



Fisheries management controls for dab in The North Sea

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Summary

- Dab is a **highly productive, widespread, abundant flatfish** in the North Sea and Skagerrak.
- Dab **matures at a young age and small size**, ensuring a reasonable proportion of the spawning stock biomass is not selected by the main fisheries catching dab.
- It is a **bycatch species** with no targeted fishery, **mainly discarded** by most métiers in the North Sea.
- The **low price** of dab means other flatfish species are favored by the fishery.
- Total Allowable Catches (**TACs**) **have never limited total catch** of the stock.
- Despite the previous lack of stock specific management for dab, the stock is currently, and has been in the past, in **good condition**. Dab is currently classified as a species of '**Least Concern**' on the IUCN red list of threatened species.
- Under a **landings obligation**, the quantity of dab caught and the difficulty in avoiding catching dab could lead to significant problems for the métiers catching dab e.g. by becoming choke species or impacting on operations of fishing vessels (e.g. space limitations). Given the high rate of discarding of dab, despite a low discard survival, total fishing mortality would be higher (~10%) if all caught fish were landed.
- Putting dab in a **grouped bycatch TAC** would likely prevent the effective control of the exploitation of other, less abundant bycatch species included in the group.
- The **control regulations for the target species** (e.g. sole, plaice, cod) in the fisheries mostly having dab as bycatch have led to a reduction in fishing effort since 2003, and are likely to be sufficient to prevent the overexploitation of dab.
- **Stock specific output controls (i.e. TAC) for dab seem ineffectual and unnecessary** in the North Sea and Skagerrak.
- In the absence of a TAC for this stock, the **condition of the stock would still need to be monitored** to ensure that it is not driven out of safe biological limits. This necessitates good data collection.

Introduction

Dab is a widespread demersal flatfish species that is one of the most abundant demersal species in the North Sea (Daan et al. 1990; ICES 2015a). With its depth range extending down to 100 m, and occasionally deeper, dab is found all over the shallow North Sea, but is most common in the south eastern parts (Lozán 1988; Daan et al. 1990). Dab is a bycatch species, mainly caught in the south in mixed fisheries targeting sole and plaice, and in the north in mixed fisheries targeting demersal roundfish such as cod and haddock. It is among the most discarded fish species in the North Sea. In the beam trawl fishery on sole about 90% of the catches of dab are discarded (e.g. van der Reijden et al. 2014).

Depending on the stock being managed and the nature of the fisheries exploiting it, either input or output controls or a combination of both are used to prevent the unsustainable exploitation of fish stocks, and to maintain the economic viability of fisheries. Input controls regulate the access to fish resources, while output controls regulate the removals of fish resources. Input controls include effort limitations, spatial or temporal restriction and technical measures. Output controls mainly take the form of Total Allowable Catches (TACs) limiting the amount of fish from a particular stock that can be landed each year or fishing season. The effectiveness of chosen control measures depends on a number of factors:

- The quality of the scientific advice underpinning the chosen controls.
- The ability to enforce enacted controls.
- The population dynamics and life history of the species being caught.
- The nature of the fishery exploiting the stock.
- The impact of controls applied for other fish stocks caught by the fishery.
- Economic conditions (e.g. costs, prices).

TACs are set for most commercial fish stocks in European waters, including dab. The proposed TACs are based on scientific advice on the stock status from advisory bodies such as the International Council for the Exploration of the Sea (ICES) and the Scientific, Technical and Economic Committee for Fisheries (STEFCF). The North Sea stock of dab is assessed by ICES in Subarea IV (North Sea) and Division IIIa (Skagerrak). Currently, there is no analytical stock assessment model available as a basis for scientific advice for dab (WGNSSK; ICES 2015a). With official landings, only three years of discard data (2012-2014), and survey data are available, dab is defined as a category 3 species according to the ICES guidelines for data limited stocks (ICES, 2012): advice is given based on survey trends.

This document examines the current management controls affecting dab in the North Sea, and the impact of current and future fisheries management controls on the sustainable exploitation of this stock. In particular, the need for a TAC to ensure sustainable exploitation of dab in the North Sea is evaluated.

Management of dab in the North Sea

Current management

The primary fisheries management control applied to dab in the North Sea is an annual TAC. The EU TAC for dab (Figure 1) is defined for the EU waters in Subarea IV and Division IIa (Norwegian Sea) and is a combined TAC together with flounder (*Plathichthys flesus*). Since ICES considers the North Sea dab stock to extend into Division IIIa, for which there is no TAC, this means that the TAC does not cover all areas in which the dab stock is caught. This TAC has been in place since 1998. However, it has never constrained the total amount of dab landed (Figure 2a). Dab landings peaked at 60% of the combined TAC in 2007, and since then have decreased to about one third of the available TAC. Even when combined dab and flounder landings are considered, no more than 90% of the available TAC has ever been landed. Moreover, no individual country with dab quota is fully utilizing their dab quota on a regular basis (Figure 2b). The Netherlands, the country with the biggest quota share (Figure 1), has never utilized more than 60% of their quota. France has apparently exceeded their quota only once but given their small share in absolute terms this is only an insignificant amount of the dab landings. This indicates that the TAC for dab in the North Sea has never been effective in exerting any control on the amount of dab caught.

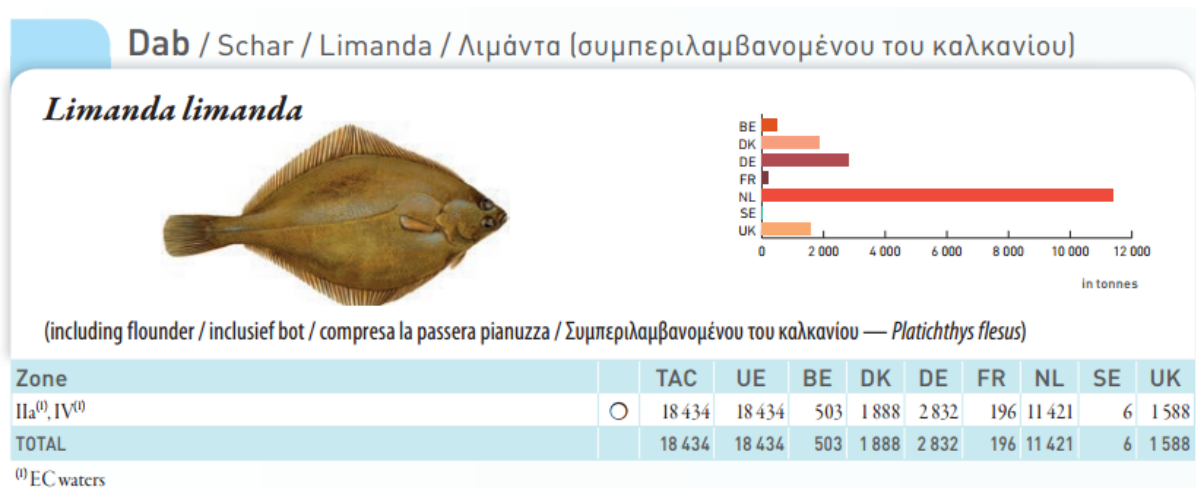


Figure 1. Dab and flounder TAC and country shares for 2015, as fixed by the EU Council Regulations (EU) No 1221/2014 of 10 November 2014, No 1367/2014 of 15 December 2014, No 2015/104 of 19 January 2015, and No 2015/106 of 19 January 2015. Changes may be made during 2015 (http://ec.europa.eu/fisheries/documentation/publications/poster_tac2015_en.pdf).

There are no specific fishing effort regulations that are related directly to the dab stock in the North Sea. However, a number of other regulations and management plans do apply fishing effort restrictions on most of the métiers executing the mixed fishery in the North Sea. In particular, the long term management plan for the sole and plaice stocks in the North Sea (Council Regulation 676/2007) includes a cap on the total amount of effort by the beam trawl fleet in the North Sea and the cod management plan (Council Regulation 1342/2008) includes effort controls for all métiers catching significant quantities of cod. There is no minimum landings size (MLS) for dab in the EU, though in the Netherlands producer organisations have a self-imposed MLS of 23cm, which is based on market demand. Other countries have similar national MLSs, such as Belgium (also 23cm) and the UK (20cm).

