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Annexes to Joint Recommendation of the Scheveningen Group

Discard Plan for Demersal Fisheries in the North Sea

Content

Annex A: Gear Code Acronym Table

Gear Code	Type of gear
OTB	Bottom Otter Trawl
OTT	Otter Twin Trawls
OT	Otter Trawls (Not Specified)
PTB	Bottom Pair Trawl
PT	Pair Trawls (Not Specified)
TBN	Nephrops Trawl
TBS	Shrimp Trawl
OTM	Mid-water Otter Trawl
PTM	Mid-water Pair Trawl
TMS	Mid-water Shrimp Trawl
TM	Mid-water Trawls (Not Specified)
TX	Other Trawls (Not Specified)
SDN	Danish Anchor Seine
SSC	Scottish Seine (Fly Dragging)
SPR	Scottish Pair Seine (Fly Dragging)
TB	Bottom Trawls (Not Specified)
SX	Seine Nets (Not Specified)
SV	Boat or Vessel Seine
TBB	Beam Trawl
GN	Gillnets (Not Specified)
GNS	Gillnets Anchored (Set)
GND	Gillnets (Drift)
GNC	Gillnets (Circling)
GTN	Combined Gillnets-Trammel Nets
GTR	Trammel Net
GEN	Gillnets and Entangling Nets (Not Specified)
GNF	Fixed Gillnets (On Stakes)
LLS	Set Longlines
LLD	Drifting Longlines
LL	Longlines Not Specified
LTL	Trolling Lines
LX	Hooks and Lines (not specified)
LHP	Handlines and Pole Lines (Hand Operated)
LHM	Handlines and Pole Lines (Mechanised)
FPO	Pots
FIX	Traps (Not Specified)
FYK	Fyke Nets
FPN	Stationary Uncovered Pound Nets

Annex B: Exemption request for Nephrops discard survival in Scottish creel fisheries

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Background

The latest reform of the Common Fisheries Policy (CFP) identified the reduction of discards and bycatch as a key objective (EC 2013). In combination with catch quotas, a discard ban will be gradually introduced for all regulated species in European waters between 2015 and 2019. Exceptions to the landing obligation will be made for species which “"*according to the best available scientific advice, have a high survival rate when released into the sea under conditions defined for a given fishery*" (EC 2013). This paper will discuss *Nephrops* discard survival in the Scottish creel fishery, provide an overview of previous studies and consider if this fishery meets the exemption criteria.

Introduction

Nephrops is a marine decapod crustacean, widely distributed across the Northeast Atlantic and Mediterranean Sea where it inhabits burrow complexes constructed on areas of muddy sediment. It is commercially valuable and exploited throughout its range by both trawl and creel fisheries. Total landings of *Nephrops* by UK vessels into Scotland amounted to just under 18,000 tonnes in 2013 with a first sale value of £61.7 million, making *Nephrops* the second most valuable species landed into Scotland (Marine Scotland Science (MSS), 2014).

Creel fishing for *Nephrops* is well established in Scotland, particularly in the inshore waters and sea lochs on the west coast of Scotland. Although creel fishing typically accounts for a relatively small proportion of total Scottish landings (~ 10 % in 2013, ICES, 2014), creel-caught *Nephrops* attract high prices in the live export market and can provide an important source of income for small local boats. To the west of Scotland, creel fishing accounted for 17 % of landings in the North Minch and almost 20 % in the South Minch in 2013 with the ports of Portree (~490 tonnes) and Stornaway (~330 tonnes) receiving the greatest amount of creel-caught landings (Marine Scotland Science (MSS), 2014).

Creels and trawls exploit *Nephrops* populations in different ways, with trawl catches highly dependent on seasonal and daily burrow emergence patterns related to light levels and tide (for example) while creel catch rates are influenced by feeding activity in response to bait and agonistic behaviour (Adey, 2007; Bjordal, 1986). For this reason, creels are more selective for larger *Nephrops* than trawls, and catches typically exhibit a length composition consisting of a significantly greater proportion of large individuals in comparison to trawl catches (Bjordal, 1986; ICES, 2014; Leocadio *et al.*, 2007; Morello *et al.*, 2009; Ziegler, 2006). Discarding related to minimum landing size (MLS) is therefore likely to be at a lower level than in trawl fisheries although market driven size related discarding still occurs (above MLS). Creel-caught *Nephrops* may also be discarded when they are soft-shelled (due to recent moulting) or damaged during the capture process either by gear, poor handling or in-creel predation. There is little quantitative information on the level of *Nephrops* discards from creel fisheries in Scotland, and observer trips on board these vessels are not currently part of the MSS sampling programme. A number of trips were conducted on the West of Scotland during 2008-2010 and indicated highly variable creel-caught *Nephrops* discard rates – between 0 and 40 % by number with an average of around 10 % over all trips. However, it is not known whether these values are indicative of current creel discards rates.

Discard survival rates

The immediate survival rate of discarded *Nephrops* is highly variable and depends on a number of factors, including the amount of damage incurred during capture and post-capture handling, air temperature and the level of predation by sea-birds, fish and other marine predators during their return to the sea-bed (Chapman, 1981). The type of ground the *Nephrops* are returned to will affect their longer-term survival, as *Nephrops* have specific sediment requirements for the construction of burrows. The probability of being returned to suitable habitat will therefore depend upon the fishery practice and the spatial structure of the particular grounds.

Although there have been no studies of Nephrops discard survival conducted in the context of the management of commercial creel fisheries, numerous scientific studies have taken place demonstrating high survival rates of creel caught *Nephrops* returned to the sea. As a consequence mortality of *Nephrops* due to discarding in the creel fisheries has been considered negligible compared to other sources of fishing mortality (trawl landings and discards, creel landings)

Observations on the survival of creel caught *Nephrops* have mainly been made during experiments to estimate the mortality of trawl-caught individuals, where creel caught animals act as a control - or during tagging studies . Wileman et al. (1999) reported on a study in the Gairloch area of the North Minch in which only 3 of the 576 creel caught control individuals (held in pens on the sea bed) died in captivity (which corresponds to a survival rate of > 99 %). Other studies conducted in northern European waters have shown similarly high post-capture survival rates. Harris and Ulmestrand (2004) estimated 92 % survival, based on a control sample of twelve *Nephrops* caught in baited creels (off the Skagerrak, West Sweden) and maintained in holding tanks for two weeks. An alternative control sample which was exposed to air at a 90 min period had a 100 % survival rate. Chapman (1981) estimated the survival at 97 % after individuals caught in creels were transferred to cages on the sea bed on the west coast of Scotland.

Similar studies have recently been conducted in more southern European waters. Mehault et al. (2011) estimated a survival of 88 % for creel Nephrops after re-immersion at the Bay of Biscay. A similar experiment (Campos et al., 2010) carried out off the south coast of Portugal showed an 84 % survival rate for creel caught Nephrops that were used as a control group for estimating trawl discard mortality. Table 1 gives a comparison of the post-capture survival rates provided in these studies.

Studies of trawl-caught *Nephrops* indicate that damaged individuals have a lower rate of post-capture survival than healthy individuals (Mehault et al. (2011)). However, creel fishing is regarded as a less stressful method of capture than trawling and creel-caught *Nephrops* generally suffer less physical and physiological damage during the capture process than trawl-caught individuals (Ridgway et al., 2006). A large portion of the creel landed *Nephrops* are exported live to markets in southern Europe and good post-capture handling techniques are viewed as an important practice that adds value to landings. This practice further minimises the likelihood of damage and increases the chances of survival if discarded.

Anecdotal information from the fishery suggests that at certain times of year, a small proportion of individuals may be discarded due to damage incurred during interactions with other animals (both *Nephrops* and other species such as octopus) within the creel during the capture process. The percentage of animals damaged in this way is unknown and no studies have been conducted on the survival rate of damaged creel-caught individuals. However, Adey (2008), in a study on creel ‘ghost fishing’, frequently monitored creels left on the sea bed for up to a year and found no evidence of *Nephrops* damage due to predation and no *Nephrops* mortality until the creels had been in place for more than six months.

Eye damage due to light exposure had been described in literature (Gaten, 1988; Shelton *et al.*, 1985) but according with Chapman *et al*. (2000), this type of lesion does not seem to influence the long term survival, growth or reproduction of *Nephrops*. Prolonged aerial exposure and changes in ambient temperature have also been shown to have physiological, immunological and pathological effects (Ridgeway *et al*., 2006). Again, the limited time on board the creel boat and quick release into the water column ensures a prompt return to appropriate temperatures.

Predation Mortality

Additional mortality due to post-release predation is not accounted for in the survival rates given in Table 1. Predation by seabirds was estimated to be 8.6 % of discarded creel-caught animals in Loch Torridon (Adey, 2007) but there seems to be considerable regional variation between areas, depending on the size and behaviour of local populations of seabirds. The same study concluded that there was very little or no mortality of creel-caught discards due seabirds throughout the year in Loch Fyne where seabirds instead follow the local trawl fishery.

In some areas of the West of Scotland, fishermen have implemented measures to mitigate discard predation by seabirds by using a device which provide some protection to discarded individuals near the surface. The device consists of a plastic tube or escape pipe on the side of the boat which releases the *Nephrops* approximately 1 m under the surface and offers protection from foraging seabirds when descending to the sea bed. (A Weetman, pers. comm) MS Science has not evaluated the efficacy of these devices.

Longer term survival

Longer-term discard survival rate is influenced by the type of ground to which the *Nephrops* are returned as they have specific sediment requirements for the construction of burrows. The probability of being returned to suitable habitat will therefore depend upon the fishery practice and the spatial structure of the particular grounds. The process of catch sorting differs between *Nephrops* creel and trawl fisheries. In the trawl fishery, catches may be sorted while steaming between grounds and hence *Nephrops* may be discarded onto unsuitable habitat. In this situation, *Nephrops* are unlikely to find a suitable refuge and are at a much higher risk of predation mortality (Harris and Ulmestrand, 2004). In creel fisheries, the catch is sorted during the creel hauling process and discarded *Nephrops* are returned to the same location from which they were caught, therefore increasing the chances of survival.

Experimental work which used creel-caught *Nephrops* to study the effect of eye-damage on post-release survival and growth suggest high long-term survival rates. Almost 20 % of the originally captured (and tagged) individuals which were released back into the sea (rather than retained in tanks) were recaptured, with some individuals being recaptured and released multiple times during the 7 year study period (Chapman et al., 2000). There was no impact of eye-damage (which occurs when individuals are brought to the surface) on the survival rate.

Discussion

The Scientific Technical and Economic Committee for Fisheries (STECF) report on the landing obligation highlighted a number of issues relating to the exemption based on high survival (STECF, 2013). It emphasised the importance of international guidance and protocols as to best practices with regards to “scientific evidence” and also points out that the term “high survival” is somewhat subjective (STECF, 2013).

Although there have been no studies of Nephrops discard survival conducted in the context of the management of commercial creel fisheries, the high survival rate of creel-caught *Nephrops* retained in tanks or cages and used as a control group in experiments or monitored over a number of years in tagging studies, provides good evidence that the discard survival of healthy creel-caught *Nephrops* is likely to be high. Given that short creel soak times, minimal post-capture handling and rapid return of animals to the sea are features of this creel fishery, the potential for damage during the capture process is minimised, ensuring discarded individuals are in good condition (and likely experience high rates of survival).

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Table A1: Summary of creel-caught Nephrops survival rates from control groups in trawl discard survival studies.

Location	**% Survival**	**Sample size**	**Study Period**	**Reference**
Southern Portugal	84	24	2 days	Campos et al. (2010)
West of Scotland	97	NA	8-9 days	Chapman (1981)
Skagerrak, Sweden	92	12	2 weeks	Harris & Ulmestrand (2004)
Bay of Biscay	88	16	3 days	Mehault et al. (2011)
North Minch (WoS)	>99	576	14 days	Wileman et al. (1999)

Annex C: Request for exemption from the landing obligation for high survivability of Nephrops caught in trawls equipped with species selective grid, SELTRA-panel, and in the creel fishery

In the framework of the landing obligation in accordance with article 15 of regulation (EU) No 1380/2013, an exemption for high survivability is requested for Nephrops in area IIIa;

- caught with bottom trawls (OTB, TBN) with a mesh size of at least 70 mm equipped with a species selective grid with bar spacing of maximum 35 mm
- caught with bottom trawls (OTB, TBN) with a mesh size of at least 90 mm equipped with a top panel of at least 270 mm mesh size (diamond mesh) or at least 140 mm mesh size (square mesh)
- caught with creels (FPO).

Supporting information from recent survival trials is included in Annex Ci.

Define selected species

Norway lobster (*Nephrops norvegicus* L.) is distributed from the Barents Sea to the Iberian coast. They are limited to muddy habitats, where they live in burrows. The availability of suitable sediment defines their distribution and productivity. Adults undertake very small-scale movements (a few hundred metres), confining individuals to “functional units” (FUs). Larvae can be transported between separate mud patches in some areas.

Nephrops is mainly fished with otter trawls with bycatch and discards of other species, such as cod, haddock, and whiting. 9% of Nephrops landings in IIIa are caught with creels. Discard reduction initiatives in trawl fisheries are in place.

Adult stock size for Nephrops in Skagerrak-Kattegat is unknown but probably stable. Fishing pressure is low enough to ensure an optimal use in the long term.

Management units (types of gears employed)

The three gears proposed to be subject to the exemption are the only gears used in Swedish, Danish (and Norwegian) Nephrops trawl fisheries in the Skagerrak (harmonised national legislations on allowed gears). The gears are:

- bottom trawls (OTB, TBN) with a mesh size of at least 70 mm equipped with a species selective grid with bar spacing of maximum 35 mm
- bottom trawls (OTB, TBN) with a mesh size of at least 90 mm equipped with a top panel (SELTRA) of at least 270 mm mesh size (diamond mesh) or at least 140 mm mesh size (square mesh)
- Nephrops creels (FPO)

Catch composition

The creel fishery has catches with only minor proportions of undersized Nephrops and fish (see UK creel high survivability Nephrops). Trawl fisheries with grid catch mostly Nephrops but with some by-catches of undersized fish (see Annex Ci - Effects of gear on the discard mortality of Norway lobster), while the fishery with SELTRA-trawls is a traditional mixed Nephrops/fish fishery with Nephrops and most demersal fish species in the catches. Both trawl categories show high discard rates for Nephrops.

Discard profile of selected species

Discard rate for Nephrops in the two Skagerrak/Kattegat (IIIa) trawl fisheries is typically around 50% according to ICES estimates. In the creel fishery, a discard rate of 10% has been reported (Jansson 2008).

Motive and evaluation of effect on stock

The possibility to release undersized Nephrops will be beneficial to the Nephrops stock. An indication of this is that the stock has a good status in spite of long-term high levels of discarding. According to the trials referred to in Annex Ci the survivability may be considerable for Nephrops caught in the fisheries concerned. There are thus indications that present discards contribute significantly to the reproduction and productivity of the stock. For a stock with such characteristics, having to land and kill unwanted catch would, under unchanged prerequisites, risk to unintentionally increase fishing mortality on the stock. Therefore it would be of advantage for the stock status to continue the practise of releasing undersized Nephrops and allowing them to spawn and contribute to the spawning stock biomass. This needs to be seen in the context of the MCRS and of the TACs under a landing obligation.

Annex Ci: Effects of gear and season on discard survivability in three Swedish fisheries for Norway lobster (*Nephrops norvegicus*)

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Introduction

A major change in the management of European fisheries, introduced in the reformed Common Fisheries Policy (CFP; Regulation (EU) No. 1380/2013), is the introduction of an obligation to land all caught quota species. This obligation will be phased into different fisheries between 2015 and 2019. One exception to the landing obligation can be made for species which "*according to the best available scientific advice, have high survival rates when released into the sea under conditions defined for a given fishery*" (EC 2013).

This paper reports on two experiments designed to estimate the effects of seasonality and the gear used on survivability of discarded Norway lobster (*Nephrops norvegicus* L.) in the three main Swedish *Nephrops* fisheries. The experiments were performed during March and September 2015.

Of 1 270 tonnes of Swedish *Nephrops* landings in 2014, 27 % (340 tonnes) was caught with creels and 73 % by trawls. The trawl landings is dominated by two separate fisheries defined by gear design; a directed fishery using the Swedish grid (a Nordmore grid with a bar distance of 35 mm as defined in Council Regulation (EU) No 43/2009.) and a mixed fishery using SELTRA (270 mm top panel) and 90 mm diamond mesh cod-end. In 2011 to 2014 between 70% and 76 % of the trawled *Nephrops* was caught by grid trawls (around 700 tonnes).

The minimum landing size (MLS) for *Nephrops* in the Skagerrak and Kattegat (area IIIa) is 40 mm carapace length (CL; 130 mm total length). This relative high MLS in area IIIa compared to *Nephrops* stocks in the North Sea (25 mm) is mainly market-driven. However, this leads to a high discard ratio (discards/ discards + landings) and at present 67% of the catch (in number) in IIIa consists of undersized individuals that are discarded back to sea. In the ICES-assessment of the state *Nephrops* stock a harvest rate is estimated. As the harvest rate is defined as (landings + dead discards)/total population, it is therefore important to use a correct discard survival rate.

Material and methods

The survival experiments were performed between 2 March- 1 April (WINTER) and 31 August - 23 September (SUMMER) 2015, at Kristineberg Marine Research station. Since some of the WINTER sampling was delayed because of hard weather conditions during the period and vessel failure, we kept the different replicates between 15 and 30 days of observations. In this paper we report on the survival for the first 15 days for all individuals and treatments. However the daily mortality rate was reduced significantly after 10 days in all treatments and prevailed so throughout the period, in most 30 days.

Sampling

Nephrops were collected from a commercial creel vessel and two trawlers. Both trawlers used a twin rig with a standard Swedish grid trawl (35 mm bar space in the GRID and 70 mm square mesh cod-end; GRID) mounted on one trawl and a 90 mm diamond mesh cod-end with a 270 mm window) on the other trawl (SELTRA). Tow duration was set to 4 h, the median tow duration in the Swedish *Nephrops* fishery. Three replicate trawl hauls/creel catches were sampled for each combination of treatment and season, except in the WINTER experiment when only two creel samples were possible to collect.

The fisherman was instructed to handle and sort the catch as in normal commercial practise. Trained scientific staff controlled the procedure and took care of rejected specimens of *Nephrops* at the time they normally would have been discarded. Specimens were then randomly collected, checked for injuries and tactile responses after a scheme before they were placed in a rack with individual compartments (commercial racks used for live storage of *Nephrops*; Fig 1.) and submerged in a tank on deck with aerated deep sea water with approximately the same temperature and salinity as where the *Nephrops* where caught. All "discarded" individuals were subjected to the randomized process leading to some mortality already at day 0 (individuals who was crashed or obviously dead when handled), in order to estimate the total discard mortality of the whole fishing operation. At each fishing location a CTD was deployed down to the sea floor measuring salinity and temperatures profile at the location. Handling time before the last individual was immersed in the deep-water tank aboard was less than 1.5 h.

After the sampling of individuals for the survival experiment, the total catch by species, both landed and discarded, were measured for both cod-ends. All landings were measured and two randomly chosen baskets from each cod-end (about 50 kg) of the discard was measured and enumerated to the total catch of the haul and cod-end.

Experimental setup

Racks (40 x 40 x 20 cm; Fig. 1) with 81 individual compartments for *Nephrops* were randomly distributed in three tanks (1 x 1 x 0.5 m, 3 racks in each tank) in a thermal constant room at Kristineberg Marine Research station (Table 2 and Figure 1). In the WINTER experiment, air temperature was set to 10°C and the deep-water flow through system held a temperature between 5 and 6°C and a salinity of 32 to 33 psu. For the SUMMER experiment, air temperature in the room was set at 14°C, while deep-water temperature held 14-15 °C and salinity 33-34 psu. A water inlet was placed underneath each rack and the outflow was on the top of the tank (Fig. 1). In both experiments the water renewal was set to ≥10 L per minute in each tank, giving a renewal rate of water of less then an hour. When the vessel returned with the samples to the laboratory, a water sample was collected from the holding tank aboard and during the experiment, water samples was taken from each tank weekly. Water samples was analysed for nitrate, ammonium, phosphate and silicate. Oxygen concentrations in the water tank aboard and in the laboratory were measured on daily basis with a calibrated WTW oxygen meter.

Measurement and Response

Survival was monitored on a daily basis. All racks were lifted out of the water tanks and the viability was checked in air, by observing movements on each individual. In the absent of visible movement the individual was trigged to response with a tweezers. Individuals that did not respond to stimuli was moved to a smaller water tank and observed until we were sure the individual was dead. Carapace length, sex and female maturity stage were determined on all individuals at the end of the experiment or when they were found dead.

Results

In total 1237 individuals *Nephrops* (539 in WINTER and 698 in SUMMER) was caught and transported to the laboratory for the experiment. In total, 407 individuals (162 WINTER+245 SUMMER) were sampled for the creel treatment. Corresponding figures for the GRID and SELTRA treatments were 465 (222 WINTER+243 SUMMER) and 365 (155 WINTER+210 SUMMER) respectively (Table 2). One combined SELTRA and GRID replicate (28 individuals, Rack B5 WINTER, Table 2) was later omitted from the analyses, since the total catch in this haul was very small and the survival (average >85%) of this replicate was significantly higher than the other replicates and was therefore judged as unrepresentative.

Figure 2 shows the average survival rate in all treatments. The average cumulative proportion survivals at the end (day 15) of the WINTER experiment were 98% for creel, 75% for GRID and 59% for SELTRA. Corresponding figures for the SUMMER experiment was 95%, 42% and 38%. Table 3 shows the results of a two-way analysis of variance. Both main factors (gear and season) were highly significant ($p<0.0001$). However, also the interaction term gear x season was significant ($p=0.004$), which indicates that the main effects shall be interpreted with caution. Post hoc analyses (Tukeys HSD test; Quinn and Keough 2002) revealed that creel survival was higher than trawl (GRID and SELTRA) survival irrespective of season and that there was no difference in creel survival rate between the two seasons. GRID exhibited higher survival than SELTRA in the WINTER experiment but there was no difference between the two trawl designs in the SUMMER experiment. For both trawl treatments (GRID and SELTRA) survival rate was significantly higher in the WINTER experiment.

The sampled discarded *Nephrops* was between 22 and 46 mm in carapace length, with the large majority between 30 and 40 mm. The proportion of females was 60% and did not differ between gears. The two trawl gears exhibited similar size composition; while the creel caught *Nephrops* generally were larger (Figure 3). We found no sex difference in survival rate (one-way ANOVA, $p>0.2$), however there was a negative relationship between female size and survival rate for GRID and SELTRA combined (linear regression, $p=0.039$). However, for males and for both sexes combined, no relation between survival rate and size was found (linear regression, $p>0.2$).

The average total catch weight in the sampled hauls differed between GRID and SELTRA codends, 115 and 227 kg, respectively (Table 1).

Injuries and tactile responses were recorded before the individuals were placed in the racks. Both observed injuries and lack of reflex responses was affecting the average survival time negatively, however there was a large variation (Figure 4). A problem with recording injuries is that it could sometimes be hard to distinguish new and old injuries. Another problem with observing reflexes like for example tail flips is that the individuals can hurt themself when they are triggered to flip, since this is such a large muscle in *Nephrops*.

Nutrient levels were stable during the experiment, both aboard and in the laboratory. Oxygen saturation in the water was kept well above 80% both aboard and in the laboratory.

Discussion

We observed significant differences in discard survival between gears and season in the present study. Survival was higher in the WINTER experiment for both trawl treatments studied. Creel caught *Nephrops* showed much higher survival than trawl caught ones and did not differ in survival between seasons. After 5-10 days the daily mortality rate stabilised and was thereafter low in all treatments, up to 30 days the in creel treatment, and 28 days in the GRID and SELTRA treatments.

Creel

The estimated survival rate for creel caught and discarded *Nephrops* in the present study was 98% and 95% for WINTER and SUMMER experiments respectively. Several previous studies have reported high survival rates (84-99 %) of discarded creel-caught *Nephrops* (Wileman et al. 1999, Harris & Ulmestrand 2004, Mehault et al. 2011). The present study confirmed a high survival rate in spite of a wide temperature range (water and air) for the two experiments and a low salinity surface water in the fishing area, both are stressors that can affect mortality (Harris & Ulmestrand 2004, Ridgway 2006, Lund et. al 2009, Campos et al. 2015).

The catch handling aboard a creel vessel means that the catch is sorted directly during the hauling process (creel by creel) and discarded individuals will only be exposed to air and ambient air temperature for a short period of time (typically less than one minute) before discarded back at sea. The handling procedure also ensures that discarded individuals will be released in an area with suitable sea floor habitat and depth. To minimize the risk of predation by seabirds (e.g. Evans et. al 1994) some Swedish fishermen have installed a pipe at the sorting table that ends approximately a meter below the water line, giving some protection to predation by sea birds. Such a device minimizes surface predation and is a cheap and easy way to further reduce the discard mortality of *Nephrops* and other species (e.g. cod) in the creel fishery.

Trawl (GRID and SELTRA)

Earlier reviews have shown highly variable discard survival rates (11 to 79 %, STECF 2013) of trawled *Nephrops*. Several factors may affect the survivability, including catch composition (abrasive catches), total catch weight, tow duration, sea state, air temperature and handling time on deck. No significant differences have, however been observed between different trawls - codends (Wileman et al. 1999). A value of 25 % discard survival (i.e. 75 % mortality) is used for *Nephrops* in VIa and IIIa by the ICES for stock assessment purposes, based on a study conducted at the Scottish west coast (Sangster et al. 1997, Wileman et al. 1999), that reported an average captive discard survival rate of 31% for trawled *Nephrops*. The missing 6% (up to 75% mortality) is assumed to reflect additional mortality causes, e.g predation mortality which was not studied by Wileman et. al (1999).

In this study we observed differences in discard survivability between the two main trawl gears used in the Swedish *Nephrops* fishery in the WINTER experiment (75 % for GRID vs. 59% for SELTRA). No difference between the two trawl designs was found in the SUMMER experiment (42% for GRID vs. 38% for SELTRA). Temperature is a factor known to affect discard survival for *Nephrops* (Castro et. al 2003, Broadhurst et. al 2006, Lund et. al 2009). During the WINTER study, the air temperature was similar to the water temperature (about 5°C), while in the SUMMER study water bottom temperature was 15°C and air temperature around 18°C. There was no pronounced low salinity layer near the sea surface in either of the seasons (around 25 psu).

Haul duration and catch composition were within the range of normal commercial hauls. The average total catch weight and the composition differed between cod-ends, mainly because the GRID excludes larger specimens and therefore decreases the total catch weight (Valentinsson and Ulmestrand 2008). Ridgway et al. (2006) observed significantly lower mortality rates (< 40 % mortality rate) for *Nephrops* from a haul with a total catch weight of 113 kg compared to 262, 346 and 577 kg (> 70 % mortality rate), when studying the effect of different haul duration (1 and 5 h). This is not directly comparable since the haul duration did not differ between treatments in our study, but the differences in total catch weight corresponds to this study.

Important to note is that the survival estimates presented here are based on captive experiments, with an inherent risk of biases. Some stressors like extra handling, transportation, and long-term laboratory storage in restricted pens without food may introduce additional mortality. However, the negligible mortality in the creel replicate boxes (controls) indicates that the experimental design itself induced marginal additional mortality. A bigger issue is that captive experiments excludes the effects of post-discard predation and may therefore overestimate the true survival rates. To date, post-discard predation mortality for most species and fishing operations remains unknown and is inherently difficult to quantify. A possible method to improve this knowledge is large-scale tagging experiments, which is an expensive and long-term methodology in light of all specificities needed to generate relevant knowledge for the many stocks, areas and fisheries on most commercial species. As mentioned above ICES currently assumes a 6 % "extra" for post-discard mortality for *Nephrops*, a figure representing a guesstimate.

