Reducing discards in Shrimp fisheries with the Letterbox

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Leeswijzer

Voorliggende rapportage beschrijft de uitkomsten van het onderzoek naar de brievenbus, dat is uitgevoerd in het voorjaar en het najaar van 2010. De rapportage is geschreven in het Engels, voor de Latijnse namen en een vertaling van de Engelse soortnamen naar het Nederlands wordt verwezen naar appendix D.

Achtergrond

De Nederlandse garnalenvisserij is momenteel bezig met het verkrijgen van MSC certificering. Binnen het MSC traject bestaat de noodzaak om over te gaan tot verdergaande maatregelen om discards in de garnalenvisserij terug te dringen. In de Nederlandse garnalenvisserij wordt reeds gebruik gemaakt van de zeeflap: een aanpassing in het net die ervoor zorgt dat vissen uit het net onder water kunnen ontsnappen. Hiermee worden de discards van vis verminderd. Het gebruik van de zeeflap is verplicht gesteld in de periode 15 november tot 15 april. In het managementplan dat is opgesteld ten behoeve van het behalen van het MSC certificaat, wordt gestreefd naar een permanente verplichting van het gebruik van een nettaanpassing als de zeeflap die discards van vis verminderen. De zeeflap is echter niet altijd even praktisch in het gebruik: wanneer er veel algen en zeewier in het water zit, slibben de zeeflapnetten dicht (met name in het voorjaar en de zomer).

De Brievenbus

Als mogelijk alternatief voor de zeeflap is de zogenaamde brievenbus ontwikkeld. Het is hierbij niet de bedoeling de dat de brievenbus de zeeflap volledig zal vervangen, eerder dat de tuigen naast elkaar kunnen worden gebruikt. De brievenbus is een aanpassing gebaseerd op loosgaatjes die eerder ook al in de boomkorvisserij gebruikt werden om koeteieren te lozen. Binnen dit project was de bemanning van de WR54 (Jan, Piet, Peter en Erik Rotgans) verantwoordelijk voor de ontwikkeling van de aanpassing samen met Sander van Rijswijk (C.I.V. Den Oever). Tijdens de ontwikkeling is gebruik gemaakt van onderwaterbeelden en is regelmatig terugkoppeling geweest met de kenniskring duurzame garnalenvisserij.

De brievenbus bestaat uit een snede overdwars in de onderkant van het net, welke ervoor moet zorgen dat de garnalen het achtereind van het net in gaan, terwijl platvissen kunnen ontsnappen. Aan de achterzijde van de brievenbus is een zogenaamd loostouwtje geplaatst van 70 cm. Dit touwtje maakt de opening van de brievenbus aan de achterzijde korter dan aan de voorzijde, waardoor het net onder water geforceerd open blijft staan. Tevens is er een schotje geplaatst in het net. Het schotje bestaat uit een vierkant netwerk, dat duidelijk zichtbaar is. Met behulp van dit schotje worden de platvissen die zich onderin het net bevinden naar de brievenbus geleid, terwijl de garnalen door en over het schotje heen alsnog in het achtereind van het net terechtkomen. Voor een tekening van het net met de brievenbus: zie appendix B. In eerste instantie ging het schotje ook over de achterkant van de brievenbus heen. Halverwege het project, na de eerste 3 reizen, is dit achterste gedeelte van het schotje verwijderd omdat vermoeden bestond dat hiermee het verlies van marktwaardige garnaal zou verminderen.

Doel en proefopzet

Tijdens dit onderzoek werd de volgende onderzoeksvraag gesteld: *is de brievenbus <u>minstens</u> even effectief in het verminderen van discards van (jonge) platvis in de garnalenvisserij als de zeeflap?*

Ondanks dat discards van met name juveniele schol een van de belangrijkste onderwerpen is in de garnalenvisserij, moeten de overige discards niet worden vergeten. Daarom werd tevens de volgende, meer generieke onderzoeksvraag gesteld: *hoe presteert de brievenbus ten opzichte van de zeeflap als het gaat om ongewilde bijvangst van vis en benthos?*

Om te komen tot een antwoord op deze vragen zijn in de periode van mei/juni en sept/okt 6 reizen uitgevoerd aan boord van twee verschillende garnalenschepen (WR54 en WR57). Tijdens deze reizen werd gevist met een zeeflap aan bakboord zijde en een brievenbus net aan stuurboordzijde. Op deze manier kon direct een gepaarde vergelijking van beide netten worden gedaan. Hiertoe werden gegevens over garnalenvangst en bijvangsten vis en benthos tijdens de onderzoeksreizen bijgehouden door een onderzoeker van IMARES, in samenwerking met de bemanning aan boord van de beide schepen. Tijdens het onderzoek werd gewerkt volgens een vast protocol (appendix A).

Resultaten en conclusie

Resultaten worden gepresenteerd in grafieken en tabellen in appendix C. Voor een overzicht van de gemiddelde bijvangsten vis & benthos en het gemiddelde verschil in aantallen tussen de zeeflap en de brievenbus wordt verwezen naar Table 2 & Table 3. Het gemiddelde verschil wordt in deze tabel aangegeven met een ratio: de aantallen in de brievenbus ten opzichte van de aantallen aangetroffen in de zeeflap. Een ratio < 1 betekend dat er gemiddeld minder exemplaren in de brievenbus werden aangetroffen een ratio > 1 betekend dat er gemiddeld meer exemplaren in de brievenbus werden aangetroffen.

In eerste instantie is de garnalenvisser geïnteresseerd in de vangsten marktwaardige garnaal. Idealiter is er dan ook geen verschil in opbrengst tussen de zeeflap en de brievenbus. In de eerste 3 reizen bleken de opbrengsten garnaal van de zeeflap 1.3 maal zo hoog als de brievenbusopbrengsten. Na de aanpassing van het schotje bleek het verlies aan garnaal ten opzichte van de zeeflap in de laatste 3 reizen te verwaarlozen (factor 1.05 verschil).

De eerste onderzoeksvraag betreft het verminderen van discards van (juveniele) platvis. Schol was hierbij de soort die in absolute aantallen het meest is aangetroffen in de discardmonsters van beide netten. Het betrof hierbij allemaal juveniele exemplaren van 5-12 cm. Met betrekking tot het verminderen van discards van deze juveniele schollen lijkt de brievenbus de verwachtingen waar te maken. De schollen die gevangen werden varieerden in lengte van 5-12 cm. Er werden significant minder schollen aangetroffen in de brievenbus dan in de zeeflap (gemiddelde factor 0.6). Dit betekent dat er gemiddeld 40% minder schol werd aangetroffen in de brievenbus ten opzichte van de zeeflap. Het verschil tussen de beide tuigen was het duidelijkst in de eerste drie reizen die in het voorjaar zijn uitgevoerd. In het najaar werd geen significant verschil gevonden. Ook voor tong gold dat gemiddeld minder exemplaren werden aangetroffen in de brievenbus en dit verschil was significant in het voorjaar. Voor de andere platvissoorten; schar en bot was het verschil tussen beide tuigen niet significant. In de brievenbus werden van deze beider soorten ook grotere exemplaren bijgevangen en de zeeflap is juist efficiënt in laten ontsnappen van deze grotere exemplaren; vissen met een lengte >10 cm.

Voor andere soorten was het beeld wisselend, er werd geen verschil in aantallen aangetroffen voor haring en wijting. Terwijl van bijvoorbeeld zeedonderpad en vijfdradige meun er significant meer exemplaren aanwezig waren in de brievenbus dan in de zeeflap (factor 1.72 resp. 1.3). Voor andere soorten was het verschil in aantallen weer lager in de brievenbus: zeenaalden (0.56), smelt (0.88) en steenbolk (0.78).

Zoals hierboven is vermeld is de brievenbus tussen de twee onderzoeksperioden, in het voorjaar en het najaar aangepast. Dit maakt dat het niet in alle gevallen even duidelijk is of de verschillen in uitkomsten in tussen de twee perioden een seizoenseffect is, of werd veroorzaakt door de netaanpassing. Het verdient daarom de aanbeveling om met het nieuwe net nog eenmaal in het voorjaar van 2011 (wanneer er veel jonge schol aanwezig is) een vergelijkbare proef uit te voeren.

Concluderend konden de onderzoeksvragen als volgt worden beantwoord:

- De brievenbus is tenminste even effectief als, en waarschijnlijk zelfs effectiever dan de zeeflap in het verminderen van discards van juveniele platvis (in het bijzonder schol).
- De brievenbus is tenminste even effectief als de zeeflap in het verminderen van een aantal overige ongewilde bijvangsten, bijvoorbeeld voor de jonge haring, zeenaalden en smelt.
- Echter, de brievenbus is in sommige gevallen minder effectief dan de zeeflap in het verminderen van ongewilde bijvangsten, bijvoorbeeld voor grotere (plat)vissen en zeedonderpad.

De brievenbus kan worden gezien als een goed bruikbaar alternatief voor de zeeflap. Met name in het voorjaar en de zomer, wanneer veel juveniele schol aanwezig is in de Waddenzee en tegelijkertijd de zeeflap de neiging heeft dicht te slibben door de algen en de wieren. Hierbij moet wel vermeld worden dat de brievenbus niet voor alle soorten even effectief is in het verminderen van discards als de zeeflap.

Summary

Two gear adjustments for reducing discards in brown shrimp fisheries were compared; the sievenet and the letterbox. Sievenets are already used in the Netherlands since 2002 and are cone-shaped nets inserted into standard trawls, which direct unwanted by-catch to an escape hole in the body of the trawl. The letterbox is a new gear adjustment that consists of a release hole transversely over the net. The idea is that the shrimps go over the hole in the net, while flatfish can escape through the release hole. In this research paired comparisons were made between the letterbox and the sievenet to see if the letterbox is at least equally effective as a sievenet in reducing discards juvenile flatfish in shrimp fisheries. As flatfish are not the only bycatch in shrimp fisheries also information on other bycatch was collected to see how the letterbox performs compared to the sievenet with regard to by-catch of (round)fish and benthos. A total of 6 research trips were conducted in 2 different periods in 2010 (May/June and September/October).

The letterbox seemed to perform well in the first period of the research, especially with regard to plaice the bycatches were significantly less in the letterbox as compared with the sievenet. However there was also a relative large loss of marketable shrimp, which needed to be solved. A small gear adjustment seemed successful: in the second period comparable amounts of marketable shrimps were caught with both nets.

