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Quantification of volumes and economic effects of handling and landing

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Ter onderbouwing van een de-minimisverzoek voor ondermaatse wijting gevangen met zogeheten BT2-vistuig in de Noordzee, waren meer gegevens nodig over de omvang van deze vangsten en de kosten voor het verwerken en aanlanden. Het totale netto economische effect van het verwerken en aanlanden van de ondermaatse wijting voor de Nederlandse BT2-vloot is 60.000 euro voor de Eurokotters en 828.000 euro voor de grote kotters (gemiddelde van 2018 en 2019). Dit is 18% en 4% van hun gemiddelde nettowinst over dezelfde periode.
In het geval van visreizen met een hoog volume ondermaatse wijting, zoals die zijn voorgekomen in de periode 2011-2019, kan het totale volume wijting 12-14 keer hoger liggen dan gemiddeld.

To substantiate a de minimis request for undersized whiting caught with the so-called BT2 gear category in the North Sea more data about the extent of the catches and the costs of handling and landing were needed. The total net economic effect of handling and landing the undersized whiting for the Dutch BT2 fleet is 60,000 euros for the euro cutters and 828,000 euros for the large cutters (average over 2018 and 2019). This is 18% and 4% of their average net profit over the same period.
In the case of catches of high volumes of undersized whiting, which have occurred during the period 2011-2019, the total volume of whiting may be a factor 12-14 higher than average.

Key words: landing obligation, whiting, North Sea, BT2 fishery

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Preface

The landing obligation requires all catches of regulated commercial species on-board to be landed and counted against quota. The fishing industry considers it to be difficult to land undersized whiting in beam trawl fisheries due to disproportional costs. A so-called 'de minimis exemption' to the landing obligation is possible on the basis of disproportional costs, provided that a request is done via the Scheveningen Group. In 2020, the Netherlands submitted a request and a one-year exemption was obtained. The Scientific, Technical and Economic Committee for Fisheries (STECF) commented that the studies on the economic effects were insufficient and needed improvement.

The European Commission considers it necessary to resolve the six points of STECF in order to maintain the exemption after 2021. The Ministry of Agriculture, Nature and Food Quality wants to maintain the exemption for the Dutch fisheries and asked Wageningen Research to help to substantiate the new de minimis request.

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Summary

S.1 Main findings

The total volume of whiting discards in the Dutch BT2 fleet varied considerably over the last years, ranging from 0.09-18 tonnes per quarter for the 100-119 mm fishery, 0.03-104 tonnes for euro cutters using 70-99 mm mesh size and 24-690 tonnes for large cutters using 70-99 mm mesh size.

Discard rates also varied considerably from 0-0.06 kg/kwday for the 100-119 mm fishery, 0.0-1.4 kg/kwday for euro cutters using 70-99 mm mesh size and 0-0.75 kg/kwday for large cutters using 70-99 mm mesh size.

The total net economic effect of handling and landing the undersized whiting for the Dutch BT2 fleet is 60,000 euros for the euro cutters and 828,000 euros for the large cutters (average over 2018 and 2019). This is 18% and 4% of their average net profit over the same period. The average costs of handling and landing undersized whiting is 0.87 and 0.73 euro/kg for euro cutters and large cutters respectively.

In the case of catches of high volumes of undersized whiting, which have occurred during the period 2011-2019, the total volume of whiting may be a factor 12-14 higher than average. These high catch rates of whiting result in a net economic effect of 1,100 euros per trip for euro cutters and 3,000 euros for large cutters. For euro cutters this means that the net profit of the trip becomes negative (-600 euro instead of +500 euro), for large cutters the net profit is halved (3,300 euros instead of 6,300 euros).

Table S.1 *Overview of key metrics of catching and landing undersized whiting*

	100-119 mm		70-99mm <300hp		70-99mm>300hp	
Catches	**Low**	**High**	**Low**	**High**	**Low**	**High**
Total per quarter (tons)	0.09	18	0.03	104	24	690
Catch rates per year (kg/kwday)	0.00	0.06	0.00	1.4	0.00	0.75

Costs	Euro cutter (<300 hp)			Large cutter (>300 hp)		
	low	**average**	**high**	**low**	**average**	**high**
Net total costs (*1,000 euros)		60,000			828,000	
Costs per kg (euro)		0.87			0.73	
Net economic effect per trip (euro)	-4	-98	-1,181	-2	-235	-3,246
Resulting profitability per trip (euro)	524	436	-575	6,258	6,041	3,261

Source: Wageningen Research

S.2 Methodology

In 2020 the Netherlands summitted a request for a de minimis exemption for undersized whiting caught with BT2 gear in the North Sea. The substantiation for this request was the disproportional costs involved in keeping undersized whiting on board. Although a one-year de minimis exemption for undersized whiting was obtained, STECF commented that the substantiation was insufficient.

In order to facilitate the Dutch government in answering to the comments of STECF, the objective of this project is to provide information about the extent of the catches of undersized whiting and to estimate the costs of handling and landing undersized whiting and relating these to the total costs and revenues of the fishery concerned (BT2).

To provide information on the level of catches of undersized whiting and the cost related to the handling and landing of these, the following steps were taken:

1. Estimating the total amount of discards and the high and low discard levels based on discard data that were collected in the Dutch discard monitoring programme (through the Data Collection Framework)
2. Estimating the handling time per kg of discards and other marketable fish based on a field experiment in which the handling time was recorded onboard a fishing vessel
3. Estimating the costs and revenues BT2 fleet, based on the economic data collected through the data Dutch collection programme for fisheries and logbook data on fishing activities of the BT2 fleet.
4. Estimating the costs and revenues of landing and handling the undersized whiting (both average levels and high and low levels) based on a combination of the results of step 1-3.

If there were less than three self-sampling trips for a métier within a year and quarter, the coverage of this year/quarter/métier combination is too low for the raising procedure and these trips were excluded from further analyses.

Therefore it wasn’t possible to generate ‘high’ and ‘low’ scenarios per quarter. The amount of discards were on average the highest in quarter 4, so it seems plausible that the trips with the highest discard ranges will occur in that quarter, but there is no certainty.

Given the short timeframe of the project only a single trip on one vessel equipped could be carried out in order to estimate the handling time for undersized whiting.

Samenvatting

S.1 Belangrijke uitkomsten

Het totale volume wijting-discards in de Nederlandse BT2-vloot vertoonde de afgelopen jaren aanzienlijke schommelingen, variërend van 0,09-18 ton per kwartaal voor de 100-119 mm visserij, 0,03-104 ton voor Eurokotters die vissen met maaswijdtes van 70-99 mm, en 24-690 ton voor grote kotters die vissen met maaswijdtes van 70-99 mm.

Discardpercentages varieerden ook aanzienlijk van 0-0,06 kg/kWdag voor de 100-119 mm visserij, 0,0-1,4 kg/kWdag voor Eurokotters die vissen met maaswijdtes van 70-99 mm, en 0-0,75 kg/kWdag voor grote kotters die vissen met maaswijdtes van 70-99 mm.

Het totale netto economische effect van het verwerken en aanlanden van de ondermaatse wijting voor de Nederlandse BT2-vloot is 60.000 euro voor de Eurokotters en 828.000 euro voor de grote kotters (gemiddelde van 2018 en 2019). Dit is 18% en 4% van hun gemiddelde nettowinst over dezelfde periode. De gemiddelde kosten voor het verwerken en aanlanden van ondermaatse wijting zijn 0,87 en 0,73 euro/kg voor respectievelijk Eurokotters en grote kotters.

In het geval van visreizen met een hoog volume ondermaatse wijting, die zijn voorgekomen in de periode 2011-2019, kan het totale volume wijting 12-14 keer hoger liggen dan gemiddeld. Deze hoge vangstpercentages voor wijting resulteren in een netto economisch effect van 1.100 euro per visreis voor Eurokotters en 3.000 euro voor grote kotters. Voor Eurokotters betekent dit een negatieve nettowinst per visreis (-600 euro in plaats van +500 euro), en voor grote kotters halveert de nettowinst (3.300 euro in plaats van 6.300 euro).

Tabel S.1 *Overzicht van de belangrijkste gegevens over de vangst en aanlanding van ondermaatse wijting*

	100-119 mm		70-99 mm <300pk		70-99 mm >300pk	
Vangsten	**Laag**	**Hoog**	**Laag**	**Hoog**	**Laag**	**Hoog**
Totaal per kwartaal (ton)	0,09	18	0,03	104	24	690
Vangstpercentages per jaar (kg/kWdag)	0,00	0,06	0,00	1,4	0,00	0,75

Kosten	**Eurokotter (<300 pk)**			**Grote kotter (> 300 pk)**		
	laag	**gemiddeld**	**hoog**	**laag**	**gemiddeld**	**hoog**
Totale nettokosten (*1.000 euro)		60.000			828.000	
Kosten per kg (euro)		0,87			0,73	
Netto economisch effect per visreis (euro)	-4	-98	-1.181	-2	-235	-3.246
Resulterende winstgevendheid per visreis (euro)	524	436	-575	6.258	6.041	3.261

Bron: Wageningen Research

S.2 Methodologie

In 2020 heeft Nederland een verzoek ingediend voor een de-minimisvrijstelling voor ondermaatse wijting gevangen met de boomkor (BT2) in de Noordzee. Het uitgangspunt van dit verzoek was de disproportionele kosten die gemoeid zijn met het aan boord houden van ondermaatse wijting. Hoewel met deze onderbouwing een eenjarige de-minimisvrijstelling voor ondermaatse wijting werd verkregen, oordeelde STECF dat de onderbouwing onvoldoende was.

Om de Nederlandse overheid in staat te stellen te reageren op het commentaar van STECF, levert dit project informatie over de hoeveelheid ondermaatse wijting die wordt gevangen en wordt een schatting gemaakt van de kosten voor het verwerken en aanlanden van ondermaatse wijting. De kosten worden gerelateerd aan de totale kosten en opbrengsten van de betreffende visserijvloot (BT2).

Om informatie te verstrekken over de hoeveelheden ondermaatse wijting die worden gevangen en de kosten met betrekking tot de verwerking en aanlanding hiervan, zijn de volgende stappen genomen:

1. Een schatting maken van de totale hoeveelheid discards en de hoge en lage discardniveaus op basis van discardgegevens die zijn verzameld in het discards monitoringprogramma van de Nederlandse demersale vloot (vanuit de Data Collectie Verordening (DCF))
2. Een schatting maken van de verwerkingstijd per kg discards en andere vermarktbare vis op basis van een praktijkproef waarbij de verwerkingstijd werd geregistreerd aan boord van een vissersvaartuig.
3. Het berekenen van de kosten en opbrengsten van de BT2-vloot op basis van de economische data verzameld via het monitoringprogramma voor visserij en vergaard via logboekgegevens van visserijactiviteiten van de BT2-vloot.
4. Een schatting maken van de kosten en opbrengsten van het aanlanden en verwerken van ondermaatse wijting (zowel van gemiddelden als hoge en lage niveaus) op basis van het combineren van de resultaten van stappen 1-3.

Als er minder dan drie zelfbemonsteringsvisreizen voor een métier binnen een jaar en kwartaal zijn, dan biedt deze jaar/kwartaal/métier-combinatie onvoldoende basis voor doorberekening; de data van deze visreizen werden niet gebruikt bij verdere analyses.

Het was daarom niet mogelijk om ‘hoge’ en ‘lage’ scenario’s per kwartaal te genereren. De hoeveelheid discards was gemiddeld het hoogst in kwartaal 4, zodat het plausibel lijkt dat de visreizen met de hoogste discardpercentages in dat kwartaal plaatsvinden, maar dat is niet met zekerheid vast te stellen.

Door de korte doorlooptijd van het project konden maar tijdens één visreis gegevens worden verzameld om de verwerkingstijd voor ondermaatse wijting in te schatten.

1 Introduction

Over the last years the Landing obligation (EU regulation 1380 (2013)) has been implemented gradually, obliging fishermen to land undersized catches of regulated species. Based on this EU regulation, fisheries can get a de minimis or a high survivability exemption.

In 2020 the Netherlands submitted a request for a de minimis exemption for undersized whiting (with a length of 27 cm or less) caught with the so-called BT2 gear category in the North Sea. The BT2 gear category refers to a beam trawl (traditional beam trawl, pulse trawl) gear with the mesh size between 70-119 mm (STECF, 2016). In the North Sea the minimum mesh size for beam trawl fishing (BT2) is 80 mm instead of 70 mm, so there is no beam trawl fishing with a mesh size of 70-79 mm. The substantiation for this request was the disproportional costs involved in keeping undersized whiting on board. This request was based on studies of the economic effects of the landing obligation on Dutch fisheries (Buisman et al. 2013, Baarssen et al. 2015, VisNed 2019). Although a one-year de minimis exemption for undersized whiting was obtained, STECF commented that the substantiation was insufficient.

STECF's comments and findings on the 2020 request were:

1. The information provided indicates that the costs of landing unwanted catches of whiting are significant and would require additional labour on board. However, given the de minimis volume would cover only a small part of the overall unwanted catches, the costs for handling the residual unwanted catches not discarded under the exemption would remain regardless of whether the exception is in place or not.
2. The studies only cover the Dutch fleet and it is not clear whether it is representative of other fleets availing of this exemption.
3. Calculating the de minimis based on catches of sole and plaice, means 100% of unwanted catches below Minimum Conservation Reference Size (MCRS) can be potentially discarded.
4. The actual amount of de minimis volume should be clarified as there are different percentages specified in the delegated act (2%) compared to the JR (3%).
5. There is evidence of increased costs associated with handling and storing unwanted catches in the relevant fisheries, but this is quantified at the fleet level and not specific to whiting.
6. Evidence that landing unwanted catches has an associated cost, is not sufficient to demonstrate those costs are disproportionate. Improving selectivity in the relevant fisheries should be the priority as this will reduce the costs for handling unwanted catches.

The objective of this project is to provide information to the Dutch government to help them address the comments of STECF (specifically comments one, four and five). To the end, the extent of the catches of undersized whiting and the costs of handling and landing undersized whiting are estimated and related to the total costs and revenues of the fishery concerned (BT2).

For this the following steps were taken:

1. Assessment of the amount of unwanted by-catch of whiting per quarter for the period 2011-2019.
2. Estimation of the handling time of these unwanted by-catches of whiting based on data from the current Fully Documented Fisheries (FDF) research.
3. Estimation of the costs and revenue of the fishery concerned (BT2) and combination of these costs with the discard data to estimate the cost and revenues resulting from the handling and landing of undersized whiting.

Because catches of undersized whiting are by nature highly variable and unpredictable, the analysis also included an assessment of the variation and the costs related to low and high levels of catches.

2 Method

In order to provide information on the level of catches of undersized whiting and the cost related to the handling and landing of these, the following steps were taken which are treated as separate sections in this report:

1. Estimating the total amount of discards and the high and low discard levels
2. Estimating the handling time per kg of discards and other marketable fish
3. Estimating the total costs and revenues of the BT2 fleet
4. Estimating the costs and revenues of landing and handling the undersized whiting (both average levels and high and low levels).