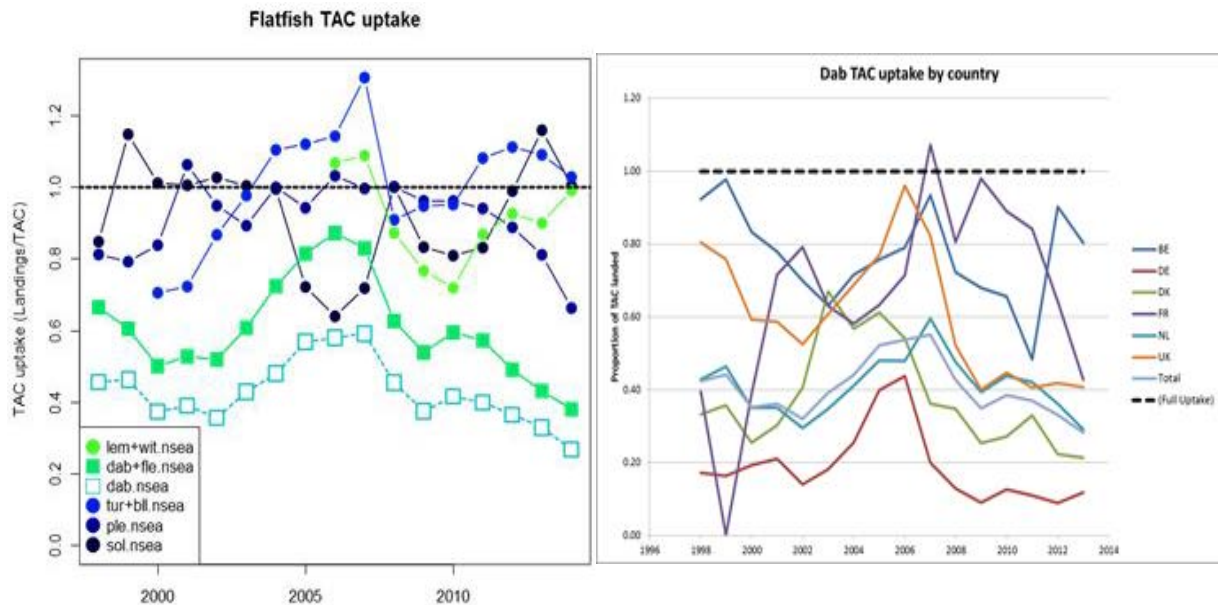


Figure 2(a-b). a) The uptake of TACs (Landings/TAC) of flatfish stocks in the North Sea (=1 implies full utilisation, <1 implies underutilisation). Dab landings compared to the combined dab and flounder TAC are presented (dab.nsea) as well as the combined dab and flounder landings compared to the combined TAC (dab+fle.nsea). Single stock TACs are in place for sole (sol.nsea) and plaice (ple.nsea), and combined TACs for lemon sole and witch flounder (lem+wit.nsea), turbot and brill (tur+bll.nsea). b) Uptake of TACs by country assuming the same relative stability as 2014 for all years, not accounting for international quota swaps.

Possible implications of the new Common Fisheries Policy (CFP) on mixed fisheries

The new Common Fisheries Policy (CFP), Council Regulation (EU) No 1380/2013 (EU, 2015), has established as one of its objectives the elimination of discarding through the introduction of a landing obligation. This change in regime serves as a driver for more selectivity. To allow fishermen to adapt to the change, the landing obligation will be introduced gradually, between 2015 and 2019 for all commercial fisheries (species under TACs, or under minimum landings sizes) in European waters. Under the landing obligation all catches have to be kept on board, landed and counted against the quotas. Undersized fish cannot be marketed for human consumption purposes.

Further, the CFP should ensure that fishing activities contribute to long-term environmental, economic, and social sustainability. Management decisions relating to maximum sustainable yield in mixed fisheries should take into account the difficulty of simultaneously achieving maximum sustainable yield for all stocks in a mixed fishery. This is particularly problematic when it is very difficult to avoid the phenomenon of choke species (species for which limited quota are available in a fishery, but which still would need to be landed) by increasing the selectivity of the fishing gears used.

Since dab is under a TAC, from 2019 onwards all dab caught will have to be kept on board. The current discarding rate is very high (~90% of the total catch is discarded e.g. van der Reijden et al. 2014). This is in part due to the widespread distribution and high abundance of dab making it difficult to effectively avoid catching it. Under a landings obligation this will lead to various practical difficulties for the fishery. Buisman et al. (2013) predicted that this new regulation will lead to increased operating costs for the fishery (particularly the beam trawl sector), in part due to the requirement to land large quantities of low value bycatch species, such as dab. Further details on the financial implications of the landings obligation on the Dutch fleet can be found in Buisman et al. (2013).

Additionally, the new CFP foresees the prioritisation of management measures in the context of multi-annual plans (MAPs; Article 9), though harvest control rules (HCRs) have been removed from the legislation. Recently STECF carried out quantitative analyses assessing the biological, economic and social consequences of implementing the various possible options for a proposed MAP covering the demersal fisheries in the North Sea (STECF, 2015). It was assumed that this MAP will in future replace the existing EU multi-annual plans for cod and for sole and plaice.

Resilience of dab to exploitation

Despite relatively few effective management controls for dab through the 1980s and 1990s, observations of the abundance of dab from the International Bottom Trawl Survey (IBTS) increased during the 1980s and remained at a relatively high CPUE throughout the time series (Figure 3). Though there is currently no analytical stock assessment for dab, the high abundance of dab in the hauls of the IBTS (dab is one of the most commonly caught species throughout the range of the IBTS, Figure 4) provide a robust indicator of changes in stock size. As a result, dab is currently classified as a species of 'Least Concern' on the IUCN red list of threatened species (last reviewed in 2014; Monroe et al. 2014).

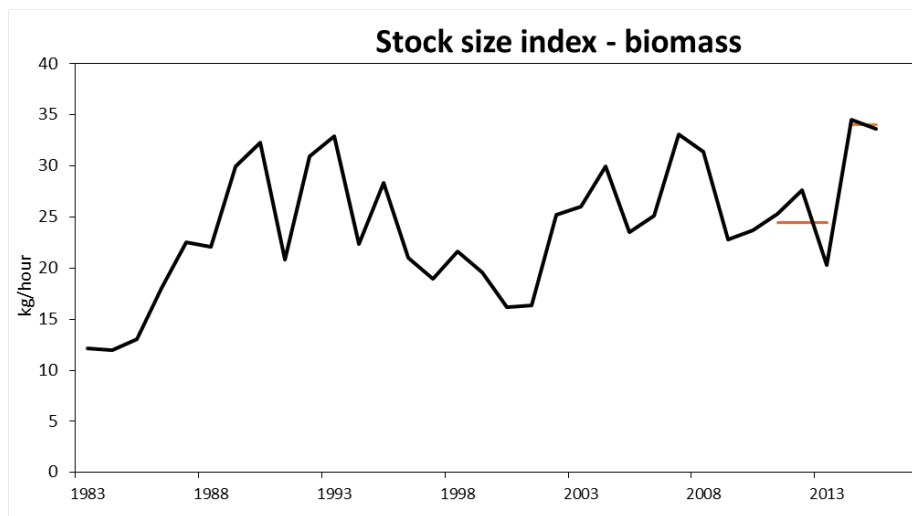


Figure 3: Dab in Subarea IV and Division IIIa. Mature biomass index for Subarea IV and Division IIIa (kg hour^{-1} , from IBTS Q1). The red lines indicate the average of the last two years and the preceding three years – the ratio between these two is used under Category 3 of the ICES data-limited stocks approach to adjust fishing opportunities for the next year. (Source: ICES advice 2015, Section 6.3.7.)

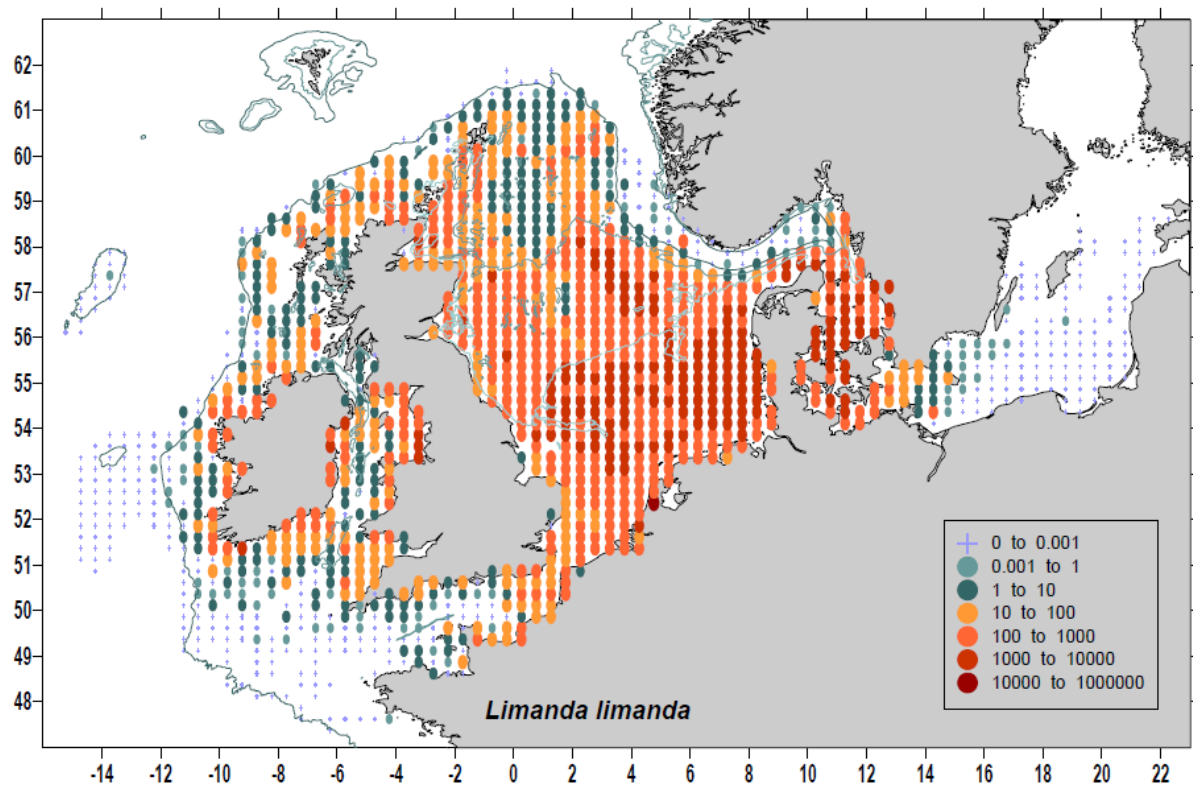


Figure 4. Abundance of dab observed by scientific surveys in and around the North Sea (Source: Heessen, H.J.L. , N. Daan, and J.R. Ellis. *In press*. Fish Atlas of the Celtic Sea, North Sea and Baltic Sea).

