32.9		76.5		0.415
	8		9		41.6		7.9		0.839
	9		72		31.7		26.7		0.372
	10		38		30.6		13.0		0.338
4	0								
	1	1754	1222	21.3	25.1	164.0	194.2	0.093	0.159
	2	186	891	21.5	27.5	18.8	194.8	0.101	0.219
	3	253	4167	22.5	29.2	28.0	1131.9	0.110	0.272
	4	14	673	24.0	29.5	1.9	194.0	0.135	0.288
	5		258		32.9		103.3		0.400
	6	21	245	25.0	28.6	3.2	66.4	0.155	0.272
	7		123		31.5		45.9		0.372

8	8	39.5	5.9	0.705
9	12	35.0	5.9	0.477
10	39	30.0	11.0	0.282

Table 3.3.11. Dab. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for beam trawl (TBB) with an engine power larger than 300 HP using 80 mm mm cod-end mesh size in 2008. *nm*=not measured.

HP	Mesh	Gear	Vessel	Quart	Numbers			Weight		
					L	D	%D	L	D	%D
>300	80	TBB	R94	1	39	333	90%	9	17	65%
			R95	1	50	1827	97%	10	104	91%
			R96	2	185	1169	86%	31	72	70%
			R97	2	nm	570		6	33	84%
			R98	2	nm	844		5	36	87%
			R102	3	nm	1617		4	80	95%
			R103	3	8	560	99%	2	27	92%
			R104	4	12	603	98%	2	31	93%
			R105	4	14	940	99%	3	61	96%
			R106	4	nm	400		3	29	92%
				Mean	**51**	**905**	**95%**	**8**	**49**	**87%**

Table 3.3.12. Dab. Average landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessel with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Numbers			Weight		
	L	D	%D	L	D	%D
1	45	1080	96%	10	61	86%
2	185	861	82%	14	47	77%
3	8	1089	99%	3	53	94%
4	9	636	99%	3	38	94%

Table 3.3.13. Cod. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for beam trawl (TBB) with an engine power larger than 300 HP using 80 mm mm cod-end mesh size in 2008. *nm*=not measured.

HP	Mesh	Gear	Vessel	Quart	Numbers			Weight		
					L	D	%D	L	D	%D
>300	80	TBB	R94	1	*nm*	<1	-	<1	<1	2%
			R95	1	*nm*	32	-	<1	5	89%
			R96	2	*nm*	1	-	<1	<1	30%
			R97	2	*nm*	15	-	1	3	71%
			R98	2	*nm*	5	-	2	1	37%
			R102	3	*nm*	0	-	7	0	0%
			R103	3	*nm*	0	-	<1	0	0%
			R104	4	*nm*	<1	-	<1	<1	0%
			R105	4	*nm*	0	-	<1	0	0%
			R106	4	*nm*	<1	-	4	<1	3%
				Mean		**5**	**-**	**2**	**<1**	**35%**

Table 3.3.14. Cod. Average landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessel with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Numbers			Weight		
	L	D	%D	L	D	%D
1		16		<1	3	81%
2		7		1	1	52%
3		0		4	0	0%
4		<1		1	<1	2%

Table 3.3.15. Whiting. Landings (L), discards (D) and percentage discards (%D) per hour in numbers (left) and weight (right) for beam trawl (TBB) with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008. *nm*=not measured.

HP	Mesh	Gear	Vessel	Quart	Numbers			Weight		
					L	D	%D	L	D	%D
>300	80	TBB	R94	1	*nm*	30		<1	2	96%
			R95	1	*nm*	93		<1	8	93%
			R96	2	*nm*	29		<1	2	97%
			R97	2	*nm*	22		<1	2	85%
			R98	2	*nm*	27		<1	3	84%
			R102	3	*nm*	15		<1	1	89%
			R103	3	0	14	100%	0	<1	100%
			R104	4	0	17	100%	0	<1	100%
			R105	4	*nm*	50		<1	4	99%
			R106	4	*nm*	53		<1	5	90%
				Mean	**0**	**15**	100%	<1	**3**	93%

Table 3.3.16. Whiting. Average landings (L), discards (D) and percentage discards (%D) per hour and per quarter in numbers (left) and weight (right) for beam trawl vessel with an engine power larger than 300 HP using 80 mm cod-end mesh size in 2008.