In the end we could conclude that the letterbox is at least equally effective as a sievenet in reducing discards of juvenile plaice. Also we have reasons to believe that the letterbox performs better than the sievenet in reducing discards of juvenile flatfish. However the effects of net modification and period are confounded, which made comparison of results between period 1 and 2 rather difficult. Therefore it is recommended to conduct another experiment in spring 2011 when high abundances of juvenile plaice are present, using the newest net design. For the other by-catch species the results were variable; the letterbox was for some species at least equally effective as a sievenet in reducing several other discards, but for other species the letterbox was not as effective in reducing all discards.

The letterbox can be a good alternative for the sievenet, especially in spring, when there is high abundance of juvenile plaice in the Wadden Sea. It should be taken into account, however, that the adjustment is not as effective as the sievenet for all species.

1 Introduction

1.1 Background

In the process towards acquiring an MSC certificate (Marine Stewardship Council), the Dutch brown shrimp (*Crangon crangon*) fisheries set up a management plan (Anonymus, 2009). An important issue addressed in this management plan is substantially reducing discards. Apart from the brown shrimp, a shrimp fisher also catches other species. This by-catch is in most cases not of interest to the fishers and therefore thrown overboard again, or discarded. By-catch and discarding of juvenile (flat)fish species, in particular plaice, in the brown shrimp fishery is extensively reported and a well-recognised problem (Revill and Holst, 2004; Catchpole et al, 2008). EU regulation[1] is requiring all fishers in the European brown shrimp fisheries to use selective gear in order to reduce discarding of juvenile commercial fish species, and Dutch shrimp fishers are obliged to use a sievenet since August 2002. Sievenets (also known as veil nets) are cone-shaped nets inserted into standard trawls, which direct unwanted by-catch to an escape hole in the body of the trawl (Revill and Holst, 2004).

In the Netherlands, an exception for the use of the sievenet is made from 15 April – 15 November (Quirijns et al, 2008). However, the management plan targets to use the sievenet whole year round. Fishing without the sievenet will only be permitted if an alternative technique is used that is equally efficient in reducing discards as the sievenet. Some fishers have difficulties to use the sievenet, as it clogs in periods with high abundance of seaweeds (mainly spring and summer). This clogging of the meshes by seaweed is a well-known problem, causing losses of shrimp catches (Marlen, 2001). Reason enough to develop a new gear adjustment that reduces discarding of (flat)fish at least as efficient as the sievenet. The result was the so called letterbox, a gear adjustment realised through close collaboration between fishers, fishers representatives, net manufacturers and scientists.

1.2 The letterbox

The letterbox (in Dutch: brievenbus) is an attempt in the development of an alternative for the sievenet. The letterbox consists of a release hole transversely over the net (§3.1). The idea is that the shrimps go over the hole in the net, while flatfish can escape through the release hole. As the first tests of the letterbox in 2008 were promising, the letterbox was believed to be a possible alternative net adjustment to the sievenet (Quirijns et al., 2008).

The producers organisation, PO Wieringen, together with shrimp fishers Erik and Jan Rotgans (WR54) and net manufacturer Sander van Rijswijk (Coöperatieve Inkoop vereniging (C.I.V.) Den Oever), initiated the currently described project titled: “net innovation letterbox” . This project started in 2009 and the goal was to optimize the letterbox design and investigate the performance of the gear in relation to the sievenet. IMARES was responsible for the latter investigation. The project was funded by the Dutch Fisheries Innovation Platform (VIP). Results were regularly discussed within the Dutch Fishermen Study Group* for Sustainable Shrimp Fishery, funded by the ministry of Economic Affairs, Agriculture and Innovation.

[1] COUNCIL REGULATION (EC) No 850/98 of 30 March 1998 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms PB L 125/1. Article 25.

1.3 Assignment

The main question addressed during this study was: *is the letterbox at least equally effective as a sievenet in reducing discards juvenile flatfish in shrimp fisheries?*

Although discards of juvenile flatfish is one of the main issues in flatfish fisheries, also other discards should be taken into account. Thus the second research question is more generic: *how does the letterbox perform compared to the sievenet with regard to by-catch of fish and benthos?*

During this project following steps were undertaken consecutively:

1. Fishers and net manufacturers optimized the gear adjustment while using under water observations.
2. IMARES joint the fishers on board their vessels for comparison of shrimp catches and discards between the sievenet and the letterbox in May & June and September & October 2010

In order to promote the initiatives of the shrimp fishers, an informative movie was made of this project (to be requested at PO Wieringen).

* *Fishermen Study Groups* where introduced in the Netherlands in 2008. The Study Groups consists of a maximum of 16 fishermen from the same fleet segment but from different regions in the Netherlands, which work together and exchange knowledge. Each group is facilitated by two scientists. The main goals of these Study Groups are to overcome the lack of cooperation among fishermen from different regional areas, and at the same time stimulate and empower fishermen to innovate towards more sustainable fisheries (de Vos & Mol, 2010; www.kenniskringenvisserij.nl).

2 Materials and Methods

2.1 Sampling procedure

Data were collected on board of 2 vessels: WR54 and WR57 during 6 different trips. The same nets were used on the two vessels. The sampling procedure to collect data on discards and shrimps was based on the standard procedure used for discards sampling on board shrimp vessels (see Appendix A). This procedure was internationally agreed upon at the Crangon workgroup of ICES (ICES, 2008; Tulp et al, 2010). The difference with the standard procedure was, that during this research non-marketable shrimps where not recorded. The trips were carried out with the sievenet at starboard and the letterbox at portside. In this way a paired comparison of each haul could be made.

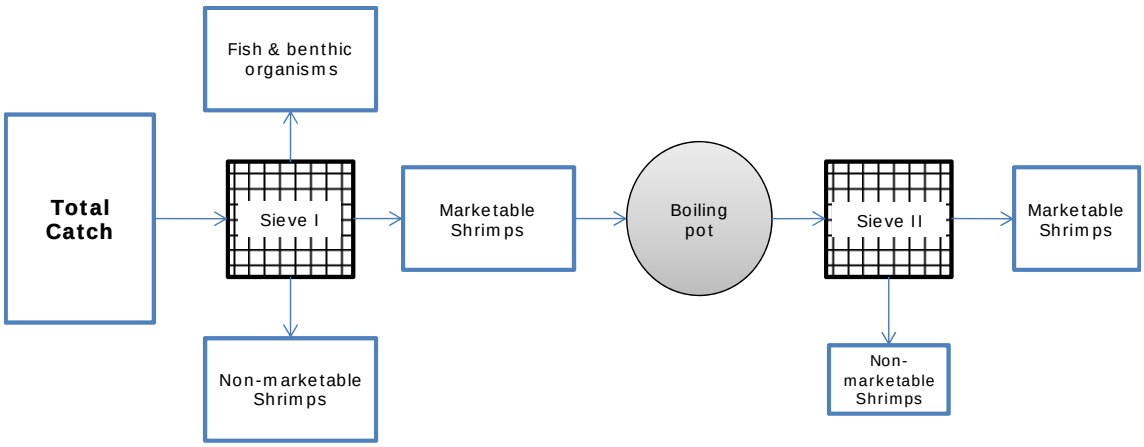

Figure 1 Sorting of shrimps on board of a shrimp vessel (schematic).

For each haul, data on position, haul duration, wind direction, fishing depth were recorded on a trawl list. Then for starboard and portside nets the following steps were undertaken:

1. Estimate the total catch per side. Registration of total catch in volume on the trawl list.
2. After the sieving of the total catch (Figure 1; sieve I) the fish and benthic organisms were collected (Figure 2). All fish and benthos were sorted by species and registered as follows:
    a. Commercial fish species (plaice, dab, flounder, sole, whiting, herring and cod) were sorted, and length measurements were taken and registered by species and length class.
    b. Total number per species were registered from the other fish and the benthos.
    c. In cases of large quantities of fish/benthos a subsample was taken.
3. Marketable shrimps were boiled in the boiling pot and collected after sieving (Figure 1; sieve II). Total weight of marketable shrimp per haul per side in kg was registered.

Back at the laboratory all data were entered and uploaded into the IMARES database. Before uploading into the database all data were checked.

Figure 2. Collecting the by-catch from Sieve I on board of the WR54.

2.2 Data analyses

For each haul, weight of shrimps, numbers of fish and benthos caught with the sievenet and the letterbox are compared. Observed weights and numbers are estimated per hour fishing. A Paired Samples T Test is used to compare the arithmetic means from the observations in both nets, provided the conditions for this test are met (observations are independent, the variances are constant and the errors are normally distributed). In cases that the errors are not normally distributed a Wilcoxon's rank-sum Test is used. When differences are significant, we use bootstrapping to obtain a 95% confidence interval for the mean of differences. The ratio of numbers in the nets are analysed by taking the logarithms of the observations and compare these also with a paired T Test or Wilcoxon Test. In case that the observation in both nets of one haul is zero, the ratio (0/0) is substituted by (1/1). If a zero is observed in just one of the nets that haul is omitted from the analysis. All analyses are carried out using the statistical programming software R (R Development Core Team, 2005)

3 Results

3.1 Development of the gear adjustment the letterbox

The net adjustment for reducing discards was designed and further improved during this project by the crew on board of the WR54 (Jan, Piet, Peter and Erik Rotgans) together with Sander van Rijswijk from the C.I.V. Den Oever. In order to do so several exploratory trips were conducted in early spring 2010. Underwater observations (video) were used to look at the behavior of the net. Also some basic information on catches and discards was collected by the fishers themselves. During these trips final decisions were made on the best location of the release hole in the net. A guiding panel was built in the net, so the (flat)fish were basically guided towards the escape hole. Also, to force the release hole to stay open during fishing, the backside of the letterbox was made shorter with a little rope. The final design of the net is shown in Appendix B. The letterbox consists of a release hole in the bottom and two guiding panels alongside of the release hole. In the first three weeks also a panel was placed on top of the release hole. This panel was removed in the second stage of the research (Sep-Oct) as it was believed to cause a loss of marketable shrimps.