Various explanations have been made for why the dab population is able to remain relatively stable despite the lack of direct management (for an overview see Kaiser and Ramsay, 1997):

- Intensive fishing following World War II has reduced the population size of predatory species that feed on dab (e.g. cod, Daan et al. 1990, Greenstreet & Hall 1996).
- Dab are highly opportunistic feeders (Hinz et al., 2005), this makes the species more resilient against potential reductions in the biomass of specific food types since they can easily adapt by (temporarily) changing their diet.
- Eutrophication through anthropogenic activities prior to the 1990s lead to an increase in the abundance of prey, specifically the brittlestar (*Amphipura* spp.) in the North Sea (Duineveld et al. 1987, Lindley et al. 1995), which are an important component in the diet of dab (Duineveld & van Noort 1986).
- Bottom trawling disturbs the seabed, exposing various epi- and infauna species (including brittlestars) to scavenging species such as dab. Dab are known to aggregate in recently trawled areas (Kaiser & Spencer 1994, 1996) and it has been shown that dab increase their intake of food by feeding in areas disturbed by fishing activities (Kaiser and Ramsay, 1997). This benefit of increased food availability for dab generated by fishing activities may indirectly counter the direct negative effects of bycatch mortality.
- Whilst dab does not grow very rapidly, compared to other demersal flatfish it is an intermediate grower and has a population doubling time of about 1.4–4.4 years (Froese and Pauly, 2015).
- Dab has a maximum life span of about 12 years and sexual maturation is achieved at a small size, reaching 50% maturity in 2 to 3 years at approximately 11 to 14cm total length (Figure 5), with females maturing slightly later than males. In comparison, the length at 50% retention of dab in 80mm beam trawl nets has been estimated to be in the range of 14-16cm (Figure 5, Depestele et al., 2009), while this would be even larger for 120mm otter trawl nets. Hence, this maturation at a relatively small size allows dab the opportunity to spawn before becoming fully selected by the fishery.
- Pope et al. (2000) used extended length cohort analysis and models founded on life history parameters to estimate the impact of fishing activity on the mortality of non-target bycatch species, focussing on dab and grey gurnard. They found that spawning potential was eroded

rather little by the levels of fishing mortality in 1977-1983. They concluded that it would take an unrealistic increase in F (279 times) to reduce the stock to an unsafe level. In practice, since then fishing effort has decreased significantly and is unlikely to return to the high levels of the early 1980s.

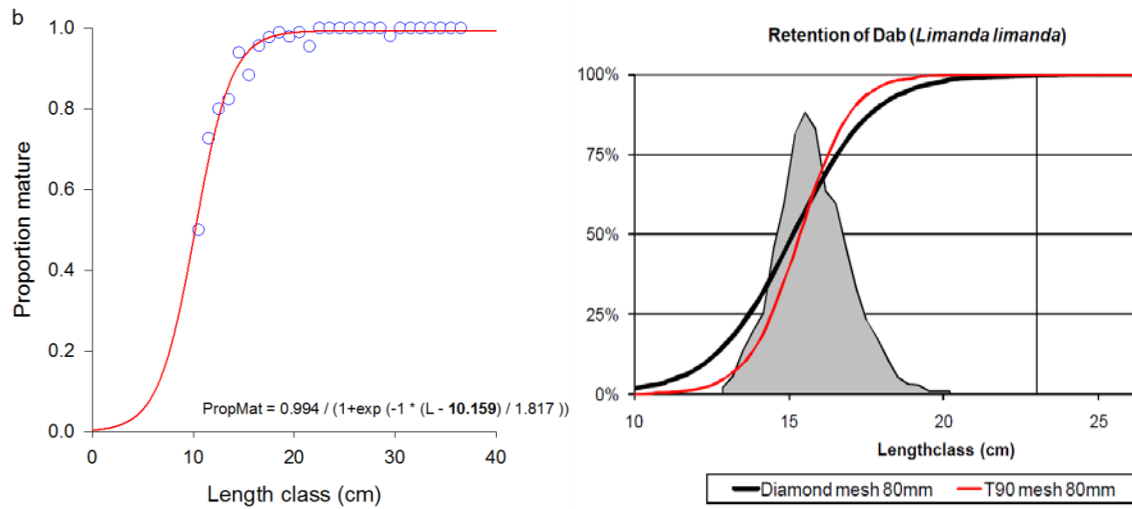


Figure 5. Left: The proportion of mature dab by length (source: WGNSSK report, ICES 2015a). Right: The selectivity of a beam trawler using a standard 80mm commercial cod-end and an 80mm T90 cod-end for dab (from Depestele et al., 2009).

Factors besides fishing may in future impact on the dab population in the North Sea. For example, intense warming of the European continental shelf in the last 30 years, and predicted future changes, are likely to result in changes in the distribution and abundance of many North Sea demersal fishes (see e.g. Rutterford et al., 2015). The shallower waters in the southern North Sea are expected to experience the warmest summer temperatures in future, and while in the past North Sea fish preferring cooler waters have shifted to deeper waters (Dulvy et al., 2008; van Hal et al. 2015), recent work suggests that there are limits to further distribution changes since habitat of suitable depth has already been exhausted (Rutterford et al., 2015). As such, the summer abundance of dab is predicted to show a large reduction in the long term (beyond 2050; Rutterford et al., 2015). However, such impacts are also expected to be seen in other target and bycatch demersal species such as haddock, plaice, saithe, lemon sole etc. As such, fisheries management in future will have to adjust for these potential changes regardless of whether or not there are stock-specific controls in place for dab.

The mixed fisheries catching dab in the North Sea

History of landings and catch

Dab is a bycatch species in almost all fisheries for plaice, sole, and demersal round fish. Through the 1970s, 1980s and 1990s landings of dab were in the region of 10 000t or higher (Figure 6; note: Dutch and Norwegian data are missing for periods of the 1980s and 1990s). Since 1999 there has been a steady decrease in the landings of dab. The majority of the landings in ICES Subarea IV is taken by the Netherlands, followed by UK and Denmark. Denmark takes most of the catch in Division IIIa (data not shown). Figure 7 shows the total catches from ICES Subarea IV and Division IIIa submitted to ICES from 1964 to 2014. Discards data have only been included since 2012. Total catches seem to be increasing but discards are poorly estimated so we cannot conclude this definitively.

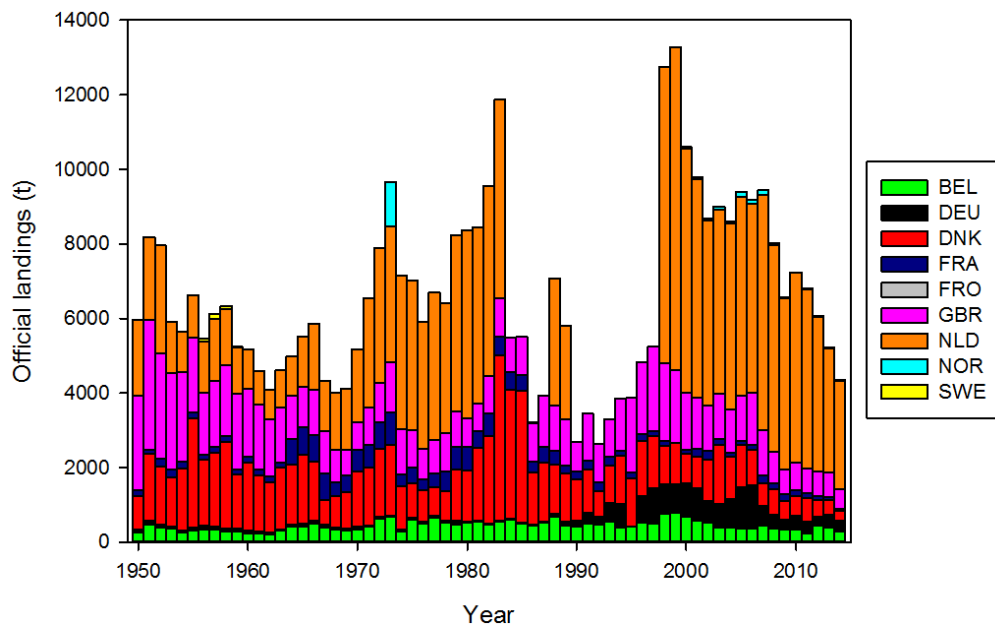


Figure 6: Official landings of dab in Subarea IV by country in 2014 (Source: ICES, 2015a). Note: The apparent decreases in official landings in the 1980s and 1990s are due to unreported catches by the Netherlands and Norway.