2.1 Estimating the amount of discards

2.1.1 Discard monitoring programme of the Dutch bottom-trawl fishery

Discard estimates were retrieved from the Dutch discard monitoring programme, which is mandated by the European Commission (EC) through the Data Collection Framework (DCF; EU 2016/1701 (EU (2016a)), EU 2016/1251 (EU (2016b)) and EU 2017/1004 (EU (2017))). The DCF states which information should be collected, managed and made available by the Member States (MS) for scientific advice regarding the Common Fisheries Policy (CFP). For this purpose, all MS are obliged to submit a work plan for data collection in the fisheries and aquaculture sectors on a multiannual basis. In this context, Wageningen Marine Research (WMR) coordinates in collaboration with the Dutch demersal fishing industry a discard monitoring programme, which delivers estimates of discards for each type of fisheries (métier), following the distribution of the fleet in space and time.

Since the DCF revision in 2009, there is a self-sampling programme for the Dutch demersal active fisheries in the North Sea in place. A 'reference fleet' of vessels of which the owners are willing to participate is recruited and fishermen within that reference fleet are requested to collect discard samples according to a definite annual sampling plan. Within this programme, discard data are collected by Dutch bottom-trawl fisheries for a number of métiers that are defined in the DCF based on gear type, target species assemblage and mesh-size (European Union (EU) decision 2016/1251, EU (2016b)). The following six métiers are defined within the Dutch bottom-trawl fisheries: beam trawlers with 70-99 mm (engine power >300 hp and engine power ≤300 hp)(both BT2), 100-119 mm (BT2) and ≥120 mm mesh size (BT1), and otter trawlers with 70-99 mm mesh size (targeting Nephrons, mixed crustaceans and demersal species, or demersal fish) and 100-119 mm mesh size. Table 2.1 shows the sampling effort and fleet effort of the Dutch demersal fleet using 2019 as an example. As this report focuses on the BT2 fishery, only those specific métiers are shown.

To verify the accuracy and objectivity of the self-sampling, 10 observer trips on board of fishing vessels that participate in the self-sampling programme are carried out annually. The relationship between the catches of both observers and the self-sampling programme are explored for correlation and systematic differences. In addition, the observer trips have proven to be of importance for training crew members in sampling of discards.

Table 2.1 *Self-sampling and fleet effort (in kWdays) of sampled métiers, and self-sampling coverage (% of kWdays) per self-sampled métier for 2019 (derived from van Overzee et al., 2021)*

Métier	Self-sampling effort (kWdays)	Fleet effort (kWdays)	Self-sampling coverage (kWdays %)
TBB_DEF_100-119	67,649.31	939,630	7.2
TBB_DEF_70-99_G300hp	808,078.8	23,847,006	3.4
TBB_DEF_70-99_S300hp	22,205	92,6360	2.4

2.1.2 Discard self-sampling programme

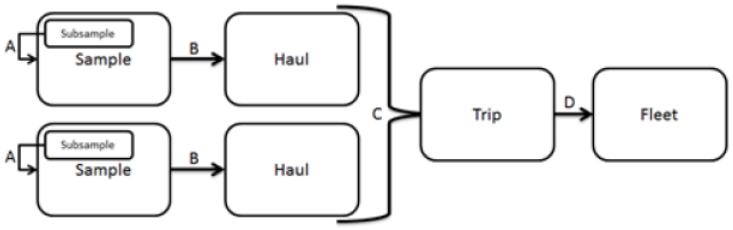
Annually approximately 160 trips in which two hauls need to be sampled are carried out. These trips are randomly divided over the protocol-instructed 'reference fleet'. Between 2011 and 2019, around 128-172 trips per year were sampled by the reference fleet, which consisted of 21 vessels in 2019. During the fishing trip, each time the fishing gear is deployed, operational and catch data are collected regarding vessel position; haul duration; depth; weather conditions; the volumes of catches and landings; the numbers at length. The total volume of discards of each haul is calculated by subtracting the retained amount of catch, recorded by the fisherman, from the total catch, estimated by the skipper/crew. In addition, the fishing crew scoops and retains per trip two boxes (one box equals approximately 40 kg) of discards, from two separate hauls. The discard samples (a total of approximately 160 kg) are collected by WMR staff and taken to the laboratory for analysis. The data is entered into a standard data management software and controlled before storage in the centralised WMR Frisbe database. The data is used for analyses within different projects, including stock assessment working groups (ICES 2020) and sent to the STECF Expert Working Group on Fisheries Dependent Information (STECF 2020) (van Overzee et al., 2021).

2.1.3 Data processing

In order to obtain information representative of the fleet, the data is processed in a raising procedure (Figure 2.1): For each self-sampled trip, the registered numbers (at length) in the samples are multiplied with the volume ratio between discard sample and total discards to estimate total numbers (at length) within each of the two hauls (Figure 2.1, *B*). Whenever a species is very abundant within the sample, a sub-sample of this species is taken and the sub-sample fraction is used to estimate total numbers (at length) within the sample (Figure 2.1, *A*). Length-weight relationships are applied to convert numbers at length to weight for all fish species.

Per trip, species' numbers and weights of the two sampled hauls are summed. Numbers and weights are then standardised into discards per unit effort rates (expressed in number/hour and kg/hour) by dividing them by the deployment duration (i.e. fishing time). Total numbers and weights per fishing trip are calculated by multiplying the standardised rates with the total duration of the two sampled hauls in the trip together (Figure 2.1, *C*). It is assumed that the sampled hauls per trip are representative in species composition and variance for all other hauls of that trip.

The fleet effort is calculated based on the official Dutch logbook information registered in the WMR VISSTAT database. A measure of fishing effort (expressed in kWdays) is estimated by multiplying the time between departure and arrival with the engine power of each vessel per fishing trip within each métier. The ratio between fleet effort and sampling effort (kWdays) is used to finally estimate total discards by species for the Dutch demersal fleet by métier (Figure 2.1, *D*).



A: $number\ in\ subsample * subsample\ fraction$

B: $number\ in\ sample * \frac{Volume\ of\ (total\ catch\ of\ haul - total\ landings\ in\ haul)}{volume\ of\ discard\ sample}$

C: $sum\ of\ numbers\ in\ both\ samples * \frac{Total\ duration\ all\ hauls\ of\ the\ trip}{Duration\ both\ sampled\ hauls}$

D: $number\ per\ trip * \frac{effort\ (kWDays)\ national\ fleet\ (per\ métier)}{effort\ (kWDays)\ sampled\ trips\ (per\ métier)}$

Figure 2.1 *The data raising procedure from sample to fleet-specific estimates (derived from Van Overzee et al., 2021)*

In order to further assess the average discard rates of whiting which could be used in the estimation of the costs, for each of the métiers, an analysis of variance (ANOVA) was carried out to assess general patterns in the discard rates for each of the metiers. This was done as the fisheries are fishing in different areas (coastal area and further offshore) and therefore differences in seasonal patterns are expected. The most complete model used was:

$$D_{ij} = \mu + Y_i + Q_j + \varepsilon_{ij}$$

where D_{ij} = Discard rate of whiting for year *i*, quarter *j* (kg/kwday), μ = overall mean, Y_i = effect of i^{th} year, Q_j = effect of j^{th} quarter, ε_{ij} = error. Non-significant terms were eliminated from the model and residuals were tested for normality. To compare group means in case of significant effects, 95% confidence limits around predicted estimations were calculated.

2.2 Estimating the handling time

2.2.1 Fully Documented Fisheries

To substantiate the costs involved in processing undersized whiting onboard a beam trawler (BT2) a field experiment using 'Fully Documented Fisheries' (FDF) was set up. The concept of FDF is that catches, i.e. both landings and discards, of a fishery are fully documented using Electronic Monitoring (EM) systems (Kindt-Larsen et al., 2011). EM is an automated system consisting of sensors on for example the winches of the gear, video registration by cameras aimed at the sorting belt and hoppers (Figure 2.2) and an onboard computer. The sensor registers when the gear is hauled and the catch comes on board and is being processed, starting and stopping the video registration automatically. By reviewing images recorded by the video registration system the catch (in numbers) per species can be determined.

Figure 2.2 *Set up of video cameras onboard beam trawl vessel. Two cameras on each sorting belt (left) and a single camera on the hopper and conveyor (right)*

2.2.2 Data recording

In this study, the EM system was used to monitor the additional processing time when whiting discards are to be landed. Beam trawl vessels participating in the 'Fully Documented Fisheries' project were approached to participate in the whiting research project as these vessels are already equipped with an EM-system onboard. One vessel was selected vessel assuming to be representative for the fishing operations of the Dutch beam trawl 70-99 mm fleet. The vessel is a large (>40m) beam trawler using a 12m beam trawl using 80 mm mesh size. The vessel is mainly targeting flatfish with its main fishing grounds in the southern Bight in the North Sea (ICES Division 4c). Beam trawlers fishing in the southern Bight are often equipped with a chain mat which consists of a matrix of chains across the mouth of the gear preventing stones to enter the trawl and enable the vessel to operate over more rough substrates compared to a conventional beam trawl rigged with tickler chains. Important to note is that during the trip initially a square chain was used (Figure 2.3, left). However, this gear broke down after 10 hauls and the vessel had to steam back to port changing the rigging to a more conventional chain mat (Figure 2.3, right).

Figure 2.3 *Rigging of the vessel using a square chain mat (left) for the first 10 hauls, changing to a rigging using a regular chain mat for 29 hauls (right)*

In week 10 of 2021 (7-11 March) the vessel conducted a regular fishing trip in which the crew (5) processed the discarded whiting every other haul. Processing included sorting discarded whiting from the sorting belt and weighing the fish below deck as would be required under the Landing Obligation. By alternating processing of discarded whiting within a trip the difference in time required between a regular haul and one in which whiting discards are processed can be evaluated.

The skipper was requested to complete a recording programme as used within the pulse fisheries research programme (van Rijssel and Rijnsdorp, 2020) to record information by haul on: time at start and end of the haul, location of the start and end of the haul, landings (kg) of sole, plaice, cod, turbot, brill and rays, and weight (kg) of discarded whiting. Additional information on landings (kg) of other species (e.g. dab, flounder, lesser weever, sharks) by haul where obtained from the weighing slip. Combining the data recorded by the skipper with the landings of the weighing slip the total landings (kg) by haul can be derived. The weighing slip also includes the time of weighing the landings in the fish hold by haul. The crew was asked to weigh the whiting discards at the very last to ensure the final processing time is registered and a difference between the whiting sorted and not sorted hauls is clear (Figure 2.4).

11-03-2021 03:17:23	1	274	Schol	40 KG	Ongesorteerd	36,000	0	€ 0,00	€ 0,00
11-03-2021 03:16:54	1	273	Schol	40 KG	Ongesorteerd	35,000	0	€ 0,00	€ 0,00
11-03-2021 01:04:35	1	272	Wijting bms	40 KG	Ongesorteerd	20,000	0	€ 0,00	€ 0,00
11-03-2021 01:04:06	1	271	Wijting bms	40 KG	Ongesorteerd	36,000	0	€ 0,00	€ 0,00

Figure 2.4 *Part of the weighing slip including weighing times of the fish boxes. The yellow marking denotes the date and time at which the last box of a haul in which whiting discards were sorted is weighed*

2.2.3 Video review

In total 39 hauls were carried out of which 22 hauls whiting discards were processed. Of the 39 hauls two hauls could not be used for the analysis because of malfunctioning of the gear in the 10th haul and the 11th haul being used as a trial to test the new rigging of the gear. In both cases, the processing time of the catch would not be representative.

The video material of 37 hauls was manually evaluated by reviewing the footage in terms of start time and end time of the sorting process, whether or not a haul was used for sorting whiting discards, and as a check for particularities in the haul. The latter is of importance as large quantities of other undersized fish, benthos or rocks may be of influence to the sorting time of the catch. The sorting time by haul is evaluated by noting the start time of the sorting process being defined as the moment at which the conveyor start running as well as the end time being the moment at which the sorting belt is empty. The time the crew spend at the sorting belt, however, is only part of the overall process time of the fish. After sorting, the fish are brought below deck and weighed. As mentioned, the weight and time of weighing is noted on the weighing slip. The time at which the last box of fish was weighed is noted as the end time of the overall processing.

To further assess the time needed to process the undersized whiting and the other fish an analysis of variance (ANOVA) was carried out in which the relationship between the sorting time and the undersized whiting and the sorting time and the other catches could be distinguished. The most complete model used was:

$$HT_i = \mu + \alpha wu + \beta ws + G_i + \varepsilon_i$$

where HT_i = handling time (minutes), μ = overall mean, wu = weight of undersized whiting, ws = weight of marketable other species, G_i = effect of ith gear (chains or chain mats), α, β = regression coefficients, ε_{ij} = error. Non-significant terms were eliminated from the model and residuals were tested for normality. To compare group means in case of significant effects, 95% confidence limits around predicted estimations were calculated.

2.3 Estimating the costs and revenues of the BT2 fleet

Estimation of the costs and revenues of the BT2 fleet was based on data from the Dutch sampling programme for economic data from the fisheries. Within this programme Wageningen Economic Research collects economic data from a panel of approx. one third of the Dutch active cutter fleet (90 vessels) through the 'Bedrijveninformatienetwerk' (Farm Accountancy Data Network, FADN). These data give detailed insight into the costs and earnings of the various vessel types and fisheries (see also www.visserijincijfers.nl).

In order to estimate the costs and earnings per quarter for the BT2 fleet, the estimated costs and earnings from all vessels in the fleet was used. From 2018 onwards, this dataset has been generated. The costs of each of the vessels in the population in the various fisheries have been estimated using regression analyses, the economic data from the FADN panel and information on effort, landings, landings value and technical characteristics of the vessels that is available for all vessels

(Oostenbrugge 2021 in prep). Within this dataset, costs and earnings are estimated by fisheries, so the costs are available for the traditional beam trawl fisheries and the pulse fisheries.

Based on the logbook data and price data, the fishing effort and income in each of the quarters was calculated and for BT2 trips (both traditional beam trawl and pulse trawls) and trips using other gears. BT2 trips were defined as trips in which the gear is a beam trawl (traditional beam trawl, pulse trawl) gear and the mesh size is between 70-119 mm. The proportion of the total effort and landings per vessel, fishery and year were used to distribute the costs and earnings per vessel and fishery over the different quarter. For instance, in case a vessel spent 50% of its total beam trawl effort in quarter 1, 50% of the total fuel costs were assigned to this quarter as the fuel costs have a clear relationship with the effort. Fixed costs were divided equally over all quarters in which the vessels were active.

For the analyses, a distinction was made between so-called euro cutters; vessels of about 24 m length having an engine of 221 or less kw and large cutters; vessels of around 40 m length having an engine power of between 1,000 and 1,471 kw.

2.4 Estimating costs of handling and landing undersized whiting

The total costs and revenues resulting from handling and landing undersized whiting were estimated in a three step procedure:

Total volume of undersized whiting per vessel and quarter was estimated using the estimated relationship between the volume of whiting and the effort (kwdays) and the information on effort from that specific quarter and vessel (see Appendix 1).

Total extra time for sorting the undersized whiting was estimated using the estimated relationship between sorting time and volume of whiting (see Appendix 2).