3.2 General trip information

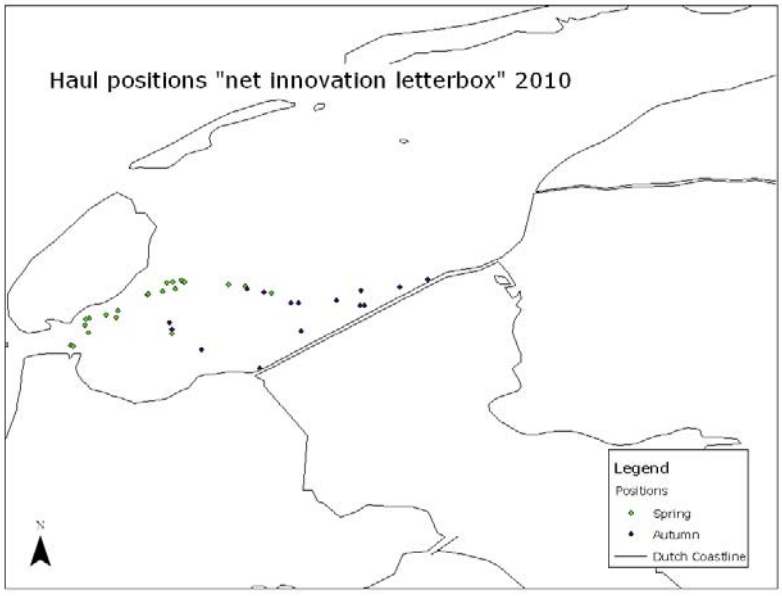

Figure 3. Positions of the hauls conducted during the field investigations in autumn and spring.

A total of six trips were conducted in the Western Wadden Sea (Figure 3); three trips in the period of May/June 2010 and three trips in the period of September/October 2010 (Table 1

Table 1). Four times the monitoring was carried out onboard the WR54 and two trips were onboard the WR57. A total of 37 hauls were monitored and haul duration ranged from 42 - 114.5 min. After the first 3 trips the letterbox was adjusted slightly, with the objective to retain shrimp catches.

Table 1. Trip characteristics

Dates	Vessel	nr hauls sampled	Average haul duration (min)	Guiding panel on top of release hole
17/18 May	WR54	10	114.5	Yes
2/3 June	WR54	7	105.7	Yes
23 June	WR54	5	85	Yes
13 September	WR54	5	76	No
22 September	WR57	5	42	No
20 October	WR57	5	87	No

3.3 Shrimp catches

Obtained shrimp catches for the letterbox and the sievenet per haul in kg/hr are shown in Figure 6.

Overall sievenet catches of shrimp are on average 1.2 times higher than catches with the letterbox. Shrimp catches per hour with the sievenet vary between 7 and 206 kg/hr with a mean of 37.5 kg/hr. The median value is 28.6 kg/hr. Shrimp catches with the letterbox vary between 5.5 and 180 kg/hr. The distribution of the catches is positively skewed with a median of 22.5 kg/hr and a mean of 33.6 kg/hr. On average, shrimp catches were 4.0 kg/hr higher in the sievenet, with a 95% confidence interval ranging from 2 to 6 kg/hr.

The differences in shrimp catches between the sievenet and the letterbox side were however not the same in the two sampling periods. During the first period shrimp catches were on average 1.3 times higher in the sievenet (ranging from 1.15-1.145). In the second period – after the adjustment of the guiding panel – there was no significant difference in shrimp catches (factor 1.05, ranging from 0.98-1.12). ANOVA shows that the effect of period on the differences between catches of the nets was significant.

3.4 Number of discards

The monitoring took place in spring and in autumn. In spring the catches were mainly dominated by flatfish and in autumn the catches were dominated by roundfish (Figure 12).

A summary of the average numbers of discards and means of differences between the sievenet and the letterbox is given in Table 2 and Table 3 (Appendix C). The means of ratios is a factor that expresses the number of species caught with letterbox versus the number of species caught with the sievenet. When the factor is < 1 it means that on average higher numbers of the species were found in the sievenet, when the factor is > 1 it means that on average higher numbers of the species was found in the letterbox.

3.4.1 Commercial fish

Catches of plaice, sole, whiting, herring, flounder and dab are presented in Figure 7 (Appendix C).

Plaice was present in all catches. Per fishing hour on average 460 more plaice are found in the sievenet compared to the letterbox. The 95% confidence limits of this mean of the differences range from 115 to 805. The mean of the ratios of plaice catches in the letterbox to catches in the sievenet is factor 0.6 with a 95% confidence interval from 0.45 to 0.8.

An effect of season was observed with regard to numbers of plaice and means of differences of these numbers between the sievenet and the letterbox. Analysis of Variance showed that this effect of period is significant ($p<0.05$). In the first period (May-June) the mean of the differences ($p=0.02$) between sievenet and letterbox catches was 745 (factor 0.45; significant with a 95% confidence interval from 0.31 to 0.65). The mean of the differences during the second period is 40 and not significantly different from zero (factor 0.91).

The mean of the differences of sole catches per hour in the two nets was 15 (3-27) more sole in the sievenet. Expressed as a factor, 0.64 times less sole in the letterbox was observed but this factor is not significantly different from equality. During the first period however, sole caught in the letterbox as factor of the sievenet catch is 0.54, significantly less than 1 with a 95 % confidence interval of 0.34-0.84.

No significant differences are found between the catches of herring, whiting, flounder and dab in both nets. Catches of whiting, flounder and dab are on average 1.4, 1.4 and 1.1 times higher in the letterbox and those of herring a factor of 0.95 times lower compared to the sievenet catches during the same hauls.

3.4.2 Non-commercial fish species

Observations of discards (number per hour) of the non-commercial fish species are presented in Figure 7 - Figure 10 (Appendix C).

Of the non-commercial species bull rout, hooknose, pipefish sp., European smelt and sandeel sp. are present in more than 50% of the hauls (Table 2

Table 2). The absolute mean of differences of 27.7 is found to be significant for bull rout; a factor 1.72 more of these species was found in the letterbox. Differences expressed as factor for the ratio of numbers caught in the letterbox as compared to the sievenet is significant lower than one for pipefish sp (0.56), great sandeel (0.88) and bib (0.78). Five-bearded rockling shows a factor 1.3 being significantly higher than 1.

The ratio of numbers of the non-commercial species in the letterbox compared to the sievenet is on average 0.9 and 1.2 for the first and the second period respectively. Factors significantly different from 1 in the first period are found for pipefish (0.31), bull rout (1.75), bib (0.65), greater sandeel (0.73) and scaldfish (0.74). In the second period significant differences are found for bull rout (1.66) and five-bearded rockling (1.88)

3.4.3 Benthic and other organisms

Observations of discards (number per hour) of the benthic and other species are presented in Figure 11 (Appendix C).

The most abundant benthos species are shore crab (*Carcinus maenas*) and common starfish. Less numbers of shore crab were found in the letterbox (81 with a 95% conf. int. of 4-160) and common starfish was more abundant (12.4; NS). Expressed as factor for shore crab 0.64 times less of this benthos species is found in the letterbox. Looking only at the first period significant differences were found for as well shore crab (0.35) as common starfish (0.5). In the second period on average more of both species were found in the letterbox, but this was not significant.

3.5 Length frequency distributions

Length frequency distribution of dab, flounder, herring, plaice, sole, whiting discarded in the two nets are shown in Figure 13 (letterbox) and Figure 14 (sievenet).

The length frequency distributions of plaice show that for both sievenet and letterbox sizes of plaice discarded range from 8-12 cm. Flounder caught with the sievenet were mainly small with a peak on 7 cm. With the letterbox more larger flounder were found, ranging up till 32 cm. Dab in the sievenet was mainly small, with a peak around 5-6 cm. Also in the letterbox the length frequency distribution of dab showed a peak around 5-6 cm, however also larger examples of dab were caught. For herring the length frequency distributions show that for both sievenet and letterbox sizes of herring caught range from 7-10 cm. Length distributions of sole and whiting are similar for letterbox and sievenet.

4 Discussion

4.1 Reducing discards and keeping shrimp

The main goal of the project was to find an alternative gear adjustment for the sievenet that is equally efficient in reducing discards. Such an innovation is only interesting for fishers when loss of marketable shrimp is zero or negligible. On average (all six trips together) the loss of marketable shrimp in the letterbox as compared to the sievenet was 17%. This seems a lot, but this high percentage was mainly caused by significant losses of the catches during the first three trips. In the end, reducing the loss of shrimp in the letterbox compared to the sievenet turned out to be successful; after a small modification to the net, equal amounts of shrimp were caught with the letterbox and the sievenet in the latter three trips.

Discards considered in this study are the by-catch of (commercial) fish and benthic organisms. Also small shrimps were discarded, measuring these was not within the scope of this assignment. Therefore, it is unknown how the letterbox affects the catch of undersized shrimp, compared to the sievenet.

Looking at the fish discards, plaice was the most abundant in both the sievenet and the letterbox; and more plaice was caught in the first period (spring), compared to the second period (autumn). The plaice were without exception small, juvenile plaice. All trips were conducted in the Wadden Sea, and this is an important nursery area for plaice (Zijlstra, 1972, Beek *et al.*, 1989). Looking at the results, the letterbox in comparison with the sievenet, seems particularly efficient in reducing the discards of juvenile plaice (factor 0.6 less). Figures presented were absolute, average numbers per hour. As shrimp catches of the letterbox were on average lower, factors presented can be multiplied with factor 1.2 for a relative figure, per kg of shrimp caught (overall sievenet catches of shrimp are on average 1.2 times higher than catches with the letterbox). Per kg shrimps, the plaice catches of the letterbox were 0.75 times the plaice catches in the sievenet (0.6 * 1.2). Differences between the two nets was however most profound in the first three trips that were conducted in spring and before the modification to the letterbox.

Other flatfish species that use the Wadden Sea as nursery area are sole and dab (Zijlstra, 1972, Beek *et al.*, 1989, Bolle *et al.*, 1994). Small flounders are found in the Wadden Sea but they also inhabit fresh water such as the lower reaches of rivers (Essink et al, 2004). Like for plaice, more sole was found in the sievenet and this was especially significant in the first period. Discards of the two other flatfish, dab and flounder were however (in numbers) higher in the letterbox than in the sievenet, although the difference was not significant. Compared to plaice larger dab and flounder were present in the letterbox which can explain this different outcome for the flatfish species; the sievenet can effectively sort out fish species with lengths over 10 cm, but juvenile fish species smaller than approximately 10 cm are not effectively released (Marlen, 2001, Catchpole et al, 2008).