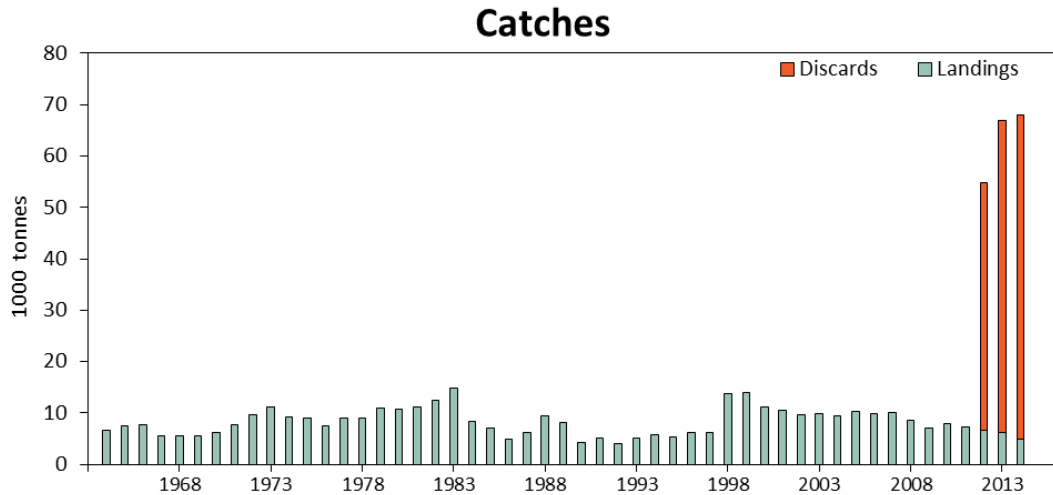


Figure 7. Dab in ICES Subarea IV and Division IIIa. Official landings and estimated discards (in tonnes); Dutch landings were not recorded between 1984 and 1997. Discards data have only been included since 2012 (Source: ICES Advice 2015).

Métiers catching dab in the North Sea and Skagerrak

According to ICES (WGSSK; ICES, 2015a) the TBB métier with small mesh sizes (70-99 mm; corresponding to STECF gear code BT2) is the main fleet landing dab in ICES Subarea IV and Division IIIa (Figure 8). While it is caught by many different métiers, none specifically target dab. Since dab is so widespread and abundant in the North sea, it is probably one of the most discarded fish species in ICES Subarea IV (WGSSK; ICES, 2015a). Figure 9 shows that the majority of discards are caught in the beam trawl fishery on plaice, on sole, and the otter trawl fishery on plaice and nephrops.

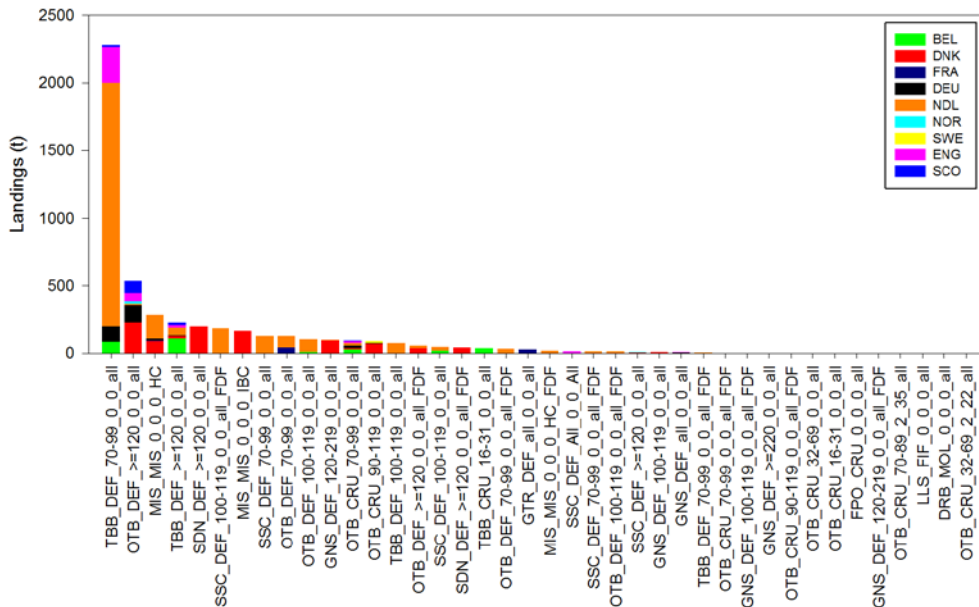


Figure 8. Dab landings for Subarea IV and Division IIIa by métier and country in 2014 as uploaded to InterCatch (WGSSK; ICES, 2015a).

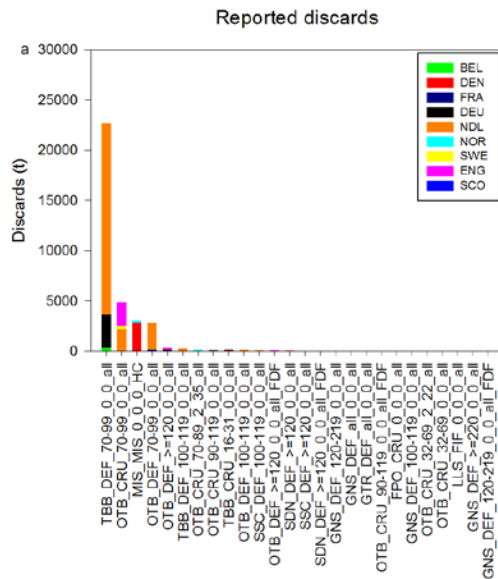


Figure 9. Reported dab discards for Subarea IV and Division IIIa by métier and country in 2014 as uploaded to InterCatch (WGNSSK; ICES, 2015a).

Data from the ICES working group on mixed fisheries advice for the North Sea (WGMIXFISH-NS, ICES 2015b; Figure 10) show that most métiers operating in the greater North Sea have catch compositions made up of a number of commercially important target and bycatch species. These data only consider ten commercially important fish and crustacean (nephrops) stocks that have high quality quantitative assessment models. However numerous influential stocks are included, such as cod, sole, plaice, which have specific management plans governing their exploitation in the North Sea. Of the métiers catching the most dab, the BT2 métier derives a large proportion of its value from sole while most of the landings are of plaice, while the TR1 métier derives most of its value from demersal groundfish stocks (e.g. cod, haddock and saithe) and has mixed landings of groundfish and some flatfish (e.g. plaice) stocks. Further descriptions of the regulations controlling these métiers are described in the Discussion section.

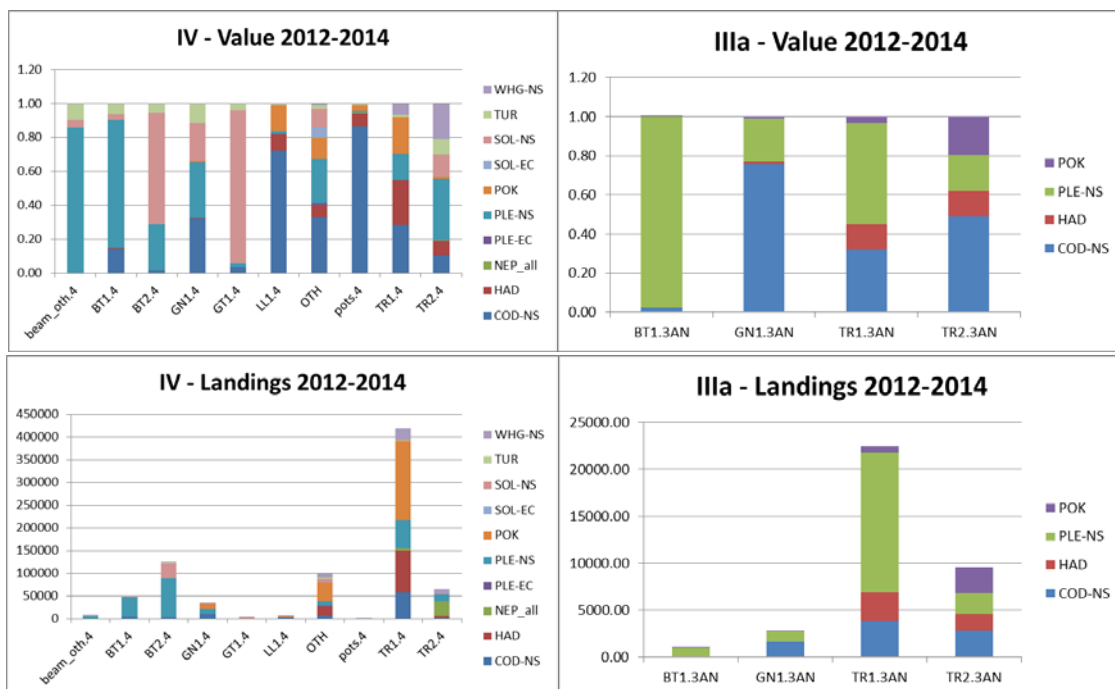


Figure 10. Relative value (top) and total landings (bottom) of the ten stocks considered by WGMIXFISH (ICES, 2015b) for the different métiers operating in the North Sea (Subarea IV, left) and the Skagerrak (Division IIIa, right). Note: 95% of dab landings come from Subarea IV, and the remaining 5% from Division IIIa.

The overall regulated fishing effort in the North Sea and Skagerrak has decreased since 2003 (STECF, 2014). Figure 11 shows the total regulated fishing effort and the effort of the two fisheries mostly catching dab: 80-120mm beam trawl (BT2) and >100mm bottom trawls and seines (TR1). Prior to 2003 fishing capacity and effort in the North Sea was much higher, though no official data are available. In the absence of targeting behavior, exploitation rates of bycatch species tend to correlate well with the amount of fishing effort. This means that the exploitation rate of dab is likely lower now than it has been in the preceding decades.