Quarter	Numbers			Weight		
	L	D	%D	L	D	%D
1		61		<1	5	94%
2		26		<1	2	88%
3	0	14		<1	<1	91%
4	0	40		<1	3	94%

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

Year/ Period	N trips	Numbers			Weight		
		L	D	%D	L	D	%D
1976-1979	21	116	8	6%	32	1	4%
1980-1983	24	85	24	22%	19	3	15%
1989-1990	6	286	83	22%	48	12	20%
1999	3	112	16	13%	32	2	5%
2000	12	90	25	22%	22	2	10%
2001	4	82	17	17%	17	1	6%
2002	6	126	38	23%	18	3	13%
2003	9	95	32	25%	20	3	14%
2004	8	175	69	28%	31	7	17%
2005	8	99	29	23%	20	2	11%
2006	9	64	26	29%	16	2	13%
2007	10	94	27	23%	22	2	10%
2008	10	95	16	16%	23	1	6%

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

| Year/ Period	N trips	Numbers			Weight		
		L	D	%D	L	D	%D
1976-1979	21	253	185	42%	108	28	20%
1980-1983	24	309	418	57%	99	51	34%
1989-1990	6	392	330	46%	104	46	30%
1999	3	145	181	55%	42	18	29%
2000	12	194	601	76%	50	47	48%
2001	4	364	1184	76%	84	89	51%
2002	6	263	868	77%	69	71	51%
2003	9	196	945	83%	52	70	57%
2004	8	158	792	83%	42	57	57%
2005	8	143	710	83%	47	51	52%
2006	9	166	997	86%	57	67	54%
2007	10	214	700	77%	67	57	46%
2008	10	169	902	84%	61	69	53%

Table 4.3. Dab. Average landings (L), discards (D) and percentage discards (%D) per hour and per period in numbers (left) and weight (right) for beam trawl vessels. Results over 1976-1983 and 1989-1990 from Van Beek (1998), 1999-2001 from Netherlands Institute for Fisheries Research unpublished data.

| Year/ Period	N trips	Numbers			Weight		
		L	D	%D	L	D	%D
1976-1979	21	12	917	99%	4	65	95%
1980-1983	24	31	796	96%	7	60	90%
1989-1990	6	15	2147	99%	2	123	98%
1999	3	112	1411	93%	13	106	89%
2000	12	28	951	97%	6	49	89%
2001	4	125	2268	95%	12	97	89%
2002	6	92	934	91%	11	57	84%
2003	9	60	1166	95%	8	64	89%
2004	8	54	1037	95%	7	51	87%
2005	8	25	492	95%	6	52	90%
2006	9	46	2335	98%	9	79	90%
2007	10	81	1196	94%	12	62	83%
2008	10	51	905	95%	8	49	87%

Table 4.4. Whiting. Average landings (L), discards (D) and percentage discards (%D) per hour and per period in numbers (left) and weight (right) for beam trawl vessels. Results over 1976-1983 and 1989-1990 from Van Beek (1998), 1999-2001 from Netherlands Institute for Fisheries Research unpublished data. *nm*=not measured.