With this caveat in mind, Table 3 presents a worked example of a global estimate of average yearly survival rate for all discarded *Nephrops* by Swedish vessels, i.e. taking into account the seasonal survival estimates (current study) and also seasonal discard volumes for the three fleets (STECF Catch A data for 2011-2014). Shown in Table 3 are also estimated gear specific survival rates for the three fisheries per year (based on a gear effect on discard survival; Figure 2). The calculations assume that the survival estimates per gear for the WINTER experiment is representative for the period November - April and the SUMMER estimates for May - October. The global estimate of 55% survival based on historical fishing pattern indicates that the 25% that is currently used for assessment purposes may be an underestimate. This holds true even if a further 6% is subtracted for predation mortality (c.f. Wileman et. al 1999), and would thus have an impact of the stock assessment outcome. To estimate the impact of a changed discard mortality estimate on total removals (landings + dead discards, a proxy for harvest rate), we used ICES catch data from IIIa for 2011 to 2013. By decreasing the discard mortality rate from 75 % to 51 % (the Table 3 estimate of annual discard survivability of 55% minus 6% predation mortality) according to this study, data suggests that current removals are overestimated by 20 %, (172 instead of 138 million individuals; Table 4). Thus, if the currently used discard mortality is an overestimation of this magnitude, a quota uplift for the landing obligation based on current discard rates and current discard mortality can result in a realised harvest rate higher than intended. Furthermore, the observed differences in discard survival between gears indicate that higher survival (less dead removals) can be achieved by further increasing the creel (and grid) share of total catches. Landing individuals that would otherwise survive the discarding process may increase fishing mortality on those size/age groups that would have been discarded, thereby potentially resulting in a negative shift in exploitation pattern. This would result in a reduction in fishing opportunities so as to remain within FMSY objectives unless improvements in selectivity can be introduced (STECF 2015).

As underlined by STECF (2015), there are no objective scientific criteria to judge whether a proposed exemption from the Landing Obligation (LO) for high survival is merited. Consequently, managers will have to judge whether such proposals are merited using relevant subjective criteria. The present paper hopefully adds some knowledge to conditions pertaining to the survival of discarded *Nephrops*, whether it is deemed high or not.

Conclusions

Survival of discarded creel caught *Nephrops* did not differ between the two experiments (98 % in March and and 95 % in September). Creel discard survival was significantly higher than survival for trawl discards.

For *Nephrops* caught with a Swedish GRID and SELTRA trawls, discard survival was 75 % and 59 % respectively in the experiment conducted in March 2015. Discard survival differed significantly between the two trawl types. Survival was significantly lower in September with 42% for GRID and 38 % for SELTRA. The March survival estimates are in the higher end of previously reported work, while the September ones are more in line with earlier studies.

The combined estimate of discard survivability for all Swedish fleets operating in the Skagerrak and Kattegat, based on the current findings, is 55 %. This estimate does not include post-discard predation mortality. If the estimates from the current study is representative, full quota uplifts based on stock assessments with the currently used 75% discard mortality (i.e. 25 % survivability) risks to increase harvest rate (fishing mortality).

Figure 1. Experimental setup. (A) Water tank with 2 of 4 racks submerged. The yellow pipes are the water inlet placed beneath each rack (B) A rack with the lid removed showing the 81 individual compartments. (C) The rack seen from above with individual *Nephrops* in all compartments.

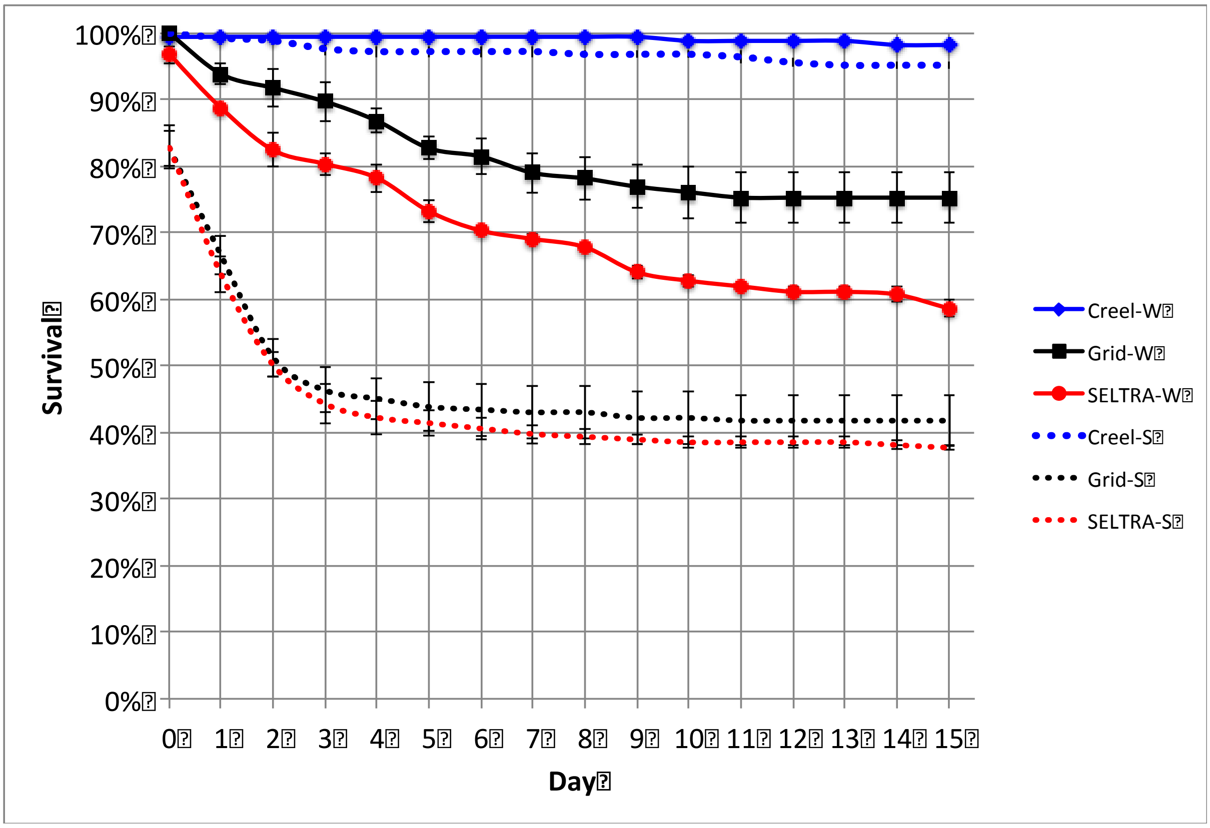

Figure 2. Average survival rate per gear and season ± SE (n=3). Solid lines represent WINTER and dashed line SUMMER experiment.

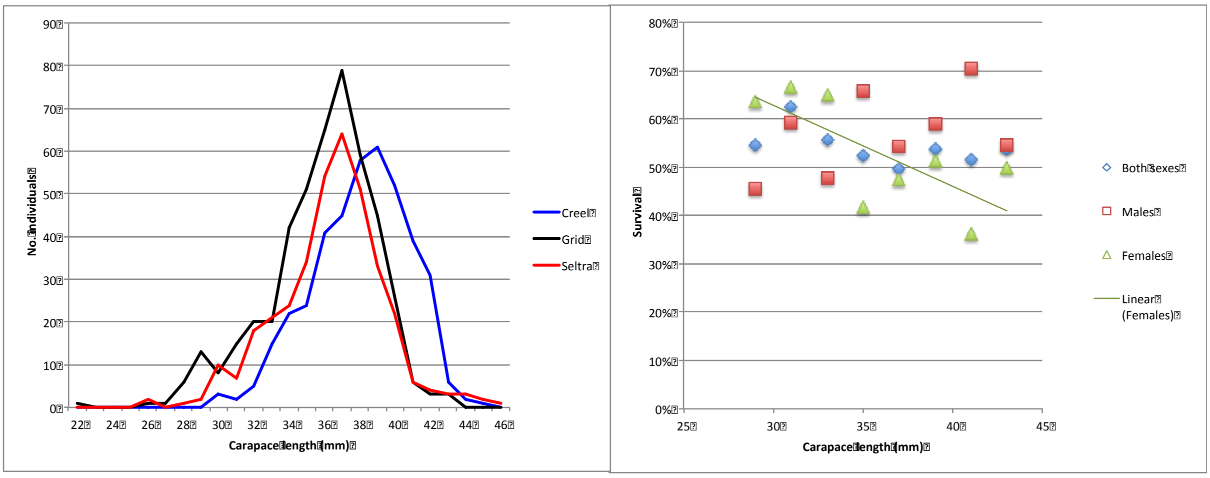

Figure 3. Size distribution of discarded *Nephrops* in the three different treatments (left), and proportion survivors per sex and 2-mm length class in GRID and SELTRA treatments combined (right). The trend line for females indicates a significant relationship (linear regression, p=0.039).

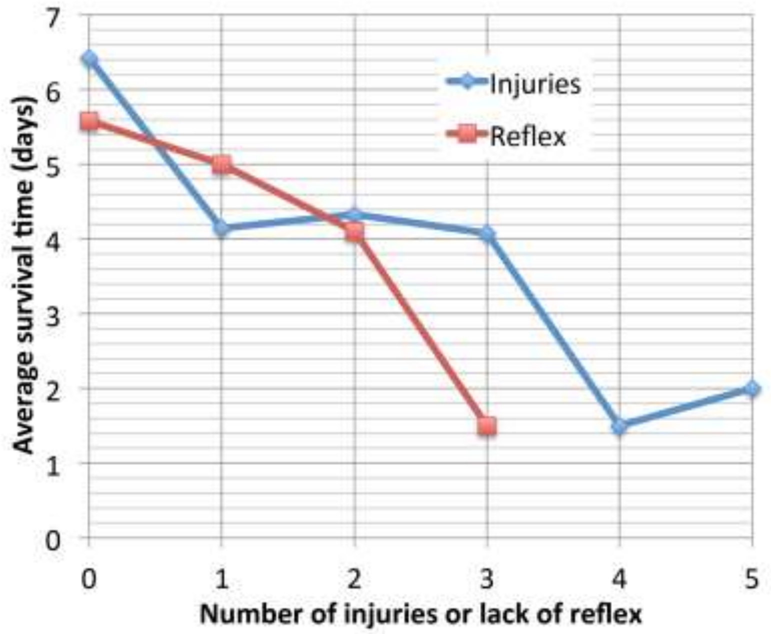

Figure 4. Average survival time of individuals that died during the experiment in relationship to number of injuries or absence of reflexes.

Table 1. Summary of experimental hauls with landed and discarded quantities.

Haul	**Haul 1**		**Haul 3**		**Haul 1**		**Haul 2**		**Haul 3**	
	Winter				**Summer**					
Date	2015-03-05		2015-03-17		2015-08-31		2015-09-01		2015-09-03	
Vessel	Canopus LL377		Ternö LL388		Ternö LL388		Ternö LL388		Ternö LL388	
LOA (m)	12		15		15		15		15	
Effort (kW)	221		296		296		296		296	
Set Position Lat	N 58° 14.60"		N 58° 22.90"		N 58° 15.40"		N 58° 23.50"		N 58° 24.80"	
Set Position Long	E 11° 13.74"		E 11° 03.43"		E 11° 14.40"		E 11° 07.20"		E 11° 07.00"	
Depth (m)	55		65		50		60		55	
Speed (kn)	2,5		2,5		2,5		2,5		2,5	
Duration (min)	250		240		240		245		240	
Species / Codend	**Grid**	**Seltra**	**Grid**	**Seltra**	**Grid**	**Seltra**	**Grid**	**Seltra**	**Grid**	**Seltra**
Nephrops	11	5	36	31	9	6	30	25	29	25
Cod		55		3		1				1
Brill	4	19		4	1	13		1		3
Whiting	1	10		11	1	5				
Plaice	2	10	1	2	0	1			1	
Total landings	**19**	**115**	**39**	**52**	**11**	**32**	**30**	**26**	**30**	**31**
Flounder	16	63	7	33		2		3	7	1
Plaice	34	43	6	25	11	8	1	0	1	2
Nephrops	7	1	22	18	1	2	4	3	3	5
Cod	11	28	1	5	7	5		1	0	
Starry ray	2	9	0	31				1		
Dab	15	20	2	3	40	28	40	12	22	16
Whiting	1	2	6	14	3	5		2	6	1
Total discards	**103**	**182**	**48**	**136**	**85**	**343**	**50**	**75**	**30**	**25**
Invertebrates+debris	2	17	24	31	2	8	55	33	50	36
Total catch (kg)	**124**	**313**	**111**	**219**	**96**	**375**	**134**	**133**	**110**	**92**

Table 2. Experimental design. Sampling date and number individuals in each rack replicate. Replicate Grid 2 and Seltra 2 (WINTER) was omitted in the analyses.

Season	Rack	Treatment	Compartment	Sample date	Dead at sampling	Total individuals
WINTER	B1	Creel 1	1-81	2015-03-02	1	81
	B2	Grid 1	1-81	2015-03-05	0	81
	B3	Creel 2	1-81	2015-03-05	0	81
	B4	Seltra 1	1-26	2015-03-05	0	26
	B5	*Grid 2*	*1-20*	*2015-03-14*	*0*	*20*
	B5	*Seltra 2*	*73-81*	*2015-03-14*	*0*	*8*
	B6	Grid 3	1-81	2015-03-17	0	81
	B7	Seltra 3	1-81	2015-03-17	4	81
	B8	Grid 4	1-40	2015-03-17	0	40
	B8	Seltra 4	42-81	2015-03-17	2	40
SUMMER	B1	Grid 1	1-81	2015-08-31	13	81
	B2	Seltra 1	1-48	2015-08-31	11	48
	B3	Seltra 2	1-81	2015-09-01	13	81
	B4	Creel 1	1-81	2015-08-31	0	81
	B5	Grid 3	1-81	2015-09-03	10	81
	B6	Creel 2	1-81	2015-09-02	0	81
	B8	Grid 2	1-81	2015-09-01	19	81
	B9	Seltra 3	1-81	2015-09-03	9	81
	B10	Creel 3	1-81	2015-09-04	2	83

Table 3. Estimate of the yearly survival rate for *Nephrops* in all Swedish fisheries (per gear and combined). Based on averaged logbook and discard data for 2011-2014.

	CREEL	GRID	SELTRA
Survival 1 (march)	0,981	0,752	0,586
Survival 2 (september)	0,951	0,418	0,377
Avg discard rate (2011-2014)	0,11	0,44	0,34
Prop landings WINTER	0,16	0,20	0,09
Prop landings SUMMER	0,09	0,32	0,13
Prop discards WINTER	0,03	0,28	0,09
Prop discards SUMMER	0,02	0,45	0,12
Yearly avg survival rate **per gear***	**0,970**	**0,547**	**0,463**
Yearly avg survival rate **all gears***	**0,552**		

*sumproduct of discarded volume per season and gear multiplied with the survival rate

Table 4. Observed catches in area IIIA 2011-2013 (ICES, 2015). Numbers in millions and weight in tonnes

Discard mortality	75%		51%	
	Number	Weight	Number	Weight
Landings	67	3922	67	3922
Discards	140	3749	140	3749
Dead discards	105	2811	71	1912
Removals	172	6733	138	5834
Catch	207	7671	207	7671
% Mortality	83,1	87,8	66,9	76,1
% Discards	67,6	48,9	67,6	48,9

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Annex D: High survival exemption for Nephrops caught using the Netgrid in ICES area IV

Request under Article 15.4(b) of Regulation (EU) 1380/2013 to exempt from the landing obligation Nephrops caught in selective Netgrid gears in ICES area IV.

Introduction

Article 15.4(b) of Regulation (EU) 1380/2013 on the Common Fisheries Policy states that the landing obligation shall not apply to:

> "species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practises and of the ecosystem;"

The Scheveningen regional group notes that scientific evidence demonstrates a survivability rate of 62% for Nephrops *(Nephrops norvegicus)* caught with bottom trawls using a selective trawl design known as the Netgrid in area IVb (Armstrong et al., 2016).

A study conducted in fishing grounds off the North East of England (area IVb) reported a survival rate of 62%. This study shows comparable results to recent Swedish studies with selective grids showing survival rates of 59-75% which supports an existing Nephrops survivability exemption in area IIIa (Nilsson et al., 2015). As this UK study and the Swedish studies show comparable results using the same methods when using similar selective trawls in this fishery, when considered together, they support extrapolation to the wider North Sea area.

This survivability exemption is based on the gear's ability to significantly reduce the volume of bycatch, reducing the weight in the cod end of the net, and therefore reducing the stressors on the Nephrops catch. It is reasonable to presume that this reduction in weight of the total catch reduces the mortality of Nephrops.

Discard profile

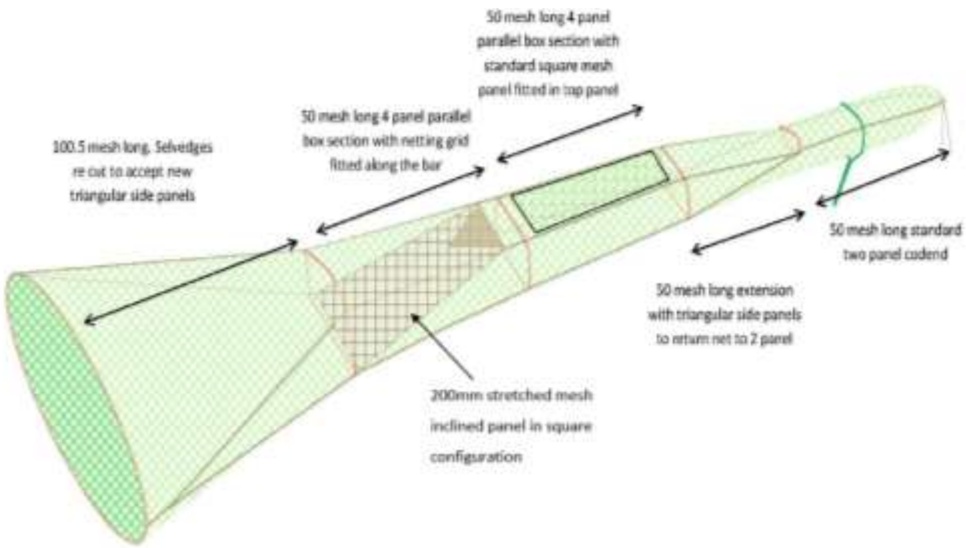
Discard rates for Nephrops in the fisheries using trawls is estimated at less than 9.6% by weight in ICES area IV (using 2014 data).

The Netgrid

The NetGrid was developed in the UK as an alternative to the Swedish Grid, as the Swedish Grid's rigid design was inappropriate for the English fishery due to handling difficulties with net drums.

The Netgrid is comprised of a four panel box section inserted into a standard two-panel trawl into which an inclined sheet of netting is laced. On the top of the box section in front of netting grid is a fish escape hole. The netting grid acts as a physical barrier and guides fish out of the escape-hole while *Nephrops* pass through the netting to the cod end.

Figure 1: Netgrid modified design 1, inclined panel 200mm, set ahead of the square mesh panel, in four-panel box section (illustration by Mike Montgomerie, Seafish).



To qualify for this survivability exemption the Netgrid must be constructed as follows:

- The NetGrid must be situated between the cod end and the existing square mesh panel.
- The NetGrid must be fixed within a four-panel box section ('the box section'), which must be inserted into the two-panel trawl.
- The NetGrid must be positioned at an incline, at the upper end of which, on the top of the box section, there must be a triangular fish escape hole, the base of which must be 28 meshes wide and formed by cutting along the bar from the outer ends till the sides meet.
- The netting barrier must be laced to the top and both sides of the box section.
- The lower end of the netting barrier must be laced to the bottom of the box section for 300mm from the relevant selvedge (each bottom outside corner) towards the centre.
- The NetGrid must be constructed of not more than 99mm mesh of twisted twine and attached in a square mesh orientation in parallel with the box section.
- The escape hole is a triangular opening with a flat apex cut in the top sheet of the trawl which allows the escape of fish too large to through the NetGrid.
- The escape hole is cut 12 meshes from each corner where the NetGrid is joined to the top panel of the box section (all bar cut) and extends along the top sheet towards the headline into a triangle, leaving five meshes across at its apex.

- The escape hole should then be strengthened with nylon twine, pulled tight to form a triangle.

Rationale for Nephrops survival work

Nephrops is a species of considerable commercial value, fished throughout its wide distribution within EU waters. The English north east Nephrops trawl fishery is a seasonal fishery, mainly carried out between September and April, predominantly using cod ends with mesh size of 80-99mm. There is a strong perception from the fishing industry that Nephrops has a high survival rate and landings of undersized Nephrops, where the quotas are low, could potentially risk a premature end of the fishing season.

Nephrops survival is among the most investigated in scientific studies on discard survival (Campos et al., 2015; Nilsson et al., 2015; Méhault et al. 2015; Frandsen et al., 2010; Harris and Ulmestrand, 2004; Castro et al., 2003), but the results are variable and available for only a few fisheries (STECF, 2014). For this reason, there is an immediate need to produce scientific evidence on a species-fishery specific discard survival rates.

Study assessing survival of discarded Nephrops in the English North East selective trawl fishery

The Centre for Environment Fisheries and Aquaculture Science (Cefas) carried out a study to assess and estimate the survivability of Nephrops caught and discarded in the English north east coast fishery when using the selective Netgrid trawl (Armstrong et al., 2016).

Vessel and fishing activity

The vessel used in this trial was the MFV Luc SN36 (17.8 m, 69 t steel stern trawler powered by a 171 KW engine) operating from North Shields on the north-east coast of England.

All tows took place in the North Sea at the southern edge of the Farne Deeps fishing grounds (ICES Division IVb, ICES rectangles 39E8 or 38E8), in depths of 40-90m. The vessel used a 73m footrope otter trawl, with cod end mesh sizes of 80 to 85mm and the selectivity Netgrid device. The vessel operated on muddy sand to target mixed demersal species but the main target catch was Nephrops. Catches from two or three tows, from 2.5 up to 4 hours in duration, were landed daily representing the normal activity of the fleet working this area.

Method used to estimate survivability

The approach used to estimate Nephrops survivability was to combine Nephrops vitality scores with the likelihood of survival for each vitality category to estimate a survival rate for the fishery. The method was consistent with recent Swedish studies (Nilsson et al., 2015). Vitality assessments were conducted on a random sample of the Nephrops catch from representative fishing trips, whereby the health status of the subject was scored relative to an array of indicators (e.g. activity, reflex responses and injuries) and a vitality category was allocated. Captive observations were then conducted on this random sample of

Nephrops catch, where individuals were monitored for 312-360 hours to determine survival rates. The random sample from each haul generated haul level survival rates. Then the estimated survival rates from each vitality category were applied to the proportion of the catch with each vitality category pooled across all hauls to estimate an overall discard survival rate.

Results

The approach used enabled the generation of a weighted overall survival rate for Nephrops based on vitality, and a haul by haul survival rate. On average, by haul, the discard survival rate in the observation period was 57% (33-70%), however, this does not account for the different Nephrops catch sizes between hauls in generating an estimate for the observed hauls. Based on the weighted vitality categories pooled across all hauls, **the estimated survival of discarded Nephrops for the observed hauls was 62%** (58-84%). The extension models used indicated that there may have been limited mortality beyond this time period, predicting a final survival rate of 57%; there was likely some limited experimental induced mortality suggesting the actual survival rate was higher.

Previous studies

Previous reviews have shown highly variable discard mortalities (21% to 89%, STECF 2013) for trawled Nephrops. The diversity of experiment conditions precludes direct comparisons between studies, but the estimated survival rate for this study is within the survival ranges of several previous studies; Méhault et al. (2011) estimated a survival range between 45% and 65% for Nephrops caught with otter trawl in the Bay of Biscay. In the study by Nilsson et al (2015) using Swedish Nephrops fishery, estimated survival rates were 59% and 75% for Nephrops caught with standard SELTRA and the Swedish grid, respectively. Other studies on Nephrops survival caught with commercial trawlers estimated lower survival rates; Campos et al. (2015) and Castro et al. (2003) showed survival rates of 17%-30% and 35%, respectively.

Conclusion

The type of fishing method is an important factor affecting survival. Several survival studies on trawled Nephrops showed that the selectivity devices can influence the survival probability of Nephrops. Campos et al. (2015) demonstrated an increase in survival associated with the use of higher selective square mesh cod ends instead of the currently used diamond mesh. Likewise, Nilsson et al. (2015) showed higher Nephrops survival rates for when using the Swedish GRID (35mm bar space in the grid and 70mm square mesh cod end in relation to the trawlers using a less selective SELTRA trawl (large mesh top panel). These designs exclude or enable the escape of larger specimens (fish) and therefore decrease the total catch in the trawl and I physical stressors in the trawl.

The Netgrid trawl design has a section of netting which acts as a physical barrier and guides fish out of an escape-hole while Nephrops pass through the netting to the cod end. Selectivity studies have showed that this device substantially decreases the catches of whitefish (whiting, haddock, cod), and thus the total catch (Catchpole et al., 2012). The catch weights, when using this trawl design, are lower than when using a conventional trawl and this may affect the stressors exerted on the Nephrops and their survival chances. Therefore, the survival estimates generated here, with the selective Netgrid trawl, maybe different from that derived from conventional Nephrops trawls owing to differences in catch composition. However, the results presented here (62% survival) are comparable with that from recent Swedish studies (Nephrops survival rate 59-75%), in which Nephrops survival was investigated for similar selective trawls and where the same experimental methods were applied (Nilsson et al 2015). This indicates that, where catch composition and environmental conditions are similar to that found in these studies, it would be reasonable to extrapolate the survival rates.

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Annex Di: Assessing the survival of discarded Nephrops in the English NE Nephrops selective trawl fishery

DRAFT REPORT

Part of ASSIST MF1232

Assessing the survival of discarded Nephrops in the English NE Nephrops selective trawl fishery

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Executive summary

This work was carried out as part of the ASSIST project (Applied Science to Support the Industry in delivering an end to discards), a Defra-funded collaborative programme of scientific research between the UK fishing industry and scientists.

Article 15 of the reformed Common Fisheries Policy (CFP) Basic Regulation, which came into force on January 1st 2014, introduced a phased discard ban or landing obligation. The policy includes a number of exemptions and flexibility tools. One exemption from the landing obligation is described for "species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem". To support any proposed exemption, scientific evidence for discard survival rates are required.

The objective of this project was to assess and estimate the survivability of Nephrops (*Nephrops norvegicus*) caught and discarded in the English north east coast Nephrops trawl fishery, when using a selective trawl design known as the Netgrid. There is a strong perception from the fishing industry that Nephrops has a high survival rate in this fishery and, where Nephrops quotas are restricted, landing undersized Nephrops could potentially risk a premature end of the fishing season. Under the landing obligation, all Nephrops catches have to be landed unless an exemption, based on scientific evidence demonstrating high survival, is awarded.

The method selected to estimate survival rates was to generate vitality (health) scores of randomly selected Nephrops caught under normal commercial fishing conditions and monitor these individuals in captive observation. Two estimates of survival are provided, one based on a weighted overall survival rate across all hauls based on a vitality score, and the other an estimated survival rate for each haul.

Nephrops were randomly selected from the total catch in each of 12 hauls and held in captive observation for 312-360 hours. On average by haul, the survival rate of discarded Nephrops was 57%. Based on the weighted proportion of Nephrops in each vitality category pooled across all hauls, **the estimated survival of discarded Nephrops in the observation period was 62% (58-84%)**. This estimate accounts for the variability in Nephrops catch size between hauls.

The survival estimates exclude avian and other marine predation and therefore may overestimate survival. In contrast, the stressors associated with captivity observation method, including, handling, confinement, changes in temperature and dissolved oxygen may have induced some limited experimental mortality, and therefore underestimate survival. Creel caught Nephrops were used as control specimens and demonstrated 92% survival, indicating the possibility of some, but limited experimental induced mortality. Therefore, the survival rates estimated in this project should be interpreted as the minimum

discard survival estimates that do not account for limited experimental mortality, but exclude predation.

To extrapolate the results from this study to the fishery, it would need to be assumed that the stress factors exerted on the Nephrops in the wider fishery are the same as those from the trips observed. The survival rates were generated under normal commercial fishing conditions, when using the selective Netgrid trawl design. We consider that these results are representative for Nephrops trawlers when using the selective Netgrid trawl design in this fishery. The results presented here (62% survival) are comparable with that from recent Swedish studies (Nephrops survival rate 59-75%), in which Nephrops survival was investigated for similar selective trawls when applying the same experimental methods. This indicates that when catch composition and environmental conditions are similar to those found in these studies, it would be reasonable to extrapolate the survival rates.