In addition to the decrease in effort, the introduction of the omega meter in 2010 would have led to a slight increase in mesh sizes in the beam trawl métier (BT2), slightly decreasing the selectivity for small dab. There is no EU minimum landing size for dab but some countries have a market-based minimum landing size. Almost all of the dab discarded in the Dutch demersal fleet is smaller than 23 cm (Figure 12) and only a small part of the catch is above 23 cm. Dab discards are mainly discarded because of low commercial value.

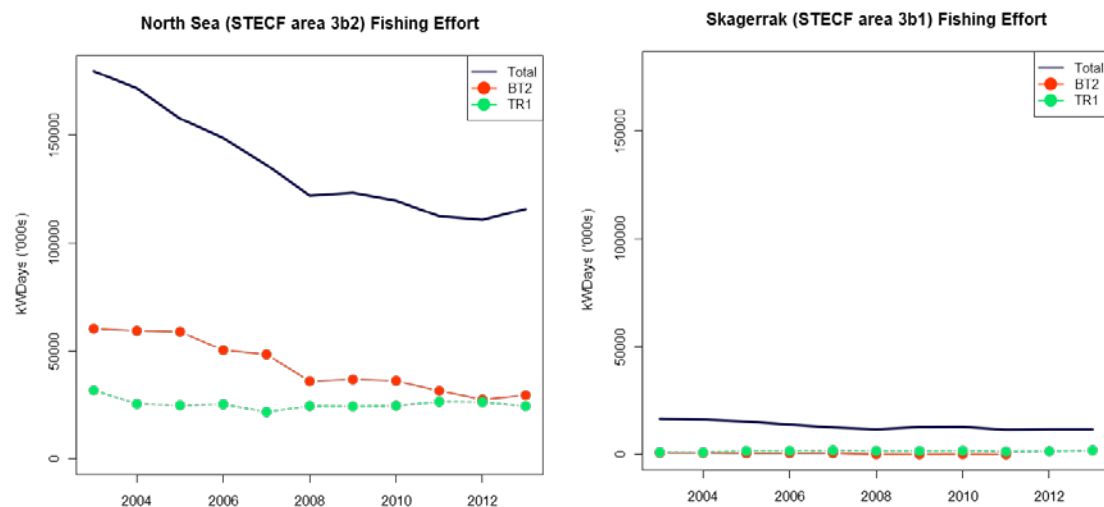


Figure 11. Fishing effort of the two main métiers catching dab (BT2, red; and TR1, green) and total fishing effort for the North Sea and the Skagerrak for 2003-2013 (data from STECF, 2014).

Discard survival

Since dab is mainly discarded it is necessary to take into account the survival rate of dab discards to estimate fishing mortality. Kaiser and Spencer (1995) found that at most 24% of captured dab in trawls survive. Additionally, preliminary results from a recently conducted survival study show an average of 14.9% (8.2%-22.4%) survival of dab after 25 days (P. Molenaar, IMARES, pers. comm.). The study however was conducted just after spawning when dab is not fully recovered yet. These results indicate that survival is likely low and makes dab ineligible for exemption of the landings obligation on the basis of high survivability. Nevertheless, given that currently up to 80-90% of all caught dab are discarded, assuming only a 10-15% discard survival would imply that landing all dab would increase total fishing mortality on the stock of approximately 10% i.e. total fishing mortality would be higher if all catches needed to be landed.

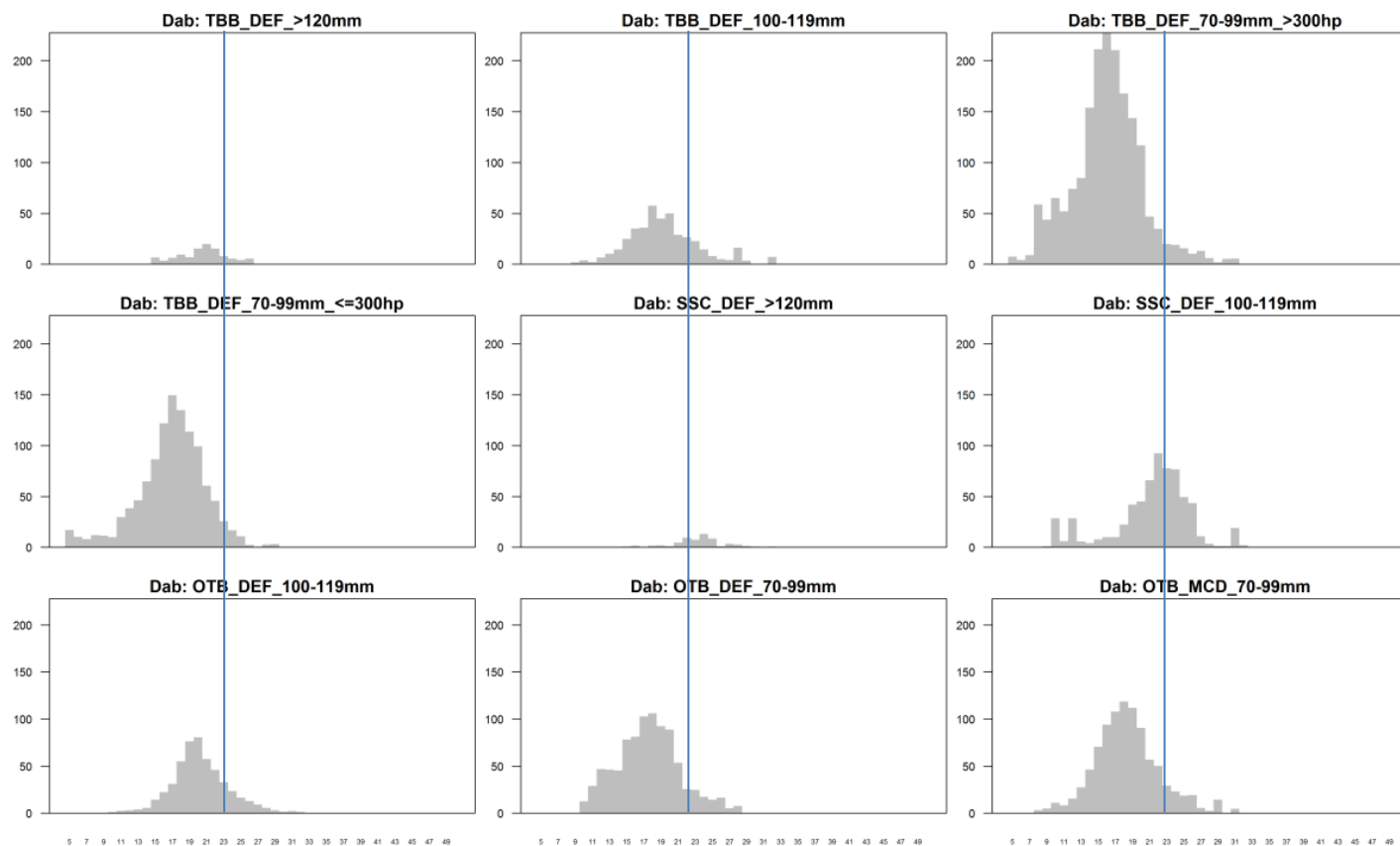


Figure 12. Length distribution of dab discards from the Dutch demersal fleet (van der Reijden et al., 2014). The blue vertical lines indicate the Dutch minimum landings size for dab (23 cm). Gear types: TBB = beam trawl, SSC = seine, OTB = otter trawl; Fishery type: DEF = demersal fish, MCD = mixed demersal fish and crustaceans (nephrops).

Changes in the North Sea beam trawl fishery

In recent years the main Dutch métier catching dab (BT2, beam trawlers targeting sole) has adopted several significant changes with regards to their fishing gears. The most important change has been the gradual introduction of the pulse trawls since the mid-2000s (Figure 13). These pulse gears catch flatfish by electrically stimulating them off the bottom and are effective at slower fishing speeds. These changes have resulted, among others, in a changing catchability for dab.

A recent paper by van Marlen et al. (2014) conducted a comparative fishing experiment with one vessel using conventional beam trawlers, and two other vessels using pulse trawls. The total catch in the pulse trawls was considerably lower, only 37% of the conventional trawl. The discards of the main target species are also lower, for plaice the ratio by hectare was 62%, and for sole 46%. Furthermore a simulation of data collected under the Dutch discards monitoring programme examined the effect of a total transition of the beam trawl fleet to pulse trawls (Goudswaard et al., 2015). Results show a decrease of almost 20% in the volume of discards of dab (Figure 14) but a higher volume of sole, the main target species and most important factor currently driving effort in the Dutch beam trawl fleet. This means less dab is caught per unit of sole in a pulse trawl fleet.

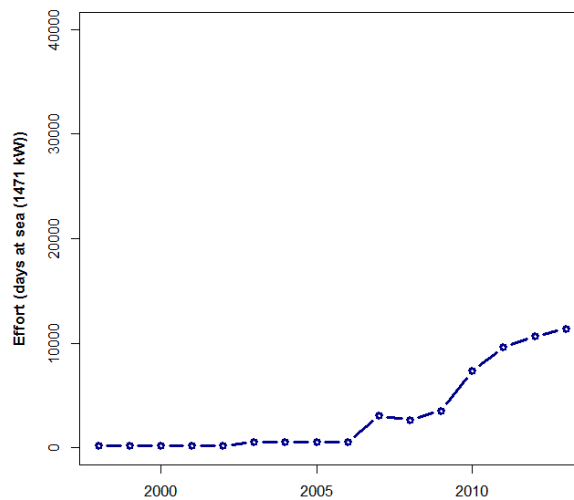


Figure 13: Effort from beam trawlers fishing with pulse gears (Goudswaard et al., 2015).