| Year/ Period	N trips	Numbers			Weight		
		L	D	%D	L	D	%D
1976-1979	21	10	34	78%	3	5	62%
1980-1983	24	21	89	81%	5	11	69%
1989-1990	6	5	122	96%	1	17	95%
1999	3	*nm*	77		<1	10	93%
2000	12	*nm*	117		2	9	85%
2001	4	*nm*	69		1	9	86%
2002	6	14	104	88%	1	7	85%
2003	9	2	40	96%	<1	3	86%
2004	8	0	46	100%	<1	2	92%
2005	8	3	18	85%	<1	2	85%
2006	9	*nm*	36		<1	3	74%
2007	10	0	10	100%	<1	3	87%
2008	10	0	15	100%	<1	3	93%
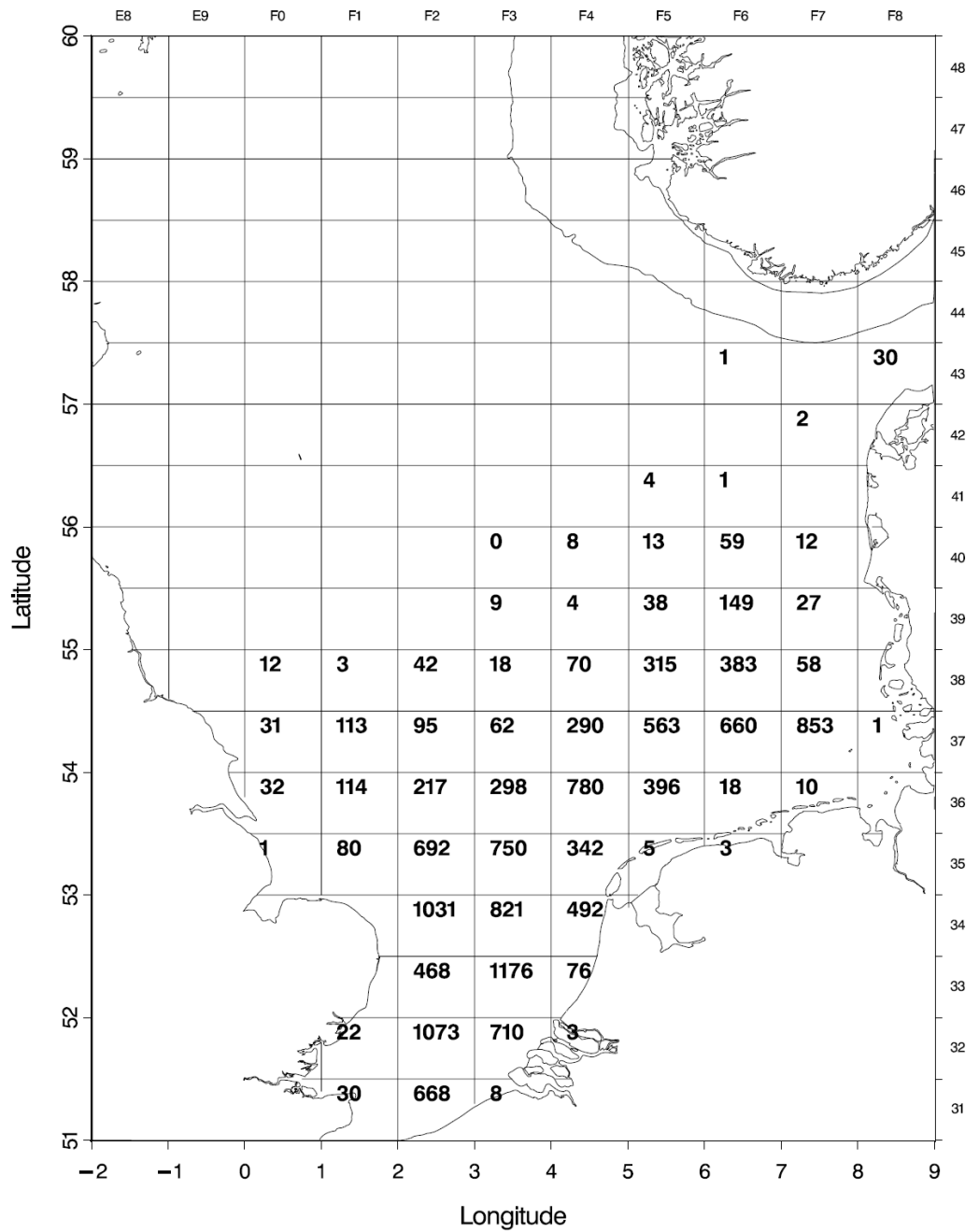
Figure 3.1.1a. Distribution of effort in days at sea by the Dutch beam trawl fleet in 2008, for vessels larger than 300 HP using 80 mm cod-end mesh size. Data from VIRIS database.
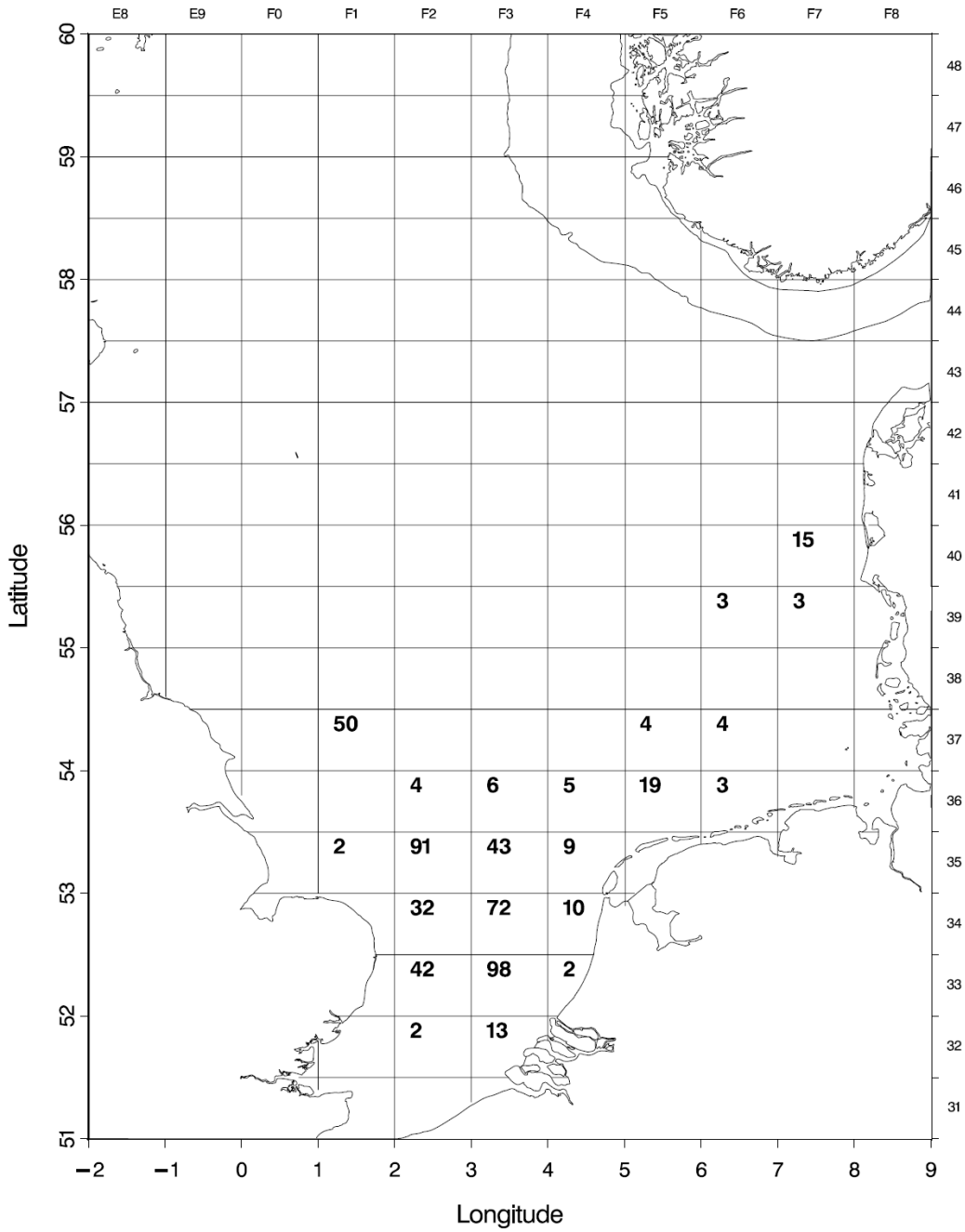
Figure 3.1.1b. Distribution of hours sampled for the sampled Dutch beam trawl