Introduction

The principle of the reformed Common Fisheries Policy (CFP) is to encourage fishers to avoid catching unwanted fish and shellfish. This reform introduced a phased landing obligation for regulated species beginning on January 1st 2014. This landing obligation, also referred to as a discard ban, will cover all quota stocks in EU waters (and those with a Minimum Landing Size in the Mediterranean) by January 2019.

Within the CFP are a number of exemptions and flexibility tools. One such exemption from the landing obligation is described for "species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practices and of the ecosystem". To support any proposed exemption, scientific evidence for discard survival rates are required. Previous research has shown that some discards survive, and in some cases, the proportion of discarded species that survives can be substantial, depending on the species, the characteristics of the vessels and other operational, biological and environmental factors. Therefore, these exemptions are likely to be fishery specific, where these factors are consistent, and based on survival estimates that are representative of the fishery (STECF, 2014).

There are several published scientific studies on discard survival, for a variety of species and fisheries, and Nephrops survival is among the most investigated (Campos *et al.,* 2015; Nilsson *et* al., 2015; Méhault *et al.* 2015; Frandsen *et al*., 2010; Harris and Ulmestrand, 2004; Castro *et* al., 2003), but the results are highly variable and available for only a few fisheries (STECF, 2014). For this reason, there is an immediate need to produce scientific evidence on a species-fishery specific discard survival rates.

Nephrops is a species of considerable commercial value, fished throughout its wide distribution within EU waters. The English north east Nephrops trawl fishery is a seasonal fishery, mainly carried out between September and April, predominantly using cod ends with mesh size of 80-99mm. There is a strong perception from the fishing industry that Nephrops has a high survival rate and landings of undersized Nephrops, where the quotas are low, could potentially risk a premature end of the fishing season.

This work is expected to complement other studies being undertaken in England and other Member States and the outputs are expected to guide English fisheries managers on whether exemptions from the Landing Obligation should be applied for. We aimed to estimate the Nephrops survival rates, when caught by trawlers using a selective trawl design known as the Netgrid. We investigated Nephrops across the full length range of the catch, under the assumption that, if awarded Nephrops at any length could be discarded under an exemption.

The approach selected to estimate Nephrops survivability was to combine Nephrops vitality scores with the likelihood of survival for each vitality category to estimate a survival rate for the fishery. Vitality assessments were conducted on a random sample of the Nephrops catch from representative fishing trips, whereby the health status of the subject was scored relative to an array of indicators (e.g. activity, reflex responses and injuries) and a vitality category was allocated. Captive observations were then conducted on the random sample of Nephrops catch, where individuals representing the various vitality levels were monitored to determine survival rates. The random sample from each haul generated haul level survival rates. Then the estimated survival rates from each vitality category were applied to the proportion of the catch with each vitality category pooled across all hauls to estimate an overall discard survival rate. The study followed the same procedures as in recent Cefas survival studies in order to have standardized and comparable results (Catchpole et al., 2015; Smith et al., 2015, Randall *et al,* 2016).

The primary objective of this project was to estimate the survival rate of discarded Nephrops caught in the NE Nephrops trawl fishery when using the Netgrid selective trawl. The information may be used to support an application for exemption from the Landing Obligation (LO) under the high survival provision.

Materials & Methods

The Vessel

The vessel used in this trial was the MFV Luc SN36 (17.8 m, 69 t steel stern trawler powered by a 171 KW engine) operating from North Shields on the north-east coast of England skippered by Peter Clark (Figure 1).

Figure 1: MFV Luc (SN36) pictured at North Shields harbour.

Fishing Activity of the vessel

All tows took place in the North Sea at the southern edge of the Farne Deeps fishing grounds (ICES Division IVb, ICES rectangles 39E8 or 38E8), in depths of 40-90m (Annex 1). The vessel used a 73m footrope otter trawl, with codend mesh sizes of 80 to 85mm and the selectivity Netgrid. device The Netgrid is comprised of a four panel box section inserted into a standard two-panel trawl into which an inclined sheet of netting is laced. On the top of the box section in front of the inclined sheet of netting is a fish escape hole. The internal netting acts as a physical barrier and guides fish out the escape-hole, while Nephrops pass through the netting to the codend (Figure 2). The vessel operated on muddy sand to target mixed demersal species but the main target catch was Nephrops, also known as prawn, scampi or langoustine (*Nephrops norvegicus*). Catches from two or three tows, from 2.5 up to 4 hours in duration, were landed daily representing the normal activity of the fleet working this area. The assessment was conducted from the 3rd February to the 11th March 2016.

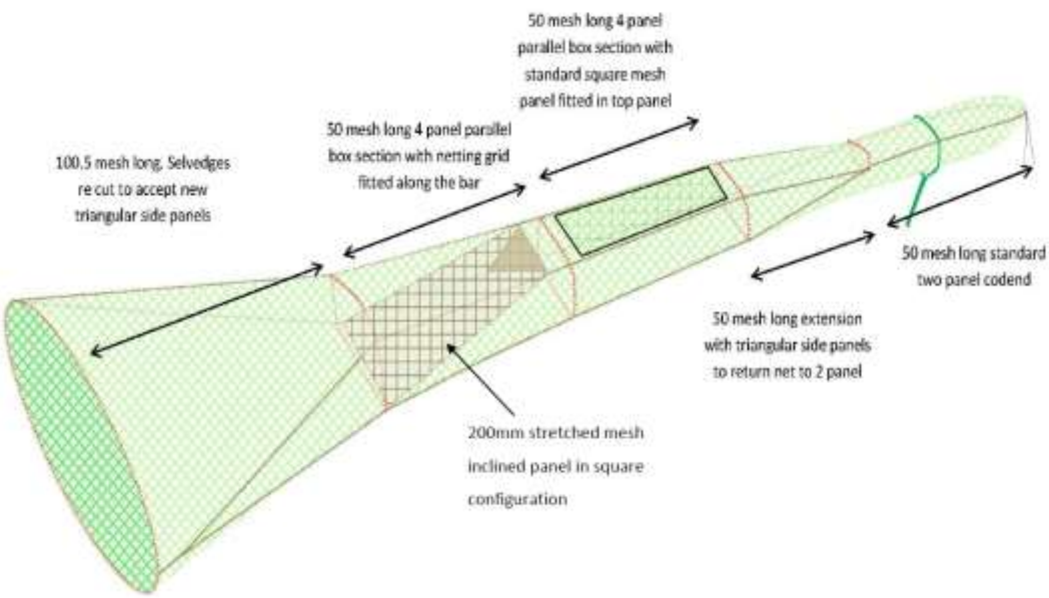


Figure 2. Netgrid modified design 1, inclined panel 200mm, set ahead of the square mesh panel, in four-panel box section (illustration by Mike Montgomerie, Seafish).

Catch Sampling

When the net was brought to the surface, hauling was performed by a net drum until all the catch could be seen to have descended to the cod end. This was then closed and slack net was paid off allowing the weight to be transferred to the lifting gear which raised the cod end from the water into an aluminium reception hopper. The cod end was opened and the fish dropped into the hopper where they remained until the trawl was redeployed. Redeployment of the trawl took about 10 minutes before sorting of the catch began. A door in the hopper was opened allowing a small quantity of the catch to move onto an aluminium sorting table. Once the sorting of the catch had begun, the observer removed samples of Nephrops for measurement, and for assessment of both vitality and injury. Random samples were taken throughout the period of sorting. All Nephrops were assessed for vitality during the period of catch sorting and retained for monitoring in the on board holding tanks.

Vitality Assessment

Vitality assessments were conducted by removing individual Nephrops at random from a 5 stone basket containing the sample. The length of the individual Nephrops was recorded. After assessment, each Nephrops was placed in an individual tube or cell, within a standard commercial Nephrops tray (Figure 3). Nephrops with a carapace length of 38mm or less were placed in trays with small cells (30mm x 30mm x 155mm), while the larger specimens, with a carapace length above 38mm were placed in trays with large cells (38mm x 38mm x 205mm).

Vitality Assessment Protocols

The health or vitality of Nephrops was assessed using two methods; a semi-quantitative assessment of the vigour of the individual Nephrops and a semi-quantitative reflex and injury scoring method. The vigour assessment was based on four ordinal classes that are defined, at one extreme characterising very lively and responsive Nephrops (1, excellent) and at the other extreme, unresponsive (5, dead) individuals (Table 1). This was adapted from previous studies, e.g. Nilsson et al. (2015).

A protocol for the vitality reflex (Table 2) and injury (Table 3) assessment was developed during the study. To maintain consistency in the vitality scoring the vitality scoring was completed by one scientist. All Nephrops with health scores, of ‘Excellent’, ‘Good’, ‘Poor’ and ‘Moribund’ were inserted into tubes for captive monitoring.

Figure 3: A standard commercial tray of tubes containing Nephrops.

At Sea Data Collection

The specification of the fishing gear used was recorded along with the times the fishing gear was shot and hauled. The times that the sorting process started and finished were also recorded. The catch was sorted by the crew as per normal commercial practice. Nephrops were selected for vitality assessments and captive observation at the point the Nephrops would normally be discarded. They were assessed, using the vitality assessment score, to have excellent, good, poor, moribund, dead health states and were scored by the presence or absence of specific reflexes and injuries (Figure 4).

Figure 4. Assessing vitality of Nephrops; left Nephrops demonstrating tail flex, right Nephrops demonstrating limp tail.

Table 1: Description of the categories used to score the pre-discarding vitality of individual fish for the semi-quantitative activity method (adapted from Benoît, et al., 2010).

Vitality	Code	Description
'Excellent'	1	Vigorous body movement; all limbs moving & tail moves or is held flexed.
'Good'	2	Vigorous body movement; all limbs moving but no movement of tail. Tail hangs limp
'Poor'	3	Limited or no body movement but movement of maxillipeds
'Moribund'	4	Any slight movement (response to touching or prodding)
'Dead'	5	No movement at all (no response to touching or prodding)

Table 2: Vitality reflex protocol developed for Nephrops.

Name	Reflex Response
Abdominal turgor	Abdomen extends horizontally or tail flip
Limb motion	Limbs move in held animal
Maxilliped motion	Maxillipeds move when stimulated

Table 3: Injury assessment protocol developed for Nephrops.

Name	Injury Description
One claw missing	One chela (claw) is absent
Two claws missing	Both chela (claw) is absent
Rostrum damaged	Rostrum is reduced or absent
Thorax crush	Crushing damage to the exoskeleton of the thorax
Tail crush	Crushing damage to the exoskeleton of the abdomen

Thorax puncture	Puncture to the exoskeleton of the thorax
Tail puncture	Puncture to the exoskeleton of the abdomen

On-board tanks

The MFV LUC landed catches on a daily basis. Therefore, Nephrops were kept on-board for a period of less than 12 hours before being transferred to onshore holding tanks. The on-board tanks comprised of a cold water loft tanks with a capacity of 227 Litres (50 Gallons) (Figure 5). Fresh sea water was supplied via the vessels deck hoses to the bottom of the tank. Excess water being lost from the open top of the tank.

Figure 5: 227L tank in situ containing trays of tubed Nephrops.

Transit from Sea to Shore

The vessel returned to port each day with selected Nephrops in the on-board tanks. The pump supplying the on-board tank with seawater was turned off when the vessel reached an appropriate distance from the port entrance to avoid subjecting the fish to substantial changes in salinity. Immediately on docking the trays of Nephrops were offloaded into a van and transported to the onshore holding tanks located 10 miles away at the RNLI Blyth boat station in the port of Blyth. The Nephrops were transferred in their trays into each of the holding tanks. At the point of transfer any Nephrops that died (as per definition in Table 1) in transit were measured, identified, recorded and removed from the experiment.

Onshore Holding Tanks

A suitable site for the onshore holding tanks could not be found at the landing port (North Shields) due to the freshwater influence of the River Tyne. As such, the onshore tanks were located adjacent to the RNLI Blyth boat station, in the town of Blyth, Northumberland, 10 miles from the port. The tanks where sited on a small pier within the river Blyth a few hundred metres from the sea (Figure 6). Water from the sea was pumped into the holding tanks. At low water, there was a seven metre height difference between the water source and the holding tanks. The water supply for the onshore holding tanks was drawn from the bottom of the Blyth estuary to which the waste water from the tanks was returned. Flow rate to the individual holding tanks was set at approximately 6 litres per minute. The inlet and outlet pipe were separated by several metres.

Figure 6: The onshore holding tanks located at Blyth and trays of tubed Nephrops inside tank.

Monitoring Captive Nephrops

During the trials, Nephrops were inspected every 24 hours. The trays were lifted out of the tanks of water and the individuals were checked in air. Survival was checked firstly by observing movements of each Nephrops. Any individual that showed no movement was gently stimulated with forceps. Any individual that failed to react to stimulus were gently removed from their tube for further inspection. If continued to not react to stimulus, the individual was removed from the experiment, being considered dead (Table 1), any injuries were logged.

Monitoring Control Nephrops

During the monitoring of Nephrops sampled from the final two days of fishing, a control treatment was introduced. Additional trays of Nephrops were added to the tanks sourced from a local creel fishery. These specimens would undergo the same experimental conditions as the experimental treatment but had not gone through the trawl capture process. It was assumed that the creel capture method of the control Nephrops did not induce any mortality. As with the experimental trawl caught Nephrops, control Nephrops with a carapace length of 38mm or less were placed in trays with small cells, while Nephrops with a length above 38mm were placed in trays with large cells. One tray of small control Nephrops and one tray of large control Nephrops were added to each of the two shore tanks. The monitoring of the control Nephrops was exactly as described for the experimental trawl caught Nephrops.

Monitoring of Environmental Conditions

During the trials, air and water temperature were measured using an electronic thermometer at the start of each haul. Temperature and dissolved oxygen of each individual onshore holding tank were monitored every 24 hours using a portable dissolved oxygen meter.

Analytical methods

Survival estimate methods

A simple survival estimate is generated for each haul based on the percentage of experimental Nephrops that survived from each random sample of the catch. The captive observation data provide the length of time that each Nephrops was observed following capture and the state of the Nephrops (dead or alive) when the final observation for that Nephrops was made. This type of data is called longitudinal data and is analysed using survival methods. These methods provide estimates of the survivor function, S(t), the probability of surviving for longer than time t.

Survival estimation methods account for a common property of survival data known as censoring. The data for Nephrops that were still alive at their final observation time are referred to as right censored. Here, we know that a Nephrops survived until at least that observation time but not how long it would have survived if the observation period was extended.

Kaplan-Meier plots

The Kaplan-Meier (K-M) estimator generates the survivor function against time. K-M estimates with 95% confidence intervals were calculated for each category of fish vigour, using the R function survfit. Confidence intervals were computed on the log-log scale.

The K-M method has the advantage of making few assumptions about the data, although it cannot be used to predict outside the observed experimental period. K-M estimates can also be variable towards the end of the experimental period when few fish remain observed. Therefore, a “plus-group” time was defined and times greater than these assigned to the plus-group time when calculating the K-M estimates.

In this case study there were 3 different observation periods: 312, 336 and 360 hrs and the plus group were 312, 336 and 360 hrs, respectively. For each case study, the survivor curves from each vigour category (Excellent, Good, Poor, Moribund) were then compared using the log-rank test (R function survdiff). First, an overall comparison of all curves then comparisons between each pair of vitality categories.

Survival estimation models

For discard survivability studies, a plausible description of the results is that the proportion of Nephrops surviving will gradually decrease and then flatten off with a proportion of Nephrops surviving the capture, handling and release process. To model this process and predict the long-term survival probability requires an extension of standard survival analysis models as these assume that the discard-related mortality must extend until survival is zero. The extended models are referred to as cure models or mixture-distribution models.

Two such models were fitted to the case study results: (1) a semi-parametric proportional hazards mixture cure model (PHMC) as implemented in R package smcure (Cai et al. 2012); (2) a parametric mixture distribution model (Benoit et al. 2012), fitted by maximizing the likelihood function for the model within the R optimization function optim. Fitting more than one model, using different implementations, is valuable to provide evidence on the sensitivity of the estimates to the model properties.

Model (1) fits a common baseline survivor curve across all vitality, based on the observed pattern of mortalities, and then scales the risk to reflect the survival within each vitality category. Model (2) assumes that the survival pattern can be modelled by the Weibull statistical distribution, this is a relatively flexible distribution that can represent a range of survival functions commonly encountered in ecological data. Here, we fitted Model (2) to each vitality category separately to remove any assumption of similarities in their survivor curves.

The estimate of survival probability from each model was extracted to apply to the vitality data.

Applying survival rates to vitality data

The estimated survival rates estimated for each of the categories of vigour (Excellent, Good, Poor, Moribund) were applied to the proportion of Nephrops assessed with that category from the total catch of Nephrops.

Summing across the proportions of catch at each vitality, multiplied by the survival rate for that category gave an overall estimated survival rate of the observed hauls combined. Three survival rates are presented, one in the context of the captive observation period, the other two using the predicted final survival rates for each of the vitality categories from the extension models.

Results

Sampling and Catches

In total, 12 hauls from the commercial Nephrops trawl fishery were sampled between the 3rd February and 11th March 2016 (Annex 1). The tow durations varied between 2.5 and 4 hours, in line with normal commercial practice. The catch composition was dominated by Nephrops. The total catch of Nephrops was recorded, but random samples were taken for measurement, vitality and injury assessment and captive observation. A total of 2,475 Nephrops were measured and held for observation. The mean carapace length of Nephrops in the catch from all hauls was 33mm. There were 245 individuals in the control group. The mean carapace length of control Nephrops was 40mm. The length distributions for Nephrops in the experiment and control are shown in Figure 7.

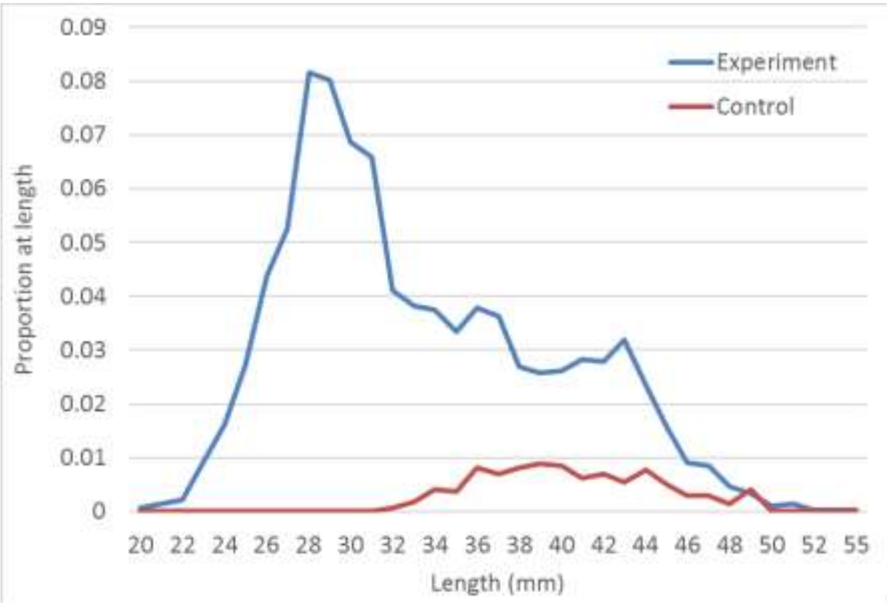


Figure 7. Length frequencies of Nephrops held for observation.

Vitality Assessment

An initial comparative analyses did not show any differences between the vitality assessments between the small (<= 38mm) and large (>38mm) Nephrops, so all further analyses were made for all Nephrops aggregated.

From experimental Nephrops sampled in this study (n=2475), 45% were Excellent, 42% and 10% in Good and Poor conditions, respectively. 3% of the Nephrops caught were assessed as ‘Moribund’ and none were assessed to be ‘Dead’ at the point of discarding. At the end of the monitoring period the vitalities for the experimental Nephrops were scored as 44% Excellent, 9% Good, 4% as Poor and 44% died during the experiment (Figure 8). In the initial vitality assessment, the control Nephrops (n=245) were assessed as 74% Excellent, 24% Good and 2% Poor. No ‘Moribund’ Nephrops were recorded in the control group (Figure 7).

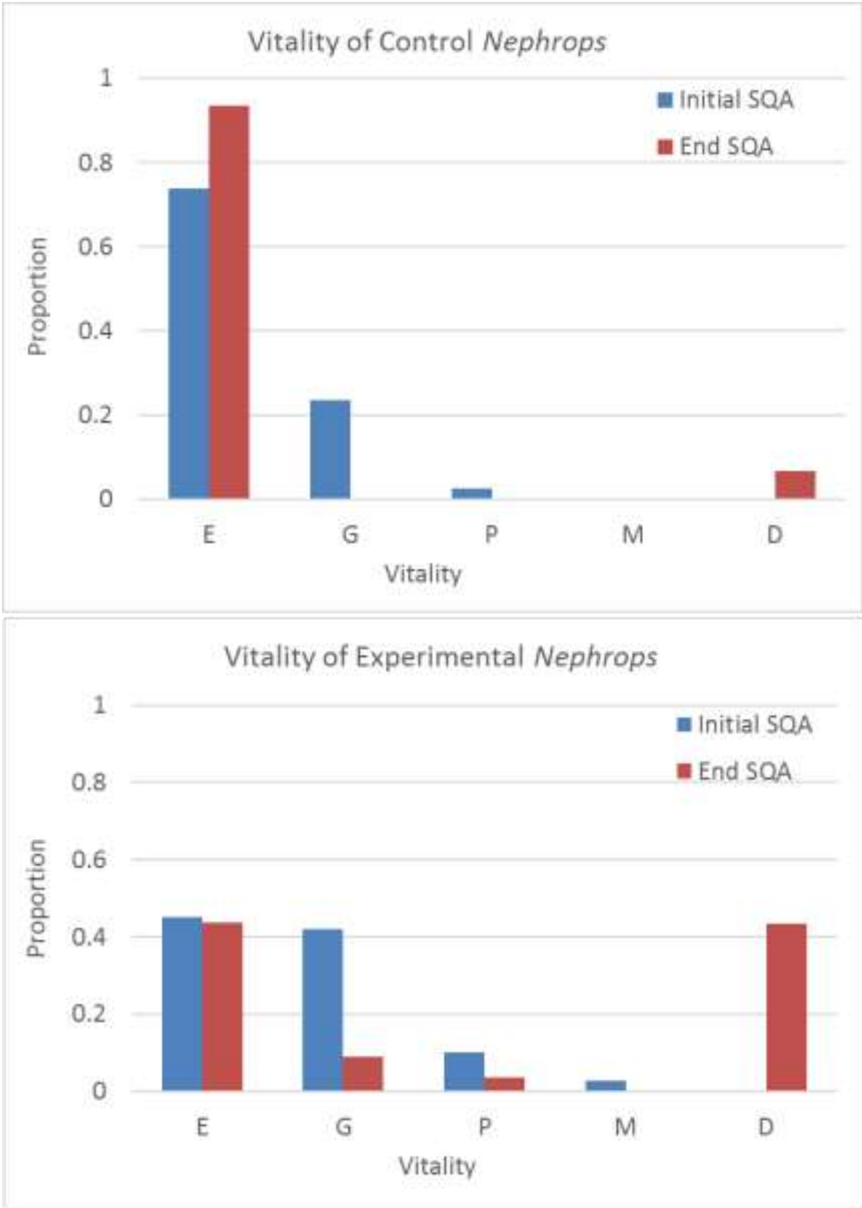


Figure 8. Semi-quantitative vigour vitality score of Nephrops trawl catches. Top plots shows vitality for the assessed experimental Nephrops; bottom plot for the control Nephrops. Key: E – Excellent; G – Good; P – Poor; M – Moribund; D - Dead.

Survival of Captive Nephrops

In total, 2475 Nephrops were monitored during the survival experiment. Nephrops were held in captivity up to 312-360 hrs. Survival for Nephrops was 66% for Excellent Nephrops, 61%, 17% and 12% for Good, Poor and Moribund Nephrops, respectively (Figure 9). When weighted to the proportion of Nephrops in each vitality category in the total catch, the estimated survival in the observation period was 62%. The control Nephrops showed low mortality overall, with an overall survival rate during the observed period of 92% (n=275). The “Excellent” control Nephrops showed 93% survival rate, while 66% of the ‘Poor’ control Nephrops survived. Despite the high survival rate of the controls, this could indicate that the experimental conditions induced some mortality to the Nephrops but this was likely minimal.

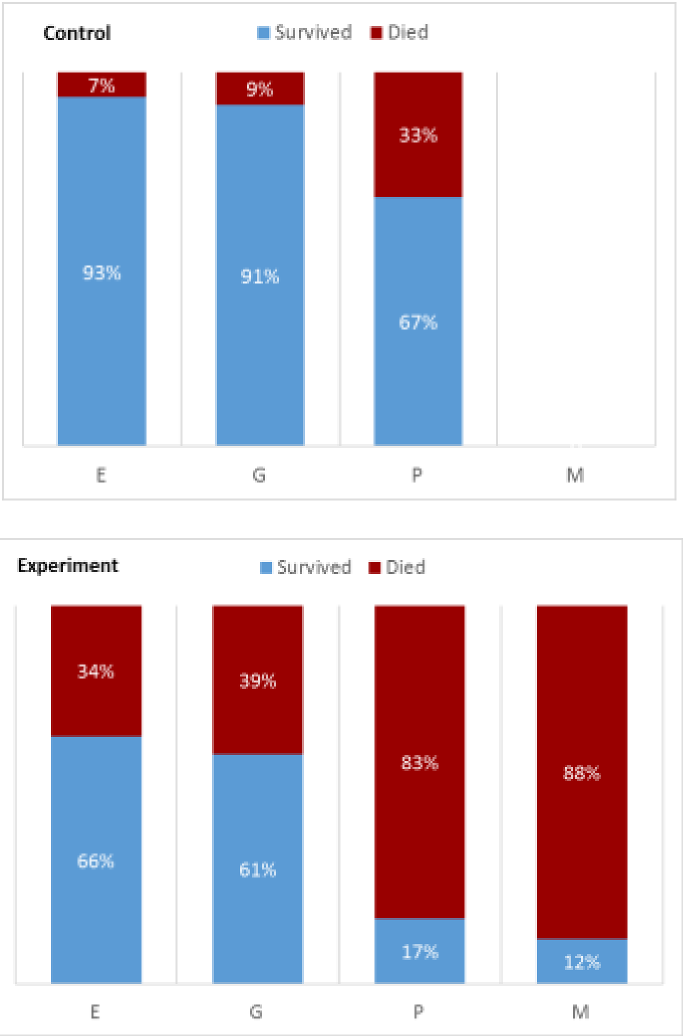


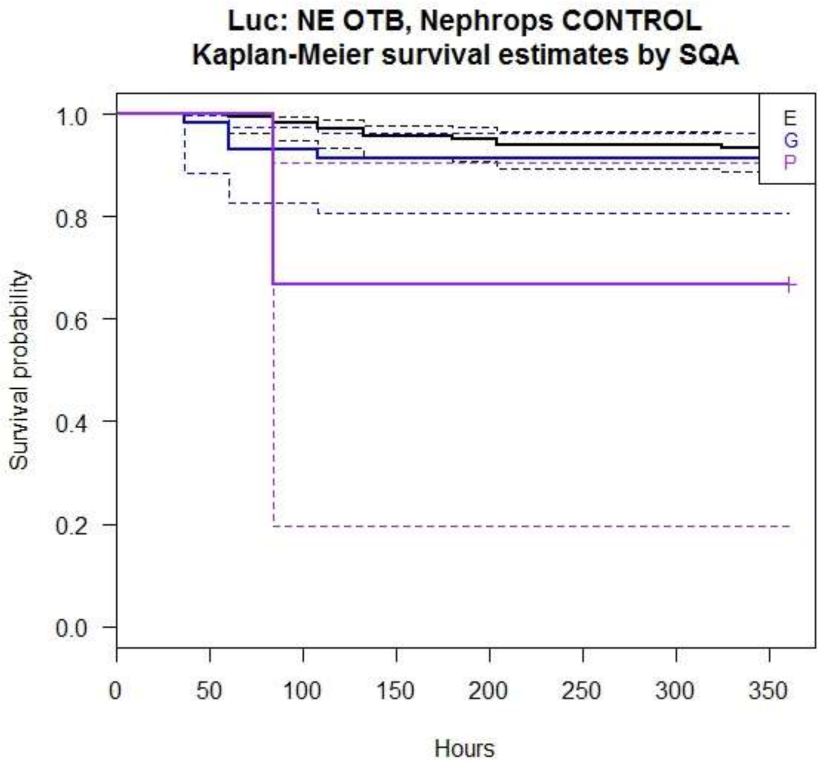
Figure 9. Proportion of captive Nephrops died/survived during the control (top plot) and in the experiment (bottom plot), in each vitality category. E – Excellent; G – Good; P – Poor; M- Moribund

Because the Nephrops were randomly selected, the fate of all Nephrops from each haul were combined to estimate survival rates per haul (Table 4).

