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Analyses of changes in spatial distribution of the beam trawl fleet and their effects on the plaice and sole stock, 1990-2005

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Summary

Management measures directed at limiting fishing effort may have had an influence on the behaviour of the beam trawl fleet that negatively affected the North Sea plaice and sole stocks. This study analyses trends in fleet behaviour and fishing pressure in relation to management measures proposed by the fishing industry. These measures comprise (1) more days at sea for vessels using larger mesh sizes, (2) all weekends and fixed weeks in which vessels have to refrain from fishing plus 230 days at sea for all vessels during the rest of the year; (3) restoring the proportion of the Dutch quota for sole : plaice back to 1:5; (4) reducing fleet capacity by 20 % and (5) decreasing the minimum landing size for plaice from 27 to 25 cm. It is shown that the proportion the Dutch quota for sole and plaice decreased from 1:5 to 1:2 and that days at sea have become limiting since 2003 due to effort regulations. Coinciding with this, the fleet shifted to more southern fishing grounds closer to the coast. In this area, densities of under-sized plaice and hence discard rates are higher. Due to the shift in the spatial distribution of both the fleet and under-sized plaice to deeper water, fishing pressure on under-sized plaice has increased. Fishing pressure on marketable plaice and sole decreased over the period 1995-2005 which is caused by a decrease in total fishing effort (mainly through decommissioning). It is likely that the observed changes in distribution of the fleet are related to the decrease in the TAC as well as the quota ratio between sole and plaice. Whether the decrease in the days at sea has contributed to the shift in distribution of the fleet remains uncertain because there are several confounding factors such as available quota, days at sea, fuel prices and mesh size used.

Introduction

The Dutch beam trawl fishery is a mixed fishery targeting plaice and sole. Although the spatial distribution of both species overlaps, the fleet can concentrate in certain areas to specifically target either species. The part of the fleet mainly targeting sole, fishes in the southern North Sea (51° - 54° N) with 80 mm mesh sizes. The part of the fleet mainly targeting plaice fishes in the northern North Sea (mainly > 56° N) with 100 mm mesh sizes. In the sole fishery under-sized plaice (<27 cm) is caught and discarded, due to the mesh sizes of 80 mm and the high densities of under-sized plaice at sole fishing grounds. This results in a high mortality of under-sized plaice. At the Northern plaice fishing grounds, densities of sole and under-sized plaice are low and hence, discard rates are lower here. Currently, high discard catch rates contribute to the high fishing mortality of plaice. In the 2006 ACFM[1] advice, fishing mortality rate for discards was estimated at 0.55 / year and for landings 0.26 / year[2].

The Dutch fishing industry hypothesized that the beam trawl fleet has changed its spatial distribution pattern by reducing the fishing effort on the plaice grounds in the central North Sea and increasing its effort in the more southern areas. The areas that would be fished more intensively are important areas for the part of the plaice population that is sensitive to discarding: plaice in the size class 15-26 cm. In addition, a change in the spatial distribution of under-sized plaice was observed. Now, under-sized plaice spread out further away from the coast (Van Keeken et al.[3]) which may result in a higher discard rate and hampering the recovery of the plaice stock. Both the supposedly changed spatial distribution of the fleet and the observed changes in the plaice population may have increased fishing pressure on the under-sized part of the plaice stock.

Factors that may have caused the supposed shift in the spatial distribution of the beam trawl fleet are:

- Plaice Total Allowable Catches (TAC) have decreased faster than sole TACs, causing the ratio of the Dutch quota for plaice: sole to decrease. This resulted in an increasing part of the fleet targeting sole. This may have induced the fleet to shift to the southern North Sea, where more sole can be caught.
- A reduction in the available days at sea (due to effort restrictions) could have resulted in the concentration of the fleet towards the (Dutch) coast.
- An increase in fuel prices may also have led to a concentration of the fleet in the (Dutch) coast.

By redirecting the fleet to areas where less plaice discards would be caught, sustainability of plaice and sole exploitation could be improved. Adjustments in the long term management facilitating such a redirection could therefore prove important.

This report describes trends in spatial distribution and trip length of the beam trawl fleet from 1990-2005. It quantifies the effect of the changes in fleet distribution on plaice and sole landings and on plaice discards. Several possible long term management scenarios proposed by the fishing industry and their effect on the stocks are discussed.