fleet in 2008 for vessels larger than 300 HP fishing using 80 mm cod-end mesh size.
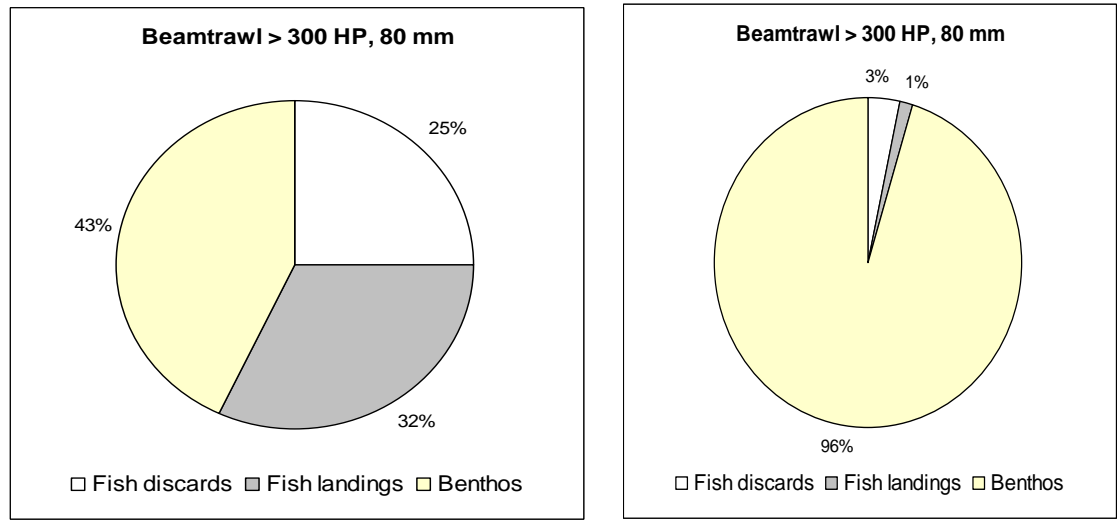
Figure 3.2a. Composition of the catch in weight **(left panel)** and numbers **(right panel)** for beam trawl vessels larger than 300 HP using 80 mm cod-end mesh size.
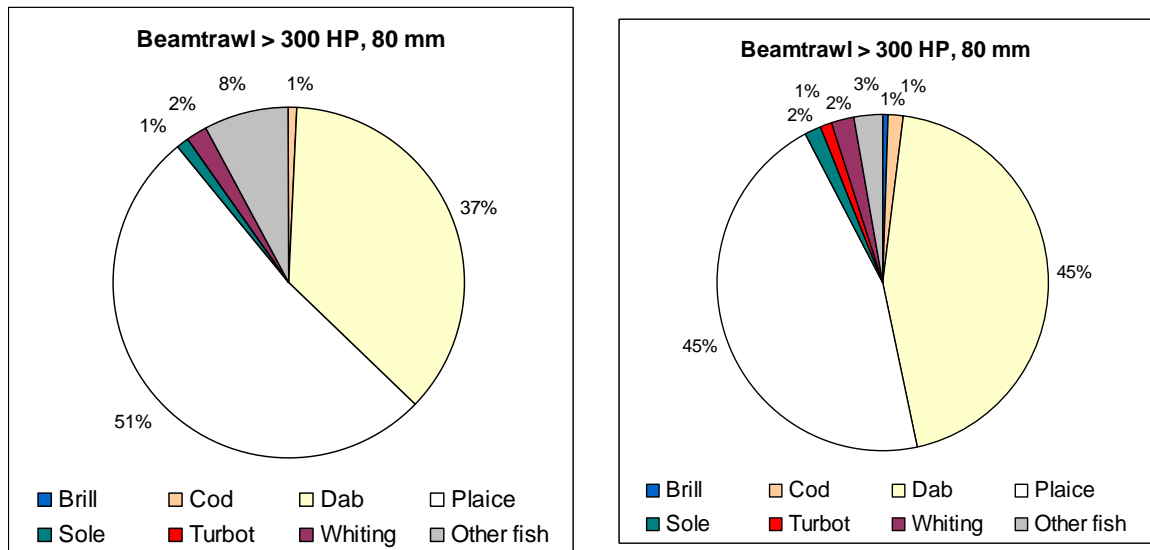