Another species that is using the Wadden Sea as a nursing area is herring. Herring of sizes 7-10 cm were caught mainly in autumn; and there was no significant difference in amounts in both nets. At the same time there wasn't a significant difference between catches of shrimp in this period as well. So expected is that with regard to juvenile herring, sievenet and letterbox net are equally effective in reducing discards.

Most of the other fish species in the catches, like bull rout, five bearded rockling and goby, in the discards are permanent residents of the Wadden Sea (Essink et al, 2005). The results with regard to these species were variable. For some species significant higher numbers (per hour) were discarded with the letterbox (bull rout and five bearded rockling); for other species there was no real difference (goby);

and for other another group of species lower numbers per hour were discarded with the letterbox compared to the sievenet (pipe fish and bib).

The second category by-catch is benthos and other seabed organisms. Most present in the catches were common starfish and shore crab. For both species significant less were found in the letterbox during the first period. However, in the second period there were no significant differences.

The effects of net modification and period are confounded, which made comparison of results between period 1 and 2 rather difficult. For example for plaice, but also for shore crab letterbox caught significant less in spring, before the net alteration. After the net alteration there were no significant differences between the sievenet and the letterbox for both species. Therefore it is recommended to conduct another experiment in spring 2011, a period of high abundance of juvenile plaice (<10 cm), using the newest net design.

4.2 Conclusions

The main question in this project was: *is the letterbox at least equally effective as a sievenet in reducing discards juvenile flatfish in shrimp fisheries?*

The answer to this question is as follows:

- Yes, the letterbox is at least equally effective as a sievenet in reducing discards of especially juvenile plaice.

The other research question: - *how does the letterbox perform compared to the sievenet with regard to by-catch of fish and benthos?* – could be answered in two ways:

- The letterbox is at least equally effective as a sievenet in reducing several other discards, like small herring, pipefish and great sandeel.
- The letterbox is not as effective in reducing all sorts of discards, like bull rout and five bearded rockling.

We have reasons to believe that the letterbox performs better than the sievenet in reducing discards of juvenile flatfish. Larger dab and flounder were caught in the letterbox, while they did not appear in the sievenet. For some roundfish and benthic species the performance of the letterbox is varying from more or equally effective to less effective as the sievenet.

In the end there were no losses of catch of shrimp with the letterbox – without the panel on top of the release hole and high abundance of shrimp. The latest design of the letterbox and sievenet are equally effective in catching shrimp.

The letterbox can be a good alternative for the sievenet, especially in spring, when there is high abundance of juvenile plaice in the Wadden Sea. It should be taken into account, however, that the adjustment is not as effective as the sievenet for all species.

5 Acknowledgements

Jan, Piet, Peter and Erik Rotgans (WR54) and came up with the idea for the letterbox and together with the enthusiastic help of Sander van Rijswijk (C.I.V. Den Oever) the letterbox was improved to what it is now during this project. We would like to thank the skippers Jan Rotgans (WR54) and Jan de Haan (WR57) and their crew for their hospitality on board and cooperation during the research. Also we would like to thank Ab Post and PO Wieringen for the coordination of the project and finaly our gratitude goes to the members of the study group for Sustainable Shrimp Fishery for their support and their useful comments during the process of the project.

6 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

References

Anonymus, 2009. De Noordzeegarnalen (Crangon crangon) visserij; Managementplan voor garnalenvissers 1 juli 2009 – 1 juli 2014. Opgesteld door de Producenten Organisaties (POs) van de visserij op Noordzeegarnalen, Januari 2009.

Beek, F.A. van, Rijnsdorp, A.D. and Clerck, R. de, 1989. Monitoring juvenile stocks of flatfish in the Wadden Sea and coastal areas of the southeastern North Sea. Helgoländer Meeresunters. 43: 461-477.

Bolle, L.J., Dapper, R., Witte, J.Y. and van der Veer, H.W., 1994. Nursery grounds of dab (*Limanda limanda* L.) in the southern North Sea. Neth. J. Sea Res. 32: 299-307.

Catchpole, T. L., A. S. Revill, J. Innes & S. Pascoe (2008). Evaluating the efficacy of technical measures: a case study of selection device legislation in the UK Crangon crangon (brown shrimp) fishery. Ices Journal of Marine Science 65(2): 267-275.

Essink, K., Dettmann, C., Farke, H., Laursen, K., Lüerßen, G., Marencic, H. and Wiersinga, W. (Eds.), 2005. Wadden Sea Quality Status Report 2004. Wadden Sea Ecosystem No. 19. Trilateral Monitoring and Assessment Group, Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Marlen, B., 2001. REDUCTION OF DISCARDS IN CRANGON TRAWLS (DISCRAN). REVISED FINAL REPORT for the period 01-03-1999/28-02-2001. RIVO-rapport; C012/01.

Quirijns, F.J., van Giels, J. & Dijkstra, E.S. (2008). Garnalenvisserij: pilots voor verbetering discardsoverleving. IMARES report C116/08.

Revill A., Holst R., 2004. The selective properties of some sieve nets. Fisheries Research 66; 171–183

R Development Core Team 2005. “R: a Language and Environment for Statistical Computing,” R Foundation for Statistical Computing, Vienna, Austria. http://cran.r-project.org

Tulp, I., Leijzer, T., Helmond, E., van, 2010. Overzicht Wadvisserij. Deelproject A; bijvangst garnalenvisserij. Eindrapportage. IMARES report, C102/10.

de Vos, BI, Mol, APJ., 2010. Changing trust relations within the Dutch fishing industry: The case of National Study Groups. Marine Policy doi:10.1016/j.marpol.2010.01.011

Zijlstra, J.J., 1972. On the importance of the Wadden Sea as a nursery area in relation to the conservation of the southern North Sea fishery resources. Symp. zool. Soc. Lond. 29: 233-258.

Justification

Rapport C023/11
Project Number: 4301300301

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Floor Quirijns
Senior Onderzoeker

Signature:

Date: 4 maart 2011

Approved: Tammo Bult
Head department of fisheries

Signature:

Date: 4 maart 2011

Appendix A. Protocol discardsmetingen WR54 & WR57 (Brievenbus)

Benodigd materiaal

- Sorteertafel
- Touwen om tafel mee vast te zetten
- Meetplank
- Mandjes van ca. 35 kg
- Emmers
- Maatbeker
- Plastic zakken
- Treklijsten
- Turflijsten
- Brief van Wageningen IMARES
- Paspoort
- WUR ID kaart
- Draagbare 220 volts vriezer
- diepvrieszakjes (veel)
- pennen/potloden
- klembord
- monsterblaadjes voor in de vriesmonsters
- rekenmachine
- schepnet
- opvangnet
- vissengids
- handschoenen
- verlengsnoer

Gedurende de hele reis

- Houd de treklijst bij (denk vooral aan het noteren van het totaal aantal kg landings per trek, vraag hiervoor de visser)
- Houd goed overleg met de bemanning en betrek ze zoveel mogelijk bij de volumeschattingen van de totale vangst

Voordat de vangst aan boord komt

- Schat hoeveel manden totaal in de bak passen, waar de vangst vanuit het net in wordt geloosd. Doe dit zoveel mogelijk samen met de bemanning.
- Zet meettafel en ander materiaal zeevast klaar.

Vangstverwerking (stuurboord en bakboord apart, ook goed nettype vermelden!!!)

1. Schat het aantal manden in de totale vangst (zoveel mogelijk samen met de bemanning)
2. Voer de vangst door de zeef
3. Vang de marktwaardige garnalen op en noteer het volume
4. Vang de vis + discards op en neem hieruit een monster
5. Zoek monster uit per soort:
    a. Vissen – aantallen per cm-klasse (afronden naar beneden op hele cm) voor sol, ple dab, whg, cod en her
        i. overige vis: aantallen
    b. Benthos – aantal per soort
    c. Debris – volume aan stenen, veen enz.
6. Registreer de meetgegevens van punt 3 en 5 op de turflijst.
7. Voer alle gegevens in, in Billie Turf
8. Laat de gegevens opnemen in de database

Appendix B. Gear design of the letterbox

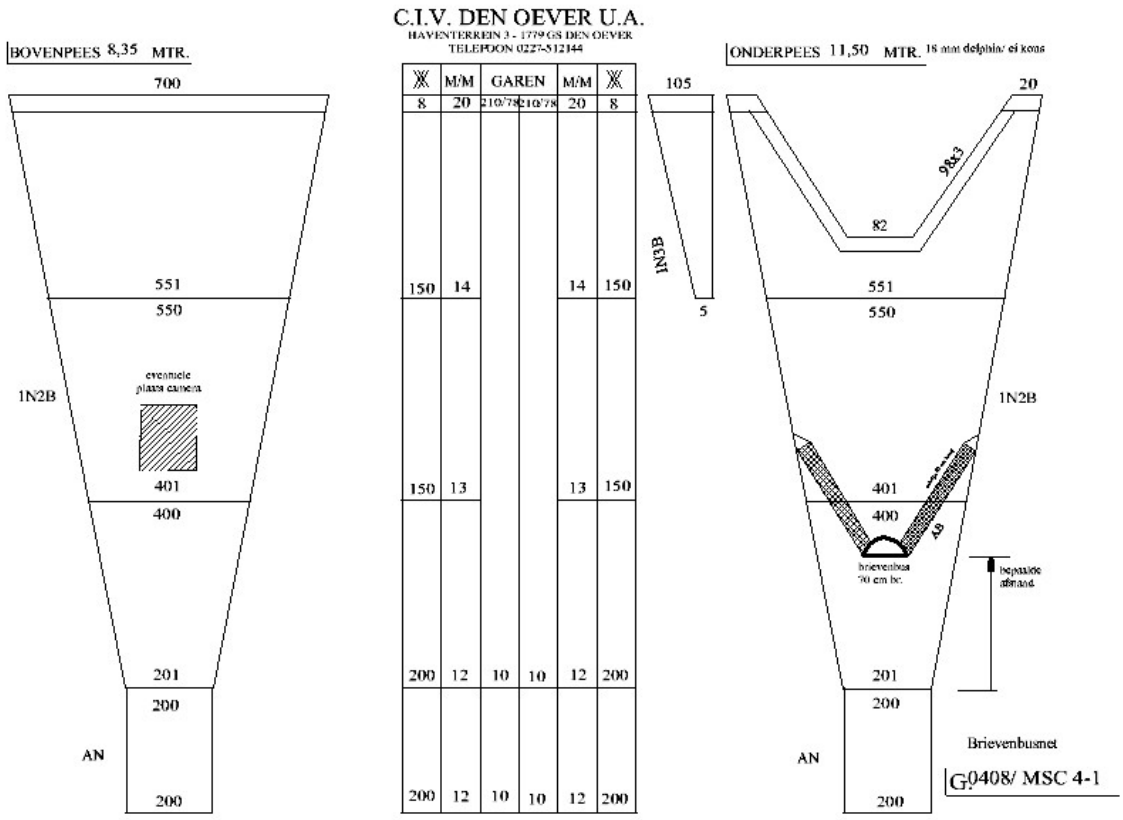

Figure 4. Design drawing of the letterbox (brievenbus).