The costs and revenues from handling and landing the discards were estimated based on relationships between the volume of undersized discards and the various cost items for the specific vessel and quarter. These relationships were developed during an expert session with inputs from various fish auction representatives and validated by sector experts and can be found in Appendix 3. Crew costs were assumed to be related to the extra sorting time. Other costs were related to the extra kg of fish landed or the extra value of landings.

Total costs and revenues were estimated for each vessel by quarter and for both average levels of undersized whiting landings, high and low levels. The total costs for the average levels were aggregated for the total fleet of euro cutters and large cutters for each of the quarters of 2018 and 2019. For the sake of clarity, average total values per fleet over the two years are presented in the results section. Because the high and low levels of undersized whiting catches were available on the annual level, the comparison between the costs and revenues with high and low catch levels was done on an annual level.

3 Amount and handling time

3.1 The amount of discards

3.1.1 Total discards

The amount of total whiting discards was calculated for the years 2011-2019, for each quarter and métier. The Dutch demersal beam trawl fishery using BT2 category gears, in the North Sea fishes with a mesh size of 100-119 (TBB_DEF_100-119_0_0) or 70-99. The latter is further subdivided based on engine size (horse power, hp) into vessels with ≤ 300hp engine power (TBB_DEF_70-99_0_0_S300hp, so-called 'euro cutters') and vessels with > 300hp engine power vessels (TBB_DEF_70-99_0_0_G300hp, large cutters). From the self-sampling data, only these three métiers were selected. Figure 3.1 shows the number of whiting trips per year for each métier. Over years there is some variation in the number of trips in which whiting discards are present, which is also reflected in the total number of trips. TBB_DEF_70-99_0_0_G300hp has 2.5-6.5 more trips with whiting discards present as compared to euro cutters. Large cutters show an increase since 2013 up to 2018. All métiers show a decrease in number of trips with whiting discards in the most recent year (2019).

For each of the three métiers, the total amount of whiting discards was calculated per year and quarter by applying the raising procedure described in paragraph 2.1.3 (Figure 2.1). If there were less than three self-sampling trips for a métier within a year and quarter, the coverage of this year/quarter/métier combination is too low for the raising procedure and these trips were excluded from further analyses. This is mainly the case for TBB_DEF_100-119_0_0. The majority of the trips with whiting discards were made by the TBB_DEF_70-99_0_0_G300hp métier.

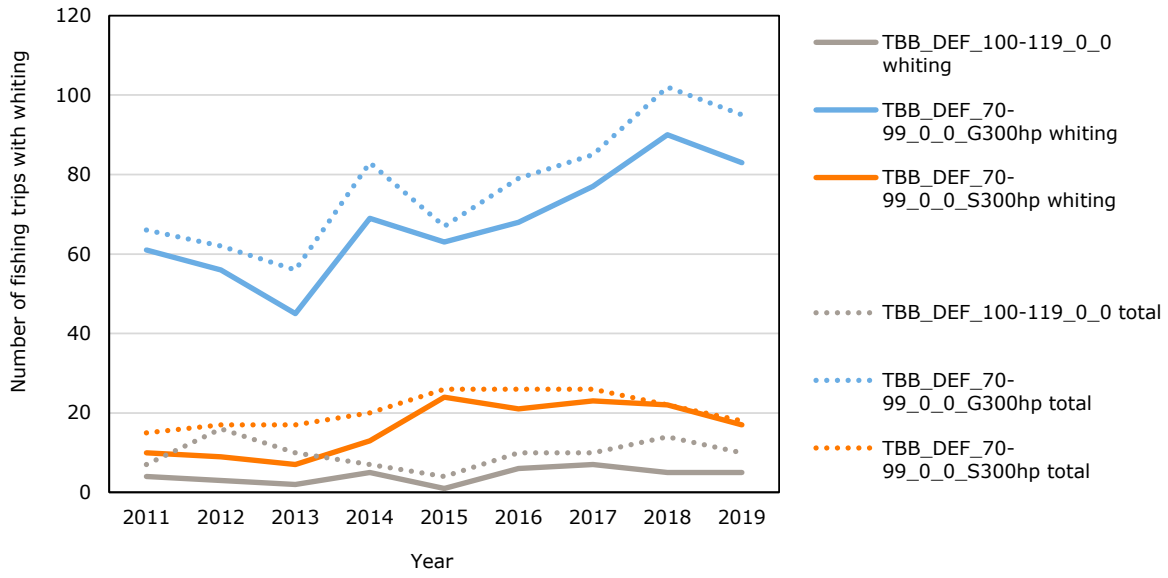


Figure 3.1 *Total number of self-sampling trips (broken line) and total number of self-sampling trips with whiting discards present per year and métier*

Figure 3.2 (a-c) shows the total amount of whiting discards for each métier per year and quarter, which was calculated via the raising procedure. Total whiting discard from quarters/years where sampling coverage was not sufficient were omitted from the raising procedure and are not shown in the Figure 3.2. In particular TBB_DEF_100-119 has low sampling coverage in most years and quarters. The total quarterly discards for this métier (Figure 3.2a) ranges from 0.09-18 tonnes. Large

cutters (Figure 3.2b) have the highest total quarterly discards which ranges between 24-690 tonnes, whereas eurocutters (Figure 3.2c) range between 0.03-104 tonnes.

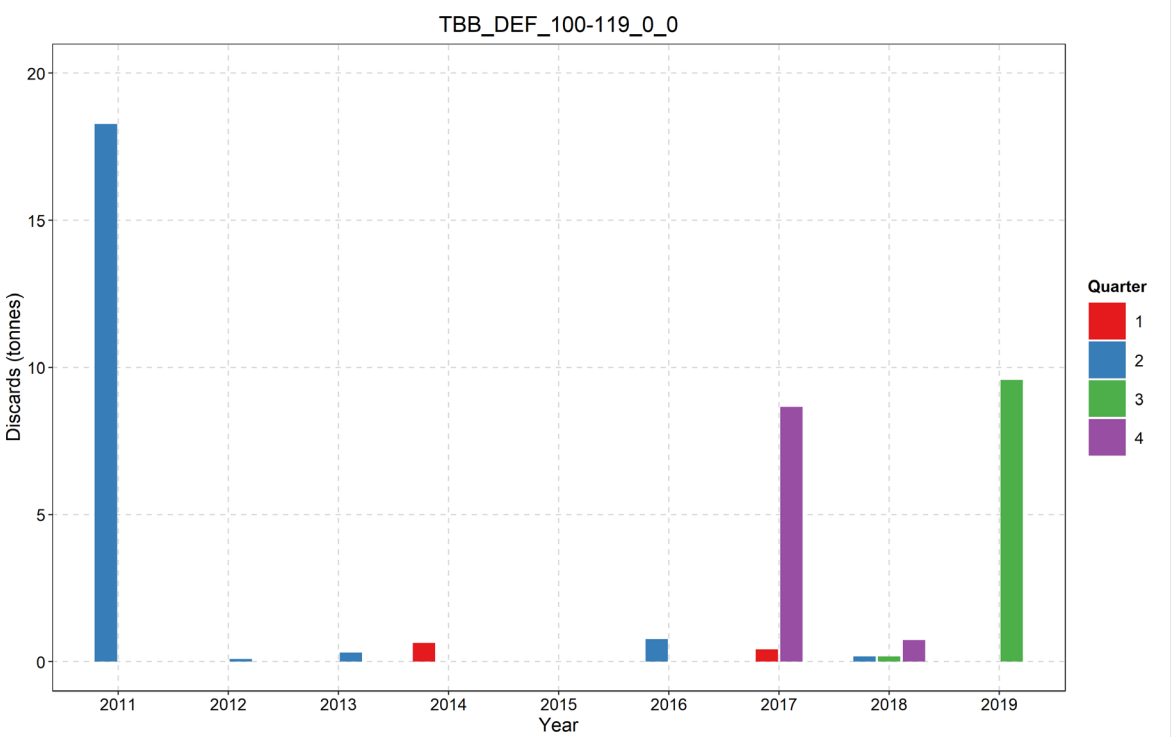


Figure 3.2a *Whiting discards (tonnes) per year and quarter for TBB_DEF_100-119_0_0*

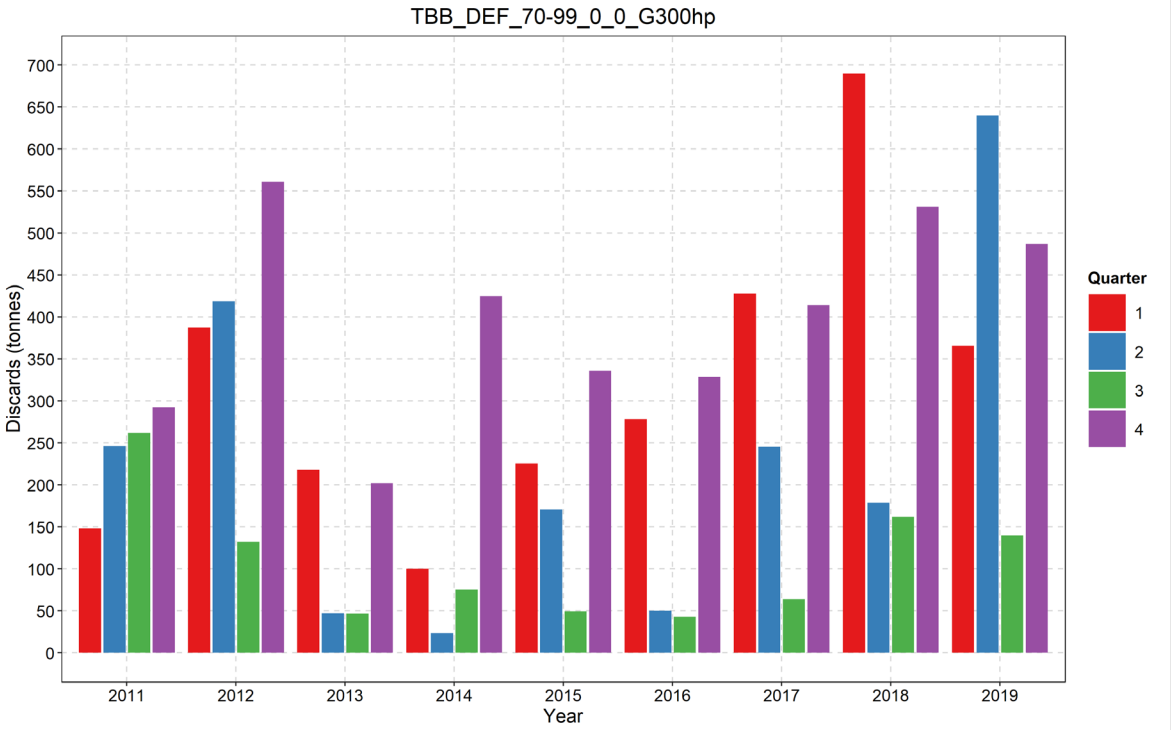


Figure 3.2b *Whiting discards (tonnes) per year and quarter for TBB_DEF_70-99_0_0_G300hp (beam trawls with engine power >300 hp)*

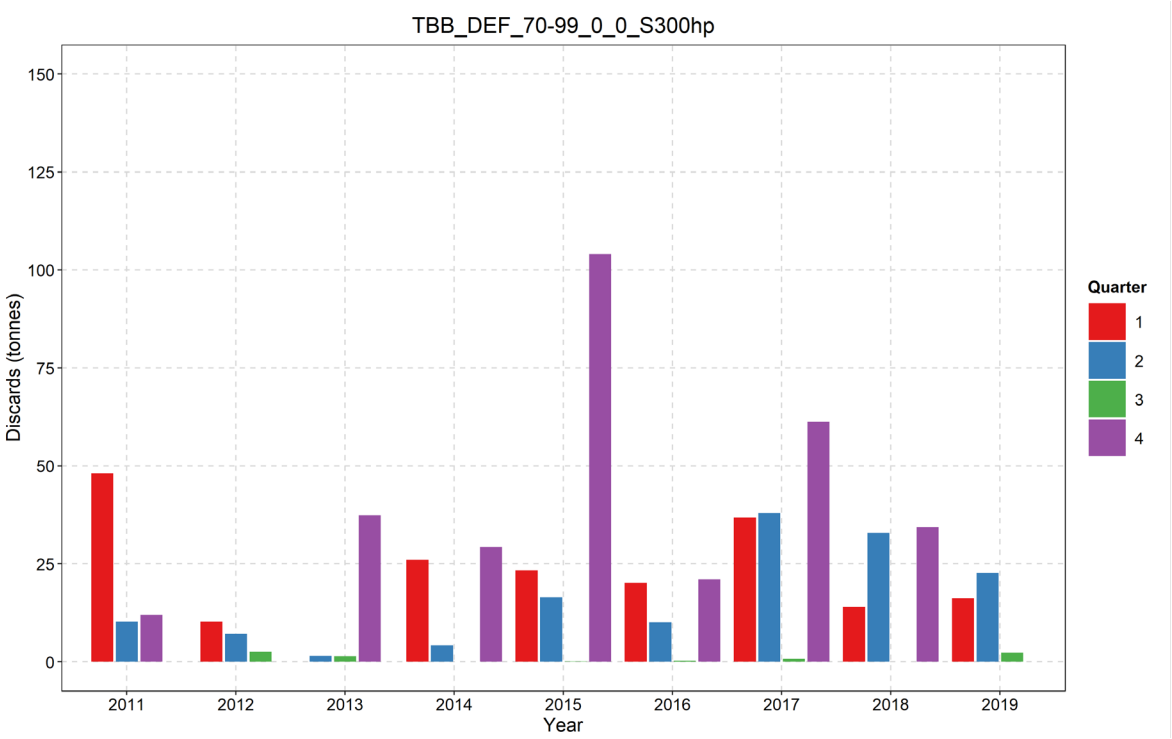


Figure 3.2c *Whiting discards (tonnes) per year and quarter for TBB_DEF_70-99_0_0_S300hp (beam trawls with engine power ≤300 hp)*

3.1.2 Scenarios

To capture the variation of whiting discards within métiers and years, two scenarios were designed: a minimum scenario based on the 5 fishing trips per year with the least amount (kg), and a maximum scenario based on the 5 fishing trips per year with the largest amount (kg) of whiting discards. To estimate total discards per year for the entire fleet, the same raising procedure (see paragraph 2.1.3) was applied to the minimum and maximum scenarios per year. In order to have enough fishing trips with whiting discards per métier, the information was combined per year and métier and variation between quarters was not taken into account. As the designed scenarios (i.e. number of chosen trips, aggregation over year) were chosen arbitrarily, they do not reflect actual observed discard ranges for the presented métiers. The scenarios should be only viewed as an indicator of the within year variation in whiting discards of the demersal beam trawl fishery.