Table 4. Nephrops survival rates for each haul.

Haul No.	No. survived	Total number	Survival (%)
1	138	212	65
2	127	202	63
3	116	212	55
4	119	199	60
5	149	212	70
6	131	202	65
7	125	212	59
8	102	199	51
9	69	212	33
10	85	202	42
11	112	206	54
12	141	205	69
Overall	**1414**	**2475**	**57**

The Kaplan-Meier plots (Figure 9) show clear separation in survival probability between Nephrops in Excellent/Good conditions from Nephrops in Poor or Moribund conditions, with the amount of survival in the expected order i.e. the highest survival with ‘Excellent’ vitality, survival decreasing with vigour. Overall, the survival curves showed statistically significantly differences between all pairs of vitality categories for Nephrops, except between the ‘Excellent’ and ‘Good‘ Nephrops (Table 5). The KM analysis in the control Nephrops showed no statistical differences between the survival curves. The number of ‘Poor’ Nephrops in the control were very low and that is reflected in the wide confidence interval (Figure 10). No ‘Moribund’ Nephrops were recorded in the control group.



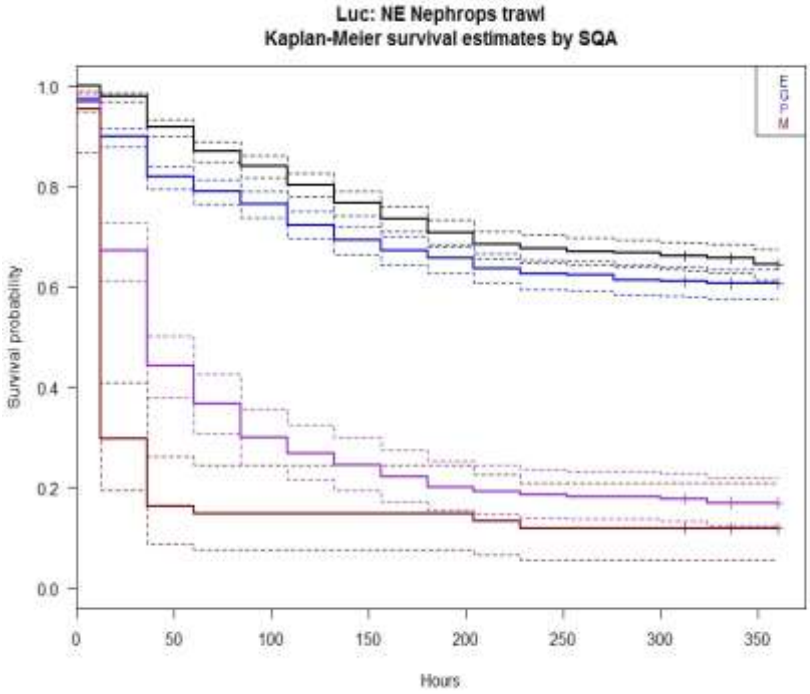


Figure 10. Kaplan-Meier estimates of survival are shown as solid lines and 95% pointwise confidence intervals as dashed lines, for control Nephrops (top plot) and experimental Nephrops (bottom plot). The small crosses at the end and along the lines mark times when one or more surviving Nephrops stopped being observed; the x-axis is the time from the beginning of the sort period until death or the end of the observation period. E – Excellent; G – Good; P – Poor; M- Moribund.

Table 5. Log-rank test to compare surviving curves

NE Nephrops otter trawl

	Comparison	Chisq	*p* - value
Control	E - G	0.3	0.565
	E - P	7.7	0.006
	G - P	3.2	0.075
Experiment	E - G	9.6	0.002
	E - P	404.2	<0.001

	G - P	241.1	<0.001
	M - E	324.5	<0.001
	M - G	165.2	<0.001
	M - P	11.9	<0.001

Two models were used to forecast the survivability probabilities forward from KM survival plots. With the predictable model 1 (ph), the forecast survival estimate varied between 14% for Moribund and 56% for Excellent Nephrops. The second prediction model (wei) outputs provided higher survival estimates for all vitality categories, except for Moribund Nephrops, varying between 12% for Moribund Nephrops and 64% for Excellent Nephrops (Table 6). When weighted to the proportion of each vitality category in the catch, the estimated overall survival probability across all hauls during the observed period was 62% for the whole catch. The estimated survival rate from the two extension models was lower, 57% for both models (Table 7).

Table 6. Survival of captive Nephrops during observation time period and modelled for extended period. The table gives the overall percentage survival of the captive Nephrops, in the control and experimental Nephrops; the survival probability within the observation period with upper and lower 95% Cis (in brackets) from the K-M analysis and also the predicted percentage survival based on a modelled asymptote in the survival curve from the two extension models. Extension model 1 (ph) gives the output from a semi-parametric proportional hazards mixture cure model (PHMC) (Cai, Zou et al. 2012); Extension model 2 (Wei) gives the outputs from a parametric mixture distribution model (Benoit, Hurlbut et al. 2012)

Species	**SQA**	**Percentage survival – Control (CI)**	**Percentage survival of captive** Nephrops	**Survival probability (KM) as percentage**	**Lower 95%**	**Upper 95%**	**Extension model 1 (ph)**	**Extension model 2 (Wei)**
Nephrops	E	93 (89-96%)	65.6	**64.5**	**61.4**	**67.4**	56.0	64.6
	G	91 (81-96%)	60.7	**60.6**	**57.6**	**63.5**	61.8	53.4
	P	66 (20-90%)	17.4	**11.9**	**5.6**	**20.9**	14.6	17.2
	M	--	11.9	**17.0**	**12.6**	**22.0**	11.9	11.9

Table 7. Estimated overall survival rates for Nephrops caught with otter trawl. Table presents the weighted overall survival rate for each model, based on the catch vitality profiles, for all Nephrops catches.

			Survival rates			
	SQA	**Proportion at each vitality of catch**	**For the obs. period**	**Survival probability**	**Extension model 1 (ph)**	**Extension model 2 (Wei)**
Nephrops	E	0.65	62%	**61 (58-84)%**	57%	57%
	G	0.61				
	P	0.17				
	M	0.12				

Discussion

Aims achieved

The project achieved its aim to generate a discard survival rate for Nephrops captured in the Nephrops trawl fishery, when using a Netgrid, operating off the north east coast of England. The structure of this project followed the methods and concepts adapted from the previous survival studies (Catchpole et al, 2015; Smith et al., 2015, Randall et al., 2016, Ribeiro Santos, et al., 2016), but the on-board and on-shore tanks were modified to accommodate the Nephrops. The selected approach was to conduct vitality assessments on a random sample of Nephrops caught during normal fishing activity and keep these individuals under captive observation. The approach enabled us to generate a weighted overall survival rate for Nephrops based on vitality, and a haul by haul survival rate. On average, by haul, the discard survival rate in the observation period was 57% (33-70%), however, this does not account for the different Nephrops catch sizes between hauls in generating an estimate for the observed hauls. Based on the weighted vitality categories pooled across all hauls, the estimated survival of discarded Nephrops for the observed hauls was 62% (58-84%). The extension models indicated that there may have been limited mortality beyond this time period, predicting a final survival rate of 57%; there may have been some limited experimental induced mortality.

Previous studies

Previous reviews have shown highly variable discard mortalities (21% to 89%, STECF 2013) for trawled Nephrops. The diversity of experiment conditions precludes direct comparisons between studies, but the estimated survival rate for this study is within the survival ranges of several previous studies; Méhault *et al*. (2011) estimated a survival range between 45% and 65% for Nephrops caught with otter trawl in the Bay of Biscay. In the study by Nilsson *et al* (2015) using Swedish Nephrops fishery, estimated survival rates were 59% and 75% for Nephrops caught with standard SELTRA and the Swedish grid, respectively. Other studies on Nephrops survival caught with commercial trawlers estimated lower survival rates; Campos *et al.* (2015) and Castro *et al.* (2003) showed survival rates of 17%-30% and 35%, respectively.

Factors affecting mortality

To assess the extent of experimental mortalities, it is favourable to use control subjects. However, is usually very difficult to find an appropriate control group, in pristine condition that were not exposed to any factors of stress, such as capture stresses. In this study it was only possible to obtain control Nephrops for the final experimental cycle. The control Nephrops were obtained from a creel fishery and their treatment was identical to that of the experimental Nephrops once at the onshore holding facility. Based on information from the supplier, the creel caught Nephrops are expected to have a mortality ranging between 5 and 10% before point of sale. The survival estimates for the control group was 92.2%. The survival rates for the control groups was within the ranges found in other studies (e.g. Campos *et al*., 2015; Méhault *et al*., 2015).

It is still possible that there was experimental induced mortality in this study. The Nephrops were kept for long periods under controlled conditions, and subjected to stressors including additional handling, rough weather affects, moving the Nephrops to the on-shore holding tanks, changes in the water temperature and reduction of levels of dissolved oxygen. These experimental stressors may have confounding effects with the experimental stressors and so induce mortality. This may be a reason why the survival rates for subjects in the control Nephrops had higher survival levels than the experimental Nephrops when assessed as having the same vitality score. It has to be noted that the sample size of the control Nephrops was lower and the individuals were larger than the experimental specimens, due to the different selectivity of creels compared to trawls (Leocádio, *et al*., 2012).

The main factors affecting the stress, injury and mortality of discarded fish or shellfish are related to technical influences (capture stresses; fishing method, catch composition and size), environmental conditions (temperature, depth, light, swell, etc) and biological traits (species, size or age, physical condition) (Davis, 2002).

The type of fishing method is an important factor affecting survival. All fishing methods induce stress and cause a degree of injuries to the captured fish or shellfish. The added protection provided by their exoskeleton could mean the chance of survival is higher in *Nephrops* when compared to fish (Campos *et al*., 2015). Several survival studies on trawled Nephrops showed that the selectivity devices can influence the survival probability of Nephrops. Campos *et al*. (2015) demonstrated an increase in survival associated with the use of higher selective square mesh codends instead of the currently used diamond mesh. Likewise, Nilsson *et al.* (2015) showed higher Nephrops survival rates for when using the Swedish GRID (35mm bar space in the grid and 70mm square mesh codend in relation to the trawlers using a less selective SELTRA trawl (large mesh top panel). These designs exclude or enable the escape of larger specimens (fish) and therefore decrease the total catch in the trawl and potential physical stressors in the trawl.

In this study, the Netgrid trawl design was investigated. This has a section of netting which acts as a physical barrier and guides fish out of an escape-hole while Nephrops pass through the netting to the cod end. Selectivity studies have showed that this device substantially decreases the catches of whitefish (whiting, haddock, cod), and thus the total catch (Catchpole *et al*., 2012). The catch weights, when using this trawl design, are lower than when using a conventional trawl and this may affect the stressors exerted on the Nephrops and their survival chances. Therefore, the survival estimates generated here, with the selective Netgrid trawl, maybe different from that derived from conventional Nephrops trawls owing to differences in catch composition. However, the results presented here (62% survival) are comparable with that from recent Swedish studies (Nephrops survival rate 59-75%), in which Nephrops survival was investigated for similar selective trawls and where the same experimental methods were applied (Nilsson *et al* 2015). This indicates that, where catch composition and environmental conditions are similar to that found in these studies, it would be reasonable to extrapolate the survival rates.

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Annex E: High survival exemption for ‘undersized’ common sole (sole less than MCRS of 24cm) caught by 80-99mm otter trawl gears in ICES areas IVc within 6 nautical miles of coasts

*Request under Article 15.4(b) of Regulation (EU) 1380/2013 to exempt from the landing obligation common sole (*solea solea*) of less than 24cm in length caught in 80-99mm otter trawl gears in ICES area IVc within 6 nautical miles of the western (English) coastline.*

To note:

1. The evidence supporting this request is for a very specific fishery occupying the zone within the 0-6 nautical miles of the western coast of IVc and the northern coast of VIId. If this exemption was granted for 2017 Member States may work to identify similar fisheries where it may be appropriate for the exemption to apply in future years. Any extension to the exemption would have to be scientifically justified and would be submitted to STECF for review.
2. This exemption is being requested in both the North Sea (area IVc) and North West Waters (area VIId) through the Joint Recommendations being submitted by the Scheveningen and North West Waters regional groups respectively. This is due to the similarities in the South East England inshore fleet, its fishing activities and environmental conditions across the two sea areas. Some evidence below refers to both sea areas together, but it is the intention that the exemption request for each sea area be considered and proposed by each regional group separately.

Summary

Article 15.4(b) of Regulation (EU) 1380/2013 on the Common Fisheries Policy states that the landing obligation shall not apply to:

> “species for which scientific evidence demonstrates high survival rates, taking into account the characteristics of the gear, of the fishing practises and of the ecosystem;”

The Scheveningen regional group notes that scientific evidence demonstrates a minimum survivability rate of 51% [1] for common sole (*solea solea*):

(i) of length less than the Minimum Conservation Reference Size (MCRS) of 24cm;
(ii) caught by vessels using 80-99mm otter trawl gears;
(iii) within 6 nautical miles of the English coast in ICES area IVc;

and recommends that catches of common sole meeting this definition should be exempt from the landing obligation on grounds of high survival rates, as provided for by Article 15.4(b) Regulation (EU) 1380/2013. This will minimise unwanted mortality of the small number of under MCRS common sole that are unavoidably caught in a highly selective inshore fishery.

The study undertaken by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) that demonstrated this high discard survivability also recorded the vitality of common sole once brought on-board the vessel, and analysed the probability of their survival as a function of this. Two further studies have been commissioned to test whether the shallower depths and shorter tow times typical to the majority of fishing activity in this fishery result in catch with a higher vitality and thus an average survival rate closer to the 69% found for common sole in excellent health. These survival rates have not been adjusted to compensate for any additional mortality introduced by the stressors involved in captive observation, and so should be interpreted as *minimum* survivability estimates.

The South East England inshore common sole trawl fishery is defined by a common métier and target species. Fishing activity and marine conditions are similar throughout, and it would therefore be appropriate for an exemption to span the two ICES sea areas. The further research commissioned will look in particular at the shallower areas, including the Solent (area VIId) and the Thames Estuary (area IVc) with depths of around 15m.

There are 143 vessels across both the North Sea and the North West Waters that would be affected by this survivability exemption, responsible for a total landing of common sole of under 160 tonnes in 2015. Cefas observer programmes between 2013 and 2015 place approximate discard rates of undersized sole in this fishery at 1% of total catches and 4% of common sole catches; if granted, this survivability exemption is estimated to result in a maximum annual discard biomass of undersized sole of approximately 6.7 tonnes, of which a minimum of 3.3 tonnes should survive. For context, the 2016 common sole TAC is set at 13,262 tonnes in the North Sea, and 3,258 tonnes in VIId (North West Waters).

The low catch rate of undersized sole indicates that the gear used by vessels in the fishery is already highly selective against undersized sole, and improvements in avoidance are difficult to achieve safely and economically due to the small size and limited range of the majority of these vessels. The low biomass involved and the significant survival rate for undersized sole ensures that the risk of unintended negative consequences is minimal.

Key Information

Exemption target:	Common sole (*solea solea*): (i) of length less than MCRS of 24cm; (ii) caught by vessels using 80-99mm otter trawl gears; (iii) within 6 nautical miles of the English coast in ICES areas VIId and IVc.
Exemption grounds:	High survivability.
Survivability rates [1]:	51%: minimum percentage of the undersized sole in a typical catch that are expected to survive all stressors associated with the fishing activity. 69%: estimated minimum survival rate of sole in excellent condition once caught.
Stock health [2] [3] [4]:	Although separate management stocks, the IVc and VIId common sole stocks overlap geographically and are genetically homogenous. Stock health varies across the fishery: in IVc, the spawning stock biomass has increased since 2007 and the fishing mortality steadily decreased since 1997, whereas in VIId the spawning-stock biomass has fluctuated without trend since 2002 and the fishing mortality increased in 2013 and 2014.
Vessels affected:	143 total: 72 in IVc only, 52 in VIId only, and 19 fishing in both.
Discard rate:	Discard rates of undersized sole in the South East England inshore otter trawl fishery are estimated to be on average 1% of total catches, or 4% of total common sole catches.
Biomass affected:	Annual landings of common sole caught in the area covered by this exemption are estimated to be under 160 tonnes. Based on the current discard rates, the annual biomass of undersized common sole covered by this exemption would be a maximum of around 6.7 tonnes.
Risk assessment:	The risk of an increase in common sole mortality due to this exemption is expected to be minimal. The low discard rate of undersized common sole indicates that the gear and fishing practices currently in use are already highly selective, and the low total biomass of undersized common sole caught indicates that any additional effort enabled by the exemption will be negligible.

The South East England inshore common sole trawl fishery

Solea solea—a.k.a. sole, common sole, Dover sole, or black sole—is a commercially valuable species of flatfish in the Soleidae family. Total landings of common sole by UK vessels into England amounted to 1,800t in 2014 with a commercial value of £12.2m (around €15.2m), making it by far the highest valued demersal fishery in England, with a value almost 50% higher than the second-highest valued, anglerfish [5]. Of this, less than 160 tonnes are caught across IVc and VIId in the South East England inshore common sole trawl fishery[1], with the majority found in the shallow waters of the eastern English Channel and Greater Thames Estuary, where depths are typically under 15 metres (see attached bathymetry maps). Peak season is between July and September.

Area	Number of vessels	Biomass (tonnes)	Value (£)
IVc	91	121.6	564,000
VIId	71	37.7	235,000
Total	143[2]	159.4	799,000

Table 2: 80-99mm mesh otter trawl common sole landings for non-sector vessels in IVc and VIId (2015 data)

The vessels which operate within this fishery are predominately part of the English non-sector/small-scale fleet: they are not part of a producer organisation and they fish against restricted monthly catch limits, managed by England's Fishing Administration, the Marine Management Organisation (MMO). Common sole provides a valuable income for the inshore trawl fishery (Table 2). Of the vessels which landed common sole in 2015, 79% are 10 metres or under in length.

Many of these vessels have fairly basic on-board equipment, and so from a safety and an economic perspective are restricted to operating within their local area, making avoidance techniques difficult to implement. The adoption of spatial measures to avoid undersized

[1] The total biomass of common sole landed by non-sector UK vessels in IVc and VIId in 2015 was 159.4 tonnes. A length restriction by the Southern Inshore Fisheries and Conservation Authority (IFCA), as well as the shallow depth of the fishery (typically around 15m), prevent vessels larger than around 12m in length from trawling within 6 nautical miles of the coast. Very few vessels in this length range are represented by producer organisations, so in this case non-sector landings are a good proxy for total landings. On the other hand, some of these non-sector vessels do fish beyond 6 nautical miles, and so the figure of 159.4 tonnes is thought to be an overestimation for the total biomass of common sole caught within the South East England inshore common sole fishery.

[2] The total (143) is not the sum of the numbers of vessels fishing in IVc (91) and VIId (71), because 19 of those vessels fish in both.

common sole is further complicated by the lack of any known spawning concentrations in UK waters in the eastern Channel [6] [7], or of any juvenile concentrations of an appropriate size for closure, as juvenile common sole are predominantly located along the French coast in the south and the east [8].

The trawl designs and mesh size used by the South East England inshore common sole trawl fishery are well suited to shallow water and are highly selective for common sole, in keeping with the latest reform of the Common Fisheries Policy, which identified the reduction of discards and bycatch as a key objective [9]. The vessels use an 80–99mm mesh trawl with a very low headline height (usually less than 750mm) and the trawl doors and centre skids are small and lightweight, thereby minimising round-fish bycatch. 80mm mesh size trawls are effective at selecting out undersized common sole, however despite this some are sometimes still caught, especially when seaweed and other debris—often found in the shallow waters of the fishery—unpredictably alter the selectivity during the trawl. To mitigate this and allow cleaning of the net, tow times in the shallower waters are typically limited to 1–1.5 hours.

80mm mesh limits undersized common sole bycatch to on average 1% of the total catch, or 4% of the common sole catch[3], which puts the total annual biomass of undersized common sole caught by these vessels at around 6.7 tonnes[4] (of which 5.1 tonnes is caught in IVc and 1.6 tonnes in VIId). Attempts to reduce this by increasing the mesh size would lower catches of common sole above MCRS, rendering the trip uneconomical for these small inshore vessels for whom common sole is the smallest species they are targeting. For context, the 2016 common sole TAC is set at 13,262 tonnes in the North Sea, and 3,258 tonnes in VIId.

The Cefas common sole survivability study (summary)

Cefas was commissioned to assess whether common sole caught with 80-99mm otter trawl gears in the South East England inshore fishery has a high survival rate.

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[3] The ICES InterCatch database actually lists discards for English vessels as 0.0% [11], however this includes many vessels not subject to this exemption and so effectively hides discards by this fleet segment as it catches only a small proportion of the total caught biomass of common sole. The figure used here is from a Cefas observer programme across 14 trips on board otter trawls in IVc between 2013 and 2015, which put average discard rates of undersized common sole at 1% of total catches and 4% of common sole catches.
An additional 14 trips were carried out on board otter trawls in VIId in this time period, giving an average discard rate of 0.3%; these trips however were not exclusively over the sole fishery grounds, and so we use the higher discard rate found in IVc as indicative of the fishery as a whole.

[4] Based on 2015 landings data (see footnote 1) and the Cefas observer programme discard rate (see footnote 3). 4% of the total common sole catch is undersized, so the 160 tonnes landed represents 96% of the total common sole catch. 160 tonnes divided by 96% gives 6.67 tonnes undersized common sole caught.

The approach they selected was to use vitality (health) assessments of common sole caught under normal fishing conditions and to combine information with captive observation of selected individual common sole with different vitality. With this data Cefas were able to estimate a weighted overall mortality for common sole due to fishing activity, as well as discard survivability rates for common sole as a function of their health when caught.

Vessel and gear

The vessel used for this trial was a steel hulled twin rig otter trawler of 9.82m overall length with a 179kW engine. The trawler uses 80mm cod-end mesh size, which is routine for an under 10m trawler in the area [10].

Fishing activity

The sea trials were carried out in ICES division IVc rectangle 33F1 (Figure 2) where typical depths are around 25m, the upper end of the depth range for the wider South East England inshore common sole fishery. The fishing activity (gear and tow times) was representative of normal practices for this fishery area just south of Lowestoft, and took place in the latter part of the common sole fishing season. Catches remained at normal to low levels throughout the study.

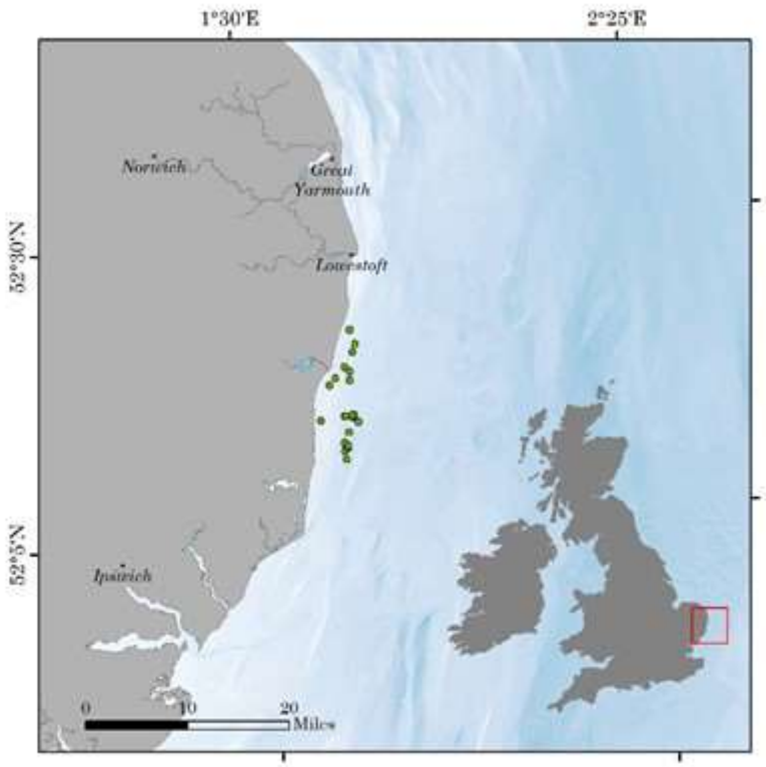

Figure 2: Locations of the fishing hauls in the study

Eight individual day-trips were undertaken between 4th October and 26th November 2015. The vessel was operated by the skipper and one crew member. The trawl gear was deployed, towed, and hauled according to normal commercial fishing practices for between 1.5 and 2 hours. The cod-ends were emptied into the aft pound and the nets were fully re-deployed ahead of catch sorting. This process took about 10-15 minutes, after which sorting of the catch began. The crew sorted the catch by hand, as they normally would, however instead of pushing the smaller unwanted common sole back into the sea, they were moved to purpose made on board hold tanks after being measured and assessed for their health condition.

Vitality assessment

Once the common sole were sorted, each individual was measured and scored using a pre-defined assessment protocol. The health or vitality of each fish was assessed using two methods: a semi-quantitative assessment of the vigour of the individual fish, and a semi-quantitative reflex and injury scoring method. A vigour assessment was conducted on all common sole based on four ordinal classes that are defined with a class at one extreme characterising very lively and responsive fish (1, excellent), and at the other extreme, a class characterising unresponsive fish (4, dead), with good and poor fish as intermediate categories (2 and 3 respectively).

Vitality assessment	Proportion of undersized common sole at each vitality in study	Survivability probability (%)
Excellent	0.57	69.4
Good	0.18	50.6
Poor	0.20	10.6
Dead	0.05	0.0

Table 3: Survivability and catch profile of study by vitality assessment

Common sole were also scored by the presence or absence of specific behavioural reflexes and injuries: body flex, operculum closure, tail grab and orientation right. A reflex action was scored as unimpaired (0) when it was strong or easily observed, or impaired (1) when it was not present or if there was doubt about its presence. An injury score based on the presence of different injury types was also recorded. Injuries were scored as absent (0) when not present or there was doubt about its presence, and present (1) when clearly observed.

Vitality composition

From all the common sole considered in this study (1329), 63 (5%) were dead when assessed at the point they would be discarded. The remaining fish were scored as either excellent (43%pt), good (27%pt) or poor (25%pt). When considering only the common sole under minimum landing size (i.e. under 24cm in length), the vitality score profile changes slightly, with 57% of the catch considered excellent, 18% as good, 20% as poor and 5% as dead (Table 3).

Survival of captive fish

A proportion of fish at each of these vitality scores was selected (by length) for on-board observation tanks. In total, 287 fish were captive for the survival experiment. Fish were held in captivity for 360 hours (2 weeks): survival for common sole was 69.4% for common sole in excellent health, 50.6% for common sole in good health, and 10.6% for common sole in poor health. When weighted to the proportion of the each vitality category of the total catch, the estimated overall survival probability during the observed period was 51% for the undersized common sole and 46% for the whole catch. These rates are not adjusted to compensate for the effects of induced experimental mortality, and so should be interpreted as the minimum estimates for the survival rate for discarded undersized common sole.

Factors influencing discard survival

The use of a binomial GLM model showed that common sole with impaired orientation and tail grab had a significant higher mortality than unimpaired common sole. The impairment of these two reflexes showed significant association with the proportion of dead to alive fish.

In this study, the injuries most commonly found in common sole were abrasion, scale loss and fin bleeding, with 74%, 57% and 53%, respectively, of the fish sampled suffering with these injuries. The injuries that had the most significant association on the proportion of dead fish were scale loss.