Figure 5. Picture of the letterbox with guiding panel; red arrows point to the guiding panel (schotje) and the release hole (brievenbus).

Appendix C. Tables and Figures

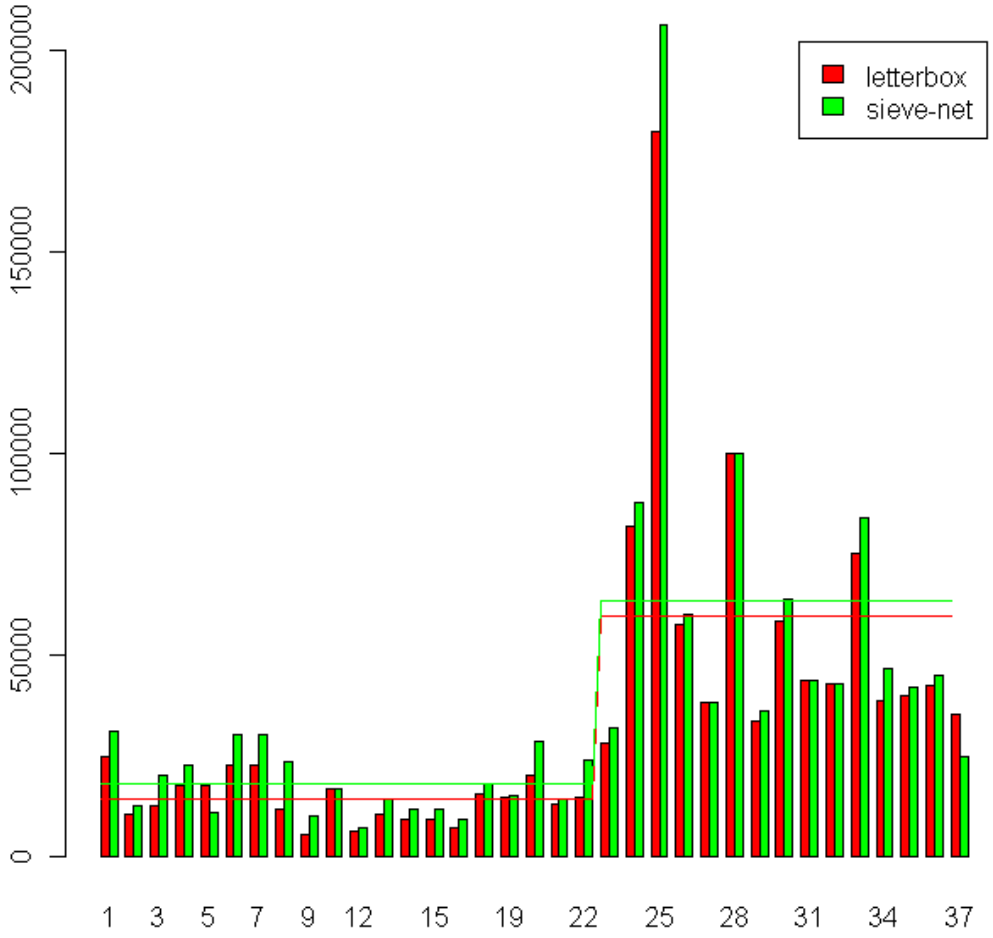

Figure 6. Barplot of the Shrimp catches kg/hr; y-axes) in the sievenet (green) and letterbox-net (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season)

Table 2. Means and medians of numbers of fish caught with the sievenet and the letterbox. Differences of means between the two net and the mean of ratios: a factor that expresses the number of species caught with letterbox versus the number of species caught with the sievenet. Significance is showed with asterisks: ** $p < 0.01$, * $p < 0.05$.

	Sievenet				**Letterbox**				difference	mean of
	% of hauls absent	median	mean	range	% of hauls absent	median	mean	range	of the means	ratio's
Plaice	0	756.0	1374.0	43-20314	0	248.0	914.5	10-15343	-459.2**	0.60**
Sole	7	15.0	28.2	192	8	9.0	12.8	41	-15.4**	0.64**
Herring	9	4.9	214.2	3897	7	4.0	146.9	2040	-67.3	0.98
Whiting	11	4.8	7.5	48	5	3.0	7.6	43	0.2	1.35
Flounder	24		3.4	86	3	4.0	5.9	34	2.5	1.39
Dab	19		15.2	189	12	2.0	13.0	137	-2.3	1.04
Bull Rout	3	32.2	45.4	376	0	42.0	73.1	392	27.7**	1.72**
Hooknose	8	10.0	16.5	102	8	8.0	14.3	77	-2.2	1.00
Pipefish sp	11	4.1	42.4	384	9	3.0	37.1	576	-5.4	0.56*
European smelt	13	6.9	62.1	696	18	1.0	68.7	716	6.5	1.05
Sandeel sp	16	1.5	11.0	115	19		6.9	77	-4.1	0.87
Goby	19		578.1	8160	18		772.9	9147	194.8	1.05
Viviparous Blenny	22		7.1	115	21		7.9	54	0.8	1.03
Sea-snail	22		2.5	24	24		2.8	24	0.3	0.94
Great sandeel	24		1.9	17	24		1.3	10	-0.6	0.88*
Butterfish	25		1.6	16	26		1.0	9	-0.6	0.92
Bib	27		6.4	120	23		4.4	77	-2.1	0.78*
Scaldfish	27		1.1	18	29		0.5	6	-0.6	0.89*
Five-bearded rockling	28		4.3	64	29		5.5	72	1.3	1.27*
Grey gurnard	32		0.2	2	27		0.4	3	0.2	
River lamprey	32		0.5	10	30		0.2	3	-0.2	0.93
Solenette	32		0.4	7	35		0.1	1	-0.3	0.92
Sprat	33		0.2	2	34		0.9	28	0.7	0.98
Tub gurnard	35		0.1	1	33		0.4	6	0.4	1.06
Three-spined stickleback	35		0.4	10	34		0.4	11	-0.1	
Dragonet	35		0.2	5	36		0.0	1	-0.2	0.98
Brill	36		0.0	1	34		0.1	1	0.0	
Lesser weever	36		0.0	1	35		0.0	1	0.0	
Turbot	37		0.0	0	33		0.2	5	0.2	
Sea bass	37		0.0	0	36		0.0	1	0.0	
Striped red mullet	37		0.0	0	36		0.1	2	0.1	

Table 3. Means and medians of numbers of benthic and other species caught with the sievenet and the letterbox. Differences of means between the two net and the mean of ratios: # caught with letterbox versus # caught with the sievenet. Significance is showed with asterisks: ** $p < 0.01$, * $p < 0.05$.

	Sievenet				**Letterbox**				difference	mean of
	% of hauls absent	median	mean	range	% of hauls absent	median	mean	range	of the means	ratio's
Shore crab	0	120.0	207.6	2-1016	0	67.0	126.5	2-629	-81.1*	0.64
Swimming crab	12		5.4	33	10		5.9	50	0.5	1.02
Common starfish	22	9.0	25.4	187	21	4.0	37.8	448	12.4	0.66
Common squid	30		0.6	12	31		0.4	7.0	-0.2	0.92
Sepiola	36		0.0	1	36		0.0	0	0.0	

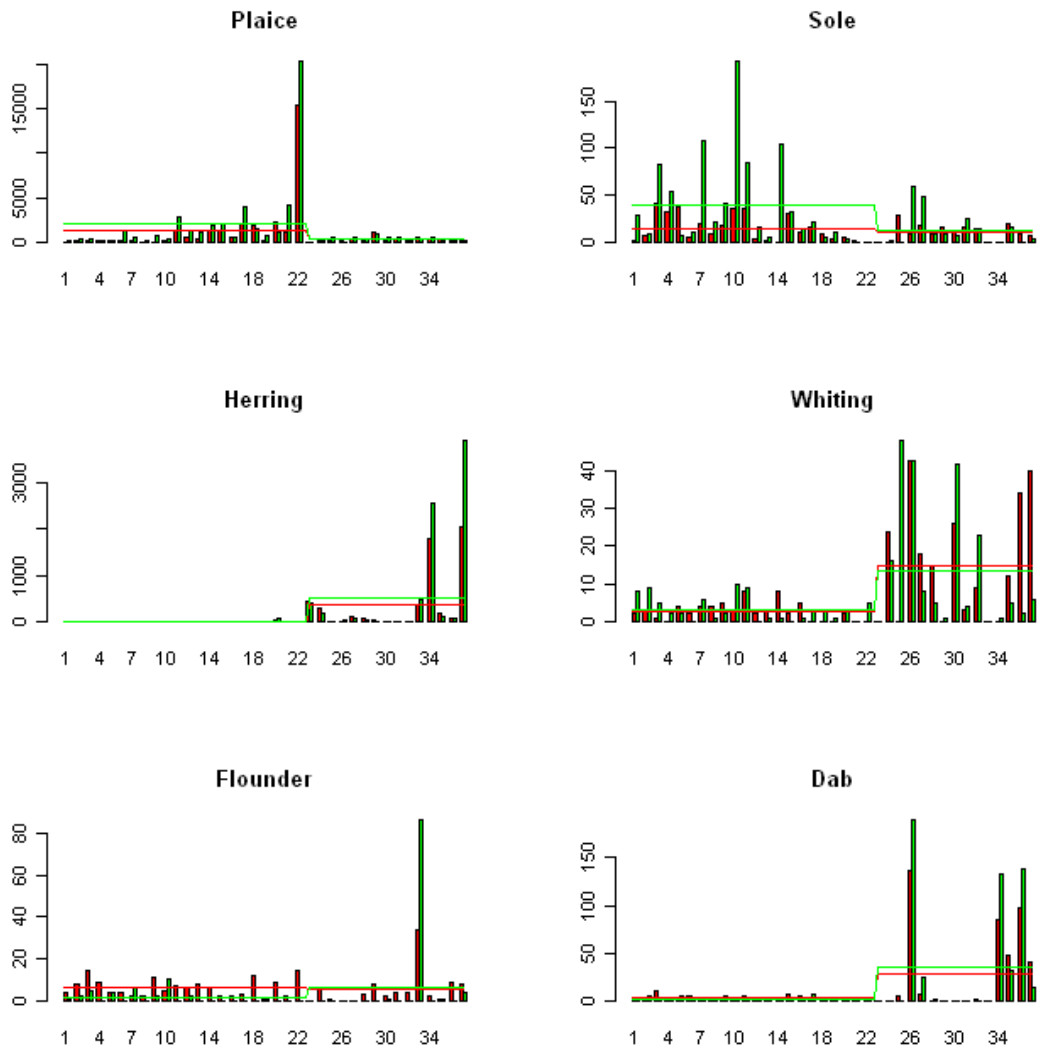

Figure 7. Barplot of of the by-catches in the sievenet (green) and letterbox (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season) of plaice, sole, herring, whiting, flounder and dab in number/hr (y-axes).