Figure 3.2b. Composition of fish discards in weight **(left panel)** and numbers **(right panel)** for beam trawl vessels larger than 300 HP using 80 mm cod-end mesh size.
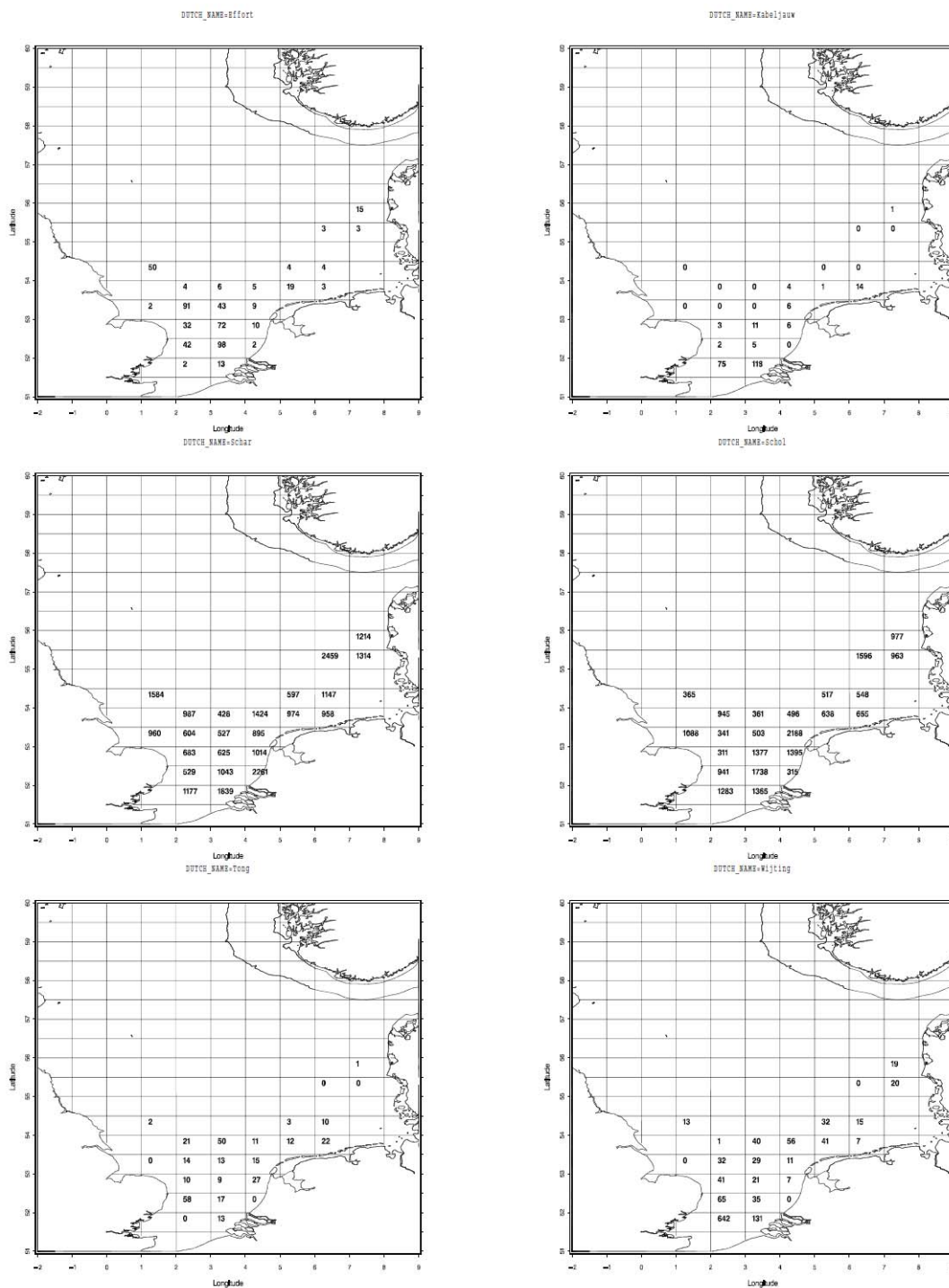
Figure 3.3.1. Effort as sampled hours for discards (upper left) and number of discards per hour per ICES area in 2008 for cod (upper right), dab (middle left), plaice (middle right), sole (lower