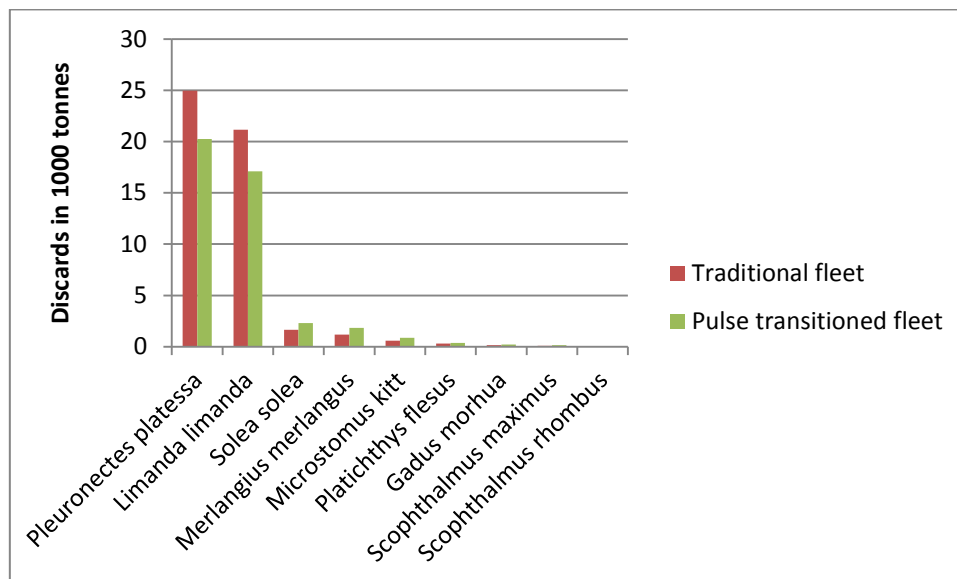


Figure 14. Representation of the total volumes of discards ('000 t) from traditional beam trawlers (red) and pulse trawlers (green) for several demersal species (Goudswaard et al., 2015).

Market factors

In 2013, dab accounted for 4% of the Dutch demersal landings by weight but only 1% of the total value of this sector. Ex-vessel prices (the prices received by fishers at the point of landing) for dab are relatively too low to make it economically interesting for targeting (Figure 15). For the fleets catching dab, the additional revenues generated from bycatch species depend greatly on the prices at which they can be sold, since these need to compensate for the extra costs incurred in landing the dab (Buisman et al., 2013). The low prices for dab generate few additional revenues, and as such most dab are currently discarded.

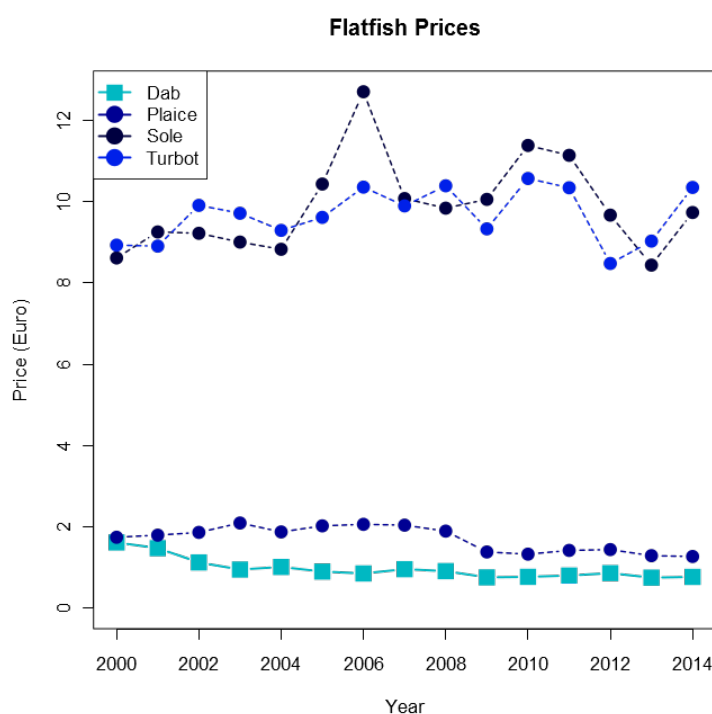


Figure 15. Annual ex-vessel prices per kilogram for four of the main flatfish species in the Netherlands. Sources: auction prices from Productschap Vis. (2000-2013); Ministerie van Economisch zaken (2014).

Though there is no EU minimum landings size for dab, producer organisations apply their own minimum landing size, essentially creating no market for small dab. This has led to high discarding of dab below these sizes (Figure 12). Under a landings obligation small dab would need to be landed but would likely receive an even lower price due to flooding of the market with less favorable sizes.

Currently even plaice, for which the Dutch have a large quota in the North Sea and which has a higher price than dab, is not being fully landed (ICES, 2015a). So in the short term it would be highly unlikely that a significant increase in landings of dab would be wanted by the fishery unless prices were to rise significantly. In the United Kingdom, reports indicated that the credit crisis led to an increase in the demand for cheap fish, with dab in particular seeing a 47% increase in British sales in 2008¹. The launch of the 'Fish Fight' campaign² in 2010 led to an increase in promotion of less common fish, in particular dab was promoted as an alternative over other flatfish³. As a result major supermarket chains in the UK

¹ <http://www.telegraph.co.uk/finance/financialcrisis/3416533/Unpleasant-tasting-fish-makes-dinner-table-comeback-because-of-credit-crisis.html>

² <http://www.fishfight.net/>

³ <http://www.theguardian.com/environment/2011/jan/17/sustainable-seafood-supermarkets-fish-fight> and <http://www.thegrocer.co.uk/fmcg/dab-and-mackerel-get-new-boost-from-hugh/215539.article>

reported significant increases in sales of dab up to 120% following the launch⁴. Even after these large increases in demand, total North Sea landings of dab have decreased significantly, indicating that these market changes have not impacted on the overall fishers behavior.

Dab remains a species that lacks the popular appeal of stocks such as sole, turbot or plaice. Additionally, there is no real processing industry for dab in the Netherlands, and this fish is harder to process into fillets than the abundant plaice (Pim Visser, VisNed, *pers. comm.*). Hence, it would be unlikely that a moderate increase in dab price would lead to a significant change in the behavior and level of fishing pressure exerted on the stock by the Dutch beam trawl fleet.

⁴<http://www.theguardian.com/environment/2012/aug/02/sustainable-fish-sales-surge>

Discussion

At present in the North Sea the primary management control applied specifically to dab is part of a combined TAC. Even though this TAC does not cover the full distribution area of the stock, the comparison of landings vs TAC since 1998 (Figure 2) indicate that this output control has never effectively limited the catches of dab for any country with fishing opportunities for this stock. In the Netherlands, fishing opportunities for sole and plaice and a self-imposed MLS from the producer organisations has likely had more impact on limiting the amount of landed dab. Since dab is almost exclusively a bycatch species, no specific input controls related to the North Sea dab stock are applied to any métiers catching dab. However, input controls of the main target species (e.g. sole, plaice and cod) have indirectly limited the impact of these métiers on the dab stock.

The appropriateness of TACs as a mechanism to control dab exploitation

There is no specific legal requirement within the CFP that states that all stocks should be managed using a TAC (EU, 2015). In fact, in European waters in the Mediterranean Sea basin most fisheries are managed by input controls only. Other common species in the North Sea (e.g. grey gurnard) also do not have TACs. However, since the memorandum of understanding between the EU and ICES calls for advice on annual fishing opportunities for all EU-relevant stocks in the ICES area, ICES provides TAC advice for dab.

This biennial TAC advice is given using the ICES approach for data limited stocks (DLS, Category 3) on the basis of survey trends and official landings (ICES advice 2015). ICES raised doubts concerning the applicability of the data-limited approach for this stock due to concerns regarding the input data (WGNSSK; ICES 2015a). The survey indices display large interannual variability and estimates of uncertainty are not incorporated in the advice rule. Further, previously the advice based on landings was considered meaningless for a species such as dab with very high, unquantified, discards. In 2015 ICES gave catch advice for dab by 'topping up' the landings advice by the expected discard rate, however these discard estimates have high uncertainty.

Dab is scheduled to be benchmarked by ICES (i.e. develop an analytical assessment) in 2016. However, the lack of annual discard estimates over the history of the fishery, combined with the very high discard rate, means that the quality of total catch estimates for this stock will be poor and will likely impact on the accuracy of any traditional age-based stock assessment model.

Besides the difficulty in informing appropriate TACs, ICES has also in the past advised the use of TACs for bycatch species may not be appropriate (e.g. ICES advice 2014). This was particularly true because prior to 2015 discarding of unwanted catches was permitted. Hence a TAC limiting landings of a bycatch species would only impact the marketable quantity of the stock that could be sold, but would effectively have no impact on the amount of the stock that could be caught. Additionally, having a TAC for more than one stock prevents the effective output control of either of the species covered since preferred (economically more attractive) species could be landed more while less favoured species could be discarded to prevent them using up the available combined TAC. However, under a landings obligation this would not be possible and the amounts of each stock landed would depend on the catchability of each stock relative to the fishery.