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[1] Advisory Committee on Fisheries Management

[2] http://www.ices.dk/committe/acfm/comwork/report/2006/oct/ple-nsea.pdf

[3] Van Keeken, O.A., Van Hoppe, M., Grift, R. E., & Rijnsdorp, A.D. In press. Changes in the spatial distribution of North Sea plaice (*Pleuronectes platessa*) and implications for fisheries management. Journal of Sea Research.

Material & Methods

Data sets

VIRIS

Commercial landings are recorded in the Dutch Fishery Registration and Information System (VIRIS) database, which contains the logbook data of the Dutch fleet and of foreign boats landing in Dutch ports. The General Inspection Service (AID) for monitoring and control implemented a first version of the database in 1990, but a more versatile and complete version was introduced in 1995, when also the non-target species such as turbot and brill and landings in the Netherlands by foreign vessels were included. The last modification stems from 1998, when also landings of dab were included. Besides landings by species, the VIRIS database contains data on nominal effort (expressed as days absent from port), vessel code, gear type, engine power and ICES rectangle of catch. An ICES rectangle is, at the latitude of the Netherlands, approximately 30x30 Nautical miles (0.5 degree latitude x 1 degree longitude). Landings from foreign vessels landing outside the Netherlands are not included in the database, neither are figures on discards.

VIRIS data were used for the period 1990-2005.

VMS (Vessel Monitoring through Satellite)

Since 2000 the Dutch General Inspection Service uses satellite data from Dutch vessels to monitor their behaviour. On average every 1.5 hour, the position of each vessel is recorded. The frequency of registration depends on the area where a vessel is located. Accuracy of a position registration is more than 100 meters. VMS obligation started at the 1st of January 2000 for vessels longer than 24 meters; 1st of September 2003 for vessels of 21-24 meters; 20th of April 2004 for vessels of 18-21 meters; and at the 1st of January 2005 for vessels of 15-18 meters.

From several vessels speed is recorded, from which the activity of a vessel, i.e. floating, fishing, or steaming, can be derived. Beam trawl vessels with an engine power between 192-221 kW (euro cutters) are assumed to be fishing at 3-6 Nm/hr; larger beam trawlers are assumed to be fishing at 5-8 Nm/hr. Speed registration is not obliged, so it is not possible to estimate the activity of all vessels. For observations without speed registration, the activity is labelled as ‘unknown’.

In order to use VMS data, permission is required from each individual ship owner. Wageningen IMARES has received permission of in total 80 vessels. Out of these vessels there are, from the beam trawl fleet, 7 euro cutters (9% of the fleet) and 53 larger cutters (41% of the fleet) represented in our sample. Given this participation level, we think that the sample of both fleets is representative enough to be used in this study.

Survey data

Data on under-sized plaice were derived from three different flatfish surveys that are carried out every year: BTS (Beam Trawl Survey), SNS (Sole net Survey) and DFS (Demersal Fish Survey). Time series of 1990-2005 were used.

- o The BTS aims to get fisheries-independent estimates of the age structure of North Sea plaice and sole. The BTS is carried out in August/September with an 8-meter beam trawl (40 mm stretched mesh). In each ICES rectangle 1-4 hauls are carried out.

- o The SNS aims to collect indices of 1-4 years old plaice and sole. The SNS is carried out in September with a 6-meter beam trawl (40 mm stretched mesh). The coastal zone from Belgium to Denmark is sampled in transects parallel or perpendicular to the coast.
- o The DFS aims to monitor young plaice, sole, shrimps and non-commercial fish stocks. The DFS is carried out in autumn with shrimp trawls of 3 (coastal zone) or 6 (Wadden Sea and Zeeland) meters in length (20 mm stretched mesh). From Zeeland to Denmark, 200-300 hauls of 15 minutes are carried out.

Description of trends in behaviour of the beam trawl fleet

Spatial distribution

VIRIS data were used to calculate the percentage of effort by ICES rectangle for Dutch beam trawlers and flag vessels[1], for each year in the period 1990-2005. By means of these percentages, the relative distribution of the fleet was plotted with a GIS (Geographical Information System).

Changes over years were inspected visually. In order to investigate whether there are changes in the micro distribution of the fleet, VMS data were used.