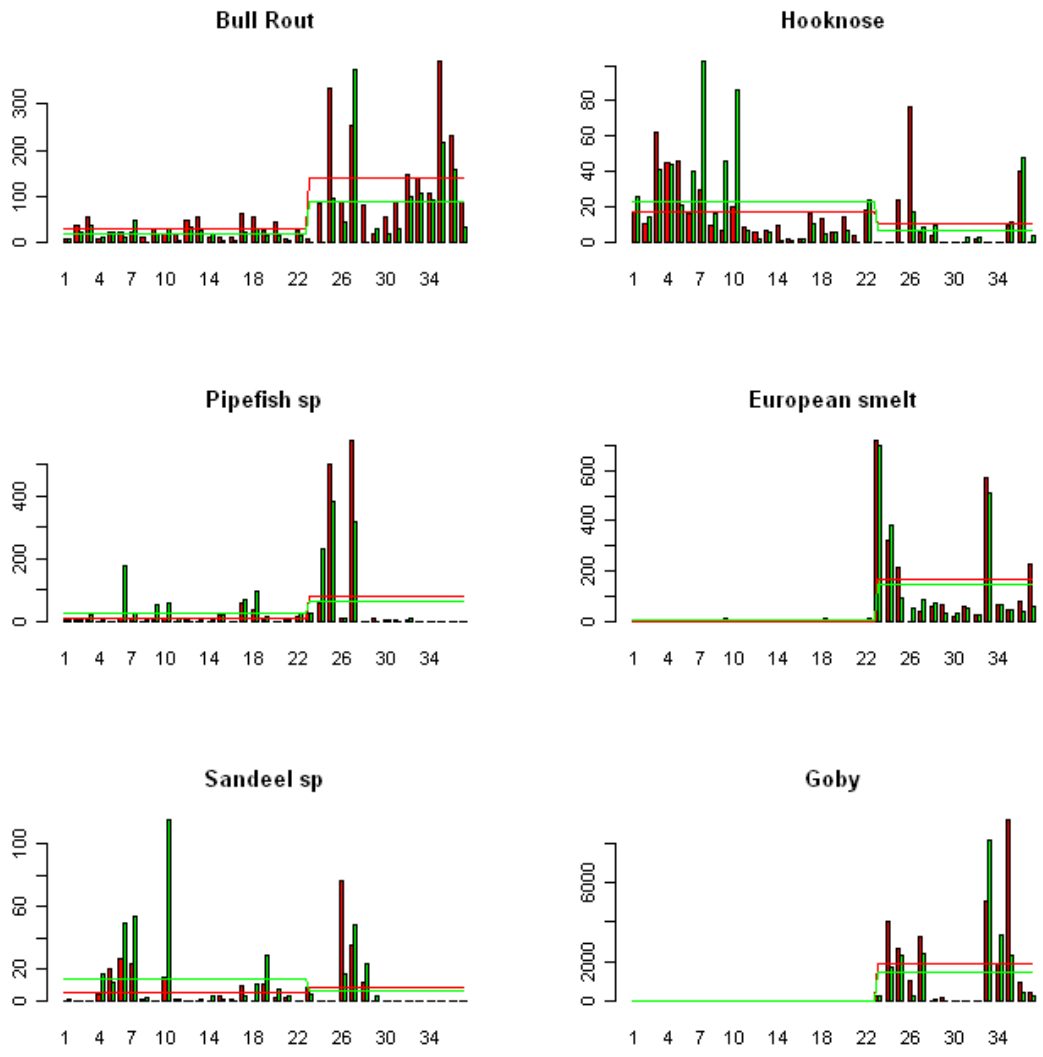

Figure 8. Barplot of of the by-catches in the sievenet (green) and letterbox (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season) of bull rout, hooknose, pipefish sp, European smelt, sandeel sp and goby in number/hr (y-axes).

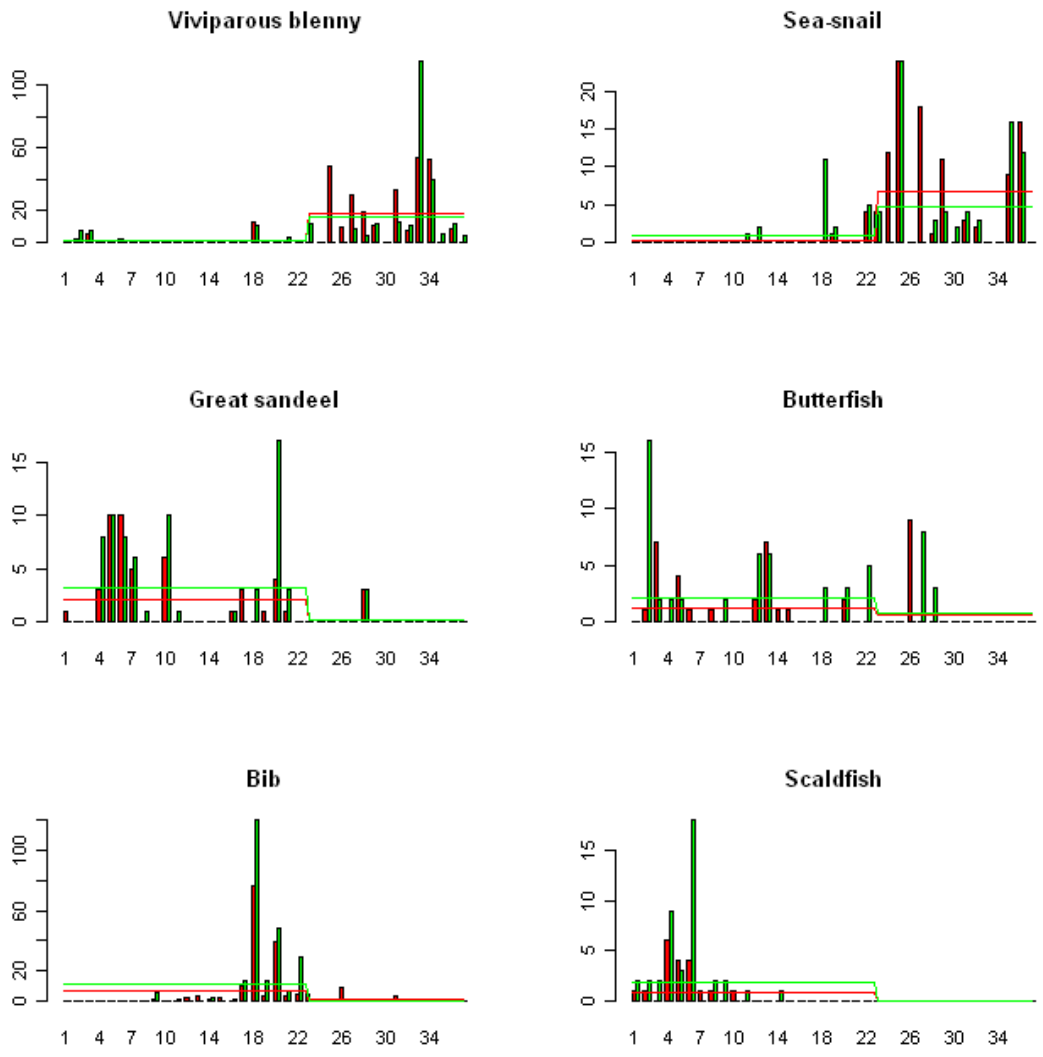

Figure 9. Barplot of of the by-catches in the sievenet (green) and letterbox (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season) of viviparous blenny, sea-snail, great sandeel, butterfish, bib and scaldfish in number/hr (y-axes).