The minimum and maximum discards scenarios per year and métier are standardised to a discards per unit of effort (DPUE, kg per kilowatt-day) and shown with the total discards DPUE per métier and year in Figure 3.3a. The calculated scenarios and total discards for TBB_DEF_100-119_0_0 (Figure 3.3a) does not contain data for all years, as sampling coverage for this métier is significantly lower as compared to the other métiers in the BT2 fishery. This explains also why the minimum scenario is sometimes higher than total. Total discards were raised per year and quarter, summarised per year and standardised to a discards per unit of effort by dividing by total fleet effort per year. If total discards were only present for one or two quarters, the DPUE is most likely underestimated. For both euro- and large cutters the maximum discard scenario shows a higher DPUE (kg/kwday) compared to total discards, in some years approximately 7 times higher (Figure 3.3b and Figure 3.3c). These scenarios show that the specifically for large cutters (4b), the range between the minimum ('best-case') and maximum ('worst-case') scenarios is wide. Total discards DPUE for this métier, however, shows a stable trend over time ranging between 0.03 and 0.09 kg/kwday.

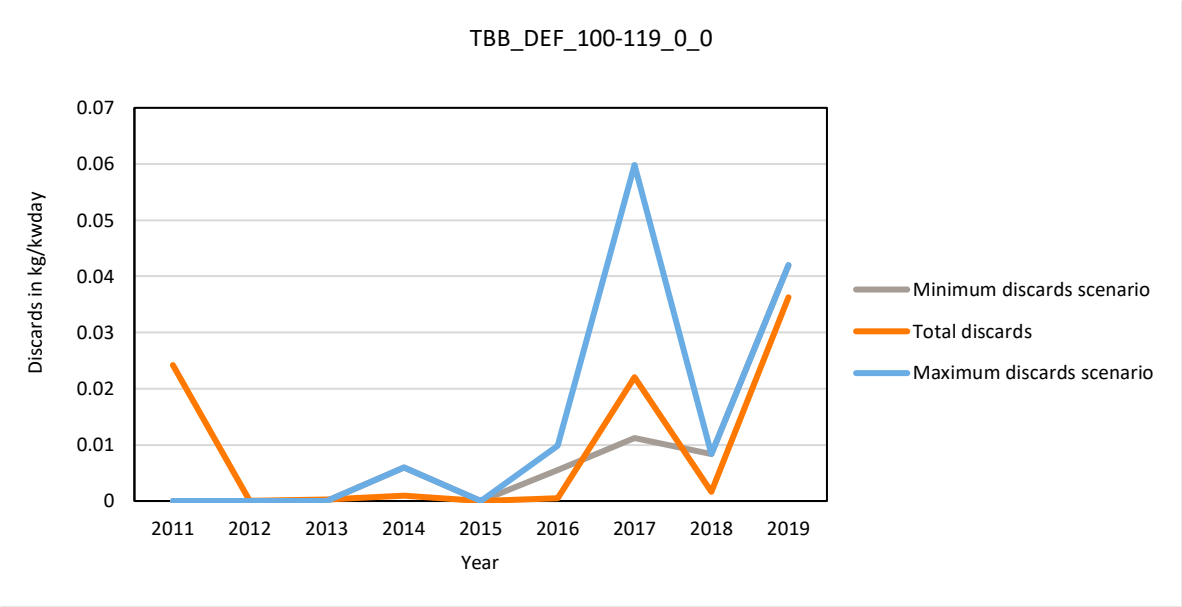


Figure 3.3a *Discards per unit of effort (kg/kwday) for minimum and maximum discards scenario and total discards per year for TBB_DEF_100-119_0_0*

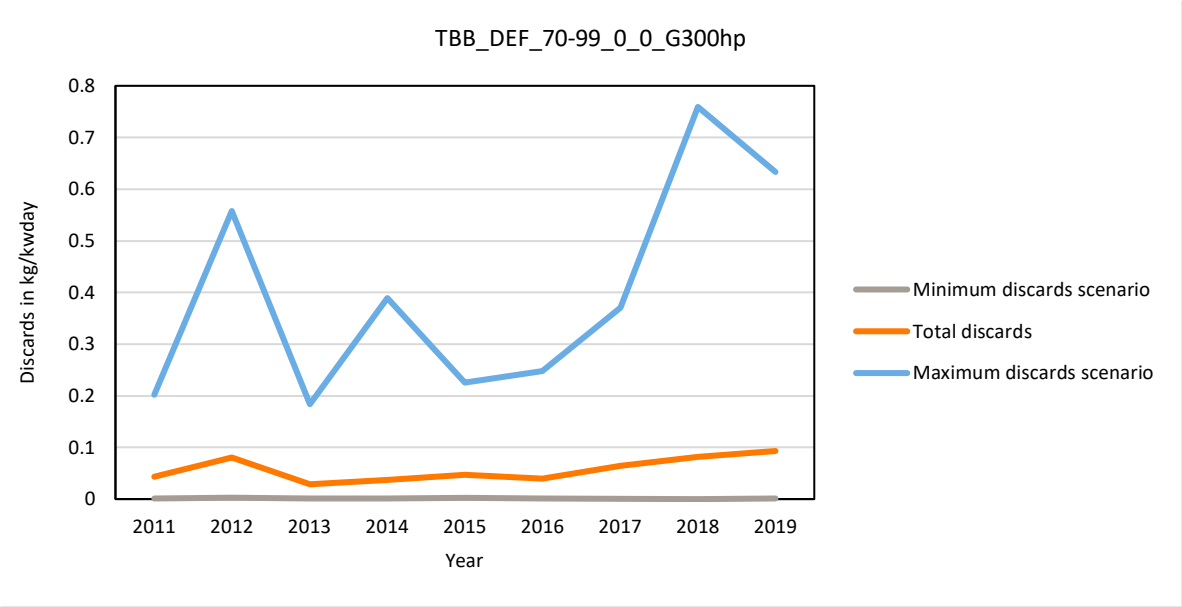


Figure 3.3b *Discards per unit of effort (kg/kwday) for minimum and maximum discards scenario and total discards per year for TBB_DEF_100-119_0_0*

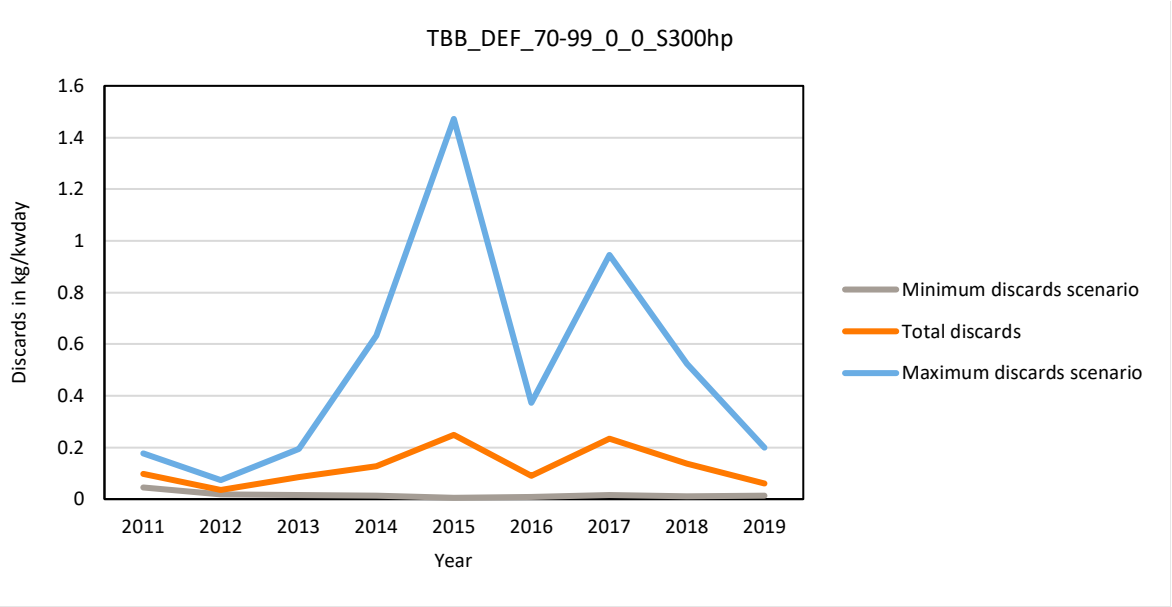


Figure 3.3c *Discards per unit of effort (kg/kwday) for minimum and maximum discards scenario and total discards per year for TBB_DEF_100-119_0_0*

3.1.2.1 Length distribution

As it is assumed that the size of the fish is the main factor driving the handling time of the undersized whiting, and the sorting time from one trip from the first quarter was used in the analysis, an analysis of the length frequencies or whiting from the different quarters was done to see whether the average size of the fish varied between the métiers and quarters. Within the self-sampling programme, numbers at length are recorded for all fish species within the sample. For each métier, we calculated the frequency of each length class (1 cm) of whiting discards per quarter within the time span 2011-2019 (Figure 3.4). The frequency was calculated as the sum of numbers per hour fishing (discards per unit of effort of sampled hauls only). TBB_DEF_100-119_0_0 has low sampling coverage and there is limited data on frequency at length available. Large and euro cutters show similar patterns in the length-frequency distribution per quarter. For both métiers, highest frequencies are found in quarter 4. Table 3.1 gives an overview of the size classes most often discarded (in numbers per hour), and the maximum size class discarded per métier and quarter for 2011-2019. Most of the discarded whiting is below its minimum landing size (MLS) of 27 cm. In 2018 and 2019, approximately 14% of discards were above the MLS, of which around 6% was above 28 cm.

Table 3.1 *Overview of the most frequent and maximum (in brackets) discarded size classes (cm) per métier and quarter*

	metier		
quarter	TBB_DEF_100-119_0_0	TBB_DEF_70-99_0_0_G300hp	TBB_DEF_70-99_0_0_S300hp
1	15 (24)	21 (38)	18 (32)
2	25 (28)	22 (36)	18 (31)
3	10 (26)	22 (31)	19 (29)
4	26 (26)	16 (34)	20 (40)

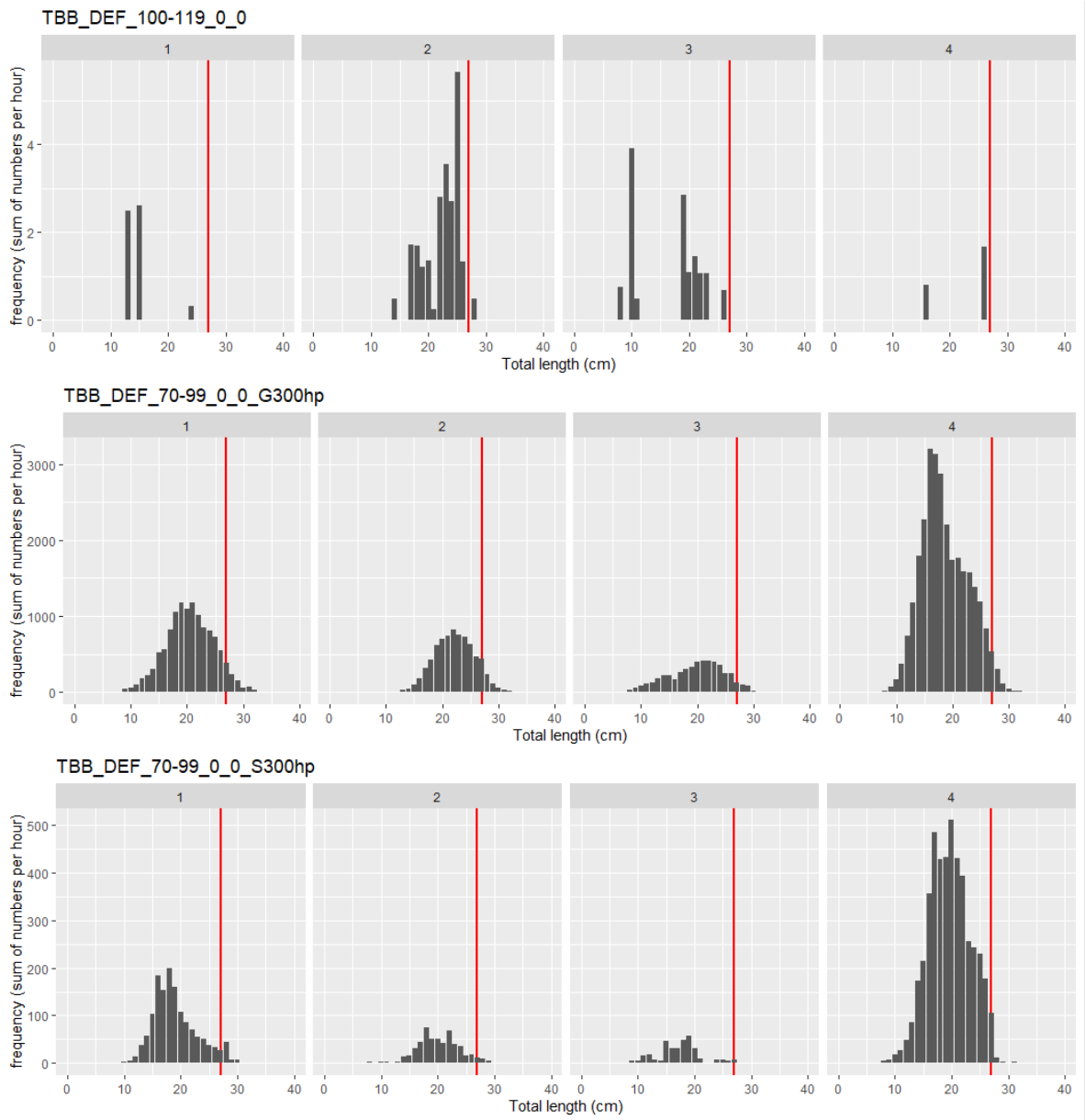


Figure 3.4 *Number per hour discarded per length class (cm) for discarded whiting for the three demersal beam trawl métiers per quarter in 2011-2019 (red line = Minimum Landing Size, 27 cm). For TBB_DEF_70-99_0_0 a distinction is made between vessels with engine power ≤300 hp (S300hp) and > 300 hp (G300hp)). Y-axes differ among the three figures*

3.2 Handling time

Over the entire EM trip, 9,635 kg of fish caught in 39 hauls were handled on board consisting mainly of flatfish species such as sole (23%), flounder (14%), plaice (8%) and dab (8%). Without taking the whiting discards into account the crew processed on average 151 kg of marketable fish each haul. In total 2.984 kg of whiting (31%) was processed over 22 hauls, with an average of 135 kg whiting discards per haul (range 2 kg to 394 kg).

Unfortunately, the gear of the vessel had to be changed during the trip. In this context, it is important to evaluate potential differences in the catches and processing time as a result of the gear change (Figure 3.5 and Table 3.2). A basic analysis calculating the average amount of fish processed shows there is a difference between hauls in which whiting is and isn't sorted, but within both scenarios there is no significant difference between both gears. In the hauls in which whiting has been processed the sorted catch is on average 56 kg more using a square chain mat compared to a regular chain mat. For

the hauls in which whiting hasn't been sorted, the difference between both gears is only 25 kg in favour of the regular chain mat. Similar results are observed in terms of processing time, where a difference between the discard scenario is noted, but not in terms of gear effect. The processing time of a haul was larger using a square chain mat compared to a regular chain mat. Figure 3.5, however, shows there is a larger variation in the data for the regular chain mat. This can be explained by the larger number of hauls carried out with this gear, i.e. 29 hauls versus 10 hauls using the square chain mat. To statistically test this, a two-way analysis of variance was carried out on the influence of gear and sorting whiting on the processing time. Both independent variables included two levels being the use of a square chain mat or regular chain mat for gear and yes or no for sorting whiting. The gear effect is not statistically significant different at the .05 level, while sorting of whiting is. The main effect for gear yielded an F ratio of F(1,33) =0.850, p=0.363 indicating that the effect of gear was not significant. The main effect of sorting whiting yields an F ratio of F(1,33)= 6.303, p = 0.017, indicating significant difference at the .05 level. These results indicate there is no substantial gear effect and do not give rise to treat both gears individually in further analysis.