TACs based on MSY are advised for most commercial valuable target species in the North Sea. In most cases these are informed by data rich, well developed assessment models and reference point analyses. Even so, TACs purely based on single species biological considerations may end up generating discordant TACs for stocks caught in mixed fisheries (i.e. TACs for caught stocks may not be in agreement with the relative availability of each stock to the fishery). In such cases TACs may not correspond to the reality of fish stocks and their exploitation (Astorkiza and del Valle, 2013). Given that dab currently has no analytical assessment model and has TACs based on advice from the ICES approach to data-limited stocks, the likelihood of inappropriate catch limits is higher than for well-studied, data rich stocks.

Fortunately, in the absence of effective output controls or any stock specific input controls, the dab stock in the North Sea is apparently in a healthy condition. There are a number of ecological and economic factors that enabled the dab stock to be robust to past high levels of exploitation pressure and most of these factors (e.g. opportunistic feeding, limited targeted fisheries, maturation at a small size) are likely to continue to allow dab to be productive in future, especially since fishing effort of the main métiers catching dab has decreased significantly since the 1990s.

Under a landings obligation, 'balancing' TACs and management targets of many stocks will be a significant challenge in the development of mixed fishery management plans (STECF, 2015). The whole process could be simplified by reducing the number of bycatch species under output controls. If this can be done while still maintaining these stocks in a healthy, sustainable condition, there would be fewer potential 'choke' species impacting negatively on the economic viability of the fisheries. One proposed option to achieve this would be to group a number of (similar) bycatch species under a single TAC. However, any such group TAC including dab would have to be very large in relation to the stock sizes of most other bycatch species to account for the likely large catches that can be sustainably taken from the highly abundant and widely distributed dab stock in the North Sea.

The low price of dab is presumed to not be enough to outweigh the costs of landing this species (e.g. fuel costs, labour costs, opportunity costs of landing dab vs other species; Quirijns and Pastoors, 2014). Despite some increase in the profile of dab in some European markets, the landings of dab by most countries have actually decreased (despite a stable TAC) over the last decade. This indicates that the optimum yield for this stock is most likely less than the *maximum* potential yield from this stock (i.e. MSY). Appropriate management should take into account both biological considerations (i.e. sustainable stocks) and economic criteria (relating to the fisheries exploiting these stocks). Ecologically it is important to ensure that the dab stock remains within safe biological limits, but this does not necessarily need to be achieved through maximizing the catch from the stock. In the absence of a TAC for dab, the low 'wanted' yield, in combination with target species management controls indirectly controlling the exploitation rate of dab, are likely sufficient to ensure the avoidance of a high level of targeted fishing pressure that could threaten the sustainability of the stock.

Alternative management controls for dab

Given the current nature of the North Sea fisheries, and the current healthy condition of the dab stock in the North Sea, removing output controls for dab is unlikely to lead to over-exploitation of the stock. However, future ecological, environmental or fishery changes may lead to the dab stock declining. At lower biomass, introducing mechanisms to try directly control the exploitation level of dab may be appropriate.

In practice this could be implemented by defining precautionary biomass limit points on the basis of a (yet to be developed) assessment model or for index CPUEs (e.g. IBTS or BTS survey time series). Below this limit reference point a restrictive TAC or effort limitation could be introduced. Above this level target species control regulations should be sufficient to ensure the sustainable exploitation of dab. The prospect of further controls at a low biomass would also provide motivation for fishers to reduce catches of dab when the stock is perceived to be declining.

Another alternative is to set a high unrestrictive TAC above the biomass limit point, but this still necessitates the need to land all dab caught under the landings obligation, significantly impacting on the economic viability of fisheries catching it.

Potential implications of removing the TAC for dab

Removing a TAC for dab will simplify mixed fisheries management, but may lead to a perception of increased risk of overexploitation in the absence of catch controls. Monitoring the stock condition in relation to a biomass limit reference point provides a safety net to allow fishing restrictions during low productivity phases. However, biological and economic factors described in this report suggest the threat of overexploitation would not increase significantly with no output controls for dab. This is in large part due to the existing regulations and controls in place for the main target species caught in North Sea demersal fisheries. Tables 1 and 2 describe the main target species and control regulations applying to these stocks that exist at present in ICES Subarea IV (Table 1) and Division IIIa (Table 2). The two main métiers landing dab, BT2 and TR1, are well regulated through TAC controls for target species (both EU TACs and EU-Norway management agreements) and effort controls through management plans.

The BT2 métier lands mainly sole and plaice and is economically dependent on sole to a large degree. Both these species are managed under an EU management plan (EC 676/2007) that constrains fleet effort through restrictive TACs and, following a period of effort reduction, caps the effort level for the BT2 fleet at the 2012 level. The most common mesh size used by this métier (80mm) only selects dab fully after the size at first maturity, minimizing its impact on the dab reproductive potential.

The TR1 métier has a diverse catch composition, including a number of commercially important demersal stocks, such as cod, saithe, plaice, haddock and whiting. All of these stocks have relatively well-informed TACs and, specifically under the EU long-term plan for cod stocks and the fisheries, effort restrictions have been frequently imposed and are currently capped at the 2012 level. The larger mesh size of this métier (>120mm) also has an even smaller impact on the spawning potential of dab than the BT2 métier.

Management controls for flounder, currently part of a shared TAC with dab, would need to be amended as well. Flounder could have a species-specific TAC or be included with other flatfish species in a group TAC, if output controls are still wanted. A report by CEFAS (Catchpole and Le Quesne, 2011) identifying underutilized species in the waters surrounding the UK, indicated both dab and flounder as underutilized species in the North Sea. Using a rapid, data-limited, life history parameter based method to assess vulnerability to exploitation, the report further concluded that flounder would be less vulnerable to overexploitation than dab, and that both of these species were comparatively less vulnerable than the reference data-rich species, haddock. This quick method assumed a knife edge selectivity at age one (i.e. all fish older than 0 are equally selected). This over-simplification therefore does not account for the fact that dab resilience is largely based on the fact that mature fish are not fully selected. Flounder, which are larger than dab, mature at approximately 25 cm, so the current fisheries in the North Sea would in theory have a higher selectivity of mature flounder than mature dab. However, spatial overlap between the fisheries and the brackish water species flounder is much lower than for dab. Nevertheless, it seems flounder, which is also mainly caught as a bycatch species by the BT2 métier targeting sole and plaice (80% of all landings), likely also has limited need for a TAC to ensure sustainable management. Similar to dab, flounder also has poor market demand and a similar management history of ineffective catch controls. At present, an IBTS index of mature biomass of flounder indicates that the stock is below the high abundance levels of the late 1980s and early 1990s, yet remains stable with no clear indication of overexploitation (ICES advice, 2015).

Other concerns and challenges with the removal of a dab TAC include:

- If discarding of dab is allowed, enforcing the retention of other flatfish species may be difficult.
- Collection of catch data. Discards estimates will still be required to monitor the condition of the stock and the impact of the fishery on it.
- Relative stability of countries quota shares will no longer apply. Countries that currently have low quota shares may increase their catches of dab in the absence of a TAC.
- Potential arrival of new players fishing dab. Under a landings obligation this is unlikely to be possible since it is difficult to target dab specifically and under the landings obligation fishers will require quota shares of the other species caught in the mixed fishery.
- Getting fisheries accreditation (e.g. MSC) for dab may be compromised, since proving appropriate management may be difficult according to existing standards.

Table 1. Summary of dab catches and target species for métiers catching Dab in the North Sea (ICES Subarea IV, ~95% of North Sea dab landings) for the years 2012-2014. Métiers are ranked in decreasing order of quantity of dab landed. Data on dab landings and discard rates comes from ICES Intercatch outputs for the North Sea dab stock (ICES, 2015a). Data on target species value and landings are taken from WGMIXFISH (ICES, 2015b), which only considers cod, haddock, nephrops, plaice, saithe, sole, turbot and whiting.

Métier	Dab		Target species						Input and output management regulations controlling the métier	Notes
			Top stocks by value			Top stocks by biomass landed (%s indicate proportion of total landings of the stock in Subarea IV)				
(STECF métier code)	Proportion of dab landings in Subarea IV	Dab discard rate* (dis/cat)	Val 1	Val 2	Val 3	Land 1	Land 2	Land 3		
BT2 (beam trawls with <120mm mesh)	49%	93%	SOL	PLE	TUR	PLE (37%)	SOL (72%)	TUR (38%)	<ul style="list-style-type: none"> • EU TACs** for PLE, SOL, other flatfish species, and smaller shares of other demersal groundfish stocks. • EU Multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Council Regulation No. 676/2007) • Main landed species will fall under the new EU multi-annual plan for the North Sea demersal stocks (under development) • Technical measures: minimum mesh size of 80mm 	<ul style="list-style-type: none"> • TAC for sole has been limiting in recent years, and a further slight decrease in F is still required to reach the MP target. • Fishing effort is capped at the 2012 level • In certain years effort restrictions from the cod management plan have applied to this métier • 80mm mesh size only selects dab larger than the size at first maturity
TR1 (bottom trawls and seines with >100mm mesh)	23%	51%	COD	HAD	SAI	POK (76%)	HAD (78%)	PLE (27%); COD (66%); WHG (59%)	<ul style="list-style-type: none"> • EU TACs** for POK, HAD, COD, WHG, amongst others. • EU long-term plan for cod stocks and the fisheries (Council Regulation No. 1342/2008) • EU-Norway management strategies for POK and WHG • Main landed species will fall under the new EU multi-annual plan for the North Sea demersal stocks 	<ul style="list-style-type: none"> • EU cod management plan includes effort regime controls for all métiers catching significant amounts of cod • TR1 accounts for the majority of the landings for several important North Sea demersal