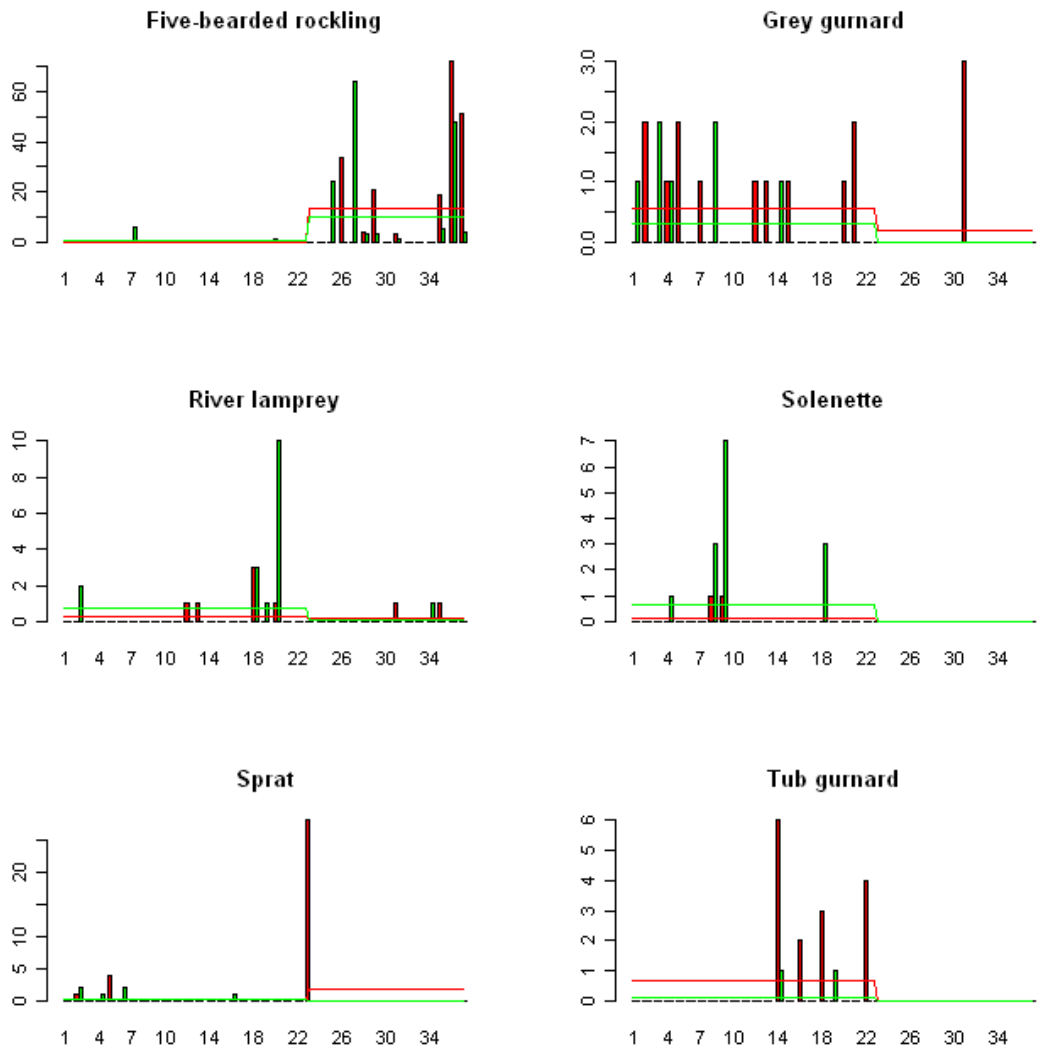

Figure 10. Barplot of of the by-catches in the sievenet (green) and letterbox (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season) of five bearded rockling, grey gurnard, river lamprey, solenette, sprat and tub gurnad in number/hr (y-axes) per haul.

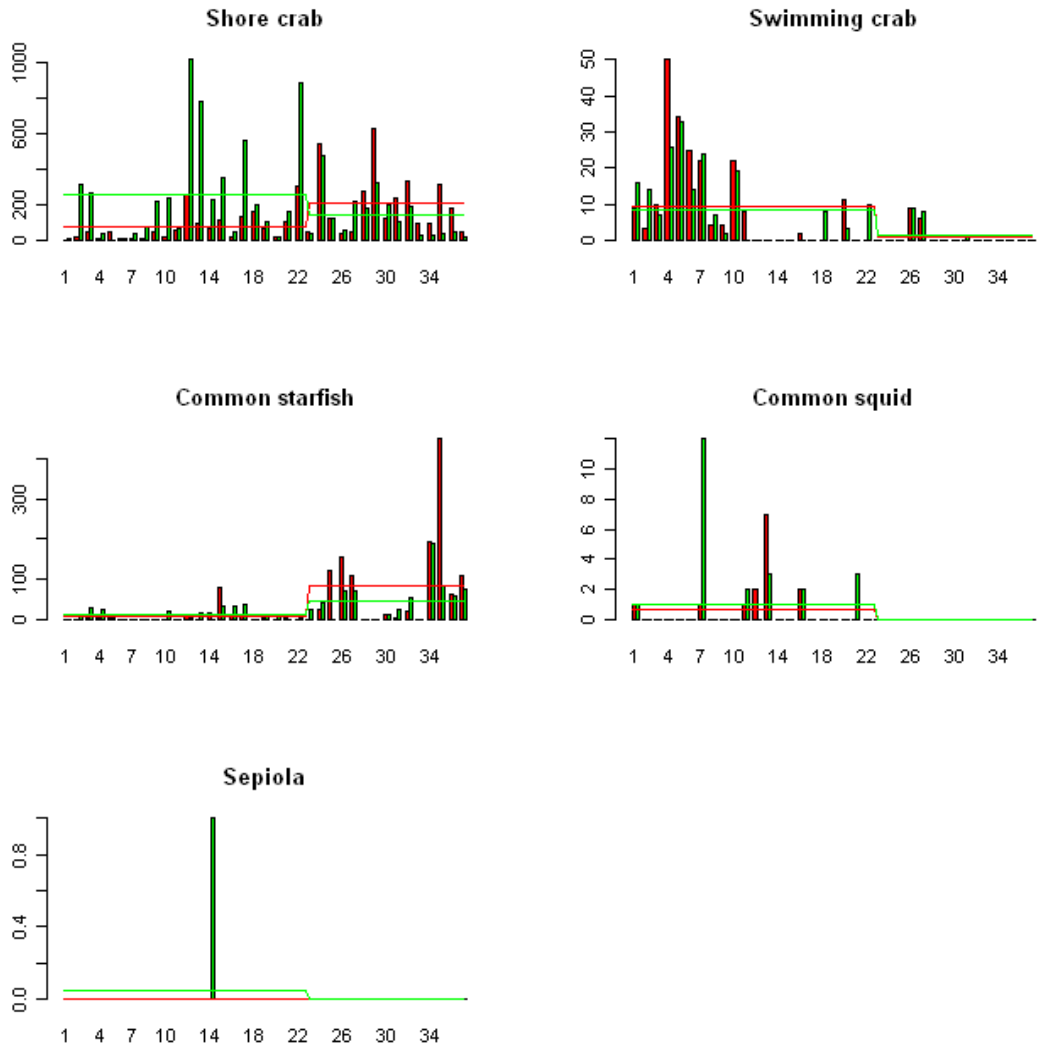

Figure 11. Barplot of of the by-catches in the sievenet (green) and letterbox (red) for the successive hauls (x-axes; 1-22: first season; 23-37 second season) of shore crab, swimming crab, common starfish, common squid and sepiola in number/hr (y-axes).

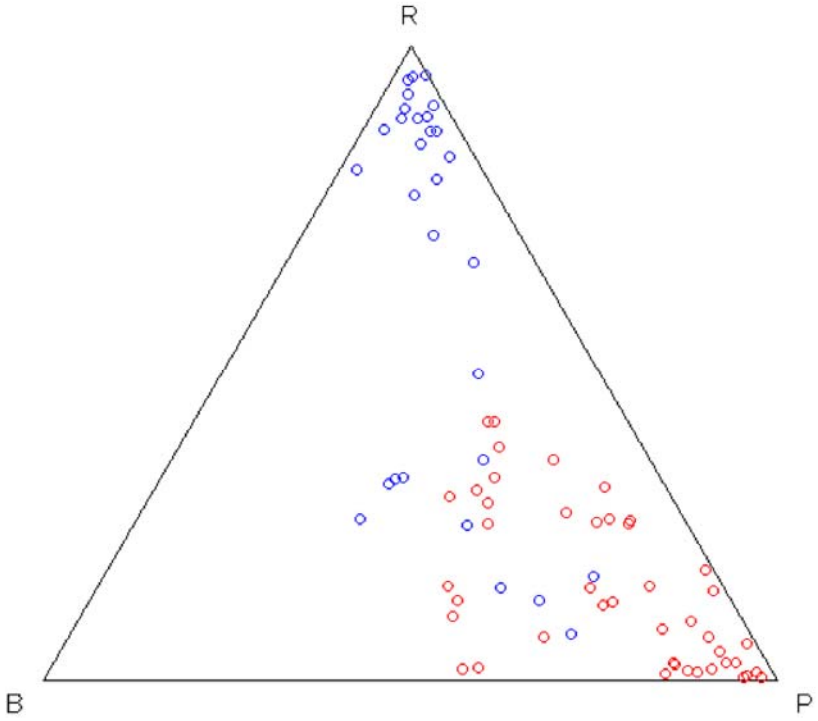

Figure 12. Ternary plot of by-catch composition in the first period (red) and second period (blue). Catches are combined in the categories roundfish (R), flatfish (P) and benthos (B).

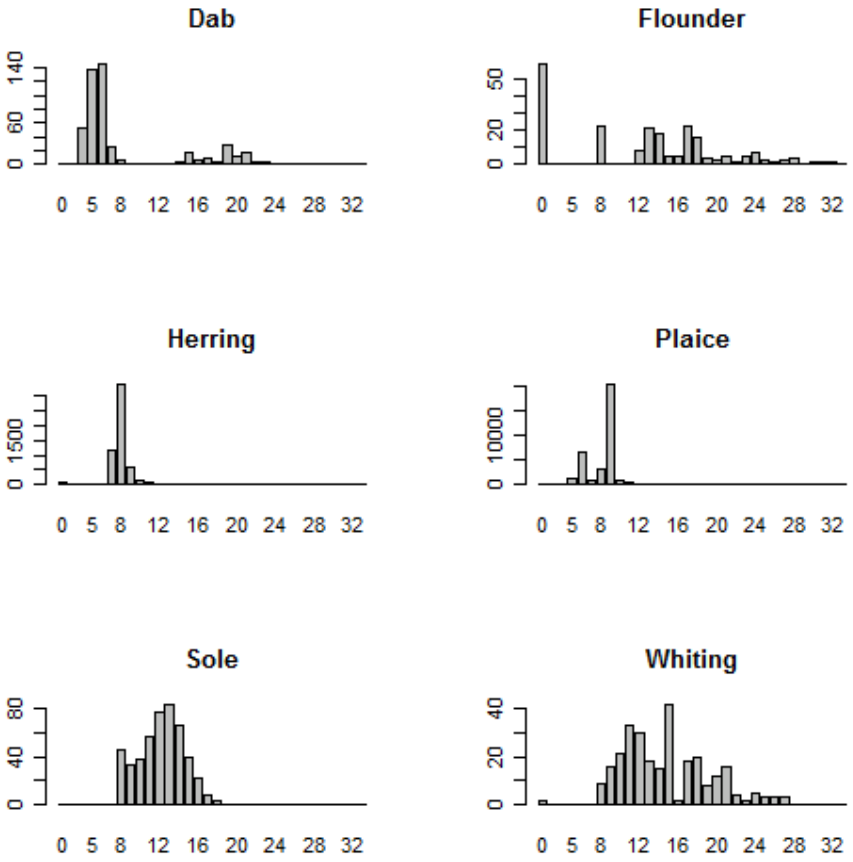

Figure 13. Length frequency distribution of dab, flounder, herring, plaice, sole, whiting in caught in the **letterbox**. Number (y-axes) per length class (cm, x-axes).