Distance covered in a trip

From VIRIS the average distance covered in a trip was calculated for Dutch vessels and flag vessels (> 221 kW). For each trip the distance was calculated between the harbour and the centre of the ICES rectangle where most effort was allocated. These values were averaged over all vessels for each year.

Importance of 80 mm mesh sizes

From VIRIS the percentage of effort used with different mesh sizes was calculated, for Dutch beam trawlers and flag vessels (>221 kW).

Importance of trips longer than 1 week

From VIRIS the percentage of trips longer than 1 week (6 days at sea) was calculated, for Dutch beam trawlers and flag vessels (>221 kW).

Effect of the changes in fleet distribution on plaice and sole

To investigate the effect of changes in spatial distribution of the fleet on the plaice and sole stock, data were required on the spatial distribution of:

1. fishing effort;
2. under-sized plaice;
3. marketable plaice and sole.

We did not look at under-sized sole, because catches of under-sized sole by commercial vessels are low (<10% of the total catch). It was assumed that the effect of changes in fleet distribution on under-sized sole is negligible.

1. Fishing effort

For each ICES rectangle total fishing effort of beam trawlers was estimated from VIRIS. For the plaice box (a partially closed area in the Dutch, German and Danish coastal zone) it was assumed that euro cutters only fish inside the box and large cutters only fish outside the box.

[1] Flag vessels are originally Dutch vessels that fish under the flag of another country. All flag vessels in this study are UK flag vessels that comprise almost all flag vessels.

2. Under-sized plaice

Survey data were used to calculate the average number of plaice in the size class 15-26 cm per hectare for each ICES rectangle and year. For ICES rectangles that partly contain the plaice box, the numbers per hectare were calculated for the area inside and the area outside the box.

3. Marketable plaice and sole

Survey data are less suitable for describing the spatial distribution of marketable plaice and sole because the survey nets have lower catch rates for larger fish. Commercial catch per unit effort (CPUE) is assumed to be a better indicator for this. From VIRIS the total landings were divided by total effort, in order to get CPUE (kg/day) per year, for each ICES rectangle. Landings in ICES rectangles that partly contain the plaice box were assumed to be caught inside the box by euro cutters and outside the box by larger cutters.

Combining data

Multiplication of fishing effort with a value for the density of plaice and sole (numbers/hectare or CPUE), gives us a measure for the fishing pressure on these different parts of the stock per ICES rectangle. Fishing pressure is obtained when the pressure indices for all ICES rectangles are averaged within a year.

$$P = \sum_i \left(f * N_i / N \right)$$

P = fishing pressure
f = fishing effort
N_i = fish density in ICES rectangle i
N = average fish density

Because total effort of the beam trawl fleet decreased over the years, due to commissioning and limiting the days at sea, it was expected that total fishing pressure had also decreased. This effect would have caused a decline in fishing pressure which would blur possible effects of a changed fishing pattern on fishing pressure. In order to explore what would have happened if effort would have remained constant, and to clearly demonstrate the effect of changed fishing patterns, fishing pressure was also calculated with a constant effort of 100.000 days at sea per year for all years (which is approximately the 1995 level). This level will be further described as 'constant effort' which thus describes a hypothetical situation: 'how would fishing pressure have developed *if* total fishing effort (days at sea) would have remained constant'. This constant effort was distributed over the ICES rectangles according to the actual percentages of effort in each rectangle in each year. In contrast, the 'actual effort' describes the real effort employed in each year and describes the actual changes in fishing pressures. These changes thus combine the effect of a changed distribution and the effect of a decrease in total effort.

Compare outcome with results from the discards research

The proportion of fishing pressure on under-sized plaice and total fishing pressure on all plaice, should be comparable to discard percentages measured in discard research. Therefore, we estimated the discard percentage through the following formula:

$$Discards \approx \frac{P_{undersized}}{\left(P_{undersized} + P_{marketable}\right)}$$

From a study by the industry, discard percentages were available for most ICES rectangles. These data could not be presented in this report, due to confidentiality issues. However, these data were aggregated and used for visual inspection of comparability between the calculated proportion of pressure and the observed discards percentages. This was only done for 2004 and 2005 since the industry's data collection program started in 2004.

Discard data are also being collected by Wageningen IMARES, but the spatial coverage of these data is thin (10 trips per year) and were not sufficient for comparison in this study.