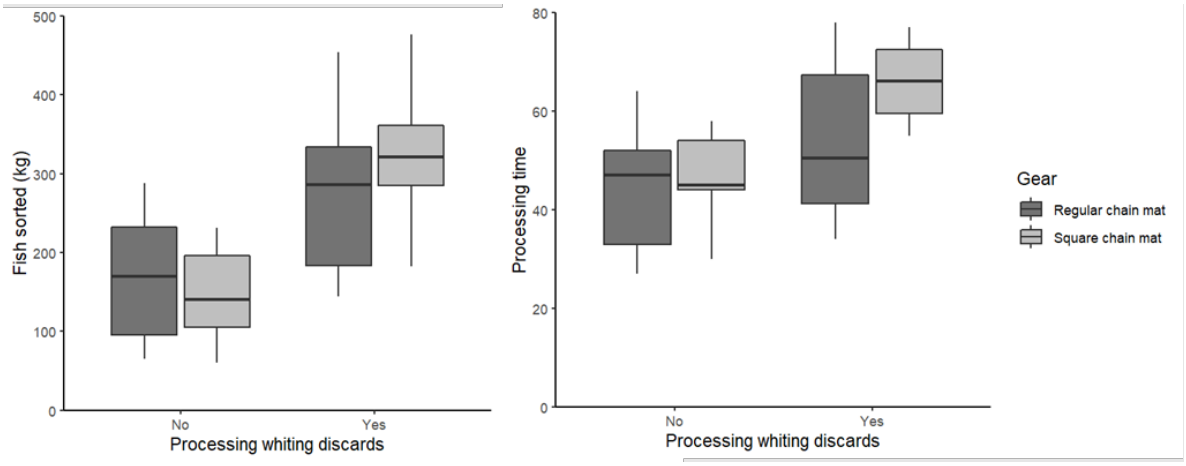


Figure 3.5 *Boxplot comparing the weight of fish processed (left) and processing time (right) for both gears when having to sort whiting discards or not. Lower and upper box boundaries represent the 25th and 75th percentiles, respectively, line inside box is the median, lower and upper error lines are the 10th and 90th percentiles*

Table 3.2 *Overview of the basic analysis on the gear effect under both discard scenarios. Sorting is the average time the crew was sorting the fish at the sorting belt. Processing is the average time for the crew to complete the entire process (sorting and weighing)*

Gear	Whiting discards	Sorting	Processing	Fish sorted excl. whiting	Fish sorted incl. whiting	Whiting sorted
		minutes	minutes	kg	kg	kg
Square chain mat	No	32	46	146.4	146.4	
Square chain mat	Yes	51	66	152.5	325.0	172.5
Regular chain mat	No	24	44	171.6	171.6	
Regular chain mat	Yes	37	53	141.6	268.7	127.1

The total processing time is defined as the time at which the conveyor starts running until the last weighing of the fish below deck. It's logical to assume that the processing time increases with the amount of fish the crew has to sort, gut (marketable fish) and weigh. Figure 3.6 indeed shows processing time is increasing as the amount of fish sorted is increasing. The lowest processing times are seen in hauls where whiting discards have not been processed. In these hauls the average overall processing time of a haul is 45 minutes whereas the processing time in which the crew is picking up and weighing all whiting discards is slightly higher at 56 minutes. Furthermore, the total amount of fish and processing time was used to calculate the kg of fish processed per hour by haul. The kg per haul normalises both scenarios for processing time and shows that the weight of fish processed per

hour is on average 91 kg hr^{-1} higher when having to process whiting discards (Figure 3.7). While there is a relation between weight of fish and processing time a more elaborate analysis is needed to evaluate if there is a structural distinction between having to sort whiting discards or not.

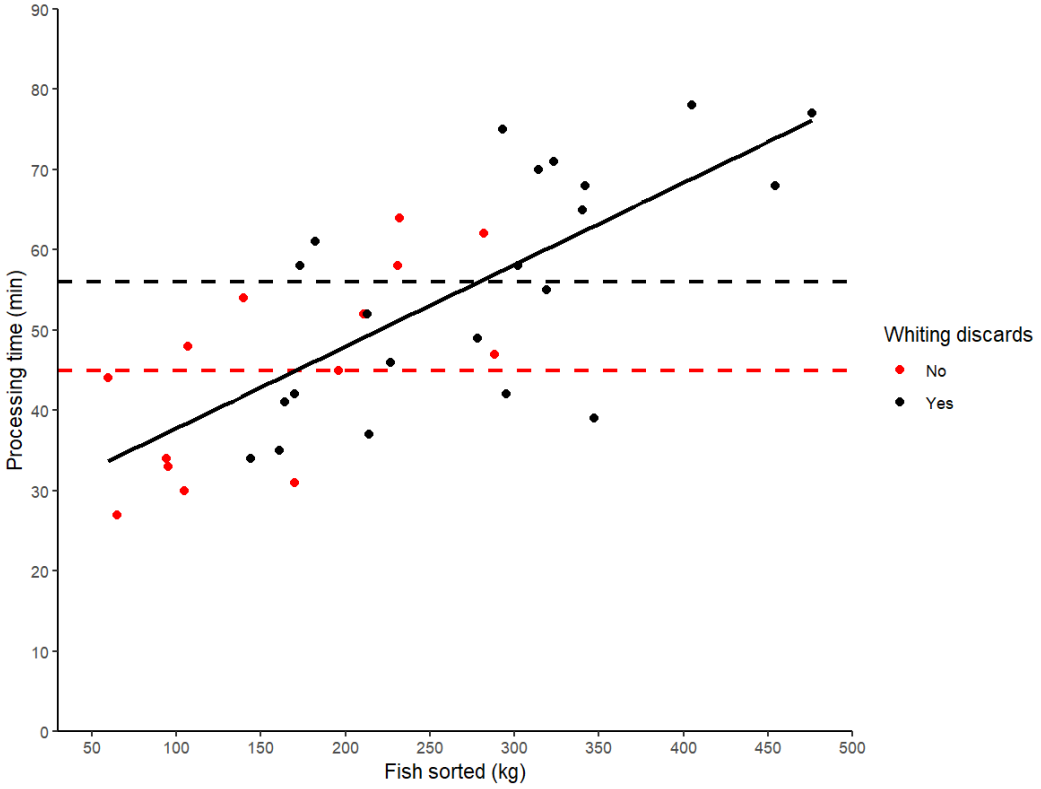


Figure 3.6 *Plot showing the processing time based on the total amount of fish sorted by haul, including information whether whiting discards were sorted (black) or not (red) in that specific haul. The dashed line denotes the average sorting time when whiting discards are sorted (black) or not (red). The solid black line denotes the outcome of a simple linear regression to predict processing time based on the weight of fish sorted. A significant regression equation was found (F(1,34) = 40.89, p <.000), with an R2 of 0.533*

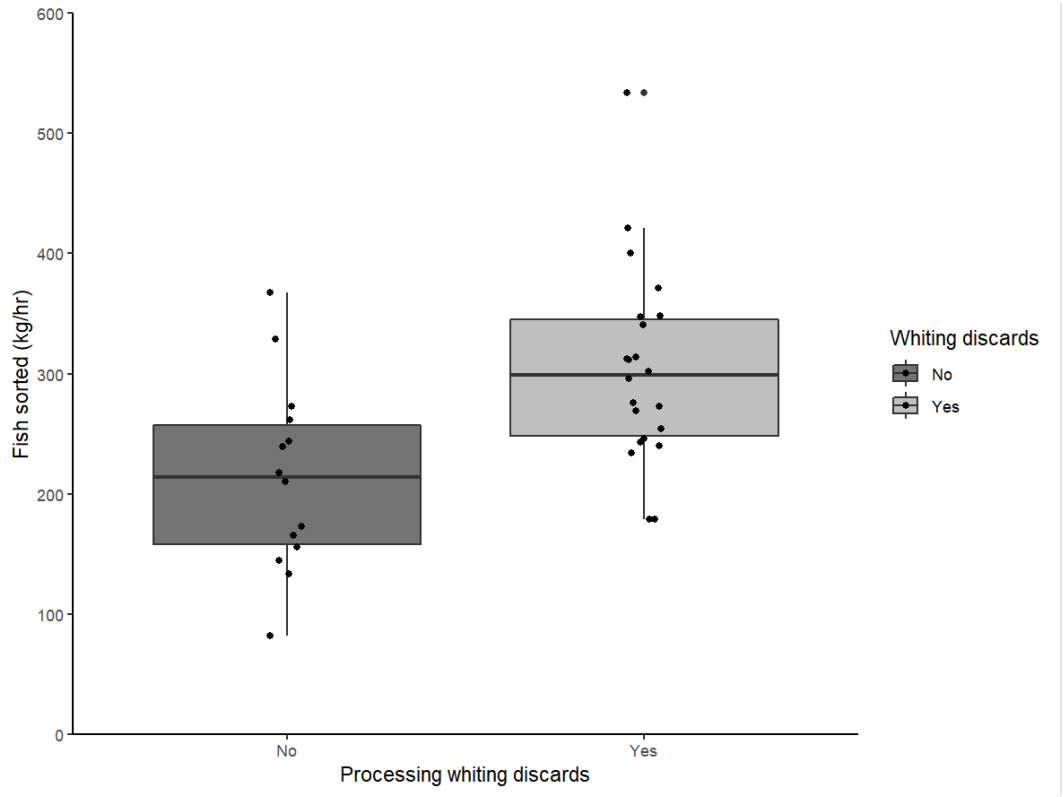


Figure 3.7 *Boxplot comparing fish processed per hour when having to sort whiting discards or not. Lower and upper box boundaries represent the 25th and 75th percentiles, respectively, line inside box is the median, lower and upper error lines are the 10th and 90th percentiles. The dots represent the observed values*

The regression analysis showed that handling time depends both on the volume of undersized whiting and the volume of other sized fish and that the sorting speeds for both categories differ (Table 3.3). The complete crew (excluding the skipper, so 5 persons) needs around 0.13 minutes to handle one kg of undersized whiting and the double (0.25 minutes) to handle the (sized) other species. This means that it takes around 0.65 minutes for one person to sort one kg of undersized whiting and approximately 30% of the sorting time during the studied trip was spent sorting the undersized whiting.

Table 3.3 *Results of the regression analysis of the sorting time for undersized whiting and other species combined*

	Parameter	Undersized whiting	Other species
estimate regression parameter	B	0.13	0.25
	Std. Error	0.02	0.01
handling labour	min/kg	0.65	1.26
	Average landings (kg/haul)	135	151
Total sorting time	minutes/haul	88	191
	% total sorting time	31%	69%

4 Costs and revenues

4.1 Total costs and earnings

The landing of undersized whiting affects both the costs and work onboard the BT2 vessels. On average the extra sorting time is estimated at 1.5% and 1.8% for euro cutters and large cutters respectively. During the fourth quarter the extra sorting time is highest for both fishing types; for the euro cutters as high as 5% extra and for the large cutters 3%. The extra sorting time becomes smaller during the other quarters until in the third quarter the extra sorting time is below 1% for both groups.

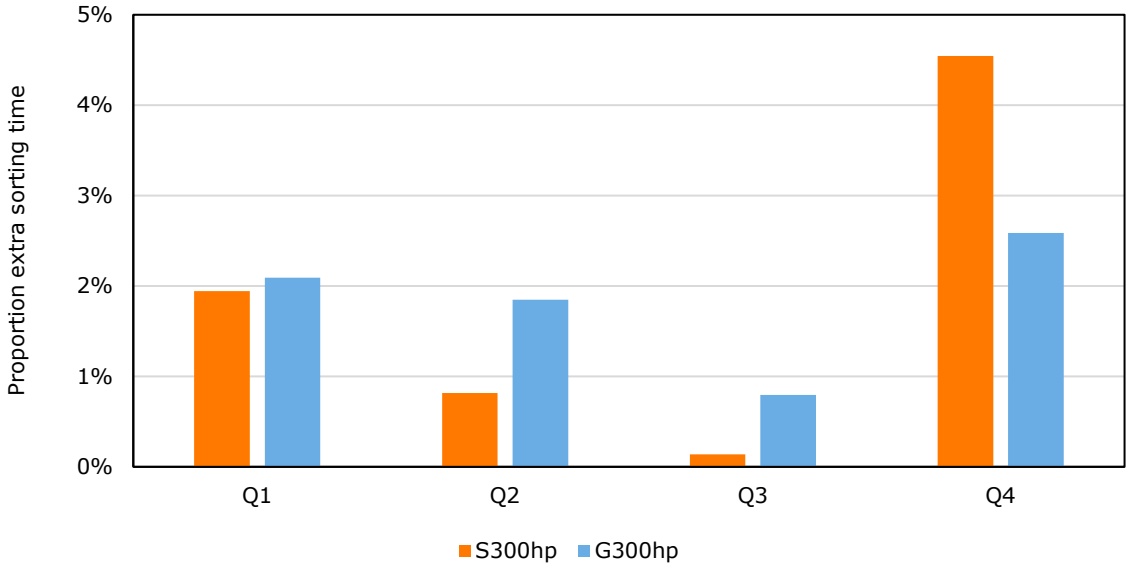


Figure 4.1 *Average proportion of extra sorting time for euro cutters (S300hp) and large cutters (G300hp) in various quarters*

The annual net economic effect of landing undersized whiting for the Dutch fleet are estimated around 60.000 euro per year for the BT2 fleet under 300 hp and around 0.8 million euro for the large BT2 fleet (Table 4.1). For the period of 2018-2019, this negative economic effect would result in a 18% lower net profit for the euro cutters and a 4% lower profit for large cutters.

More than two thirds of the costs are the extra costs for the crew, which originate from the higher sorting time. The crew costs vary among vessels and quarters as the crew gets a share of the revenue. Other important cost items that contribute to the total costs are the landing costs, which makes out the majority of the variable costs. The landed whiting represent a small value, which adds to the total revenue.

Table 4.1 *Total costs and benefits of landing undersized whiting based on average discard rates for the period 2011 – 2019 and average costs for 2018 and 2019 (in euros)*

Quarter	Revenue	Crew Cost	Non-variable Cost	Variable Cost	Net economic effect
Euro cutter					
1	1,124	15,638	299	2,570	-17,382
2	1,022	11,575	214	2,256	-13,023
3	65	857	19	162	-974
4	1,952	25,275	531	4,883	-28,737
Total	4,162	53,345	1,063	9,871	-60,116
Large cutter					
1	18,744	179,284	2,936	68,505	-231,981
2	15,939	141,524	2,599	55,437	-183,621
3	7,831	68,976	1,123	27,662	-89,929
4	25,208	251,427	3,996	92,309	-322,523
Total	67,723	641,211	10,653	243,913	-828,054

The costs for landing are proportional to the amount of extra whiting that needs to be landed and vary per quarter (Figure 4.2 and Figure 4.3). As for the extra sorting time, the costs are highest during the fourth quarter and lowest during the third quarter.