Further studies

Typical fishing activity in the South East England inshore common sole fishery is expected to cause less stress to the fish caught, due to shallower waters (10–15m, rather than 25m in the study), shorter tow times (typically 1–1.5 hours, rather than the 1.5–2 hours in the study), and an abundance of seaweed that gets caught in the net and cushions the common sole. The Cefas study showed a strong correlation between the condition of the fish once removed from the net and its survivability, and so if these less stressful conditions result in reduced damage to the catch, then the survivability should correspondingly increase.

To test this hypothesis, the UK has committed to further research in 2016 and 2017, which will involve extending the study period to the full duration of the fishing season and expanding the geographical area of the study to include the Solent (area VIId) and Thames Estuary (area IVc).

The Cefas study also identified particular types of damage that resulted in significant increases in mortality, and it is hoped that this further research may be able to identify particular methods for minimising these forms of damage to further increase the survivability of discarded common sole. This may also form the basis for further extension studies to evaluate whether the survivability exemption should be extended more widely e.g. to trawl fisheries on the southern coast of VIId and the eastern coast of IVc.

Conclusion

There is sufficient evidence for this proposal for a high survivability exemption for common sole that are:

(i) of length less than the Minimum Conservation Reference Size (MCRS) of 24cm;
(ii) caught by vessels using 80-99mm otter trawl gears;
(iii) within 6 nautical miles of the English coast in ICES areas VIId and IVc;

- scientific evidence shows the survival rate for discarded undersized common sole is at least 51%;
- additional studies have been commissioned to test whether the characteristics in the wider South East England inshore common sole fishery result in an higher survivability, and to identify potential measures to further increase this;
- the gear and techniques used in the fishery are already highly selective, and increased selectivity or avoidance is difficult to achieve safely and economically;
- the return of juvenile common sole will support improvement of future spawning numbers, which is particularly important given the unstable spawning biomass in VIId, as well as improving their yield when subsequently harvested; and
- the risk of unintended negative effects is inherently limited by the low biomass of undersized common sole caught.
- If this exemption was granted for 2017 Member States may work to identify similar fisheries where it may be appropriate for the exemption to apply in future years. Any extension to the exemption would have to be scientifically justified and would be submitted to STECF for review

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Annex Ei: Estimating the discard survival rates of Common sole (Solea solea) in the English east coast inshore otter trawl fishery

see file attached

Annex Eii: Thames bathymetry - sole

see file attached

Annex Eiii: East Anglia bathymetry - sole

see file attached

Annex F: Request for de minimis exemption for fish by-catches in the Nephrops trawl fishery with sorting grid

In the framework of the landing obligation in accordance with article 15 of regulation (EU) No 1380/2013, a de minimis exemption is requested for

- for 2017 for common sole and haddock combined, up to a maximum of 2 % of the total annual catches of species under landing obligation (Nephrops, common sole, haddock and Northern prawn),
- for 2018 common sole, haddock and whiting combined, up to a maximum of 4 % of the total annual catches of species under landing obligation (Nephrops, common sole, haddock, whiting and Northern prawn),

in the fishery for Nephrops conducted with bottom trawls (OTB, TBN) with a mesh size of at least 70 mm equipped with a species selective grid with bar spacing of maximum 35 mm in ICES area IIIa.

The request for an exemption for de minimis is based on article 15.5.c.i), due to difficulties to further increase the highly selective properties of the gear concerned. As Nephrops is the only income for users of this gear, they are particularly vulnerable for the potential losses an increase in selectivity would risk to cause.

Supporting information is included in Annex Fi on:

Management units (types of gears employed)

Catch composition

Discard profile of selected species

Motive

A limited de minimis exemption will cater for catches that are unavoidable, especially in light of the high selectivity of the gear already used in this management unit. Evidently, selectivity is always possible to improve. However, two recent scientific trials to further reduce unwanted catches by the use of modified grids in combination with improved cod-ends indicate a loss of the largest, most valuable, Nephrops of around 10 % compared to the standard sorting grid (Lövgren, 2016). Further gear research on these issues is underway. As *Nephrops* is the only income for users of this gear, they are particularly vulnerable to the economic losses an increase in selectivity is likely to cause.

Specifying de minimis catch

A de minimis exemption of 2% for haddock and sole in 2017 would correspond to total quantities of 23.1 t in 2016 (based on a 2010-2014 baseline of discarded and caught quantities for the species subject to the landing obligation- see annex Fi for specifications). Per species this would mean approximately 10.9 t of haddock and 12.2 t of sole in 2017.

A de minimis exemption of 4% for haddock, sole and whiting in 2018 would correspond to total quantities of 46.3 t (based on a 2010-2014 baseline of discarded and caught quantities for the species subject to the landing obligation- see annex Fi for specifications). Per species this would mean approximately 4.9 t of haddock, 5.5 t of sole and 35.8 t of whiting in 2018.

The requested percentage would leave room for increased uptake of the gear as a consequence of the landing obligation. Discard values are based on data from the DCF monitoring programme and varies between years to a certain extent, also against this background a certain margin is considered relevant.

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Annex Fi: Discards in the Swedish *Nephrops* grid trawl fishery and an analysis of possible de minimis exemption for certain fish by-catches

This note presents catch composition and discard profiles in the directed Swedish trawl fishery with species selective grid for Norway lobster (*Nephrops norvegicus*) in the Skagerrak and Kattegat (area IIIa) for the years 2010-2014. The paper also explore the basis for exemption in accordance with art 15.4 (c) of Regulation (EC) No 1380/2013, i.e. catches falling under the de minimis exemptions.

Background

Grid systems utilise mechanical sorting by size and was originally developed for sorting out fish and jellyfish from *Pandalus* shrimp (Isaksen *et al*., 1992), and are now used in commercial fisheries worldwide (Broadhurst 2000, Catchpole and Revill 2007). The grid developed and used in the Swedish *Nephrops* fishery is a variant of the original Nordmøre *Pandalus* grid, but with a maximum bar distance of 35 mm and an 8 m codend of >70 mm mesh size (Valentinsson and Ulmestrand 2008, Madsen and Valentinsson 2010; Fig. 1). The grid system in use have showed a 100% reduction of roundfish like cod >MLS (Catchpole *et al*., 2006, Rihan *et al*., 2009, Madsen and Valentinsson, 2010), but also substantial reductions in the catch of juvenile fish (Valentinsson and Ulmestrand 2008). The Swedish grid trawl fishery is exempted from the long term cod plan effort management system due to its documented high selectivity (art 11.2b of Regulation (EC) No 1342/2008). Several studies to further improve selectivity in grid trawls have been conducted. Results of these studies show that the retention of small fish can be further reduced but with some loss of marketable *Nephrops* (-11%; p 24 in SLU 2015).

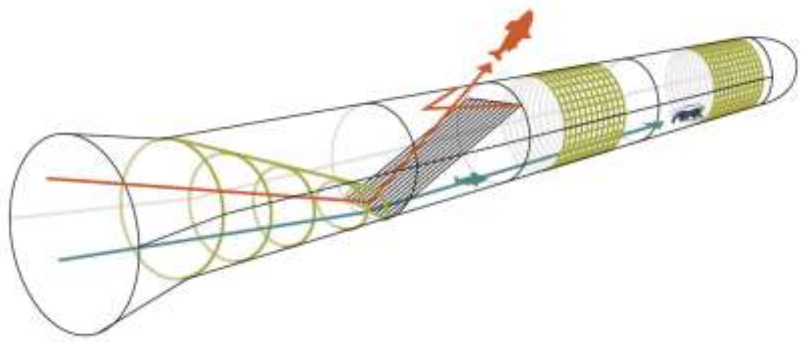

Figure 1. Illustration of the Swedish *Nephrops* grid trawl. Larger fish are deflected out of the trawl by the grid (35 mm bar spacing) while *Nephrops* (and some smaller fish) pass trough the grid and enter the codend.

The uptake and use of the *Nephrops* grid by Swedish fishermen has gradually increased since it was introduced in national legislation in 2004 (Fig. 2). During the last five years, landings by vessels using the grid averaged 54% of total Swedish *Nephrops* landings in the Skagerrak and Kattegat, and is used by most demersal trawlers (>100 vessels), at least at some times of the year.

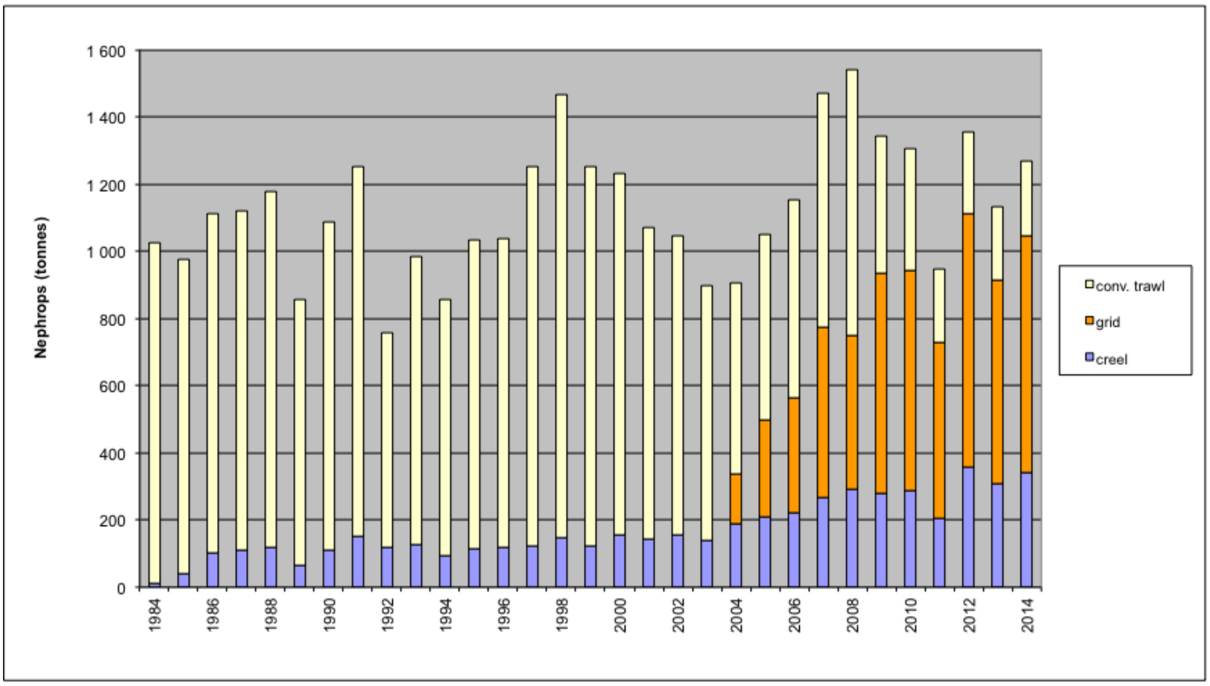

Figure 2. Swedish *Nephrops* landings by gear type in the Skagerrak and Kattegat for the years 1984-2014. The grid was introduced in national legislation in 2004 and grid uptake has increased successively due to strong incentives. Conventional trawls are >90 mm trawls (with a mandatory 270 mm SELTRA-panel in the Skagerrak since 2013).

Grid use has been promoted by incentives such as an increased quota share, access to commercially important *Nephrops* areas that are closed to other trawls fishing and unlimited effort because of high selectivity (<1.5% cod of total catches; Article 11.2 in Annex III of Regulation (EC) No 1342/2008). The gear is well defined in legislation (Regulation (EC) No 43/2009 and in (COM(2015) 7145 final) and vessels that opt to use the grid trawl work under a one-net rule and have a specific gear code in the Swedish EU-logbook. Furthermore, scientific catch data is guaranteed as the fishery is handled as a separate stratum in the Swedish DCF.

Figure 3 shows the spatial distribution of Swedish grid trawling in area IIIa during 2015.

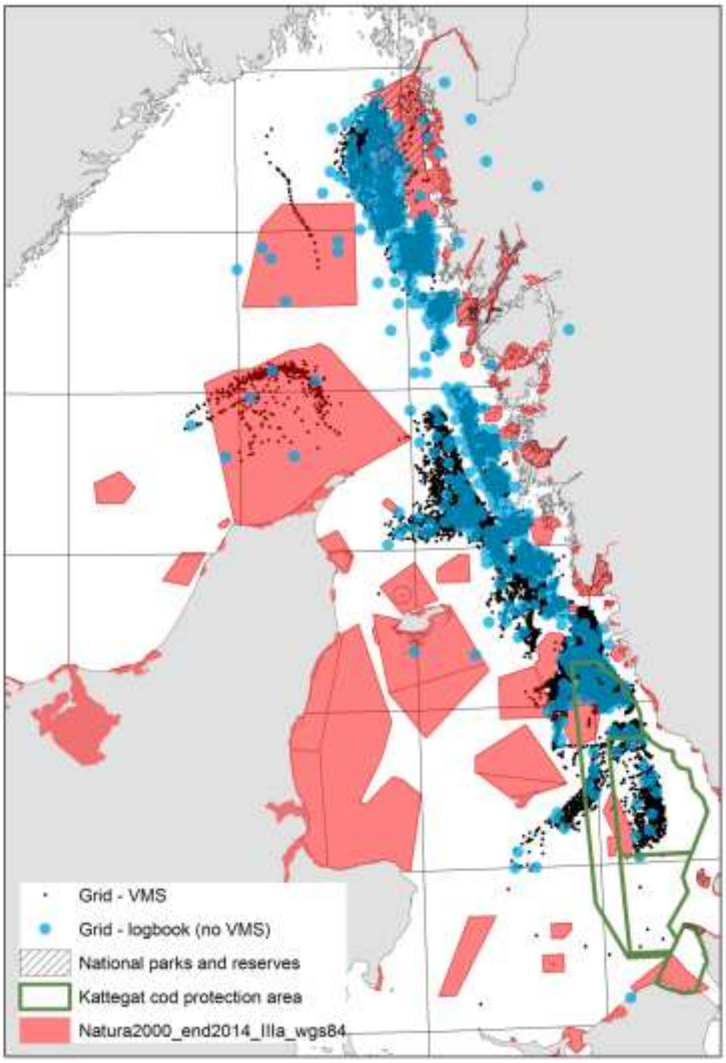

Figure 3. Swedish grid trawling in the Skagerrak and Kattegat during 2015. Data is based on VMS - and logbook positions (a part of the grid fleet is not covered by VMS). Shown is also Natura 2000- and cod protection areas in the Kattegat.

Catch data

Discard sampling by scientific observers (DCF) has been performed since the grid was introduced in 2004, with average coverage of app. 15 trips per year. The *Nephrops* grid fishery has been treated as a separate stratum in a sampling design where sampled vessels are picked out in a randomized process. Catch estimates from this (and other Swedish fisheries) are reported to the STECF-database in accordance with the annual data call (i.e. catch A file format). Catch data for the years 2010 to 2014 for the nine species listed in art 15 of Regulation (EC) No 1380/2013 (phase-in species) are presented in Table 1 below.

Table 1. Estimated discards and catches (landings + discards) in the Swedish *Nephrops* grid trawl fleet in area IIIa (the Skagerrak and Kattegat) for the nine species in art 15 of Regulation (EC) No 1380/2013. Swedish DCF-data 2010-2014 (reported to the STECF database).

Discards per species (tonnes)	COD	HAD	HKE	NEP	PLE	POK	PRA	SOL	WHG
2010	23,5	7,8	7,6	538,2	65,4	0,1	0,0	2,2	30,0
2011	3,9	1,9	11,5	429,9	79,5	0,0	0,0	6,0	22,7
2012	23,6	2,6	10,5	848,3	40,4	0,4	0,0	4,9	42,8
2013	76,1	10,2	24,6	381,6	113,3	3,3	0,0	2,3	28,2
2014	36,0	0,9	18,7	371,9	201,5	0,4	0,0	4,8	38,4
average	**29,6**	**4,2**	**14,0**	**518,8**	**94,8**	**0,7**	**0,0**	**4,8**	**30,9**
Catch per species (tonnes)									
2010	24,2	7,8	8,2	1190,8	68,9	0,1	0,6	4,3	31,6
2011	4,4	2,0	12,0	946,1	81,7	0,0	0,3	8,3	24,2
2012	23,8	2,6	10,7	1602,8	42,3	0,4	0,6	5,9	43,8
2013	76,3	10,3	25,0	986,8	117,9	3,3	0,8	4,4	29,5
2014	36,4	1,4	19,0	1078,1	209,7	0,4	0,6	7,9	42,9
average	**30,0**	**4,4**	**14,6**	**1166,6**	**99,1**	**0,7**	**0,5**	**6,8**	**32,8**
discarded proportion	98,7%	96,9%	96,0%	44,5%	95,7%	98,8%	0,0%	70,5%	94,3%

According to logbooks 2010-2014, *Nephrops* comprised over 98 % of total landings with *Nephrops* grid trawls. By adding discard data to the declared landings, average *Nephrops* contribution to total catches was 68% in grid trawls for these years (a figure not possible to calculate from Table 1 as not all caught species are included). *Nephrops* is the dominant species in terms of discards, followed by (in falling order) plaice, whiting, cod, hake, sole and haddock (Table 1). The vast majority of discards are individuals smaller than minimum landing size resulting in high discard proportions for the fish species (>90%) but with small quantities (Table 1), especially when considering that grid effort represented >60% of Swedish TR2 effort in IIIa for the five years (extracted from STECF 2014b). Most Swedish discards of these fish species occur in TR2 gear without grid (STECF 2014b).

<u>Possible de minimis percentages and quantities for by-catch fish</u>

The following calculations are based on Table A in the joint recommendation of the Scheveningen group with landing obligations per gear category at hand in May 2016. According to this, the TR2 gear category in area IIIa will have to land:

- 2016: *Nephrops*, haddock, sole and *Pandalus*
- 2017: *Nephrops*, haddock, sole and *Pandalus*
- 2018: *Nephrops*, haddock, sole, *Pandalus* and whiting
- 2019: All quota species

The analyses presented here focuses on the by-caught fish species that are to be included in the landing obligation in 2017-18.

Furthermore, the formulation of how the de minimis percentage shall be calculated is not crystal clear in art. 15.4 (c) of Regulation (EC) No 1380/2013, that states "provisions for de minimis exemptions of up to 5 % of total annual catches of all species subject to the landing obligation". STECF (2014a) also commented on this lack of clarity but found no need to prescribe a methodology. The way we have calculated de minimis percentages in this report is by dividing estimated average discards (2010-2014) with catches (landings+discards) for the phased-in species in the actual management unit itself (i.e. the same way as for the current de minimis exceptions for area IIIa in the North Sea discard plan).

Table 2. Estimated de minimis percentages for the by-catch fish species that have been decided in the landing obligation (haddock and sole in 2017 and haddock, sole and whiting in 2018). The percentages are calculated from the discard- and catch estimates presented in Table 1.

Year exempted sp	2017* HAD, SOL	2018** HAD, SOL, WHG
Proportion grid discards exempted species		
2010	0,8%	3,2%
2011	0,8%	3,1%
2012	0,5%	3,0%
2013	1,3%	4,0%
2014	0,5%	3,9%
average	**0,8%**	**3,4%**

*discards of (HAD+SOL)/catch of (HAD+SOL+NEP+PRA)

** discards of (HAD+SOL+WHG)/catch of (HAD+SOL+WHG+NEP+PRA)

Average estimated discards of haddock, sole and whiting in the Swedish *Nephrops* grid fishery in area IIIa amounted to 4.2, 4.8 and 30.9 tonnes annually for 2010-2014 (Table 1). Given that haddock and sole are under the landing obligation in 2017, unwanted catches of the two species would correspond to 0.8% of total annual catches of species subject to the landing obligation in this fishery (Table 2). In 2018, when also whiting is phased-in, the percentage of unwanted catches increases to 3.4%.

Available data thus indicate that the previously discarded amounts of these by-caught fish species, planned to be phased-in 2017 and 2018 in the IIIa *Nephrops* grid trawl fishery, is smaller than the stipulated percentage (5%) for a de minimis exception in article 15.5 (c) of Regulation (EC) No 1380/2013.

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Annex G: De minimis exemption request for the vessels using nets to catch sole in the North Sea (ICES areas IVa, b and c).

In the frame of the landing obligation for the demersal fisheries in the North Sea, a *de minimis* exemption of 3% is requested for sole (*Solea solea*) for the vessels using nets (trammel nets and/or gillnets) in the North Sea (IVa, b and c) for the time of the discard plan.

This exemption was positively assessed by STECF in 2015, here is just an update of the last version.

I Definition of the species and the stock

<u>Sole (IV)</u>[5]: For 2016, ICES advises on the basis of the second stage of the EU management plan (Council Regulation No. 676/2007) that catches in 2016 should be no more than 13 031 tonnes. If discard rates do not change from the average (2012-2014) this implies landings of no more than 12 066 tonnes,

The spawning-stock biomass (SSB) has increased since 2007 and is estimated to be above MSY Btrigger in 2015. Fishing mortality (F) has steadily declined since 1997 and is estimated to be above FMSY in 2014. $B_{trigger}$ is above trigger, B_{pa} and B_{lim} show full reproductive capacity of the stock size. Age compositions of the landings and discards are well sampled and the quality of the surveys is adequate.

Sole is a flatfish for which some studies have shown interesting survivability rate. STECF report 14-19[6] on landing obligation lists the survival studies known for sole, with no study dealing with the survival of the sole in a net fishery. Nevertheless, some studies in Canada and USA show interesting survival rate for some flatfishes (Pleuronectidae) caught by gillnets (Benoit and Hurlbut, 2010; Smith and Scharf, 2011). The ongoing project ENSURE on the survival of the discards should give new elements on the survival of the sole, caught and released by trammel nets in the English channel, by the beginning of 2017. A French project, SURSOLE, is also ongoing in the Bay of Biscay aiming to study survivability of sole

[5] http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/sol-nsea-reopen.pdf
[6] Scientific, Technical and Economic Committee for Fisheries (STECF) – Landing Obligations in EU Fisheries - part 4 (STECF-14-19). 2014. Publications Office of the European Union, Luxembourg, EUR 26943 EN, JRC 93045, 96 pp.

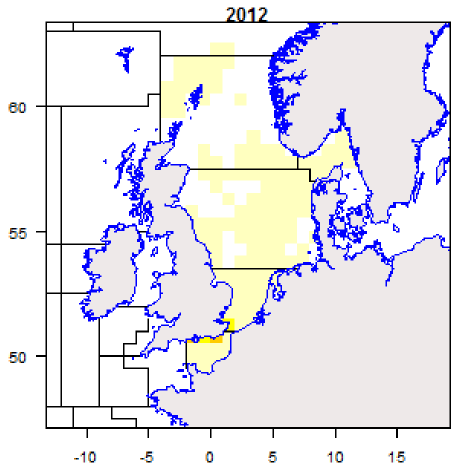
for bottom trawls and net fisheries. Results, which should be available in 2018, will give new elements of sole survival potential.

II Definition of the management unit

1) Characteristics of the fishery and its activity

The North Sea Discard Atlas (Quirijns and Pastoors, 2014) described the trammel net fisheries (GT1) as operated by a number of countries and are particularly important in more coastal waters, for example off the English North Sea and Channel coasts for sole (Fig 1.). Catches of plaice and cod are also important particularly in the fishery operated by Denmark. The main gillnet activity (GN1) is from a Danish fishery targeted mainly at cod and plaice. The importance of anglerfish in this fishery has risen in recent years and activity directed at this species has increased by UK vessels.

Gillnets (GN1)



Trammelnets (GT1)

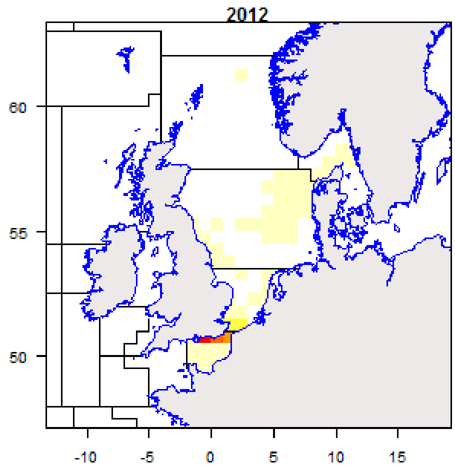


Fig 1. Distribution of North Sea, Skagerrak and Eastern Channel international fishing effort (EU) in hours fishing by ICES statistical rectangle. Figures shown for gillnets GN1 and trammel nets GT1 Note: a) that within each plot the darker the shading, the higher the effort; b) that the scales are different between the plots and so the plots should not be used to infer relative magnitude of effort between gears, but rather for examining distribution of effort (Quirijns and Pastoors, 2014)

The example of the French fleet show that all vessels using nets gears with 90-100 mm mesh width in the North Sea are likely to catch (and discard) undersized sole. The French net fishery is subject to different European and national license systems (AEP, ANP), including one for sole (AEP), without limited entry.

The Dutch gill net fishery for sole was MCS certified in the period from 2009 – 2013, but could no longer keep this certificate due to high costs. As an alternative the Dutch gillnet fishery now has the Friends of the Sea certificates for the species common sole, dab, turbot, brill and cod.

Approximately 70 French vessels are concerned by the net fishery; they are mostly based in Boulogne-sur-Mer, Calais and Dieppe harbours. There are also over 100, largely under 10m, UK vessels operating gill nets for sole. 60 Dutch vessels are mostly based off the Dutch cost (fig 3). The activity of net fishery is mainly dedicated to the sole, with some fishing trips targeting other demersal fishes, rays or crustaceans. Dutch vessels may also target plaice and cod. The size of the vessels ranges from 9 to 15 m, with an average of 12 m. The main mesh-size used for sole range from 90 to 100 m (2014 ObsMer report; Cornou *et al*. 2014). The nets are set during daily fishing trips, and the total length of nets set ranges from 7 km to 15 km according to the size of the boat and the season. Fishing operations occur in depth ranging from 5 to 50 m, with soak time lasting between 4 and 24 hours. A large part of the fleet also operates in the Eastern Channel (fig 2).

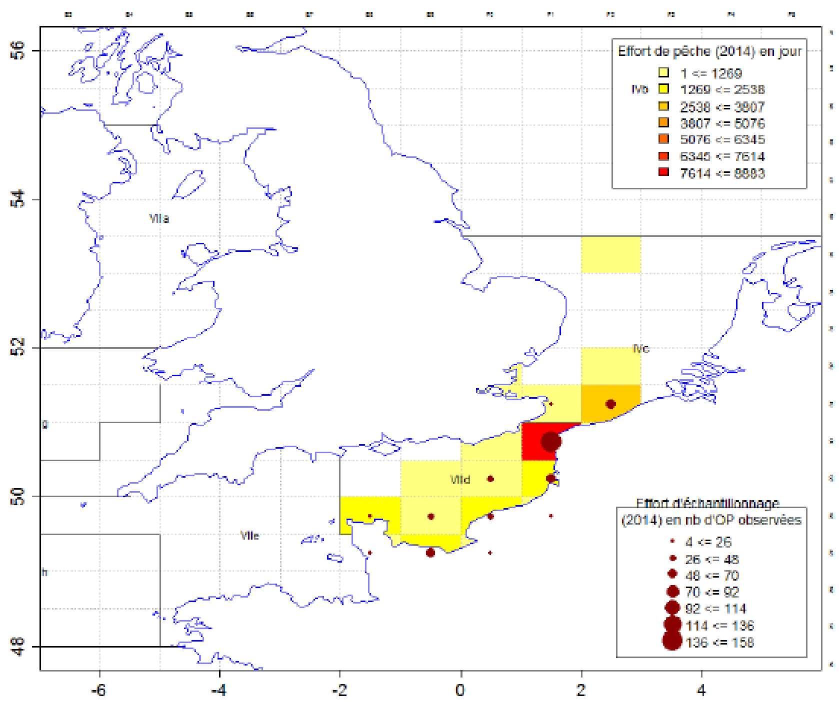


Fig 2. Spatial distribution of the fishing operations sampled (red circle) and the total fishing effort (rectangle) in number of days-at-sea operated by the French net fishery in the North Sea and the Eastern Channel (2015 ObsMer report; Cornou et al. 2015).