Effect of management measures on plaice and sole

Several management scenarios were formulated by the fishing industry and will be explored for their contribution to the improvement of the management of the flatfish stocks. The scenarios include:

1. More days at sea for vessels using larger mesh sizes
    - It is proposed to give beam trawlers fishing with >100 mm mesh size 4 days at sea per month more than those with 80 mm. The industry expects that fishermen then sooner choose to fish in the northern areas leading to lower discard rates (because of the larger mesh size and the more northern fishing area);
    - Currently, vessels fishing with otter trawls get more days at sea when they fish with 80-99 mm than when they fish with 100-119 mm. This regulation is based on the cod recovery plan. It is proposed to combine both categories in to one 80-119 mm class, and give vessels that land less cod (< 20 % of their total landings) more days at sea (the number of days at sea currently given to the 80-99 mm category).
2. Fixed weeks where vessels have to refrain from fishing + 230 days at sea for all vessels
    - 230 days at sea are proposed for all vessels, this is the number of days that was available before they were restricted but to guarantee that this scenario would lead to a decrease in fishing mortality, the following measures are proposed:
    - No fishing in the weekends, throughout the year;
    - Each vessel should stay in the harbour for four weeks during a period of 6 weeks in the plaice spawning period and during the summer (July/ August). By stretching the inactive period of four weeks over a period of 6-8 weeks, fishing continues and a continuous supply of fish is guaranteed (which is important for the processing industry).
3. Restore the proportion Dutch quota for sole : plaice
    - The proportion used to be 1:5 but was reduced to 1:2 because the TAC for plaice decreased at a higher rate than that for sole;
    - It is proposed to restore this relation by maintaining the TAC for sole and increasing the TAC for plaice.
4. 20% reduction in fleet capacity
    - Three scenarios are proposed:
        a) A 20 % reduction in the number of beam trawlers of 2000 hp;
        b) A 20 % reduction in the number of all beam trawlers (both ≤300 and 200 hp);
        c) A 20 % reduction in the power of beam trawlers of 2000 hp to 1600 hp;
    - A condition to this scenario is that scenario (2) is also implemented.
5. Minimum landing size for plaice
    - It is proposed to decrease the minimum landing size of plaice from 27 to 25 cm such that more fish can be landed and less fish are discarded.

Results

Changes in regulatory measures

In 1990 the proportion of Dutch quota was 1:5 for sole : plaice (Figure 1), but in 1996 this proportion had decreased to 1:2 and remained at that level until 2004.

The number of days at sea that could be spent by beam trawl vessels has not been limiting up to 2003. There was a certain amount of days at sea available for each vessel, but this amount could be increased at any moment, in case days were running out and TAC was still fully available. So regulation of the fleet was only carried out by means of TAC, not by means of days at sea.

From 2003 onwards days at sea have been used to manage the beam trawl fleet, in addition to TACs. For plaice and sole it can be calculated how many days at sea a vessel needs to catch its total ITQ[1]. Figure 2 shows the time series of required days at sea per vessel for plaice and sole, in relation to the available days at sea. From this figure it can be concluded that days at sea have been limiting for sole, but not for plaice. For example: In 2003 204 days were available for each vessel. In order to catch the total sole ITQ, a vessel would have needed 268 days, so the available days were not enough. To catch the total plaice ITQ 131 days would have been enough, so days at sea were not limiting for the plaice fishery.

Figure 2 shows the available days at sea from 2003 onwards. It also shows the amount of days required to catch the available ITQ

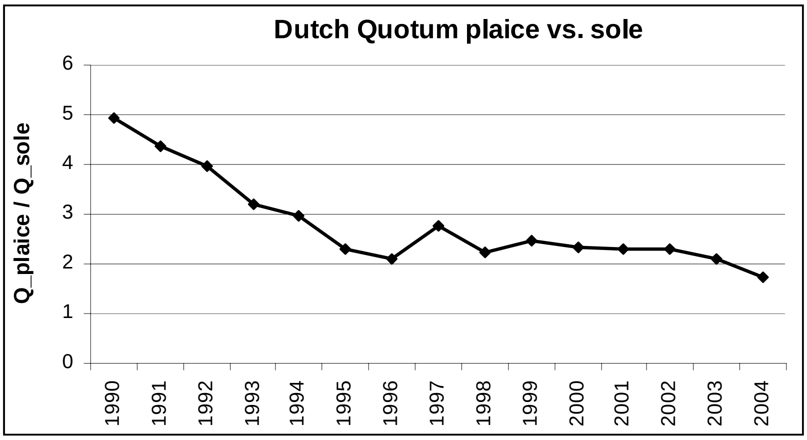


Figure 1. Proportion of Dutch quota for plaice and sole in the period 1990-2004.