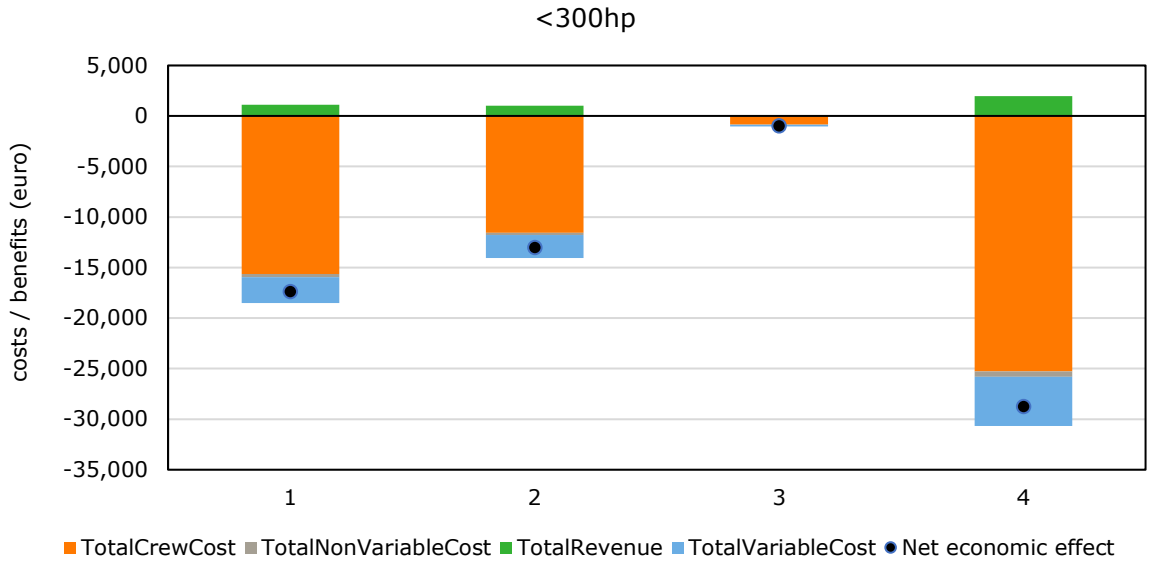


Figure 4.2 *Total costs and benefits of landing undersized whiting for euro cutters in each of the four quarters (averaged over 2018 and 2019)*

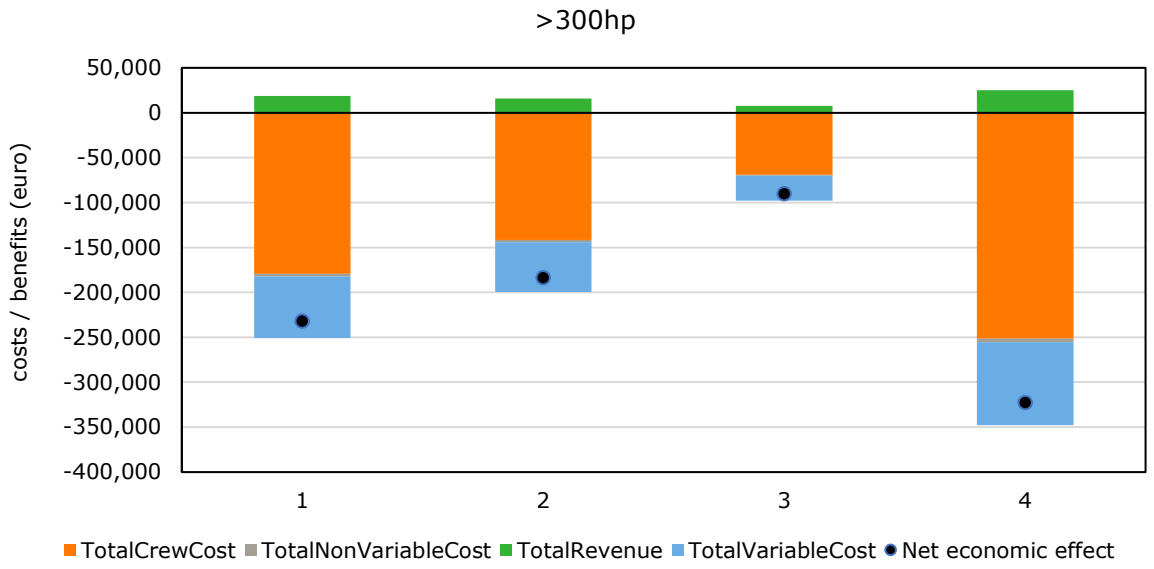


Figure 4.3 *Total costs and benefits of landing undersized whiting for large BT2 trawlers in each of the four quarters (averaged over 2018 and 2019)*

Based on the fact that the average total volume of undersized whiting per annum was 69 tonnes for euro cutters and 1.1 million kg for large cutters, the net costs of handling and landing undersized whiting are 0.87 and 0.73 euro/kg for euro cutters and large cutters respectively.

4.2 Effects of low and high discard volumes

In case of the high discard scenario, the average volume of whiting that need to be landed is approx. 12-14 times higher than the average volume and equals approximately 1.300 and 4.000 kg for euro cutters and large cutters respectively (Figure 4.4). In case of the low scenario, the amount of undersized whiting is negligible.

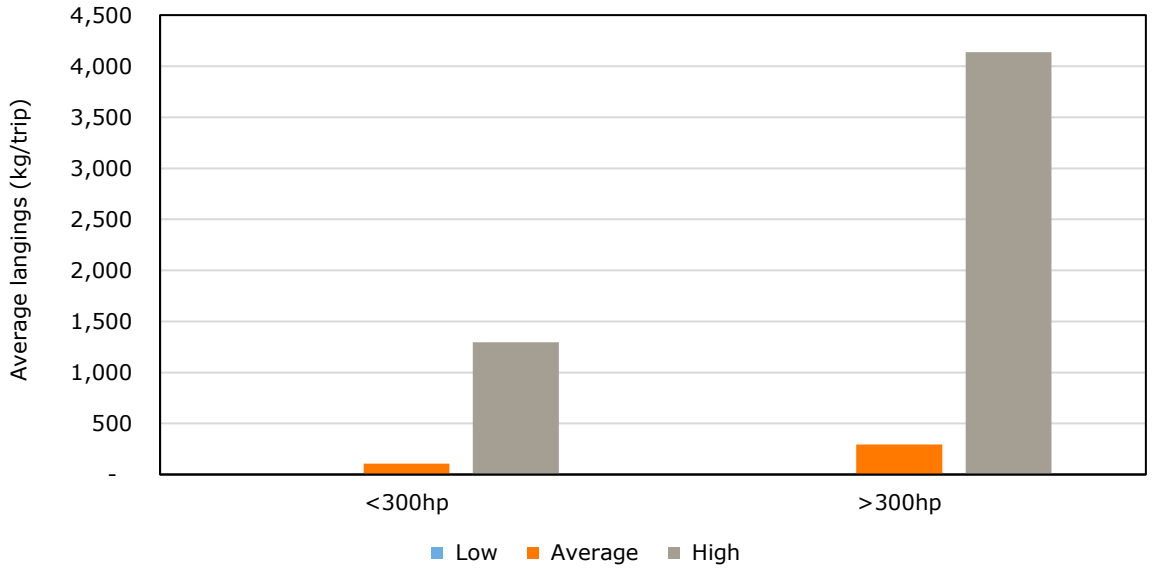


Figure 4.4 *Average volume of undersized whiting for euro cutters and large cutters for low, medium and high levels of discards. Low landings per trip are close to zero*

The high amounts of extra whiting discards in the 'high' scenario translate in significant increases in the sorting work onboard for both euro cutters and large cutters. For a euro cutter the extra time in case of high undersized volumes of whiting can be around 14 hours more per trip and for large cutters it is estimated to 45 hours, around 19-25% of the total sorting time per trip and around 1.5-2 hours per crewmember per day at sea. For the low scenario, the extra sorting time compared to discarding the undersized whiting is negligible.

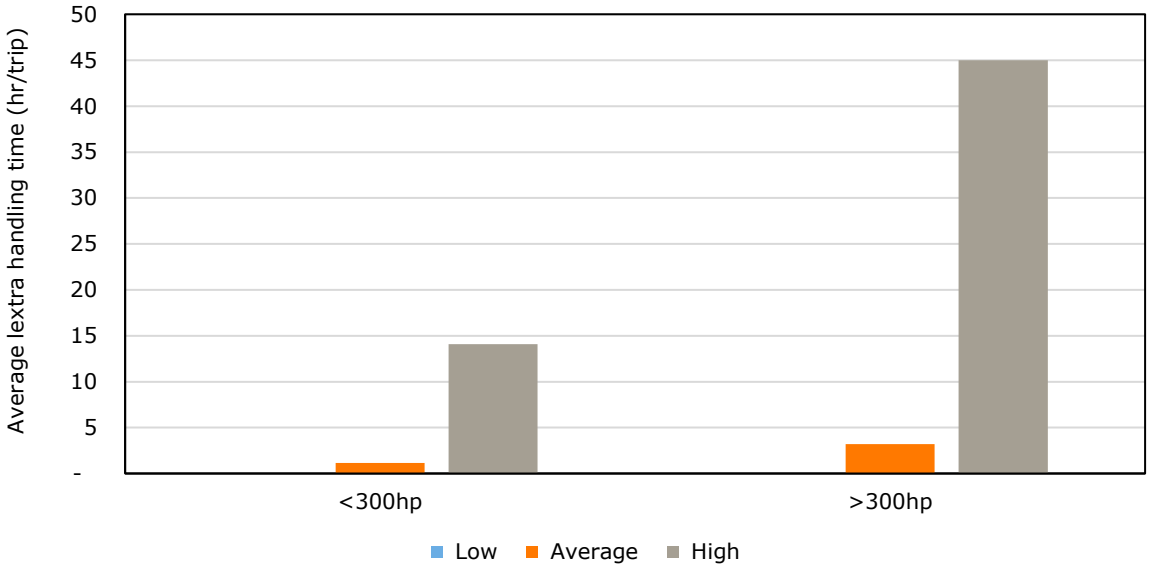


Figure 4.5 *Extra sorting time caused by undersized whiting for euro cutters and large cutters in various quarters and for low, medium and high levels of discards. Extra sorting time in case of low undersized whiting catches are close to zero*

To sort and land the extra undersized whiting, the total extra costs per trip amount to maximum of 1100 euro per trip for a euro cutter and 3000 euro per trip for large cutters. In case of the average cost structure of the Dutch fleet of 2018 and 2019, the average net result of a euro cutter trip would become negative (-600 euro) instead of 500 euro without the obligation to land any whiting (Figure 4.6). For large cutters the net result per trip drops by almost half but remains positive (3,300 euros) (Figure 4.7).

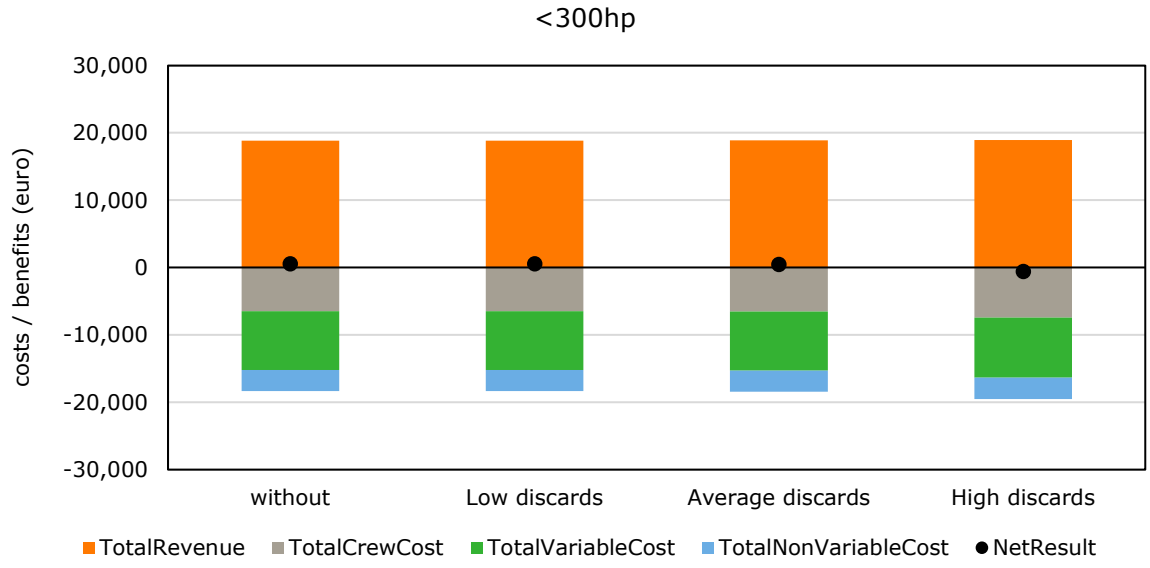


Figure 4.6 *Average cost structure for a euro cutter BT2 trip in case of various levels of discards handled and landed (average 2018-2019)*

In case of average volumes of undersized whiting the reduction in net result per trip is much less than in the extreme situation described above: both for euro cutters and large cutters the net result remains positive and the reductions are around 18 and 4% respectively.

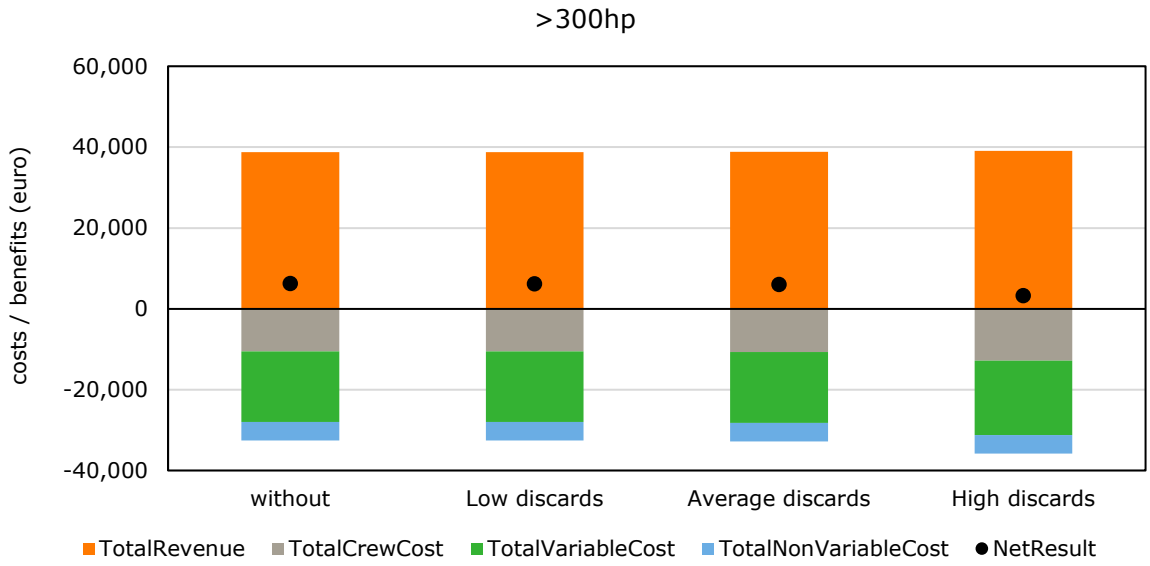


Figure 4.7 *Average cost structure for a large cutter BT2 trip in case of various levels of discards handled and landed (average 2018-2019)*

4.3 Probability of storage problems

In extreme cases, the extra whiting to be kept onboard might result in storage problems, so that the vessel needs to abort the trip and return to port earlier. The chances of this happening are however small as in most trips, the maximum storage capacity is not utilised by far. For all BT2 trips with Dutch vessel in the period 2011-2019, the average capacity, measured by the landings for the trip divided by the maximum landings per trip for that vessel is around 30%. In the majority of the trips less than 50% of the storage capacity is used (Figure 4.8).