									<ul style="list-style-type: none"> (under development) Technical measures: minimum mesh size of 120mm applies in certain areas 	<ul style="list-style-type: none"> stocks EU-Norway management strategies for COD and HAD no longer applied given changes in stock assessment models and stock areas (HAD) Large mesh size selects fewer mature dab than the BT2 métier
Other	9%	-	COD	PLE	POK	POK (18%)	HAD (16%)	COD (9%)	<ul style="list-style-type: none"> Some 'other' métiers (e.g. pots) are covered by the cod management plan 	<ul style="list-style-type: none"> Low catches have a limited impact on the abundant dab stock
TR2 (bottom trawls and seines with 70-100mm mesh)	8%	97%	NEP	PLE	WHG	NEP (84%)	PLE (6%)	WHG (21%)	<ul style="list-style-type: none"> EU TACs** for nephrops, PLE EU-Norway management strategies for WHG EU Multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Council Regulation No. 676/2007) 	<ul style="list-style-type: none"> Mainly targeting nephrops, some bycatch of flatfish and other demersals
BT1 (beam trawls with >120mm mesh)	5%	8%	PLE	COD	TUR	PLE (18%)	COD (5%)		<ul style="list-style-type: none"> EU TACs** for PLE, COD and other demersal species EU Multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Council Regulation No. 676/2007) EU long-term plan for cod stocks and the fisheries (Council Regulation No. 1342/2008) 	<ul style="list-style-type: none"> Large mesh size selects fewer mature dab than the BT2 métier
GN (Gill nets)	3%	23%	COD	PLE	SOL	POK (5%)	PLE (4%)	COD (11%)	<ul style="list-style-type: none"> EU TACs** for POK, PLE, COD and other demersal species EU long-term plan for cod stocks and the fisheries (Council Regulation No. 1342/2008) 	<ul style="list-style-type: none"> Low catches have a very limited impact on the abundant dab stock
BT shrimp (small mesh beam)	3%	>99%	Brown shrimp			Brown shrimp	Some limited flatfish landings for vessel owners with quota shares for these		<ul style="list-style-type: none"> EU regulation for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms (Council Regulation 	<ul style="list-style-type: none"> All fishers operating in the EU brown shrimp fisheries use selective gear to reduce discarding of fish

trawls)									species	No 850/98)	<ul style="list-style-type: none"> • Since 2002 the use of sievenets is obligatory (reduces catches of >10cm fish) • Some discarding of juvenile dab still occurs • Large majority of vessels fish for shrimp only, some alternate between flatfish and shrimp fishing • Low catches have a limited impact on the abundant dab stock 	
GT (Trammel nets)	1%	8%	SOL	TUR	PLE/ COD	SOL (4%)	PLE (<1%)	COD (<1%)				
TR3 (bottom trawls and seines with 16-32mm mesh)	<1%	-	Crustaceans			Crustaceans						<ul style="list-style-type: none"> • Low catches have a very limited impact on the abundant dab stock
LL (Longlines)	<1%	28%	COD	POK	HAD	COD (3%)	POK (1%)	HAD (1%)				

* Discard proportions are based only on fleet segments (i.e. countries) with reported data for both discards and landings.

** 'EU TACs'. For 2015 the following regulations apply: [Council Regulation \(EU\) 2015/960](#) of 19 June 2015 amending Regulation (EU) 2015/104 as regards certain fishing opportunities (**measures concerning *inter alia* sea bass**); [Council Regulation \(EU\) 2015/523](#) of 25 March 2015 amending Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities; and [Council Regulation \(EU\) 2015/104](#) of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in **Union waters and, for Union vessels, in certain non-Union waters**, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014.

Table 2. Summary of dab catches and target species for métiers catching Dab in the Skagerrak (ICES Division IIIa, ~5% of North Sea dab landings) for the years 2012-2014. Métiers are ranked in decreasing order of quantity of dab landed. Data on dab landings and discard rates comes from ICES Intercatch outputs for the North Sea dab stock (ICES, 2015a). Data on target species value and landings are taken from WGMIXFISH (ICES, 2015b), which only considers cod, haddock, nephrops, plaice, saithe, sole, turbot and whiting.

Métier	Dab		Target species						Input and output management regulations controlling the métier	Notes
			Top stocks by value			Top stocks by biomass landed (%s indicate proportion of total landings of the stock in Division IIIa)				
(STECF métier code)	Proportion of dab landings in division IIIa	Dab discard rate* (dis/cat)	Val 1	Val 2	Val 3	Land 1	Land 2	Land 3		
TR1 (bottom trawls and seines with >100mm mesh)	77%	47%	PLE	COD	HAD	PLE (77%)	COD (47%)	HAD (62%)	<ul style="list-style-type: none"> • EU TACs** for PLE, COD, HAD other demersal groundfish stocks. • EU Multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Council Regulation No. 676/2007) • Main landed species will fall under the new EU multi-annual plan for the North Sea demersal stocks (under development) • Technical measures: minimum mesh size of 120mm 	<ul style="list-style-type: none"> • EU cod management plan includes effort regime controls for all métiers catching significant amounts of cod • TR1 accounts for the majority of the landings for several important North Sea demersal stocks • Large mesh size selects fewer mature dab than the BT2 métier
Other	19%	94%	COD	POK	PLE	COD (33%)	POK (78%)	PLE (12%); HAD (37%)	<ul style="list-style-type: none"> • EU TACs** for COD, POK, PLE, amongst others. • EU long-term plan for cod stocks and the fisheries (Council Regulation No. 1342/2008) • EU-Norway management strategies for POK and WHG • Main landed species will fall under the new EU multi-annual plan for the North Sea demersal stocks (under development) 	<ul style="list-style-type: none"> • Low catches (compared to catches in Subarea IV) have a limited impact on the abundant dab stock
GN	3%	12%	COD	PLE		COD	PLE		<ul style="list-style-type: none"> • EU TACs** for COD, PLE, amongst 	<ul style="list-style-type: none"> • Low catches have a very

(Gill nets)						(20%)	(6%)		others. <ul style="list-style-type: none"> • EU long-term plan for cod stocks and the fisheries (Council Regulation No. 1342/2008) 	limited impact on the abundant dab stock
BT1 (beam trawls with >120mm mesh)	1%	-	PLE			PLE (5%)			<ul style="list-style-type: none"> • EU TAC** PLE • EU Multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Council Regulation No. 676/2007) 	<ul style="list-style-type: none"> • Low catches have a very limited impact on the abundant dab stock

* Discard proportions are based only on fleet segments (i.e. countries) with reported data for both discards and landings.

** 'EU TACs'. For 2015 the following regulations apply: [Council Regulation \(EU\) 2015/960](#) of 19 June 2015 amending Regulation (EU) 2015/104 as regards certain fishing opportunities (**measures concerning *inter alia* sea bass**); [Council Regulation \(EU\) 2015/523](#) of 25 March 2015 amending Regulations (EU) No 43/2014 and (EU) 2015/104 as regards certain fishing opportunities; and [Council Regulation \(EU\) 2015/104](#) of 19 January 2015 fixing for 2015 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in **Union waters and, for Union vessels, in certain non-Union waters**, amending Regulation (EU) No 43/2014 and repealing Regulation (EU) No 779/2014.

Conclusions

Current output management for dab in the North Sea is ineffectual, having limited to no impact on catches of dab since 1998. However, with future changes in the CFP (e.g. the introduction of a landings obligation), these ineffectual management measures could well have significant impacts on the métiers that catch dab. With a TAC, one of the most productive and abundant stocks in the North Sea could become a limiting factor for the fisheries operating in this area, without any clear benefits to the stock itself.

Ecological and economic factors, together with regulations controlling target species, imply that a TAC is not needed to ensure this stock remains in healthy condition or becomes overexploited. Other controls on target species driving the main fisheries catching dab are at this moment more effective. Nevertheless, the stock would still need to be monitored to ensure that it remains in safe biological limits (e.g. due to changes in fishing practices, changes in fish distribution or productivity, climate change, changes in market demand etc.).

TACs are at best partially effective in preventing the over-exploitation of dab, or at worst an unnecessary regulatory burden further complicating the efficient management of mixed fisheries catching dab.

Further work

An assessment model could provide a stronger basis to estimate past and present stock size and fishing exploitation rates. This will require a reconstruction of past discard levels, analysis of indices of abundance of dab, and identification of an appropriate stock assessment model. Dab is currently scheduled to be benchmarked by ICES in 2016.

Biomass limit reference points, either from the stock assessment model or survey indices need to be defined. In particular, appropriate treatment of uncertainty in the assessment model or index is needed in defining this limit.

Mixed fisheries simulation models could be used to further improve our understanding of the impact of target species management controls on the long term exploitation of dab (e.g. an expansion Fcube model used by ICES). In 2015 WGMIXFISH did provide some information on the likely short term impacts of North Sea fisheries on bycatch species, but a longer term understanding would be preferable.

Plans for data collection in future would need to be established to ensure that quality estimates of dab removals can still be obtained.

More generally, similar analyses could be applied to a number of other bycatch species. As indicated, flounder could likely also be managed sustainably without a stock-specific TAC.

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Justification

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The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of IMARES.

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