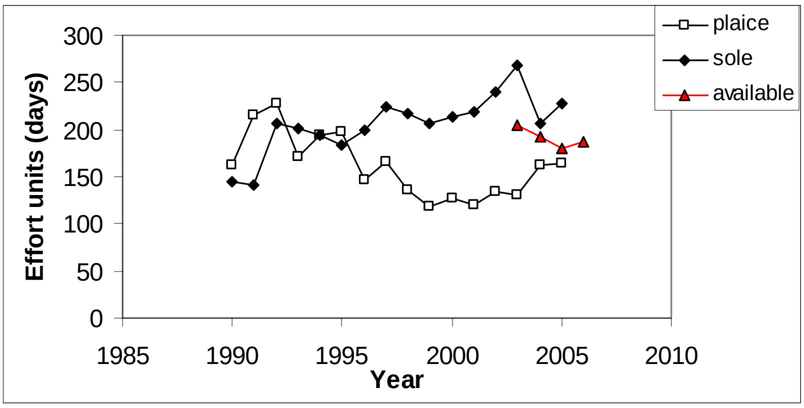


Figure 2. Days at sea by vessel from 1990-2006. Required days to fish the total quota for a year for Plaice (white) and Sole (black). Available days at sea (red).

[1] The required days were calculated from the Dutch share of the agreed level of fishing mortality and the partial fishing mortality generated by a 2000 hp beam trawler during one day at sea following the method of Rijnsdorp et al (2006) Journal of Sea Research (in press).

Trends in behaviour of the fleet

Spatial distribution

Comparing the spatial distribution of the Dutch beam trawl vessels and the flag vessels from year to year, it is clear that the fleet has concentrated in southern areas (Figure 3 shows the results for 2000 and 2005). In VMS data this can also be seen on a much finer scale. Results for all years can be found in Appendix 1.