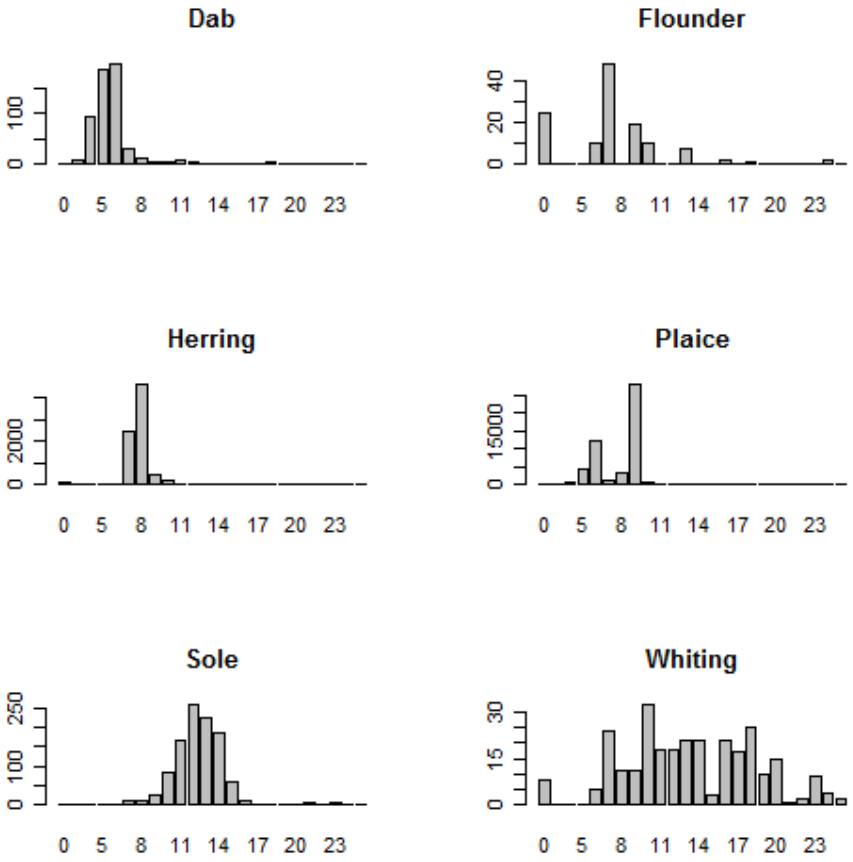

Figure 14. Length frequency distribution of dab, flounder, herring, plaice, sole, whiting in caught in the **sievenet**. Number (y-axes) per length class (cm, x-axes).

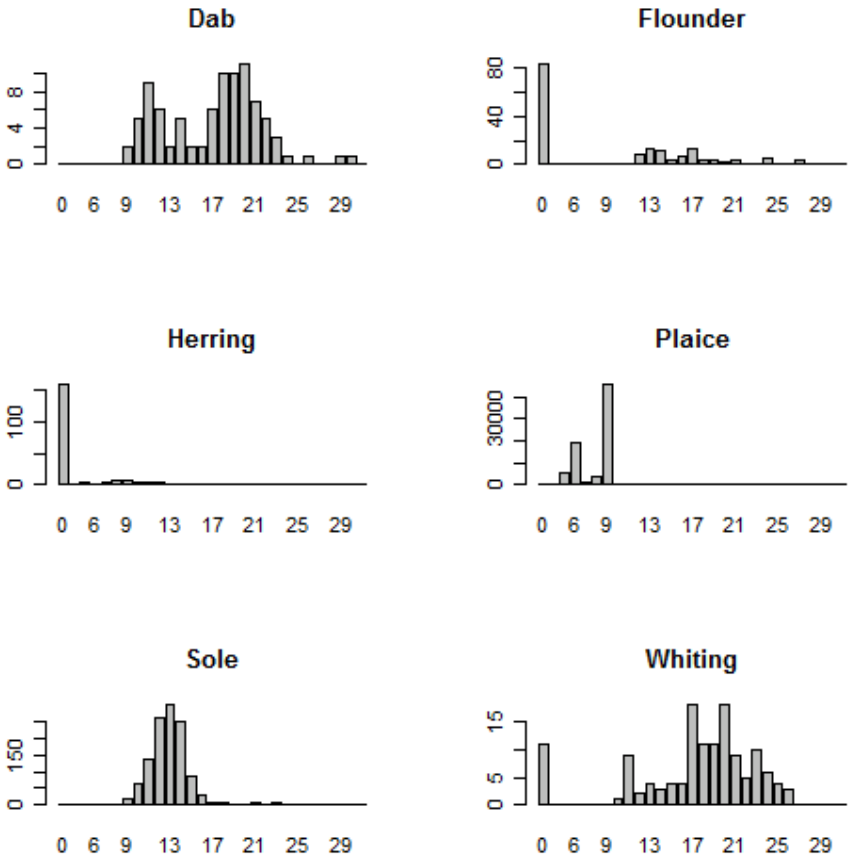

Figure 15. Length frequency distribution of dab, flounder, herring, plaice, sole, whiting in caught in the **1st period (spring)**. Number (y-axes) per length class (cm, x-axes).

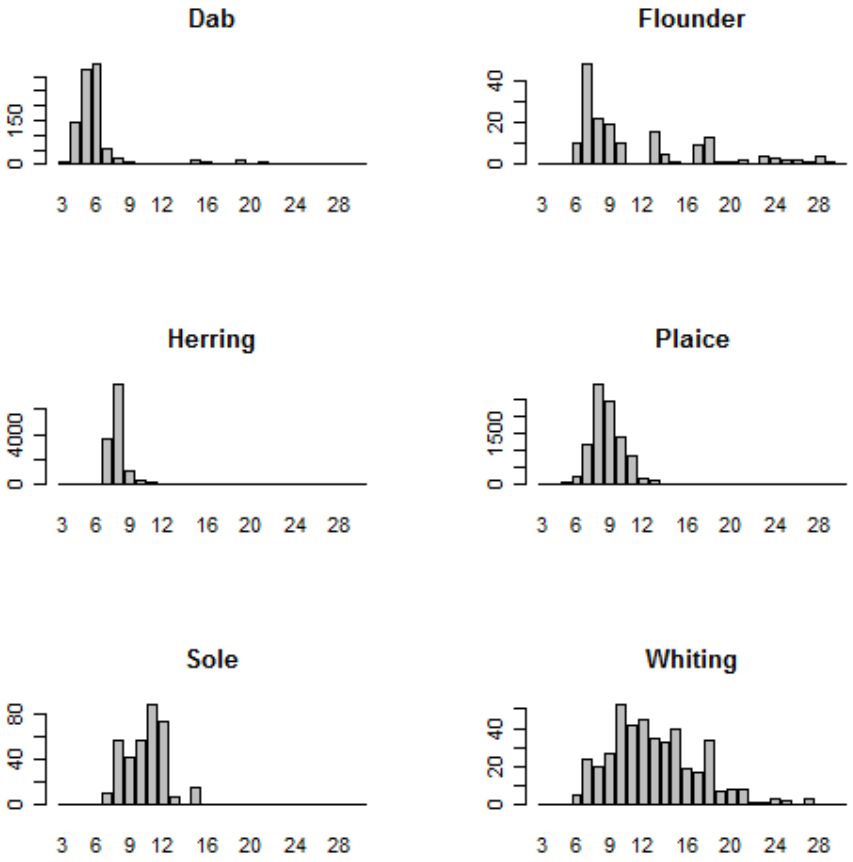

Figure 16. Length frequency distribution of dab, flounder, herring, plaice, sole, whiting in caught in the **2nd period (autumn)**. Number (y-axes) per length class (cm, x-axes).

Appendix D. English, Dutch and Sientific names of species

English	Nederlands	Scientific
Bib	Steenbolk	*Trisopterus luscus*
Brill	Griet	*Scophthalmus rhombus*
Brown Shrimp	Gewone garnaal	*Crangon crangon*
Bull Rout	Zeedonderpad	*Myoxocephalus scorpius*
Butterfish	Botervis	*Pholis gunnellus*
Common Sea Star	Zeester	*Asterias rubens*
Common Squid	Dwergpijlinktvis	*Loligo subulata*
Dab	Schar	*Limanda limanda*
Dragonet	Pitvis	*Callionymus lyra*
European smelt	Spiering	*Osmerus eperlanus*
Five-bearded rockling	Vijfdradige meun	*Ciliata mustela*
Flounder	Bot	*Platichthys flesus*
Goby	Grondel	*Pomatoschistus sp.*
Great sandeel	Smelt	*Hyperoplus lanceolatus*
Grey gurnard	Grauwe poon	*Eutrigla gurnardus*
Herring	Haring	*Clupea harengus*
Hooknose	Harnasmannetje	*Agonus cataphractus*
Lesser weever	Kleine pieterman	*Echiichthys vipera*
Pipefish sp	Zeenaald sp	*Syngnathus sp.*
Pipefish sp.	Zeenaald sp	*Syngnathus sp.*
Plaice	Schol	*Pleuronectesplatessa*
River lamprey	Rivierprik	*Lampetra fluviatilis*
Sandeel sp.	Zandspiering sp.	*Ammodytes sp.*
Scaldfish	Schurftvis	*Arnoglossus laterna*
Sea Bass	Zeebaars	*Dicentrarchus labrax*
Sea-snail	Slakdolf	*Liparis liparis*
Sepiola	Sepiola	*Sepiola sp.*
Shore crab	Strandkrab	*Carcinus maenas*
Sole	Tong	*Solea solea*
Solenette	Dwergtong	*Buglossidium luteum*
Sprat	Sprot	*Sprattus sprattus*
Striped red mullet	Mul	*Mullus surmuletus*
Swimming crab	Gewone zwemkrab	*Liocarcinus holsatus*
Three-spined stickleback	Driedoornige stekelbaars	*Gasterosteus aculeatus*
Tub Gurnard	Rode poon	*Trigla lucerna*
Turbot	Tarbot	*Psetta maxima*
Viviparous blenny	Puitaal	*Zoarces viviparus*
Whiting	Wijting	*Merlangius merlangus*