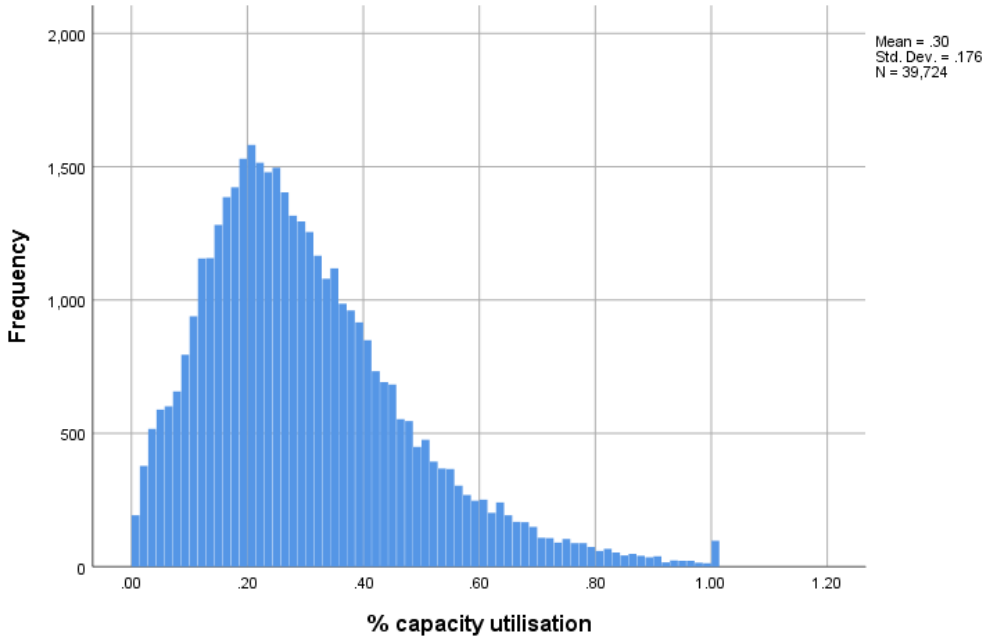


Figure 4.8 *Frequency distribution of the relative storage capacity utilisation (per trip) of the vessels in the BT2 fleet, estimated relative to the maximum landings of the fishing vessel in the period 2011-2019*

As a result of the relative low utilisation of the storage capacity, the probability that the storage capacity is reached with average volumes of undersized whiting is less than 0.1%. In case of the scenario of high volumes of undersized whiting the probability is higher, but for euro cutters it is still well below 1% and for large cutters below 2%. The probability is larger in the first quarter, because the utilisation of the fish-hold is slightly higher during this quarter. Despite the low probability this means that because of the large amount of trips per year (approximately 600 for euro cutters and 3,500 for large trawlers), a (small) number of trips might be ended earlier because of storage problems.

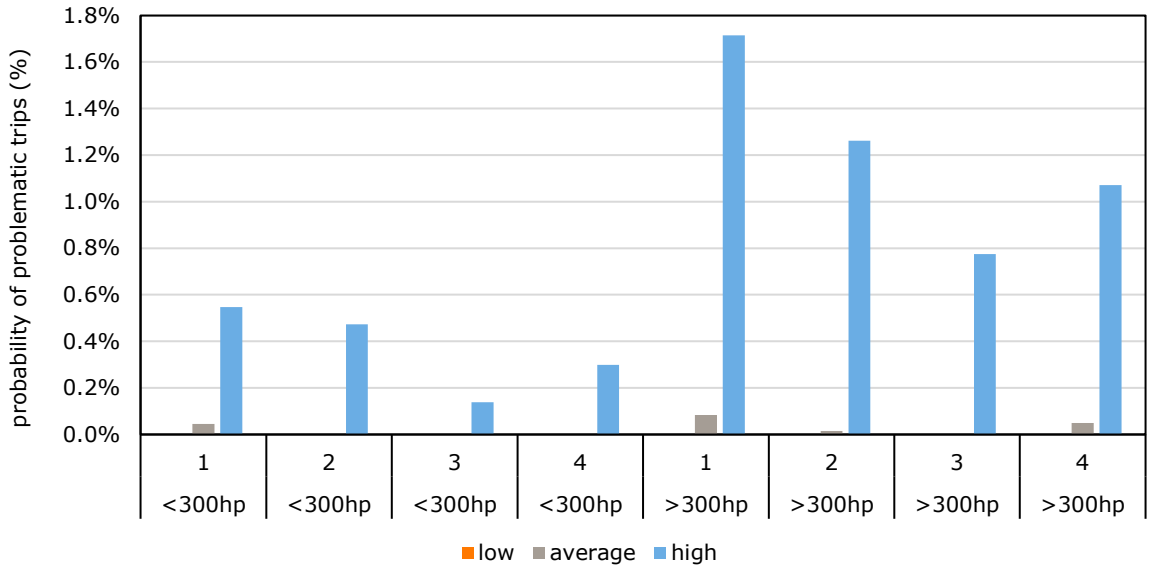


Figure 4.9 Probability of storage problems (landings higher than maximum landings) per trip for the various quarters and the euro cutters and large cutters

5 Discussion

This study seeks answers to the question how large the catches of undersized whiting are and what the economic consequences would be, if the fleet using the BT2 gear category is obliged to land these fish. In order to do so, an integrated assessment of the discard data, field research on handling time and an economic assessment have been carried out and the results have been presented in the previous chapters. The results show clearly that the handling and landing of undersized whiting have a cost and may vary considerably due to the endogenous variability of catch rates for this species. Some methodological constraints should be considered when interpreting these results.

The average costs of handling and landing the undersized whiting should be seen as estimates with statistical uncertainty which is due to the nature of the phenomena and methods used to estimate them. The sampling programme to collect the discard data and the estimation procedures are part of the standard EU Data Collection Framework and in accordance with international standards. The large variability in the discard rates of whiting (ranging from 0 to 1.4 kg per kwday) causes however uncertainty in the resulting estimates of discard rates and total discards in each of the métiers and the resulting cost estimates. In order to take this high variability into consideration, discard rates and the economic effects have also been estimated for high and low levels of whiting catches but also the average discard rates should not be seen as absolute numbers. Moreover, during recent years most of the sampling trips of discards were trips for the pulse fisheries. It is not clear how the recent change in gear to traditional beam trawls will affect the discard rates.

Given the short timeframe of the project a single trip on one vessel equipped with an EM-system could be carried out in order to estimate the handling time for undersized whiting. While the selected vessel is representative for a large beam trawler fishing in the southern Bight it may not be as representative for the entire Dutch BT2 fleet. First, this vessel uses a chain mat while a part of the beam trawl fleet uses a series of tickler chains in front of the opening of the net to stimulate fish out soft sand and muddy substrates. Second, this trip is only a single snapshot in space and time and results may not be representative for fishing activities in other areas and seasons. Although these two points may have large implications for the amount of whiting caught, the effect on the extra handling time per kg of undersized whiting will be limited and related to the third element: the representativeness of the whiting discards in terms of length composition. Analysis of the length distribution of the Dutch discard self-sampling programme has shown most of the discarded whiting is below its minimum landing size (MLS) of 27 cm. Yet, about 14% of discarded whiting is above the MLS of which about 6% are fish of more than 28cm. These fish could be measured wrongly in the onboard sorting process. To evaluate if the length distribution of whiting discards during the sampling trip is comparable with the overall length distribution of the fleet length measurements from the video-images would be required. While WMR has a software tool available to determine the length of individual fish, the accuracy of the length measurements from video-analysis is low. Hence, it has been decided not to perform an extensive length analysis on the whiting catch and length composition of the whiting discards on the sampling trip has not been determined. The skipper of the vessel indicated only a very low amount of marketable whiting was observed in the catches (pers. comm.). The analysis of the length frequencies also shows that the average length of whiting is largest in the catches of large trawlers in the first quarter. Because the number of fish per kg increases in case of smaller fish and smaller fish are harder to grasp, the handing time (per kg fish) increases with decreasing fish length. Therefore, the current handling time as observed on the vessel can be regarded as a lower estimate of the average time the crew will spend sorting the whiting over the whole year. Due to the fact that during this trip there was a good variation between the volumes of whiting discards and other species, the average sorting time could be estimated with some accuracy; the uncertainty around the estimate was 15% (see also Appendix 2).

Within the EMMF funded projects Best-practices II discard trips have been carried out, i.e. vessels sorted, stored and landed all discards of an entire trip. These trips provided insight in the catch

composition as well as additional workload and costs in case the Landing Obligation would be fully implemented, i.e. without exemptions. While the beam trawl flatfish fishery is known for the larger quantities of dab and undersized plaice in the catch, the skipper was requested to disregard all other legal discards and only to process whiting. This is also in line with the current situation in which a high-survival exemption for plaice is in effect and dab is not a regulated species. Obtained results in this project are therefore only applicable to evaluate the costs of having to process whiting discards.

The economic data, which were used for the estimation of the costs, were based on the Farm Accountancy Data Network which covers around 30% of all cutter fleet. Using regression analyses the costs per quarter have been estimated for each vessel. This results in a dataset with accurate costs for all vessels, especially for the large beamers for which the uncertainty in the estimated total costs (standard error) is low; around 5% (Van Oostenbrugge et al in prep). This uncertainty adds however to the uncertainty in the catch rates and the uncertainty in the handling time.

The considerations on the uncertainty in the estimates of the average costs of handling and landing the undersized whiting also apply to the maximum and minimum scenarios. However it should be stated that these scenarios are no theoretical maximum and minimum values, which will not occur in practice. The maximum discard rates were calculated as the average of the five trips with the largest amount of discards from a total of max 80 trips per year for large trawlers and 20 trips for euro cutters (about 7% and 25% of the of the total trips respectively). In this study we have taken the maximum value of the whole time series (2011-2019), but based on the above, it can be inferred that a significant amount of the trips per year (around 5%) may have similar costs per trip for handling and landing whiting as calculated in the maximum scenario.

One specific assumption in the economic estimation process is that the extra labour costs for the handling and landing of undersized whiting are proportional to extra time spend sorting (see 2.4). It is not certain that these costs will be made in practice (in cash) as fees for the extra time the crew spends on board and who will pay for these extra costs. As the variability in the whiting catch rate is large and it is impossible for the skipper to predict in advance the volume of undersized fish, the skipper will likely not hire extra crew to handle the extra fish caught. In case of low catches of undersized whiting, the crew might work extra without extra payment and as a result the crew will pay the costs of the handling and landing of whiting themselves in kind. In the event of high undersized catches, the extra sorting time can be substantial (+25%) and it will be up to the crew and the skipper to decide on how to deal with this situation (by either working more or delaying the next haul). In any case, either the crew or the owner will pay the costs for the handling and landing of the extra fish either in kind or in cash.

Another assumption is that the undersized whiting represents a value when landed. The average price of undersized whiting over the last years varied from 0.10 euro/kg to 0.02 euro/kg recently. In the economic estimations we used the average price of 0.06 euro/kg. As the revenue from the whiting is small in relation to the total cost (<10%) a reduction in the price would lead to an increase in the net costs of handling and landing undersized whiting. As a small percentage of the whiting discards are above minimum landing size one could argue that these might represent a higher value if sold for human consumption, mitigating part of the costs. However, the average market price of these whiting (small from beam trawl fishery) is such, (< 1.00 euro/kg) that the low proportion of sized fish would add little to the total value, Moreover, the sized fish could only be sold for human consumption in case they are they are separated from the undersized fish and gutted, which would mean additional labour and costs.

Having said this, it is clear that the potential obligation to land undersized whiting will cause an increased in handling time and costs in the BT2 fleet. The analyses show that the total effect on the BT2 fleet is 0.9 million euros, based on the average discard levels of 2011-2019. Although this is a relatively small increase in total costs (<1%), the net effect on the net result is higher: 4% for large trawlers and 18% for euro cutters. This negative effect on the economy of the fleet will probably have increased during the last years as discard rates of whiting seem to be increasing (Figure 3.3) and the economic perspectives of the Dutch BT2 fleet are unfavourable. The costs for handling and landing the

undersized whiting are around 0.80 euro per kg whereas the value of the fish ranges between 0.02 and 0.10 euro/kg. From an economic perspective, landing the fish is therefore highly unfavourable.

6 Conclusions

Based on this study the following can be concluded:

- The total volume of whiting discards in the Dutch BT2 fleet varied considerably over the last years ranging from 0.09-18 tonnes per quarter for the 100-119 mm fishery, 0.03-104 tons for euro cutters and 24-690 tonnes for large cutters using 70-99 mm.
- Discard rates also varied considerably from 0-0.06 kg/kwday for the 100-119mm fishery, 0.0-1.4 kg/kwday for euro cutters and 0-0.75 kg/kwday for large cutters using 70-99 mm.
- Average length of discards varies with between seasons and metiers, being smaller during the fourth quarter and in the catches of euro cutters. This smaller length in the fourth quarter may result in higher sorting times per kg undersized whiting and higher overall costs of handling and landing undersized whiting.
- The average volume of undersized whiting catches per annum that might become obligatory to land in absence of an exemption is 69 tonnes for euro cutters and 1.1 million kg for large cutters.
- A field experiment shows that the average time needed to handle (sort and store) undersized whiting is around 0.65 minute/kg. This is approximately half the handling time for other sized fish (1.26 minute/kg).
- The handling and landing of the undersized whiting will lead to an increase in work on board fishing vessels. Average extra handling time is estimated at 1.5% for euro cutters and 1.8% for large cutters, which equals 1 and 3 hours per trip for the total crew.
- In case of high volumes of undersized whiting this extra time is up to 19% for euro cutters and 25% for large cutters, which equals 14 and 45 hours per trip for the total crew. These high extra handling times might cause problems for the normal operations onboard and might result in fewer hauls (increasing the indirect costs of handling and landing the undersized whiting).
- The total net economic effect of handling and landing the undersized whiting for the Dutch BT2 fleet is 60.000 euro for the euro cutters and 828.000 for the large cutters (average over 2018 and 2019). This is 18% and 4% of their average net profit over the same period.
- The average costs of handling and landing undersized whiting is 0.87 and 0.73 euro/kg for euro cutters and large cutters, respectively.
- In case of catches of high volumes of undersized whiting, which have occurred during the period 2011-2019 the total volume of whiting may be a factor 12-14 higher than average. These high catch rates of whiting result in a net economic effect of 1,100 euros per trip for euro cutters and 3,000 euros for large cutters. For euro cutters this means that the net profit of the trip would become negative (-600 euros), for large cutters the net profit would be halved (3,300 euros). Low levels of discard result in negligible extra costs for handling and landing.
- Due to the low utilisation of the onboard storage capacity, it is improbable that large numbers of trips will need to be ended earlier because of storage problems (probability <2%). However, some trips might be ended earlier in case of high volumes of undersized whiting.