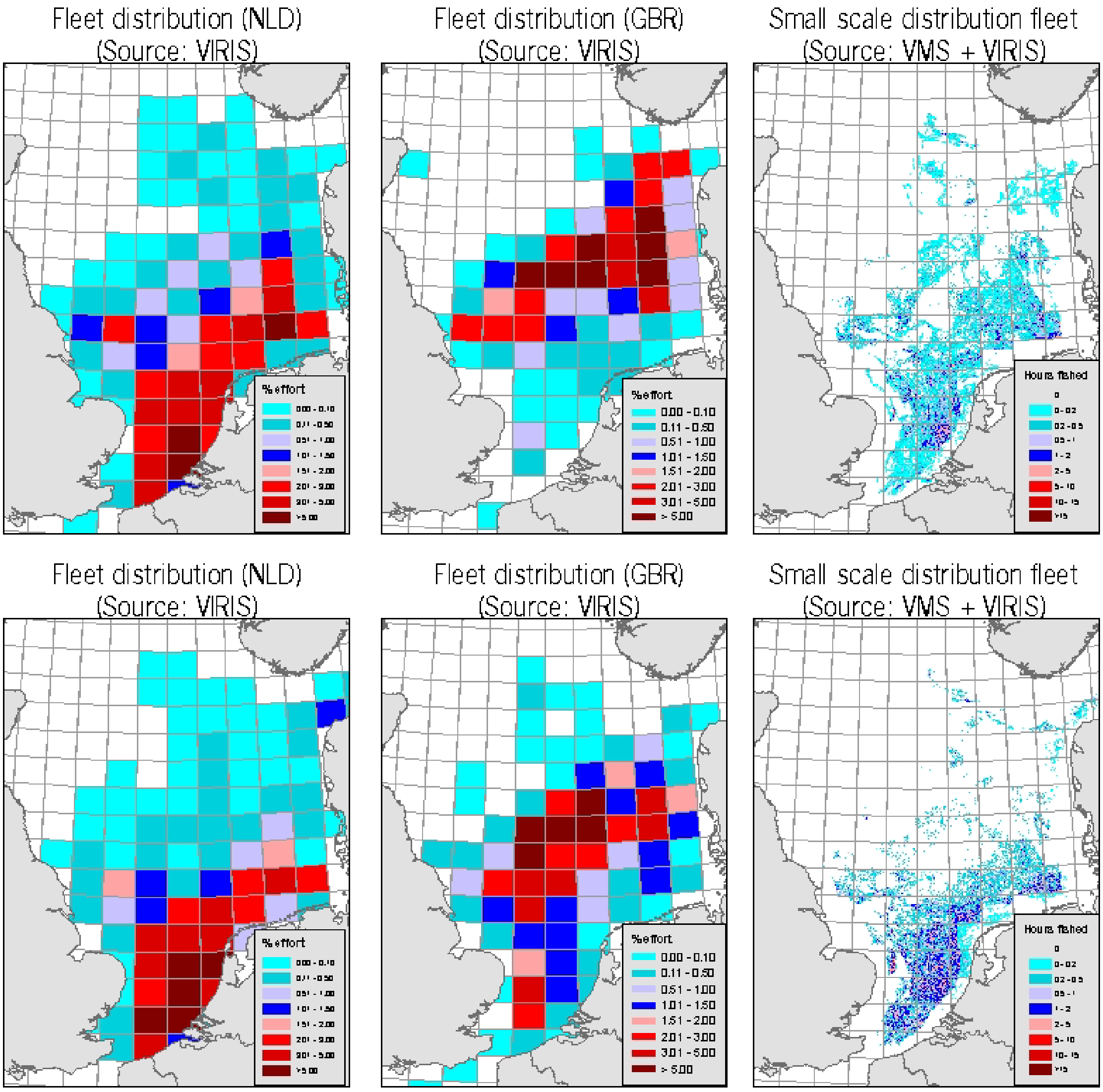


Figure 3. Effort distribution of large beam trawl vessels (> 221 kW) in 2000 (top panels) and 2005 (lower panels). Left panels show distribution of Dutch vessels; middle panels show flag vessels that landed in the Netherlands; right panels show high resolution distribution of the Dutch beam trawl fleet (VMS data).

Distance covered in a trip

The average distance from harbour to fishing ground decreased both for Dutch vessels and UK flag vessels (Figure 4). In 1990, Dutch vessels fished in areas on average 90 miles away from their departure harbour. This distance decreased steadily but slowly to 70 miles. Flag vessels fish further away from their harbour of departure, but also moved in closer: from 160 miles in 1995 to 135 miles in 2005.

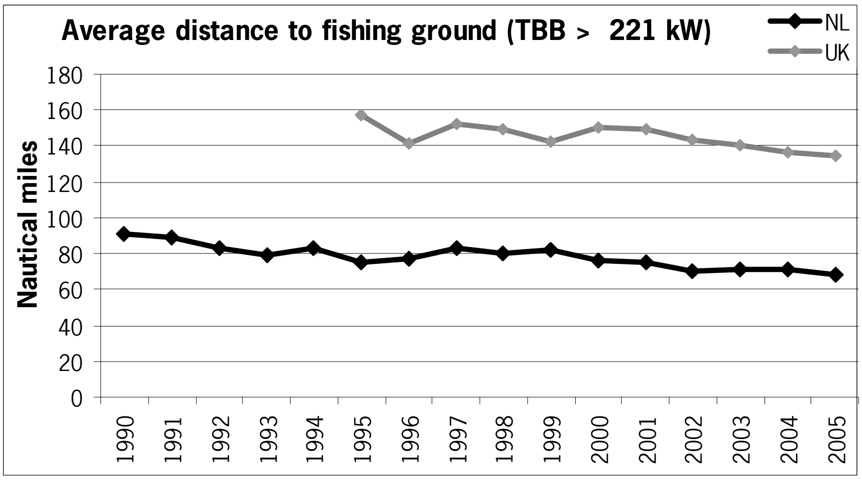


Figure 4. Average distance (Nm) from the harbour to the main fishing ground (i.e. ICES rectangle) for Dutch and UK flag vessels. Source: VIRIS 1990-2005.

Importance of 80 mm mesh sizes

The Dutch fleet has always been fishing with mainly (more than 80% of the effort) 80 mm, but since 1998 the percentage of effort carried out with 80 mm has increased up to 95% (Figure 5). Flag vessels mainly use 100 mm mesh sizes, but also in this fleet we observed an increase of effort carried out with 80 mm (from 18 to 45 %). The largest increase for both vessel groups was observed in 2000, when the 100 mm mesh size border east from 5° longitude was shifted northwards from 55° to 56° latitude.