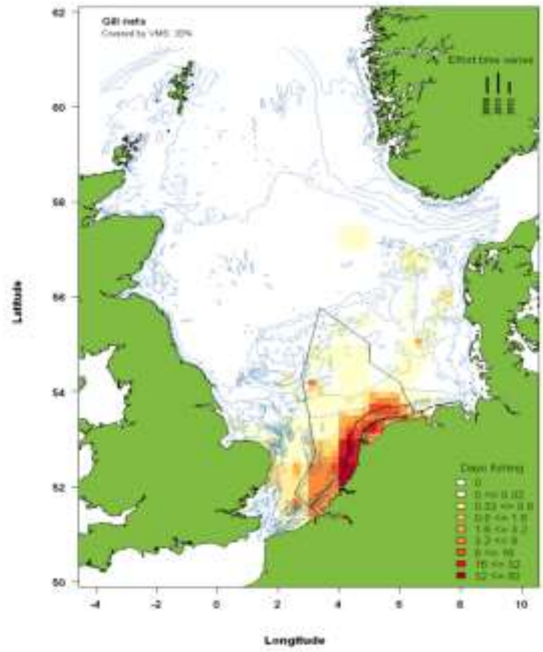


Fig 3. Spatial distribution of the fishing effort in number of days operated by the Dutch net fishery (IMARES)

2) Composition of the catches, landings and discards.

For GN1, the NS discard atlas indicates that the discard ratio of sole between 2010 and 2012 is null in average in the North Sea. The atlas does not provide information on the discard of sole for the GT1 fishery at the North Sea scale, mainly due to the fact that the majority of vessels are under 10m in length and therefore have no records of discarding. The only discard ratio for this gear is provided for France (p67) and is no more than 1% between 2010 and 2012 in average.

The proportion of sole in the catches of the French netters targeting sole in the North Sea and the Eastern Channel is high (~30%), with a really low proposition of the sole catches being discarded (~2%; Table 1). It is assumed that these figures will be comparable for similar fleets around the North Sea.

Table 1. Proportion of the catch discarded by species, for the French fleet using net in the North Sea and the Eastern Channel, according to French data (ObsMer 2014).

Nets targeting sole in the North Sea and the Eastern Channel	Proportion in the catches (%)	Proportion of the catches discarded (%)	Proportion of undersize in the discards in weight (%)

2014	30.1 [25.6 - 35]	1.8 [1.2 - 2.4]	77.4
2013	36.3 [31.3 - 41.7]	2.1 [1.6 - 2.8]	91.6
2012	23.3 [17.9 - 29.3]	2.2 [1.6 - 2.9]	92.0

The **cause of discards** for sole is predominantly related to the minimal landing size (Fig 4 and 5).

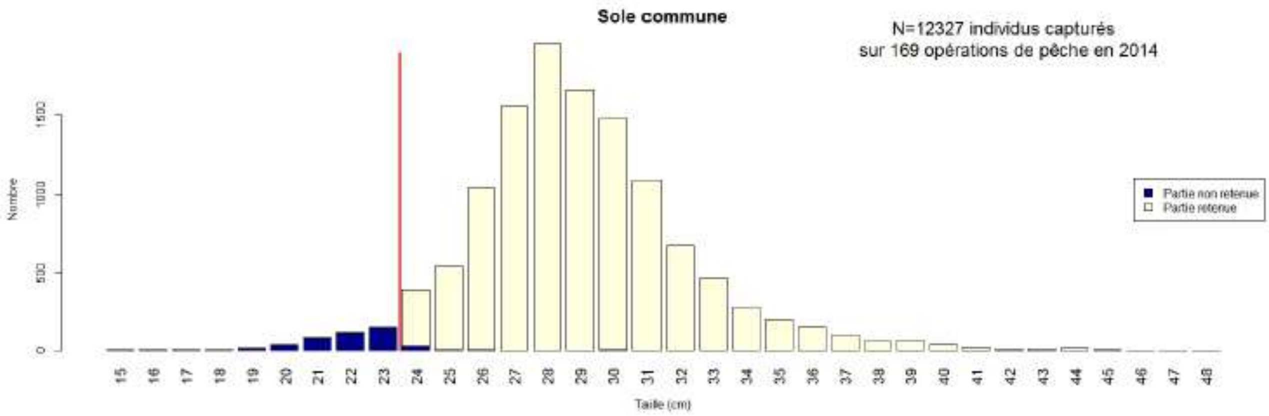


Fig 4. Length structure (in number) of sole landings and discards of French netters targeting demersal species in the Eastern Channel and the south of the North Sea in 2014 (2015 ObsMer report). 77,4% of the individuals of the 1,8% discarded are undersized.

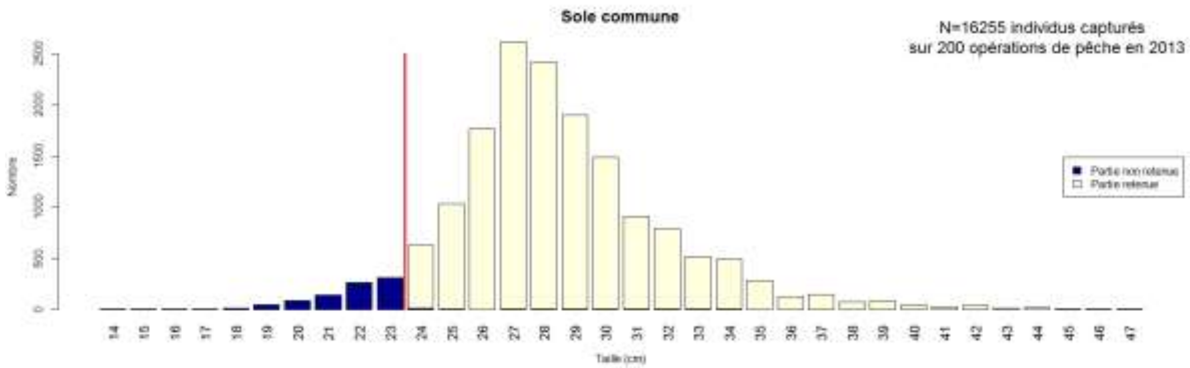


Fig 5. Length structure (in number) of sole landings and discards of French netters targeting demersal species in the Eastern Channel and the south of the North Sea in 2013 (2014 ObsMer report). 97% of the individuals of the 2.1% discarded are undersized.

3) Sorting and handling of the catches

Catches of commercial sole are directly unmeshed during the haul of the nets, and sorted and stored once the net is hauled in the boat, or stock onboard and sort at the harbour. The undersized sole are released as soon as they are unmeshed. The landings are partly sold in local markets and mainly in fish auctions (Calais).

III Current management measures of the fleet

Landings sole in zone IV are framed by the TAC and quota system. Regulation (EC) No 1342/2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks, and Regulation (EC) No 676/2007 establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North sea, limit the effort in the fishery. The second also controls the method for the definition of the quota. Regulation (EC) No 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms imposes a minimum mesh size of 90 mm and a minimum percentage of target species of 70%. The minimum landing size is 24cm.

For the sole in the North Sea, ICES advice indicates that an evaluation of the management plan (ICES, 2010) concluded that the management plan is precautionary. The stocks are in stage two of the EU multiannual plan (EU, 2007). Application of stage two of the plan is based on transitional arrangements until an evaluation of the plan has been conducted. ICES assumes that harvesting the stock with the newest estimate of FMSY is in accordance with stage two of the current plan.

IV Recent works on selectivity measures

As mentioned above in the discard atlas, the low discard rate (< 3% in 2013) of the net fishery indicates the ability of fishermen to avoid unwanted sole catches. Improving the selectivity of static gear is then difficult. Few studies have looked at the improvement of the selectivity for sole netters, the ones done in the late 1990s showing commercial losses according to the increase of the mesh size (IFREMER, 1997). In 2014, a workshop has been organized in the frame of the French selectivity project "REDRESSE" in the Bay Biscay (Annex F1), involving commercial fishermen and scientists from IFREMER. No selective measures have been identified during this workshop to reduce unwanted catches without impact on commercial catches, especially for sole for which unwanted catches are really low. For sole, reducing the length of the nets or the soaking time will not change the percentage of undersized fish caught by fishing operation, as these parameters are not involved in the cause of this discard. In REDRESSE, works have been then focused on the publication of guidance for good practice (limitation of the length of the nets and of the soak times, etc.).

V Conclusion

According to the fact that:

- Discard of sole are really low (< 3%, mostly undersize, for the dedicated fishery), i.e the selectivity is already really high for this species in the net fishery;
- Selectivity improvement by regulatory measures to avoid the undersize of sole will be hard to achieve without severe economic impacts on the revenue of the boats;
- The landings of undersized sole will represent low amounts of catches distributed in multiple little harbours all along the coast, which severely limit the possible non-human consumption outlets;
- De minimis exemptions can provide the flexibility to the fishermen to adapt their behaviour to such new regulation frame, particularly during the first years of the landing obligation implementation.

A *de minimis* exemption of 3% is requested for sole (*Solea solea*) for the vessels using nets gears (trammel nets and/or gillnets) in the North Sea (IVa, b and c) for the three years of the discard plan. According to the North Sea discard atlas (Table A.3.1, page 64), the catches of sole in the net fishery in the North Sea were on average 1.072t (including 4t of catches discarded) in 2010-2012. Based on this figures, and only for illustrative and informative purposes, a de minimis of 3% would represent a maximum amount of allowed discard for sole of 32.16t. This amount is very limited when compared to the whole TAC for sole in ICES sea areas IIa and IV (13 262 for 2016).

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Annex Gi: REDRESSE

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REDRESSE is a selectivity project which has been launched in 2014 for four gears used in the Bay of Biscay (bottom and pelagic trawls, Danish seine, and nets), which involved scientists from IFREMER and commercial fishermen from all along the French coast. The REDRESSE project's objective is to develop and test strategies to further reduce unwanted catches from fleets in the Bay of Biscay by experimenting with different solutions on board commercial fishing vessels (the use of selective devices, strategy changes, and spatial and temporal measurements, etc.). The idea is to find technical solutions able to improve the selective practices already in place and to reduce discards by minimising the impact on commercial catches in order to maintain the economic sustainability of fishing businesses.

Presentation of the project: http://www.aglia.org/sites/aglia.org/files/projets-pdf/La%20s%C3%A9lectivit%C3%A9%20en%20action.pdf

Annex H: De minimis exemption for fishing vessels using TBB gear 90-119 mm to catch sole in area IV of the North Sea because of improved selectivity

In view of the difficulty to further increase selectivity and in the spirit of the landing obligation, in particular with regards to the protection of juvenile life stages and in an attempt to reduce the occurrence of unwanted sole by catches, vessels which choose to deploy a TBB gear equipped with minimum mesh sizes of 90 mm or a gear with at least a similar increased selectivity, shall be granted an exemption of the full range of the de minimis, i.e. an exemption of 7% of the total sole catches taken with the TBB gear 80-119m. The improved selectivity of sole catches shall be closely monitored and further developed with particular emphasis to compensate potential losses of marketable sole against reductions in economic expenses related to sorting of catches and disposal of unwanted catches.

Management of the stock

The spawning stock biomass (SBB) has been increasing since 2007 and is estimated to be above MSYBtrigger in 2014. Fishing mortality has declined since 1995 and is estimated to be at F_{MSY} in 2014. Figures for Bpa and Blim show full reproductive capacity of the stock size, and the stock is harvested sustainably according to the management plan.

55% of the total revenues of the TBB gear 80-119 mm fleet stem from catches of sole. For the time being the sole fishery is essentially carried out with a gear of 80mm even though in 2013 10 UK vessels used TBB ≥ 90mm with an average catch of approximately 200 tonnes.

Selectivity

The catch situation in the sole fishery deploying beam trawl gears with a mesh size from 80-119 mm (BT2) is characterised by a composition of various species with a certain proportion of undersized fish due to the occurrence of a much wider range of species near the sea bed than in the mid-water area.

In the TBB 80-119mm sole fishery around 13% of the sole catches in weight consist of unwanted sole by-catches (Fig. 1). Even though the occurrence of such unwanted catches of undersized sole can substantially be reduced by increasing the mesh size to 90mm, even then the range of these catches can vary between 3% and 10% depending on the size of the incoming year class. To increase selectivity fishermen need to accept a loss of a considerable amount of marketable sole.

Gears with a 90mm mesh or similar selective gears are currently not widely used in the sole fishery, mainly because of loss of a large part of marketable sole. According to a study from IMARES in which the catches of fishing trips with a beam trawl with three different mesh sizes (70, 80 and 90mm) have been compared, the catches of undersized sole decrease with 50% and catches of marketable sole decrease with 30-47% when the mesh width is increased from 80mm to 90mm. The catches of undersized plaice are not lower with 90mm than with 80mm (Quirijns et al, 2007*)*.

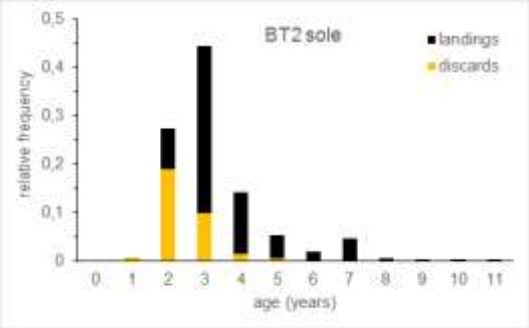

Fig. 1. Relative catch composition in numbers at age of BT2 sole fisheries in the North Sea in 2012 (STECF data from 2013). Landings and discards in numbers at age are stapled.

In pilot projects the Dutch industry is currently working on the possibilities of panels and grids to increase selectivity (van Marlen et al. 2013). The results of these ongoing studies are not available yet.

In Belgium a study (Bayse, S. and Polet, H. 2015, s. subannex) has been done to increase the selectivity in the sole fishery with a small mesh gear with large mesh extension of the trawl. The aim was to reduce the capture of sole, particularly undersized sole. After 48 comparative hauls, the large mesh trawl reduced total sole catch by 19.7%, and reduced undersized sole (< 24 cm) by 40.3%. Length analysis showed that all sole less than 31 cm were caught significantly more often by the small mesh trawl, and sole larger than 37 cm were caught significantly more by the large mesh trawl, however far fewer of these large-sized fish were caught. Increasing the mesh size of the extension in a beam trawl was shown to be an effective and simple method to reduce the capture of sole, especially sub-legal sized fish. The selectivity of this gear is hence considered similar to a gear with 90 mm meshes.

De minimis percentage

According to the discard atlas the average discards of sole over 2010-2012 with TBB gear 80-119 mm gears amount to 13% of the catches. With a gear with 90 mm or similar selective gear, a reduction of unwanted catches of undersized sole of 40-50% can be achieved, remaining a discards average percentage of 6,5 -7,8% of the total sole catches with this gear.

References

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Bayse, S. and Polet, H. 2015. Evaluation of a large mesh extension in a Belgian beam trawl to reduce the capture of sole (solea solea)

Annex Hi: Evaluation of a large mesh extension in a Belgian beam trawl to reduce the capture of sole (*Solea solea*).

BE study on large
mesh extension in bea

Annex I: Request for an Application for a 'De Minimis' exemption for undersized *Nephrops* in the North Sea in fisheries with gear type OTB 80-99mm

Request

A request for the maximum de-minimis exemption for Nephrops norvegicus caught in ICES Area IV, [IIIa] and EU waters of IIa, otter trawl fisheries based on disproportionate costs associated with disposing of catches below the MCRS (Minimum Conservation Reference Size). The total percentage of catches of undersized Nephrops are no more than 6% of the total Nephrops catch.

It is proposed that the maximum percentage for this de minimis request be set at 6% of the total annual catches of nephrops caught with bottom trawls with a mesh size of 80-99mm in Areas IIIa, IV and EU waters of IIa.

The request applies to the Dutch, English and Scottish nephrops fisheries across which there is a variation in rates of discards of nephrops under MCRS, ranging from 1% of catches in the Dutch fishery to 6.24% in parts of the Scottish fishery. Those parts of the Scottish industry with discards below MCRS exceeding 6% have limited scope or vessel capability to adapt to fish on alternative grounds and it is therefore important that the de minimis request covers their needs. This will ensure that the objective of the de minimis request – to avoid disproportionate costs being placed on the differing fleets active in the fishery- can be achieved.

Introduction

Over 270 UK based vessels and 22 Dutch based vessels (gear type OTB 80-99mm) target Nephrops norvegicus in the North Sea trawl fishery. The vessels range in size from < 10 metres to over 24 metres in length and use mesh sizes from ≥80-≤99mm. 11 Belgian based vessels target Nephrops. The landings are on a yearly basis about 400 tonnes, which represent a value of 2,37 MEURO.The most recent ICES advice indicates that Nephrops stocks in nearly all functional units which contribute to the North Sea TAC are harvested sustainably with abundance levels above B_{msy} ($B_{Trigger}$) and Harvest Ratios are below F_{MSY}.

Average landings over the previous three years from UK ITB 80-99mm vessels are 12,447t worth £35.7m. Currently discards from this fishery are thought to be small with the discard atlas estimating 6% of catch is discarded and separate UK figures, not included in the discard atlas, estimating that ~6% of catch is discarded. Unfortunately no breakdown of discards between above and below MCRS catch is available, though the key reasons given by the industry for discarding include the catch being below MCRS or the animal being damaged.

Disproportionate Costs

The volume of undersized Nephrops which will be landed and the costs associated with their disposal will not be known until the Landings Obligation is fully operational. The UK monitoring programme has shown that the percentage of undersized Nephrops represent 1.5% of the total annual catch of Nephrops. The Dutch discard self-sampling programme shows similar results. We have been informed that catches of under-sized Nephrops are concentrated in a few areas of the North Sea fishery, particularly in the functional units closer to the shore such as the Firth of Forth. Discards from the much bigger Fladen fishery are generally smaller.

For 2016 at least the undersized catch will have to be disposed of as there is little alternative use for undersized Nephrops - fishmeal is not an option for Nephrops. This reduces the ability for vessels to recoup some of the disposal costs.

There are 23 ports on the East Coast of the UK and currently none of them have any facilities for disposing of undersized Nephrops, therefore all discards will have to be transported to another location. This will create costs which the vessels will have to absorb.

The only feasible sites for disposing of under-sized Nephrops are in Invergordon in the North-West of Scotland or Liverpool on the North West coast of England, both at a considerable distance from the relevant East Coast ports A key element of the costs to be incurred under the landing obligation will involve onshore storage of the catch while waiting for transport and then transportation to a disposal site, plus the actual disposal.

The site at Invergordon uses anaerobic digestion to dispose of the Nephrops. There are few if any other options currently available for disposal given that from 2016 it will not be possible to dispose of Nephrops into landfill sites. It is possible to incinerate Nephrops but the facilities willing to do this are very limited due to the nature of the product. There is a facility in Liverpool which can handle Nephrops incineration. However, the transportation costs associated with this are significant and prohibitive. As an example, Liverpool is 280 miles from Pittenweem.

The largest part of the disposal costs appears to be relatively fixed as it includes storage facilities at port and transport to a disposal facility. Processors have informed us that environmental health protocols would not allow them to store or transport product which is not for human consumption in close proximity with product meant for human consumption, so current Nephrops storage or transport arrangements could not be used.

The quoted costs for disposal in Invergordon are £50/tonne for disposal plus £550 per trip to transport the material to the disposal site and a recurring £100/month for storage. At a 5% discard rate each vessel would have to dispose of 0.5t/month. Even allowing for a proportionate reduction in the disposal costs they would still incur additional costs of £675/month or £8,100/year per vessel. This represents a disproportionate 16% of average gross profit for vessels in 2014 (net profit figures are currently unavailable).

In the longer term the facilities and infrastructure to handle undersized catches could be established, with increased scope for economies of scale. However these facilities currently do not exist and Nephrops are a particularly difficult species to dispose of as they cannot be rendered down into fishmeal. The cost of transporting them to sites for disposal is significant and the direct impact on vessel profits would be disproportionate.

Additional costs will be incurred through a reduction in productivity because extra time will be needed to sort the catch under the landing obligation. Currently there is little or no handling of discarded Nephrops. They are either pushed over the side from the sorting table or run straight off the conveyor on those vessels that have one fitted. All Nephrops will now have to be selected along with the rest of the catch and in those cases where the size between animals above MCRS and those below is marginal they will need to be measured to ensure compliance with the regulation.

Dutch situation

22 Dutch vessels catch annually approximately 1,000 t of Nephrops with OTB 80-99 mm vessels. 1% of these catches are undersized (10t). Considering the low amount of undersized Nephrops, large investments for storage and transport must be made to dispose of these Nephrops. In an ongoing pilot project the Dutch fisheries industry is looking into costs of processing undersized catches. The costs for storage and transport of undersized Nephrops are not yet available, but are estimated to be disproportionate considering the low amount of discards that need to be transported. When in 2019 all by catch species come under the landing obligation, the disproportionality of these costs needs to be reconsidered.

Future

It is anticipated that this derogation will be a temporary measure. Work is ongoing to reduce catches of under-sized Nephrops, but it will take time to produce results. The Scottish Fishermen's Federation Gear Group, supported by the Scottish Industry Discards Initiative, as well as the English and Dutch Nephrops industry, supported by the European Fisheries Fund, is taking a fresh look at selectivity across the fishery, in an attempt to reach maximum selectivity whilst maintaining an economically viable fleet. To date all efforts were focused on cod avoidance and selectivity which is why time is now needed to develop and test selectivity options for Nephrops. Though it seems unlikely the undersized catches can be completely eliminated, we do believe they can be reduced.

Additional work is also being carried out into raising the value of Nephrops which are sold, in order to provide a larger cushion against the costs of disposal of unsold Nephrops, and also to consider the feasibility of developing onshore facilities for Nephrops disposal. Identifying and developing future non-human consumption markets for undersized prawns and whitefish is a work stream for the industry and seafood agencies. However time is needed to put solutions in place. As the landing obligation is progressively phased in there will be increased scope for economies of scale to be captured, specifically when the prawn fleet has to land below MCRS whitefish catches.

Finally a Long Term Management Plan for Nephrops which will introduce measures to protect individual Functional Units (FU) from over-exploitation is currently in development.

These processes have only just started and we will not have answers to deal with undersized Nephrops in time for the commencement of the landings obligation from 1st January 2016. Therefore in the interim period a de minimis exemption of the amounts requested is necessary to allow the fleet time to adapt to this new regime.

Conclusion

The intention of this exemption is to act as an interim measure to enable the UK and Dutch onshore sectors to adapt and provide, where possible, more cost effective ways to dispose of the undersized catch. The exemption will also afford time to look for alternative uses for the undersized prawns that could provide some return and for these facilities to be put in place. The stocks are considered healthy and quota is available. However, the issue is the disproportionate cost of disposing of unwanted, undersized catch for which there is little allowable use and for which fishmeal disposal is not an option.

Annex J: From 2018, *De minimis* exemption request for the vessels using bottom trawls < 100 mm (TR2) in the North Sea (ICES areas IVa, IVb and IVc).

In the framework of the landing obligation in accordance with article 15 of regulation (EU) No 1380/2013, a de minimis exemption is requested for Whiting (*Merlangius merlangus*) up to a maximum of 7 % (and 6% in 2018) of the total annual catches of species that would fall under landing obligation, for the trawler fishery using TR2 in ICES area IVa, IVb and IVc.

The request for an exemption for de minimis is based on article 15.5.c.i) and ii), due to difficulties to improve selectivity in a short term period. Also, vessels are operating long fishing trips (~3 days in average) at considerable distance from home harbours (more than 1000 km return). This would imply to come back often to home harbours, generating high coast for the vessel.

I. Definition of the species and the stock

Whiting (4 - 7d)[7]: For 2016, ICES advises on the basis of the EU–Norway management plan that total catches in 2016 should be no more than 30 510 tonnes. If rates of discards and industrial bycatch do not change from the average of the last three years (2012–2014), this implies human consumption landings of no more than 14 853 tonnes (12 373 tonnes in the North Sea and 2480 tonnes in Division VIId). Management for Division VIId should be separated from the rest of Subarea VII. The stock statuses show a stock for which F_{MSY}, $B_{trigger}$ and safe biological limits are undefined.

Spawning-stock biomass (SSB) and fishing mortality (F) have been relatively stable since 2003. Recruitment (R) has been low since 2003, with recruitment in 2015 above the average of the recent years.

II Definition of the management unit

1) Characteristics of the fishery and its activity

The NS Discard atlas described the use of TR2 fishery as more widespread than the TR1 gear (Fig 1.) and associated mainly with three fisheries.

1. The fishery for Norway lobster (Nephrops). This species lives on areas of soft clay muds which are distributed patchily throughout the North Sea and Skagerrak. Bycatch limits for fish species apply in the smaller meshed (80-89 mm) Nephrops fishery. The bycatch limits do not create undue problems in inshore areas where fish abundance is low. In more northerly offshore areas where fish are more abundant, adhering to the bycatch limits is more challenging.

[7] http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/whg-47d-reopen.pdf

2. A mixed fishery taking place in the more southerly parts of the North Sea and centred on the eastern Channel in which whiting and non-quota species are important constituents. This is predominantly a French fishery.

3. A 90-99 mm mesh mixed demersal fishery centred on the Skagerrak and prosecuted by Denmark and Sweden. In the Skagerrak, also a directed Nephrops fishery with sorting grid (70-89 mm mesh size) is prosecuted by Swedish vessels.

TR2

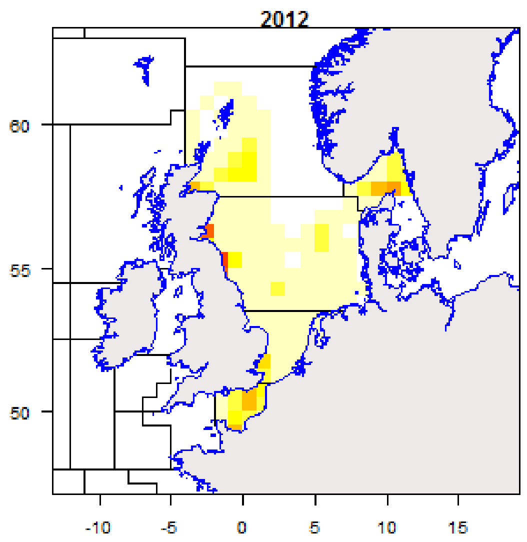

Fig 1. Distribution of North Sea, Skagerrak and Eastern Channel international fishing effort (EU) in hours fishing by ICES statistical rectangle for TR2. Note: a) that within each plot the darker the shading, the higher the effort; b) that the scales are different between the plots and so the plots should not be used to infer relative magnitude of effort between gears, but rather for examining distribution of effort (Quirijns and Pastoors, 2014).

French case: **[***To be completed by the other interested MS]*

All the French vessels using TR2 gears in the North Sea Channel are likely to catch and discard whiting. The TR2 fishery is subject to different European and national license systems (AEP, ANP), and is concerned by the Cod Plan.

In 2014, 2015 ObsMer report (Cornou *et al.*, 2015) reports approximately 120 French vessels using TR2 gears in the North Sea, distributed in more than 10 harbours. The vessels of this fishery use mainly bottom otter-trawl, but can also use otter twin trawls and Danish seine. The mesh-size used range from 70 to 99 mm (mainly 80 mm; Cornou *et al.*, 2015) to fit the Cod Plan. The fishing operations occur in depth ranging from 20 to 90 m, and last between 45min and 4 hours. Fishing trips duration are variable, from 12h to 7 days (3 days in average), depending on the size of the boats, the species targeted, the seasons, the weather forecast or even the harbour. A large part of the fleet also operates in the Eastern Channel, regularly during the same fishing trips (Fig 2 and 3).

The main target species of this French mixed fishery in the North Sea are diverse and consist of quota (whiting, sole) and non-quota species (cephalopods, red mullet, sea bass, gurnards, etc.). These species are often spatially and temporally associated. During a same fishing trip, a boat can target different species, including pelagic species with pelagic gears.