left) and whiting (lower right) for beam trawl vessels larger than 300 HP using 80 mm cod-end mesh size.
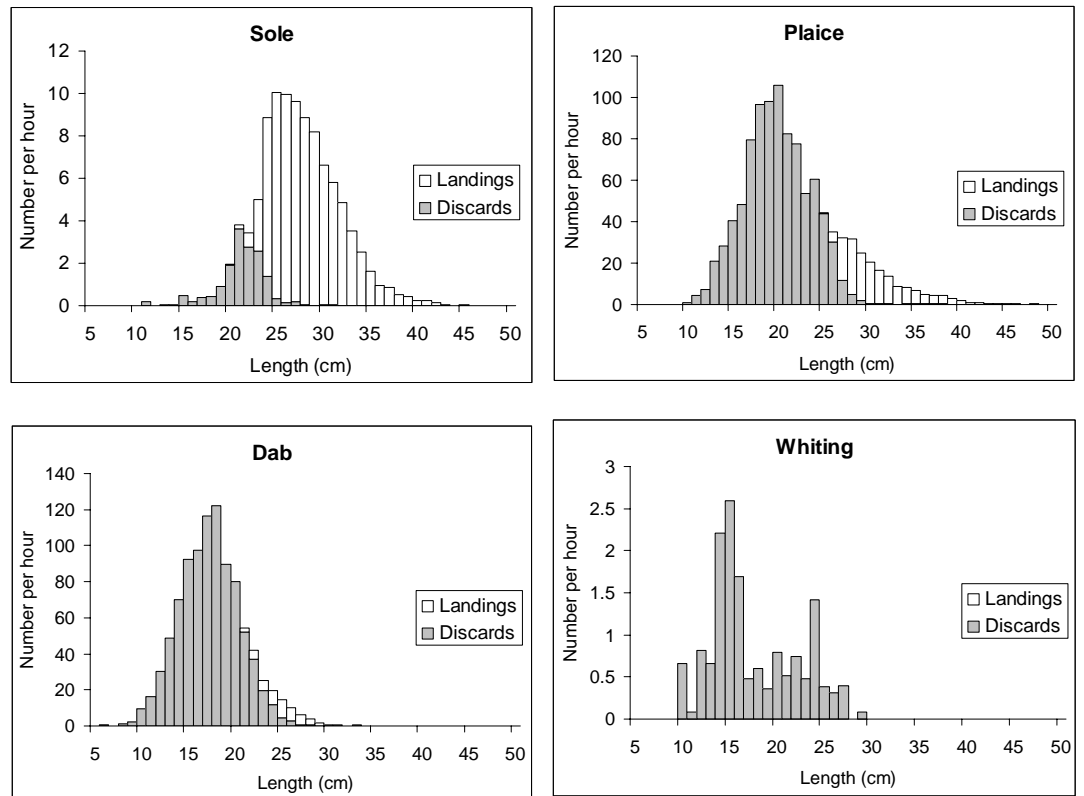
Figure 3.4.1. Length frequency distribution of plaice, sole, dab, whiting and cod in 2008, caught with beam trawl vessels larger than 300 HP fishing with 80 mm cod-end mesh size. Black bars show discards, white bars show landings.