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www.visned.nl/images/PDFs/Eindrapportage_Best_Practices_II.pdf Eindrapport Best Practices II

Appendix 1 Statistical analysis of the relation between undersized whiting and effort in the period 2011-2019

Model description:

$D_{ij} = \mu + Y_i + Q_j + \varepsilon_{ij}$

Where:
D_{ij} = Discard rate of all whiting (kg/kwday),
μ = overall mean,
Y_i = effect of i^{th} year,
Q_j = effect of j^{th} quarter,
ε_{ij} = error.

Non-significant terms were eliminated from the model and residuals were tested for normality. In order to comply with the normality condition, discard rates were log normal transposed. To compare group means in case of significant effects, 95% confidence limits around predicted estimations were calculated.

Results:
Table A1.1 shows that for the large trawlers, both the year and quarter effect are significant, whereas for the euro cutters only the effect of quarter is significant.

Tests of Between-Subjects Effects

Dependent Variable: ldiscardsDay

metier	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
TBB_DEF_70-99_0_0_G300hp	Corrected Model	2.886[b]	11	.262	4.521	.001
	Intercept	67.608	1	67.608	1164.939	.000
	year	1.517	8	.190	3.268	.012
	quarter	1.369	3	.456	7.862	.001
	Error	1.393	24	.058		
	Total	71.887	36			
	Corrected Total	4.279	35			
TBB_DEF_70-99_0_0_S300hp	Corrected Model	14.854[c]	11	1.350	6.977	.000
	Intercept	48.799	1	48.799	252.146	.000
	year	1.305	8	.163	.843	.577
	quarter	12.774	3	4.258	22.001	.000
	Error	3.677	19	.194		
	Total	68.219	31			
	Corrected Total	18.531	30			

b. R Squared = .674 (Adjusted R Squared = .525)

c. R Squared = .802 (Adjusted R Squared = .687)

Figure A1.1 and A1.2 show the overall estimates of the average discard rates in the various quarters (log transformed) for both segments the discard rates in the fourth quarter are relatively high and in the third quarter they are relatively low.

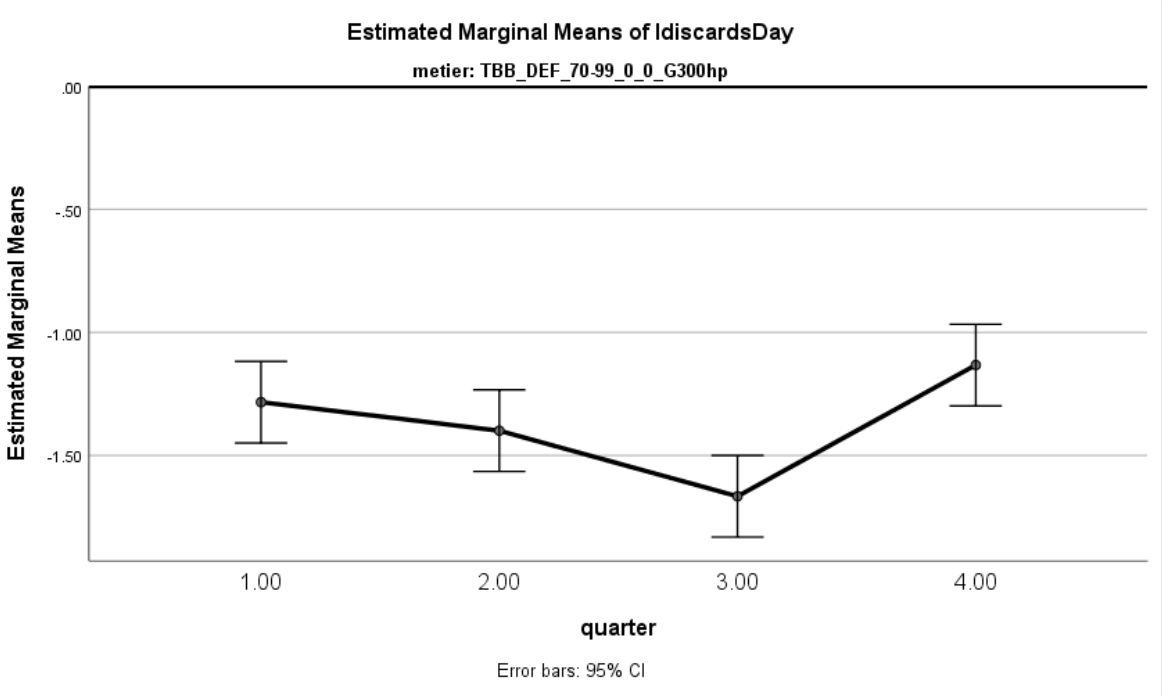

Figure A1.1 *Estimated marginal means for the log normally transformed discard rates for the various quarters in métier large trawlers fishing with beam trawls with mesh sizes between 70 and 99 mm (TBB_DEF_70-99 G300 hp)*

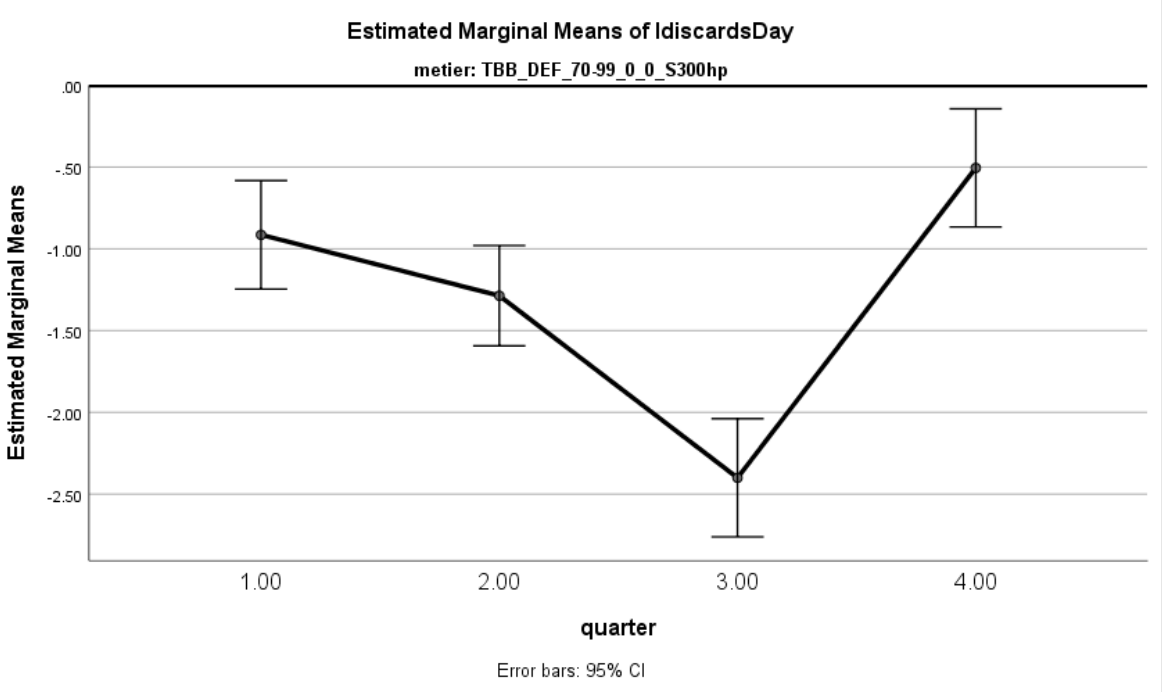

Figure A1.2 *Estimated marginal means for the log normally transformed discard rates for the various quarters in métier euro cutters fishing with beam trawls with mesh sizes between 70 and 99 mm (TBB_DEF_70-99 G300 hp)*

Figure A1.3 shows that for the large trawlers, discards rates have increased during the last years.

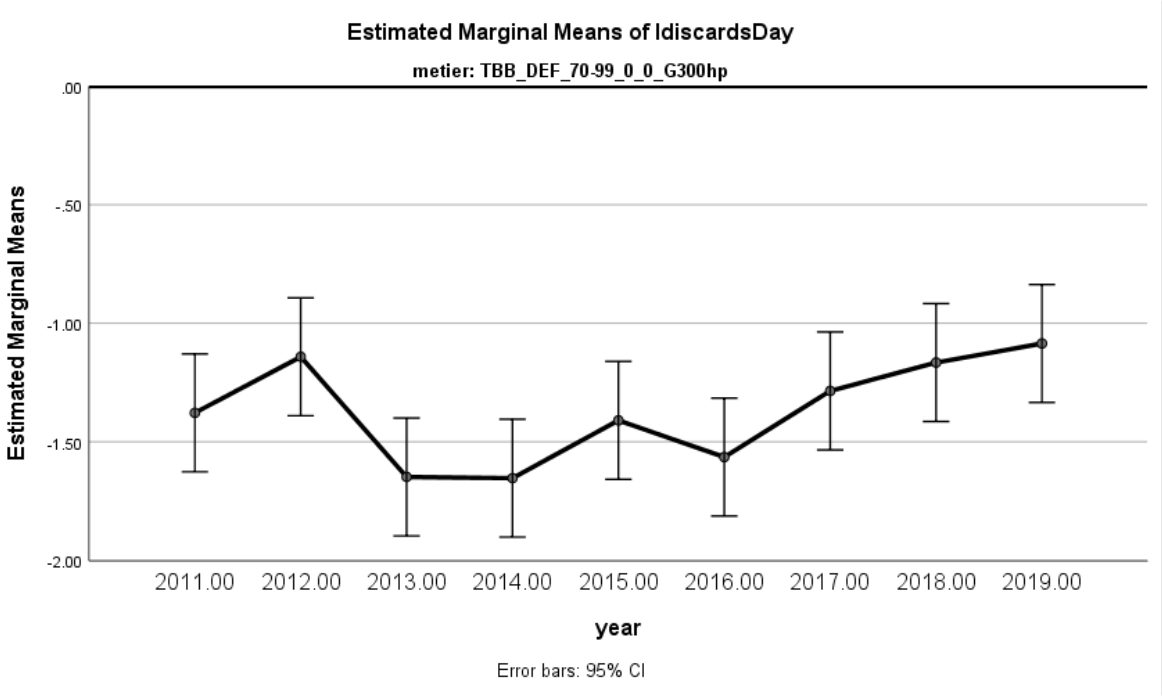

Figure A1.3 *Estimated marginal means for the log normally transformed discard rates for the various years in métier large trawlers fishing with beam trawls with mesh sizes between 70 and 99 mm (TBB_DEF_70-99 G300 hp)*

Appendix 2 Statistical analysis of the relation between sorting time and the volume of undersized whiting

Model description:

$HT_i = \mu + \alpha wu + \beta ws + G_i + \varepsilon_i$

Where:
HT_i = handling time (minutes),
μ = overall mean,
wu = weight of undersized whiting,
ws = weight of marketable other species,
G_i = effect of i^{th} gear (chains or chain mats),
α, β = regression coefficient,
ε_{ij} = error.

Non-significant terms (the type of gear) were eliminated from the model and residuals were tested for normality. To compare group means in case of significant effects, 95% confidence limits around predicted estimations were calculated.

Results:
Table A2.1 and Table A2.3 show that for the the regression model can estimate both the sorting time for undersized whiting catches and the other sized fish. The parameter estimates show the handling time needed for the complete crew minus the skipper (5) for one kg of undersized whiting and one kg of other sized fish.

Table A2.1 *Outcomes of the Regression analysis for the total handling time of the catch, goodness of fit*

Goodness of Fit[a]			
	Value	df	Value/df
Deviance	6159.331	35	175.981
Scaled Deviance	37.000	35	
Pearson Chi-Square	6159.331	35	175.981
Scaled Pearson Chi-Square	37.000	35	
Log Likelihood[b]	-147.125		
Akaike's Information Criterion (AIC)	300.249		
Finite Sample Corrected AIC (AICC)	300.977		
Bayesian Information Criterion (BIC)	305.082		
Consistent AIC (CAIC)	308.082		
Dependent Variable: handling time (min)			
Model: total kg (excl. whg), undersized wijting (kg)[a]			
a. Information criteria are in smaller-is-better form.			
b. The full log likelihood function is displayed and used in computing information criteria.			

Table A2.2 *Outcomes of the Regression analysis for the total handling time of the catch including weighing, tests of model Effects.*

Tests of Model Effects			
Source	**Type III**		
	Wald Chi-Square	**df**	**Sig.**
Total kg (excl whg)	333.340	1	.000
Undersized whiting (kg)	43.419	1	.000
Dependent Variable: verwerkingstijd incl weging (min)			
Model: totaal kg (exlc whg), BMS wijting (kg)			

Table A2.3 *Outcomes of the Regression analysis for the total handling time of the catch, parameter estimates.*

Parameter Estimates							
Parameter	**B**	**Std. Error**	**95% Wald Confidence Interval**		**Hypothesis Test**		
			Lower	**Upper**	**Wald Chi-Square**	**df**	**Sig.**
Total kg (excl whg)	.253	.0139	.226	.280	333.340	1	.000
Undersized whjting (kg)	.130	.0197	.091	.168	43.419	1	.000
(Scale)	166.468[a]	38.7031	105.543	262.562			
Dependent Variable: handling time (min)							
Model: Total kg (excl whg), Undersized whjting (kg)							
a. Maximum likelihood estimate.							

Appendix 3 Methods for estimating the costs and revenues of handling and landing undersized whiting

Tabel A3.1 *Methods for the estimation of the costs and revenues of handling and landing undersized whiting*

Variable	Calculation
Cost for provisions onboard	*% extra labour,
Costs for traveling for the crew between their village and the harbour where the vessel is located.	*% extra labour
Costs for social security fund.	*% extra labour
Crew share including unpaid labour	*% extra labour
Maintenance costs for cooling equipment onboard	* % extra kg *0.5 (50% fixed costs, 50% variable)
Value of the landings of undersized whiting	Kg whiting *0.06 euro (average price 2018-2020)
Costs for landing and sorting the catch in the harbour	*% extra kg fish landed
Costs for transport of the fish between the harbour and the auction	*% extra kg fish landed
Costs for auctioning the catch, including the costs for water, electricity and rent fishing boxes via the fish auction.	*3% of de value of undersized whiting

% of total extra labour is estimated to be 78% of the extra % of handling time as the crew also spends time on hauling and setting the net (estimated to be 15 minutes per haul for a large cutter).

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 6,500 employees (5,500 fte) and 12,500 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.