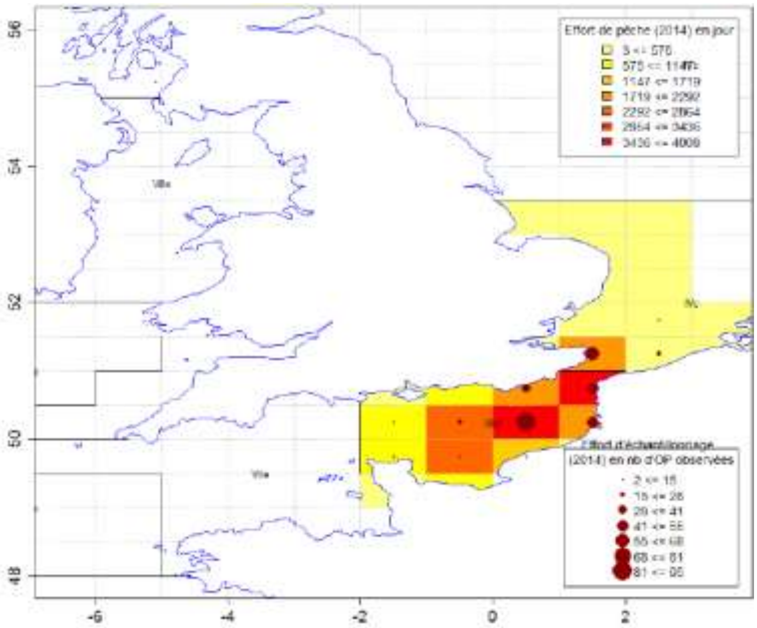

Fig 2. Spatial distribution of the fishing operations sampled (red circle) and the total fishing effort (rectangle) in number of days-at-sea operated by the TR2 fishery (vessels ≥ 18 m) in the South of the North Sea and the Eastern Channel (2015 ObsMer report; Cornou *et al.,* 2015).

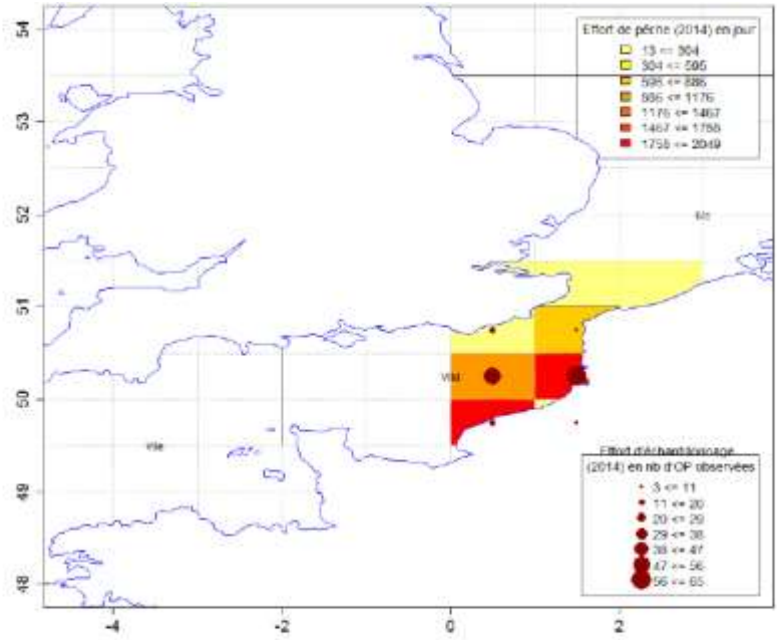

Fig 3. Spatial distribution of the fishing operations sampled (red circle) and the total fishing effort (rectangle) in number of days-at-sea operated by the TR2 fishery (vessels < 18 m) in the South of the North Sea and the West of the Eastern Channel (2015 ObsMer report; Cornou *et al.*, 2015).

2) Composition of the catches, landings and discards and calculation of the de minimis percentage

The NS discard atlas shows that the whiting represents approximately 20% of the 6 main species landings of the TR2 fishery by year (average 2010 - 2012) in the North Sea (Quirijns and Pastoors, 2014). According to STCEF data base (2010-2012), whiting represents 7% of discards over the total catches made in the TR2 fishery (Table 1). For the NS Discard Atlas (Quirijns and Pastoors, 2014), the low price is assumed to be the most dominant reason for the discarding of whiting by fishers in the Netherlands, Belgium, Sweden and Denmark. Off the eastern English coast and in the Skagerrak, local concentrations occur, and discards may be due to a lack of quota for the fishermen involved. Whiting is a substantial bycatch in the Nephrops fisheries. For the French fishery, whiting is the main species catch by this fishery, and is also the second main species released, mainly because of minimal legal size (more than 90% of the whiting discards in number; Annex Ji).

Table 1. Landings and discards of TR2 fishery in the North sea for all countries (STECF data base, average for 2010-2012, Discard Atlas 2014, Quirijns and Pastoors, 2014)

Region	Sub region	Over all catches 2010-2012 (in tonnes)	Mean Discards of Whiting 2010-2012 (in tonnes)	Discard rate 2010-2012

Region	Sub region	Over all catches 2010-2012 (in tonnes)	Mean Discards of Whiting 2010-2012 (in tonnes)	Discard rate 2010-2012
North Sea	North Sea	93 831,167	6 655,37	7%

In order to study the impact of the landing obligation on French fleets, a French program was developed by a regional fishery comity (EODE, Balazuc et *al.*, 2016). This study was conducted in the North Sea and the Eastern Channel with the objectives to look at the adaptation of the fishing strategy of two TR2 vessels (< and > 18 m) in front of the landing obligation, and the impact of the LO onboard and inland. During the trials (2 weeks per month between October 2014 and September 2015), the vessels were in the situation of full or half-full landing obligation, and had to adapt their behaviour according to the species they want to avoid. Results confirmed observation described above. Results shows for example that, for the vessels studied, whiting is one of the main species released (especially from march to July for the >18m vessel). It also confirms that whiting was mainly released because of the minimum legal size.

3) Sorting and handling of the catches

Sorting and handling of the catches are variable according to the size of the boats. For the smallest ones (< 12 m), the sorting is generally done at the back of the vessel and the catches are stored directly on the desk in fish boxes. For medium vessels (12 - 18 m), catches are often sort at the back of the deck and stored in a refrigerated hold. The largest vessels (> 18 m) have often a treadmill to help the sorting of the catches. Sorting time depends on the quantity of catches. Unwanted catches are discarded during the sorting process. Due to the age of the boats (> 20 years in average) and the costs of the adaptation, modification and improvement of the handling process are often difficult despite several tries.

As an example to illustrate the observation above, the results of the EODE program (Balazuc et *al.*, 2016) showed that the sorting and stowage time will be largely increased and this would imply less resting time for the crew. Also, the landing obligation will have impact on onboard materiel constraint. Vessels have maximal loading charge (according to their navigation permit) in order to assure security and vessel stability. On the vessels studied during the trial, the loading charge was not the main problem (even if in some cases it was, and would have conducted to stop the fishing trip) but the volume of catches.

Indeed, hold capacity is limited, especially on vessels under 18 metres. Results also showed that for vessels longer than 18 metres, fishing trip that would have been the most likely to be abort because of hold capacity limit, are the one targeting maquerels and whiting.

III Current management measures of the fleet

For the TR2 fleet, the cod management plan (regulation n°1342/2008) introduces an European Fishing Authorisation.

For the whiting in 4-7d, a management plan was agreed by EU and Norway in 2014 based on an adjusted target F of 0.15. ICES evaluated this harvest control rule (ICES, 2013d) and considered it as precautionary.

Concerning the selective device, the square mesh panel is obligatory for the TR2 fleet in the North Sea (Reg (CE) N°850/98).

Minimal landing size of whiting is 27 cm in the North Sea.

IV Recent works on selectivity measures [*To be completed by the other interested MS]*

Several studies have been conducted since the 2000s on the selectivity measures for the TR2 fishery in the North Sea and the Channel (SELECAB[8], SELECFISH[9], SELECMER[10], FMC-NS[11], SAUPLIMOR; See Annex Jii (Vogel *et al.* 2015) for more details). A recent report from IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) has been plublished (Vogel *et al.*, 2016) reporting more in details all the selectivity works conducted by France for all gears and all areas.

Square mesh cylinder, articulated rigid grid and semi rigid grid have notably been tested to improve the overall selectivity of this fishery, including demersal and pelagic species. These exercises were really difficult because of the mix nature of this fishery. Indeed, results were always mixed, the decreasing of discards for one or more species leading to severe economic impacts on the others species caught (Table 2). For example, a decrease of 56% of the discards with articulated rigid grid and square mesh cylinder is accompanied by a commercial loss about 36% (vessels ≥ 18m). Moreover, some of the selective devices tested were particularly difficult to install and handle by the crew (articulate grid).

Table 2. Examples of selectivity measures studied since the beginning of the 2000s

[8] http://wwz.ifremer.fr/manchemerdunord/Unite-Halieutique/Halieutique-Boulogne-sur-Mer/Axes-de-recherche/Dynamique-des-pecheries/Projets-de-recherche-associes/SELECCAB ; http://wwz.ifremer.fr/manchemerdunord/content/download/41271/562568/file/SELECCAB-Hauturiers.pdf ; http://wwz.ifremer.fr/manchemerdunord/content/download/41270/562557/file/SELECCAB-Artisans.pdf
[9] http://wwz.ifremer.fr/peche/Projets/Selecfish2 ; https://www.youtube.com/watch?v=KDm9yJDziPs
[10] http://archimer.ifremer.fr/doc/2009/rapport-6776.pdf
[11] http://archimer.ifremer.fr/doc/2001/rapport-3463.pdf

	Bottom trawlers < 18 m using TR2		Bottom trawlers ≥ 18 m using TR2	
	Unwanted catches	**Wanted catches (commercial catches)**	**Unwanted catches**	**Wanted catches (commercial catches)**
Square mesh cylinder (80 mm ; 2 m long)	-59 % of whiting -29 % à -35 % flatfishes	Minimal loss for whiting and cuttlefish -14 % of squids - 8 % to -22% of flatfishes	-22 % of discards (all species)	-16 % revenue (all species)
Semi rigid grid (23 mm) **+ Square mesh panel** (60 mm ; 1 m long)	-21 % of discards (all species)	-31 % revenue (all species)	-56 % of discards (all species)	-36 % revenue (all species)
Articulated rigid grid. (30 mm) + **Square mesh cylinder** (80 mm ; 2 m long)	-78 % of discards (all species)	-35 % revenue (all species)	_ _ _	_ _ _
Articulated rigid grid (30 mm)	_ _ _	__ _	-67 % of whiting -49 % of plaice	-49 % of whiting -18 % of plaice

The application of the landing obligation will certainly lead to a new reflexion on the use of the selective devices previously tested, notably according to the species that the vessels will have to land. The losses of commercial catches will have to be compared to the costs of the handling of the unwanted catches. This comparison is extremely difficult to evaluate on the light of the change in the regulation that will occur in the context of the landing obligation.

Finally, a new French selective study (REJEMCELEC[12]) has started in December 2015 and will be running during 2 years. This project has been developed by two Regional Fishing Committees in collaboration with Producers Organisations for the TR1 and the TR2 fisheries in the Western and the Eastern Channel, and will involve boats of different sizes (< and > 18 m), for preliminary results planned in 2017. This study could give precious information for the TR2 fishery also operating in the North Sea.

V Disproportionate costs of handling unwanted catches

Few studies have previously studied what will be the economic impact of a landing obligation, especially regarding what the CFP called the "disproportionate costs" (Buisman *et al.* 2013, Condie *et al*. 2013a and b, Poseidon, 2013; See Annex Jiii (Macher *et al*., 2015) for more details). It is important to notice that several scientific projects (CELSELEC, REDRESSE[13]) are currently ongoing for mixed fishery, which will try to assess the economic impacts of the landing obligation at vessel and fleet levels. It was also one of the aims of the French EODE project which ended beginning of 2016. Link to the limited hold capacity, the full application of the landing obligation would conduct to filled the hold more quickly and with a significant part of undersized fish (especially in the fishery catching whiting, French case is that 90% of discards are undersized fish) that cannot be avoid for the moment. Consequences are the return of the vessel at home harbour (those vessels can operates long fishing trips, up to 7 days) to land their catches with catches not valuable or at a minimum price. A fishing trip would therefore be less economically profitable and thus the salary of the crew will be decreased too.

European "H2020" research projects (DiscardLess[14]; MINOUW[15]) should also bring some elements on these subjects in several years.

Apart from that, general observations can emphasize the fact that the landing obligation will result in many additional costs for the fishers (as underlined by the Commission staff working paper, 2011[16]), but also for Fishing Producers and harbour operators. These costs will prove most certainly disproportionate compared to the valorisation which could be made of the unwanted catches to be landed.

- The TR2 fishery in the North Sea (and the Channel) is a mixed fishery financially depending on several species (gadoids, cephalopods, pelagic species, which are often spatially and temporally associated related), operating long fishing trips (~3 days in average, up to 7 days) at considerable distance from home harbours (more than 1000 km return). Without a *de minimis* exemption, vessels catching whiting would need to come back often to land their catches and this would generate high coast for the vessel.

[12] http://www.pole-mer-bretagne-atlantique.com/fr/?option=com_projects&view=project&id=2442&format=pdf&layout=pdf&catid=11
[13] http://www.aglia.org/sites/aglia.org/files/projets-pdf/La%20s%C3%A9lectivit%C3%A9%20en%20action.pdf
[14] http://wwz.ifremer.fr/emh/content/download/83625/1046566/file/DiscardLess.pdf
[15] http://www.helsinki.fi/science/fem/projects.html#minouw
[16] http://ec.europa.eu/fisheries/reform/sec_2011_891_en.pdf

- The sorting of the unwanted catches will increase the time of the labour by fishing operation, thus increasing the cost when the value of the catches sorted decrease, with economic impacts on the whole fishing trip.
- Vessels have a legally limited capacity of storage, which may be affected by the need to store unwanted catches at the expense of targeted and commercial catches;
- Companies which can enhance the economic value of unwanted catches are still rare in many MS resulting in additional costs related to the logistics of collecting these unwanted catches. Their onshore processing will be even more problematic, because landings of unwanted catches will not be regular in terms of quantity and quality and very scattered along landing points ;
- Development of new market for unwanted catches will take several years before being economically effective; it will not be reasonably possible before January 1st, 2017

Several of these aspects have been identified amongst others in the English Discard Ban Trial (Catchpole et al. 2014) and in the EODE program report (Balazuc et *al.*, 2016).

VI Conclusion

According to the fact that:

- The TR2 fishery in the North Sea is a mixed fishery financially depending on several species, operating long fishing trips (~3 days in average) at considerable distance from home harbours (more than 1 000 km return).
- Program working on selectivity in North Sea and the Channel showed that it is hard to find a gear that doesn't implies too many commercial loses for the fishermen, but still, selectivity program are still running (REJEMCELEC, DISCARDLESS…) with the aim to test new and existing gears;
- A substantial proportion of the whiting catches is discarded, and its reduction may take several years in the frame of the landing obligation. If an exemption of 7% will help the fishermen to adapt their fishing activity, the selective efforts to set up will still be considerable for the fishermen to reduce their unwanted catches of whiting, as wanted by the new CFP;
- Selectivity efforts for this fishery must be addressed under the new angle of the landing obligation, in a regulatory context that should be deeply modified in the coming years.
- The H2020 Discardless and MINOUW project will give precious information on the way the landing obligation can be dealt by the fishermen;
- De minimis exemptions can provide the flexibility to the fishermen to adapt their behaviour to such new regulation frame, particularly during the first years of the landing obligation implementation.

A de minimis exemption is requested for whiting (*Merlangius merlangus*) up to a maximum of 7 % of the total annual catches, for the trawler fishery using TR2 in ICES area IVa, IVb and IVc.

Estimated volume of discard under 7% de minimis exemption for whiting:

Based on recent French landings data, and only for illustrative and informative purposes, we try to estimate total catches of the french TR2 fleet by applying estimated discard rates per species for French TR2 fleet (CSTEP database, NS Discard Atlas).

In 2017, species that would be subject to landing obligation for TR2 will be: Nephrops, haddock, sole and Northern prawn.

In 2018, whiting and, as bycatches, saithe, plaice and cod (subject to cod plan) will also be subject to landing obligation.

The estimated total catches of those species combined for the French TR2 fleet is 2791 tonnes (cf. Table 3); indeed, Nephrops, sole, Northern prawn and saithe are not caught by French TR2 in the North Sea (only by TR1 for saithe), so they are not included for an estimation of the volume of total catches used to calculate what represents a 7% de minimis exemption for whiting.

A 7% de minimis for whiting on total annual catches of species under landing obligation would thus represent around **195,4 tonnes in 2018** for the French TR2 fleet.

This amount is very limited compared to the whole TAC for whiting in ICES sub areas IIa and IV (13 678 tonnes for 2016).

Such kind of calculation could be performed by other interested MS to obtain an overview at EU level.

Table 3 : estimated total catches of the French TR2 fleet per species under landing obligation

Species under landing obligation in 2018 for TR2 fleet*	Landings 2015 (French national data)	Estimated discard rate of French TR2 fleet (CSTEP data base, 2010-2012 average)	Estimated total catches (discards included) of French TR2 fleet
Haddock - églefin	101,3	1%	102,3
Whiting - merlan	1130,0	46%	1649,8
Cod - cabillaud	522,3	25%	652,9

Plaice - plie	223,1	73%	386,0
TOTAL	1976,7		2791

* Nephrops, sole, Northern prawn and saithe are also species that would be under landing obligation in 2018 but are not caught by French TR2 in the North Sea, so they are not included in this table.

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Annex Ji: Length structure of whiting landings and discards of French bottom trawlers

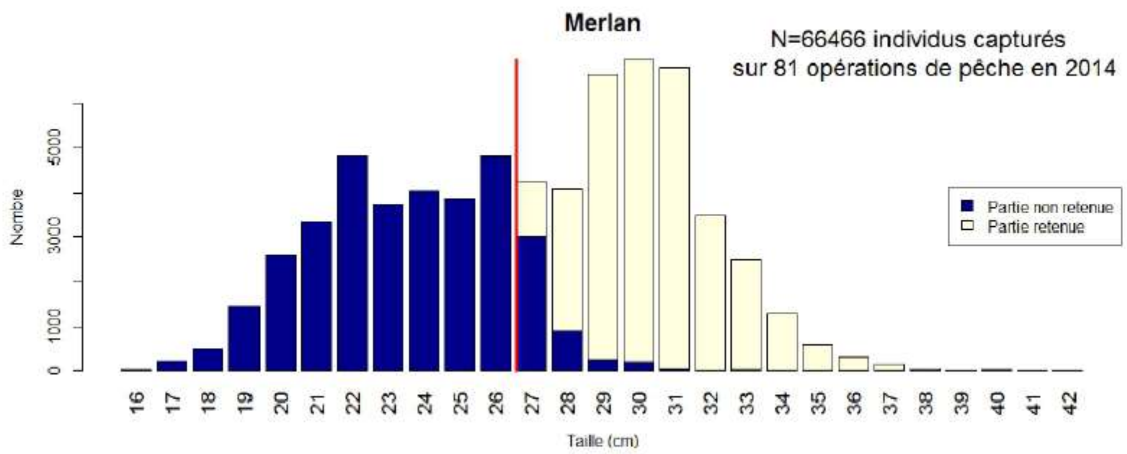

Fig 1. Length structure of whiting landings and discards of French bottom trawlers equal or larger than 18 m and targeting demersal species in the Eastern Channel and the south of the North Sea in 2014 (Cornou et al. 2015). 95% of the whiting discard (in number) were undersized.

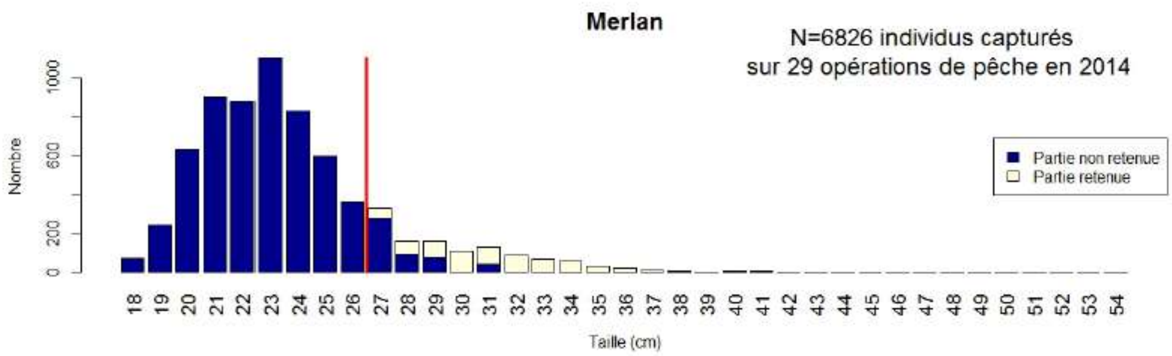

Fig 2. Length structure of whiting landings and discards for French bottom trawlers smaller than 18 m and targeting demersal species in the East of the Eastern Channel and the south of the North Sea in 2014 (Cornou *et al.*, 2015). 92% of the whiting discard (in number) were undersized.

Annex Jii: Sélectivité des chaluts de fond langoustiniers et démersaux : Etat des lieux et perspectives

see file attached

Annex Jiii: Analyse de l'impact économique de la mise en place de l'obligation de débarquement pour les chalutiers de fond : amélioration de la sélectivité, traitement des captures indésirées

see file attached

Annex K: Request for de minimis exemption for fish by-catches in the Pandalus trawl fishery with sorting grid, with unblocked fish outlet

In the framework of the landing obligation in accordance with article 15 of regulation (EU) No 1380/2013, a de minimis exemption is requested for sole, haddock and whiting up to a maximum of 1 % of the total annual catches of species under landing obligation, in the fishery for Pandalus conducted with bottom trawls (OTB) with a mesh size of at least 35 mm equipped with a species selective grid with bar spacing of maximum 19 mm, with unblocked fish outlet, in ICES area IIIa.

The request for an exemption for de minimis is based on article 15.5.c.i), due to difficulties to further increase the highly selective properties of the gear concerned. As Pandalus is the only income for users of this gear, they are particularly vulnerable for the potential losses an increase in selectivity would risk to cause.

Supporting information is included in Annex Ki on:

Management units (types of gears employed)

Catch composition

Discard profile of selected species

Motive

A limited de minimis exemption will cater for catches that are unavoidable, especially in light of the high selectivity of the gear already used in this management unit. Evidently, selectivity is certainly always possible to improve. However, as Pandalus is the only income for users of this gear, they are particularly vulnerable to the economic losses an increase in selectivity is likely to cause. Several studies have looked into possibilities to further improve selectivity in Pandalus trawls, and new studies are currently being underway. Earlier studies have shown that increases in mesh size (or changing to square mesh codends) increases the loss of large shrimp due to a typically relatively wide selection range for Pandalus (Valdemarsen 1989, Valdemarsen et al 1996, Lehman et al 1993, Hickey et al 1993).

Specifying de minimis catch

A de minimis exemption of 1 % for haddock, sole and whiting in 2017 would correspond to total quantities of 5.2 t in 2017 (based on a 2010-2014 baseline of discarded and caught quantities for the species subject to the landing obligation- see annex Ki for specifications). Per species this would mean approximately 1.0 t of haddock, 0,3 t of sole and 3,8 t of whiting in 2017.

It should to be noted that discard values are based on data from the DCF monitoring programme and varies between years to a certain extent, therefore the requested percentage has been set with a small margin (0,1 %) compared to the average discard rate.

Annex Ki: Discards in the Swedish directed *Pandalus* grid trawl fishery and an analysis of possible de minimis exemption for certain fish by-catches

This note presents catch composition and discard profiles in the directed Swedish trawl fishery with species selective grid for Northern prawn (*Pandalus borealis*) in the Skagerrak and Kattegat (area IIIa) for the years 2010-2014. The directed *Pandalus* fishery is here defined by the use of a 19 mm sorting grid without a fish retention device (COM(2015) 7145 final). The paper also explore the basis for exemption in accordance with art 15.4 (c) of Regulation (EC) No 1380/2013, i.e. catches falling under the de minimis exemptions.

Background

Sorting grids use mechanical sorting by size and were originally developed to sort out fish and jellyfish from *Pandalus* shrimp (Isaksen *et al*., 1992), and are now used in commercial shrimp fisheries worldwide (Broadhurst 2000, Catchpole and Revill 2007). The grid developed and used in the Swedish *Pandalus* fishery is identical to the original Nordmøre *Pandalus* grid, with a maximum bar distance of 19 mm (Isaksen *et al*., 1992; Fig. 1). Minimum mesh size is 35 mm. The grid system in use has showed substantial reductions of fish by-catches in shrimp fisheries (Isaksen et al. 1992, Broadhurst 2000). *Pandalus* trawlers in the Skagerrak are since 2013 obliged to use sorting grids but may opt to combine the grid with a fish retention device provided they have adequate fishing opportunities to cover fish by-catch (COM(2015) 7145 final). The fish retention device is however not permitted in Swedish national waters (inside 4 nautical miles from the baseline). In this paper we define the directed *Pandalus* fishery by vessels/trips that use the sorting grid but not the optional fish retention device.

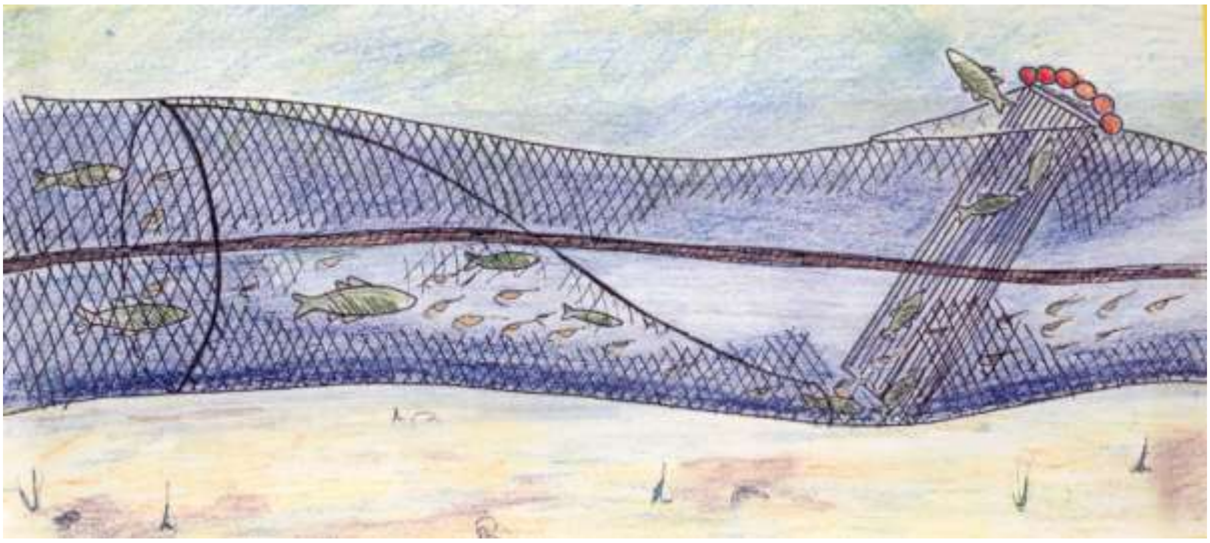

Figure 1. Illustration of a *Pandalus* grid trawl used in the directed fishery. Fish are deflected out of the trawl by the grid (19 mm bar spacing) while *Pandalus* (and some smaller fish) pass trough the grid and enter the codend.

Since the introduction of sorting grids, which solved much of the problems with unwanted fish by-catch, the main discard issue in this fishery concerns the catches of small shrimp but also to a minor extent juvenile fish that pass through the grid. Several studies have looked into possibilities to further improve selectivity in *Pandalus* trawls, and new studies are currently being underway. Earlier studies have shown that increases in mesh size (or changing to square mesh codends) increases the loss of large shrimp due to a typically relatively wide selection range for *Pandalus* (Valdemarsen 1989, Valdemarsen et al 1996, Lehman et al 1993, Hickey et al 1993). The on-going studies are therefore exploring the possibilities for increased selectivity by modifying the design of the grids in order to more efficiently sort out small shrimp (He and Balzano 2012a,b).

The uptake of the grid in the *Pandalus* fishery has gradually increased since the early 2000's (Fig. 2). During 2013-2014, landings by vessels using the grid in directed fishery (i.e. without the fish retention device) averaged 45% of total Swedish *Pandalus* landings in the Skagerrak and Kattegat (Fig. 2). Although the minimum mesh size is 35 mm many Swedish vessels voluntarily use larger mesh sizes in order to reduce catches of small shrimp. In 2015, 69% of the shrimp landings in the directed fishery was fished with trawls using mesh sizes >45 mm according to logbook recordings. By comparison, 38% of shrimp landings from trawlers using a fish retention device was fished with trawls using mesh sizes >45 mm.

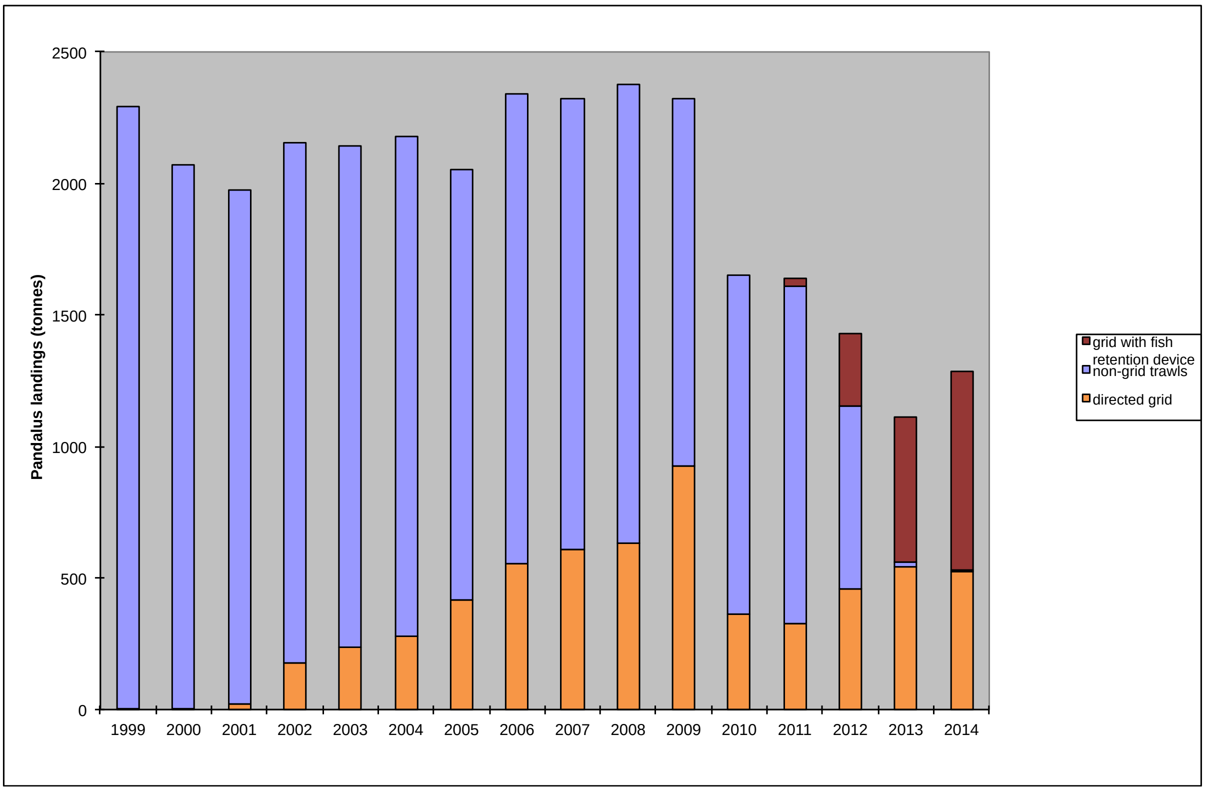

Figure 2. Swedish *Pandalus* landings by gear type in the Skagerrak and Kattegat for the years 1999-2014. Conventional trawls (without grid) were banned in 2013.

The technical specifications of the directed *Pandalus* fishery are well defined in both Swedish and EU-legislation (FIFS 2004:36; COM(2015) 7145 final), and the gear have a specific gear code in the Swedish EU-logbook. Furthermore, scientific catch data is guaranteed as the fishery is handled as a separate stratum in the Swedish DCF (see below).

Catch data

Discard sampling by scientific observers (DCF) has been performed since 2008, with average coverage of app. 12 trips per year. The directed *Pandalus* grid fishery has thus been treated as a separate stratum in a sampling design where sampled vessels are chosen by a randomized process. Catch estimates from this (and other Swedish fisheries) are reported to the STECF-database in accordance with the annual data call (i.e. catch A file format). Catch data for the years 2010 to 2014 for the nine species listed in art 15 of Regulation (EC) No 1380/2013 (phase-in species) are presented in Table 1 below.

Table 1. Estimated discards and catches (landings + discards) in the directed Swedish *Pandalus* grid trawl fleet in area IIIa (the Skagerrak and Kattegat) for the nine species in art 15 of Regulation (EC) No 1380/2013. Swedish DCF-data 2010-2014 (reported to the STECF database).

Discards per species (tonnes)	COD	HAD	HKE	NEP	PLE	POK	PRA	SOL	WHG
2010	0,2	1,1	0,0	0,9	0,1	0,0	49,1	0,0	6,8
2011	6,6	0,7	0,1	1,8	0,5	0,0	67,1	0,0	2,9
2012	0,6	0,9	0,8	2,2	0,3	0,0	128,0	0,0	1,7
2013	0,4	1,7	0,3	0,4	0,8	0,2	110,7	0,0	3,9
2014	0,1	0,2	0,5	2,0	0,0	0,0	230,4	1,5	2,0
average	**1,6**	**0,9**	**0,3**	**1,5**	**0,3**	**0,0**	**117,1**	**0,3**	**3,5**
Catch per species (tonnes)									
2010	2,7	1,2	0,2	3,4	0,1	7,0	412,6	0,0	6,8
2011	6,9	0,7	0,1	3,7	0,5	0,7	393,5	0,0	2,9
2012	1,0	0,9	1,2	5,8	0,3	1,4	573,7	0,0	1,7
2013	1,6	1,8	0,3	6,0	0,9	1,0	671,3	0,0	3,9
2014	1,6	0,2	0,5	6,7	0,0	0,0	741,9	1,5	2,0
average	**2,7**	**1,0**	**0,5**	**5,1**	**0,4**	**2,0**	**558,6**	**0,3**	**3,5**

According to logbooks 2010-2014, *Pandalus* comprised 97 % of total landings in the directed *Pandalus* fishery, compared to 64% in the fishery using grid and fish retention device. Estimated discards of unwanted fish are small in terms of quantity (up to a few tonnes annually; Table 1) and are mainly comprised of individuals smaller than minimum landing size.

<u>Possible de minimis percentages and quantities for by-catch fish</u>

The following calculations are based on the phase-in table with landing obligations per gear category at hand in March 2016. According to this, the 35-69 mm trawl gear category (Northern prawn trawls) in area IIIa will have to land:

• 2016: *Pandalus*

• 2017: *Pandalus, Nephrops*, haddock, sole, and whiting

• 2018: *Pandalus, Nephrops*, haddock, sole, whiting, cod, plaice and saithe

• 2019: All quota species

The analysis presented here focuses on the by-caught fish species planned to be included in the landing obligation in 2017. Analyses of possibilities for de minimis beyond 2017 will likely benefit from being based on updated catch data as these are likely to change the coming years.

Furthermore, the formulation of how the de minimis percentage shall be calculated is not crystal clear in art. 15.4 (c) of Regulation (EC) No 1380/2013, that states "provisions for de minimis exemptions of up to 5 % of total annual catches of all species subject to the landing obligation". STECF (2014a) also commented on this lack of clarity but found no need to prescribe a methodology. The way we have calculated de minimis percentages in this report is by dividing estimated average discards (2010-2014) with catches (landings+discards) for the phased-in species in the actual management unit itself.

Table 2 show the estimated de minimis percentages for the by-catch fish species (haddock, sole and whiting in 2017). The percentages are calculated from the discard- and catch figures presented in Table 1.

Year	2017
exempted sp	HAD, SOL, WHG
Proportion discards exempted species*	
2010	1,9%
2011	0,9%
2012	0,4%
2013	0,8%
2014	0,5%
average	**0,9%**

*discards of (HAD+SOL+WHG)/catch of (HAD+SOL+WHG+NEP+PRA)

Estimated average discards of haddock, sole and whiting in the Swedish directed *Pandalus* grid fishery in area IIIa amounted to 0.9, 0.3 and 3.5 tonnes annually for 2010-2014 (Table 1). Given that these years are representative, unwanted catches of these three species together would correspond to 0.9% of total annual catches of all catches of species subject to the landing obligation in this fishery (Table 2). Available data thus indicate that the previously discarded amounts of by-caught fish species, planned to be phased-in 2017 in the IIIa directed *Pandalus* grid trawl fishery, is smaller than the stipulated percentage (5%) for a de minimis exception in article 15.5 (c) of Regulation (EC) No 1380/2013[17].

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Annex L: Request for de minimis exemption for fish by-catches in the Nephrops creel fishery

In the framework of the landing obligation in accordance with article 15 of regulation (EU) No 1380/2013, a de minimis exemption is requested for sole, haddock and whiting up to a maximum of 0,5 % of the total annual catches of species under landing obligation, in the fishery for Nephrops conducted with creels (FPO) in ICES area IIIa.

The request for an exemption for de minimis is based on article 15.5.c.i), due to difficulties to further increase the selectivity of the gear concerned. As Nephrops is the only income for users of this gear, they are particularly vulnerable for the potential losses an increase in selectivity would risk to cause.

Supporting information is included in Annex Li on:

Management units (types of gears employed)

Catch composition

Discard profile of selected species

Motive

A limited de minimis exemption will cater for catches that are unavoidable, especially in light of the selectivity of the gear already used in this management unit. The Nephrops creel fishery causes minimal impact to the marine habitats, and is a low emission fishery which has expanded since the 1980's in accounts for the uptake of 25 % of the Swedish Nephrops quota. As Nephrops is the only income for users of this gear, they are particularly vulnerable to the economic losses an increase in selectivity is likely to cause.

Specifying de minimis catch

A de minimis exemption of 0,5 % for haddock, sole and whiting in 2017 would correspond to total quantities of 1.8 t in 2017 (based on a 2012-2014 baseline of discarded and caught quantities for the species subject to the landing obligation- see annex Li for specifications). Per species this would mean approximately 0 t of haddock, 0.4 t of sole and 1.4 t of whiting in 2017.

The discard values are based on data from the DCF monitoring programme and varies between years to a certain extent, therefore the requested percentage has been set with a small margin (0,1 %) compared to the average discard rate.

Annex Li: Discards in the Swedish *Nephrops* creel fishery

This note presents catch composition and discard profiles in the Swedish creel fishery for Norway lobster (*Nephrops norvegicus*) in the Skagerrak and Kattegat (area IIIa) for the years 2012-2014. The paper also explores the basis for exemption in accordance with art 15.4 (c) of Regulation (EC) No 1380/2013, i.e. catches falling under the de minimis exemptions.

<u>Background</u>

The creel fishery for *Nephrops* in Sweden developed during the 1980's and initially exploited grounds inaccessible to trawls. Creel vessels are generally smaller than trawlers (most are <12 m), are crewed by one to two and normally fish between 300 and 1000 creels per day. Creels are baited with salted herring or mackerel, are fished in fleets of 25-75 and are attached at intervals of approximately 15 m. The creels are normally emptied and rebaited with two to three days' intervals. At present, around 110 Swedish vessels are engaged in the *Nephrops* creel fishery.

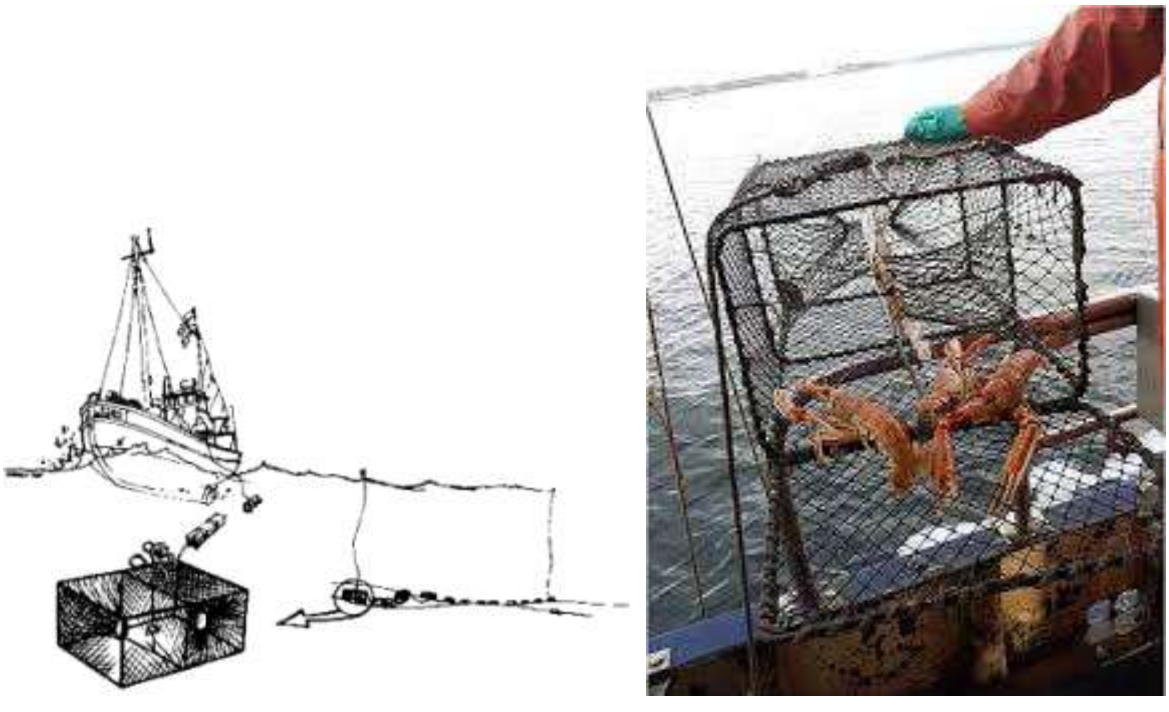

Figure 1. *Nephrops* creel fishery.

The development of the *Nephrops* creel fishery in Sweden shows a gradual increase since the introduction in the early 1980's (Fig. 2). During the last five years, landings by creel vessels averaged 25% of total Swedish *Nephrops* landings in the Skagerrak and Kattegat. The number of creel fishers and their effort increased further when an increased area closed to trawling was introduced in 2004 (Sköld *et al.,* 2011; Fig. 2).

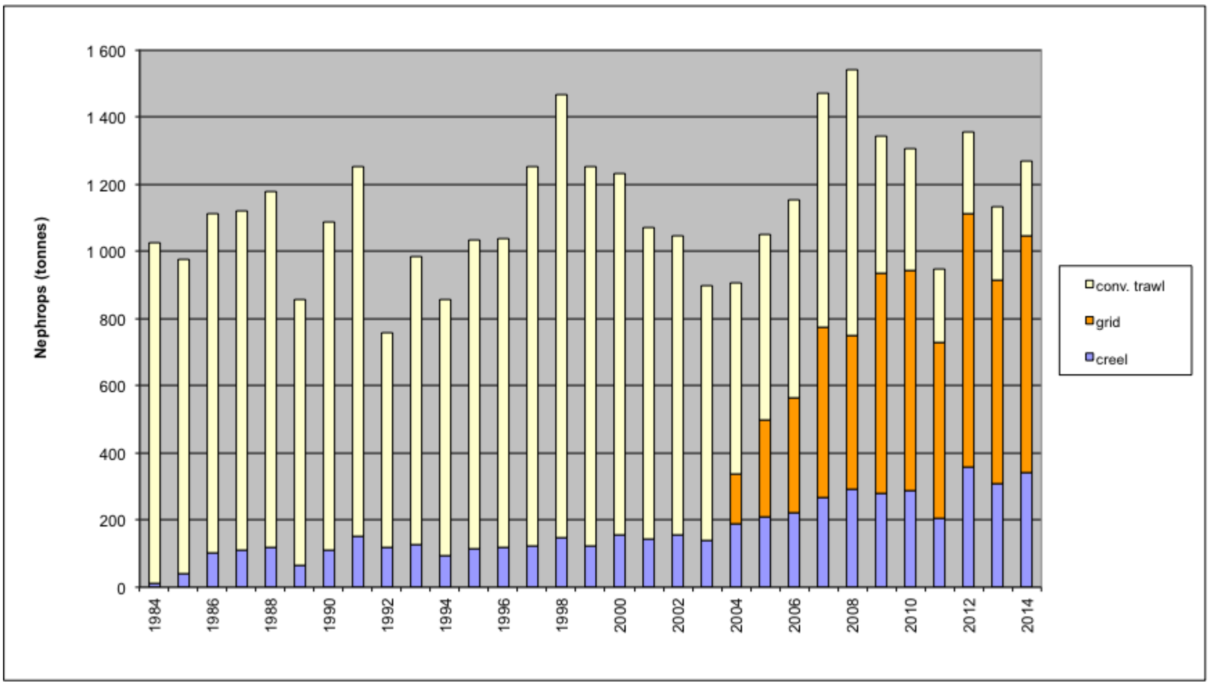

Figure 2. Swedish *Nephrops* landings by gear type in the Skagerrak and Kattegat for the years 1984-2014. The creel fishery was introduced in Sweden in 1984 and now constitutes around 25% of total Swedish landings.

Previous studies on *Nephrops* fisheries have shown that creel fishing has lower environmental impacts compared to trawling in terms of discards, fuel use and impact on benthos (Jansson, 2008; Ziegler and Valentinsson, 2008). Creel-caught *Nephrops* also normally implies higher prices than trawl-caught ones; these are in general of larger sizes and better quality than trawl-caught ones (Adey, 2007, Hornborg et al. in press).

Creel use has been promoted by national incentives such as an increased quota share (25% of the Swedish quota is set aside for creel catches) and access to commercially important *Nephrops* areas that are closed to trawls. EU-logbook and national logbooks for the smaller vessels provides for controllability and possibilities for follow-up. Furthermore, scientific catch data is guaranteed as the creel fishery is handled as a separate stratum in the Swedish DCF.

Today creel and grid trawl fishers exploit roughly the same areas closer to the coast, i.e. areas where grid trawling is the only trawl practice allowed (Anon. 2010); however, creeling and trawling may not exploit the exact same area simultaneously due to incompatibility of the fishing methods. Figure 3 shows the spatial distribution of the creel fishery in area IIIa during 2015.

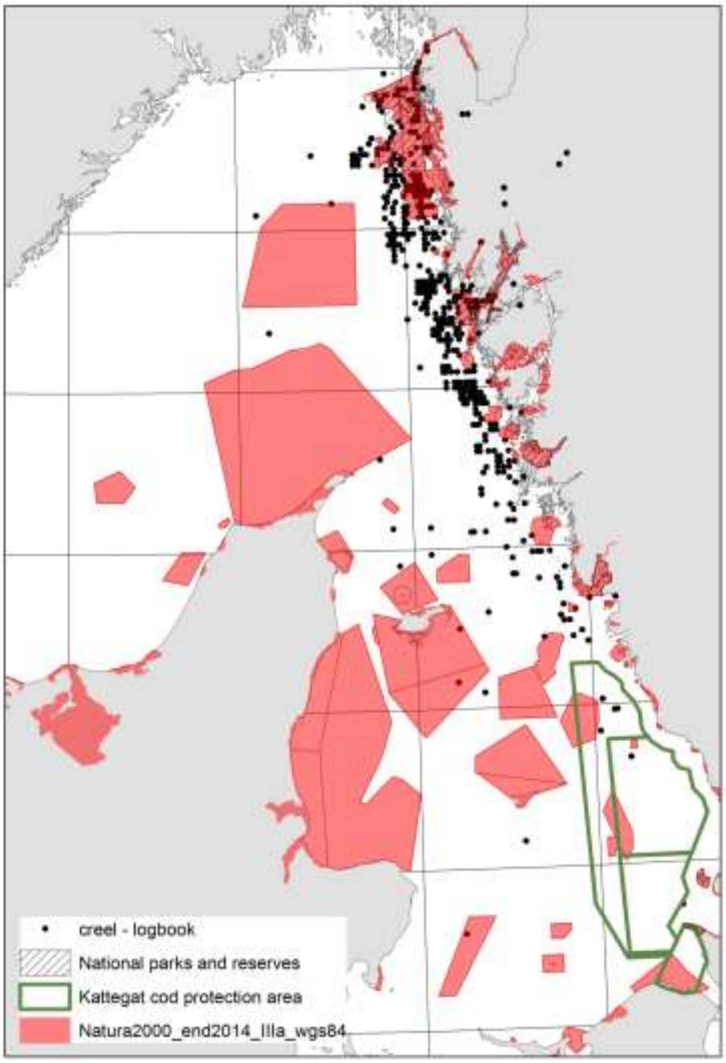

Figure 3. Spatial distribution of the *Nephrops* creel fishery in the Skagerrak and Kattegat during 2015. Data is based logbook positions (as the majority of vessels are not covered by VMS). Shown is also Natura 2000- and cod protection areas in the Kattegat.

Catch data

Discard sampling by scientific observers (DCF) has been performed since 2005, with an average coverage of approximately 12 trips per year. The *Nephrops* creel fishery has been treated as a separate stratum in a sampling design where sampled vessels are picked out in a randomized process. Catch estimates from this (and other Swedish fisheries) have been reported to the STECF-database since 2012 in accordance with the annual data call (i.e. catch A file format). Catch data for the years 2012 to 2014 for the nine species listed in art 15 of Regulation (EC) No 1380/2013 (phase-in species) are presented in Table 1 below.

Table 1. Estimated discards and catches (landings + discards) in the *Nephrops* creel fishery in area IIIa (the Skagerrak and Kattegat) for the nine species in art 15 of Regulation (EC) No 1380/2013. Swedish DCF-data 2010-2014 (reported to the STECF database).

Discards per Species (tonnes)	COD	HAD	HKE	NEP	PLE	POK	PRA	SOL	WHG
2012	42,2	0,0	0,0	59,2	0,0	0,0	0,0	0,0	1,5
2013	25,8	0,0	0,0	27,3	0,1	1,0	0,0	0,0	2,0
2014	8,8	0,0	0,1	36,1	0,0	0,1	0,1	0,9	0,0
average	**25,6**	**0,0**	**0,0**	**40,9**	**0,0**	**0,4**	**0,0**	**0,3**	**1,2**
Catch per Species (tonnes)									
2012	43,5	0,0	0,0	417,2	0,0	0,0	0,0	0,0	1,6
2013	27,7	0,0	0,0	306,4	0,1	1,1	0,0	0,0	2,2
2014	9,8	0,0	0,1	375,6	0,0	0,1	0,1	0,9	0,0
average	**27,0**	**0,0**	**0,0**	**366,4**	**0,1**	**0,4**	**0,0**	**0,3**	**1,3**

According to logbooks 2012-2014, *Nephrops* comprised over 99 % of total landings with *Nephrops* creels (a figure not possible to calculate from Table 1 as not all caught species are included). *Nephrops* and cod are the two dominating species in the discard fraction. Remaining species are only caught and discarded in small quantities, particularly when considering that around 2.5-3 million creels are hauled per year.

Possible de minimis percentages and quantities for by-catch fish

The following calculations are based on the phase-in table with landing obligations per gear category at hand in March 2016. According to this, the pots and trap gear category in area IIIa will have to land:

• 2016: *Nephrops*, *Pandalus*

• 2017: *Nephrops*, *Pandalus* haddock, sole, and whiting

• 2018: *Nephrops*, *Pandalus* haddock, sole, whiting, cod, plaice and saithe

• 2019: All quota species

The analysis presented here focuses on by-caught fish species to be included in the landing obligation in 2017. Analyses of possibilities for de minimis beyond 2017 will likely benefit from being based on updated catch data as these are likely to change the coming years.

Furthermore, the formulation of how the de minimis percentage shall be calculated is not crystal clear in art. 15.4 (c) of Regulation (EC) No 1380/2013, that states "provisions for de minimis exemptions of up to 5 % of total annual catches of all species subject to the landing obligation". STECF (2014a) also commented on this lack of clarity but found no need to prescribe a methodology. The way we have calculated de minimis percentages in this report is by dividing estimated average discards (2010-2014) with catches (landings+discards) for the phased-in species in the actual management unit itself.

Table 2 The estimated de minimis percentages for the by-catch fish species (haddock, sole and whiting in 2017). The percentages are calculated from the discard- and catch figures presented in Table 1.

Year	2017
exempted sp	HAD, SOL, WHG
Proportion discards exempted species*	
2012	0,4%
2013	0,7%
2014	0,2%
average	**0,4%**

*discards of (HAD+SOL+WHG)/catch of (HAD+SOL+WHG+NEP+PRA)

Average estimated discards of haddock, sole and whiting in the Swedish creel fishery in area IIIa amounted to 0, 0.3 and 1.2 tonnes annually for 2012-2014 (Table 1). Given that these years are representative, unwanted catches of these three species together would correspond to 0.4% of total annual catches of all catches of species subject to the landing obligation in this fishery (Table 2). Available data thus indicate that the previously discarded amounts of by-caught fish species, planned to be phased-in 2017 in the IIIa creel fishery, is smaller than the stipulated percentage (5%) for a de minimis exception in article 15.5 (c) of Regulation (EC) No 1380/2013[18].

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Annex M: Technical conservation measures for ICES area IIIaN (Skagerrak)

In order to stimulate further development of gear selectivity this joint recommendation shall be reviewed if gears having at least equivalent selectivity to the gears set out in paragraph 1, including the selection devices attached to those gears, are identified. For this purpose such selectivity shall be confirmed by experimental fishing trips and by an assessment from the Scientific, Technical and Economic Committee for Fisheries (STECF).

Specifications of fishing gears

1. The carrying on board or the use of any trawl, Danish seine, beam trawl or similar towed net having a mesh size of less than 120 mm shall be prohibited.

2. By way of derogation from paragraph 1,
   a. Trawls with at least 90 mm cod end equipped with a square mesh panel of at least 140 mm or a diamond mesh panel of at least 270 mm may be used provided the panel is:
      i. A minimum of 3 meters in length.
      ii. The panel should be positioned no more than 4 meters from the cod line.
      iii. Be the full width of the top sheet of the trawl (i.e. from selvedge to selvedge): and
      iv. In the case of the diamond mesh, the panel be placed in a four panel section and mounted with a joining ration of 3 meshes of 90 mm to 1 mesh of 270 mm.
   b. Trawls with at least 70 mm square mesh cod end equipped with a sorting grid with no more than 35 mm bar spacing may be used.
   c. Trawls with at least 90 mm cod end equipped with a sorting grid with no more than 35 mm bar spacing may be used.
   d. Trawls with at least 35 mm cod end may be used when fishing for Pandalus, provided the trawl is equipped with a sorting grid with a maximum bar spacing of 19mm.

      The use of a fish retention device is allowed provided that there is adequate fishing opportunities to cover by-catch and that the retention device is:
      i. Constructed with a top panel of a minimum mesh size of 120 mm square mesh;
      ii. A minimum of 3 meters in length.
      iii. At least as wide as the width of the sorting grid.
   e. Trawls with minimum mesh sizes of less than 70 mm may be used when fishing for pelagic or industrial species provided the catch contains more than 80% of one or more pelagic or industrial species.

Annex N: List of Vessels subject to a landing obligation determined by threshold criteria

- Table A of this Joint Recommendation include landing obligations that will only apply where a vessel has had landings of saithe above the relevant percentage threshold in the years 2013-2015 for the management year 2017. Vessels subject to the landing obligation for saithe during 2016, shall remain subject to the landing obligation for saithe during 2017.
- A Flag Member State shall determine the vessels that meet the threshold criteria designated for a particular fishery and which are, therefore, subject to the landing obligation for that particular fishery.
- The Flag Member State shall compile lists of all such vessels and the landing obligation(s) applicable to those vessels.
- Vessels to which the threshold criteria do not apply are not required to be included on the lists.
- Each Flag Member State shall transmit its lists to the secure part of the relevant EU website by 1 January 2017.
- A vessel is deemed to be subject to the Landing Obligation if it meets one or more of the definitions set out in Table A.
- The inclusion of a vessel on a list on the secure part of the relevant EU website shall be evidence (unless the contrary is shown) that that vessel is subject to a Landing Obligation determined by threshold criteria only.
- The exclusion of a vessel from a list on the secure part of the relevant EU website shall be evidence (unless the contrary is shown) that the vessel is not subject to a landing obligation determined by threshold criteria only.
- A vessel not on the list may be subject to one or more of the landing obligations in Table A which are not determined by threshold criteria.