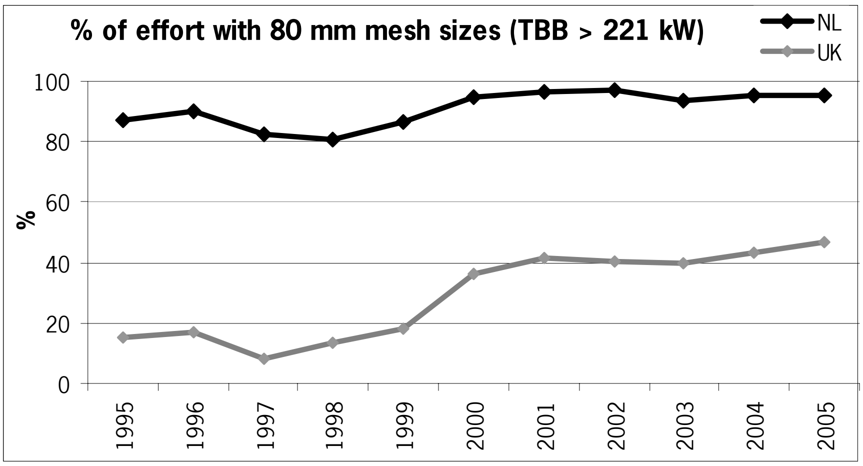


Figure 5. Percentage of effort (in days at sea) that is executed with 80 mm mesh sizes in the beam trawl fishery.

Importance of trips longer than 1 week

From 1990-1998, 5% of all trips by Dutch vessels were longer than 1 week. Since 1998 this percentage decreased to 2-3% of all trips (Figure 6). The percentage of trips longer than 1 week for UK flag vessels decreased more strongly, from 29% in 1995 to 10% in 2005. Most of this decrease is observed in the period 1995-1999.

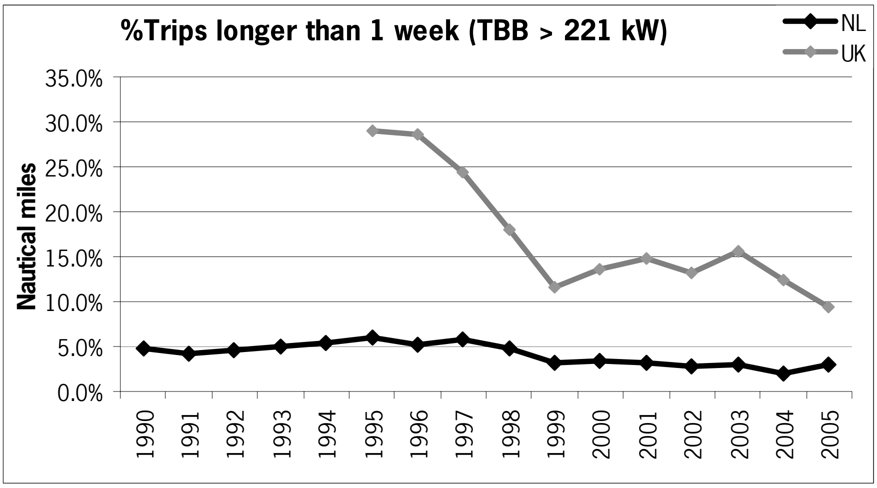


Figure 6. Number of trips longer than 1 week, expressed as the percentage of the total amount of trips per year.

Effect of the changes in fleet distribution on plaice and sole

This paragraph describes the results for the total fleet. Appendix 2 shows the results of fishing pressure by fleet segment: euro cutters; large vessels; and flag vessels.

Actual fishing pressure on **under-sized plaice** (Figure 7: black line) has more than doubled in the period 1995-2005. It slightly increased from 1995-1999. Than, a sharper increase is observed from 1999-2000, after which it slowly decreases again with a dip in 2004. If effort is set at a constant value (1995 level, grey line), fishing pressure shows a similar trend (also with a dip in 2004) but remains more stable after 2000. This means that total fishing pressure on under-sized plaice has increased but would have increased further if total fishing effort would have remained constant.

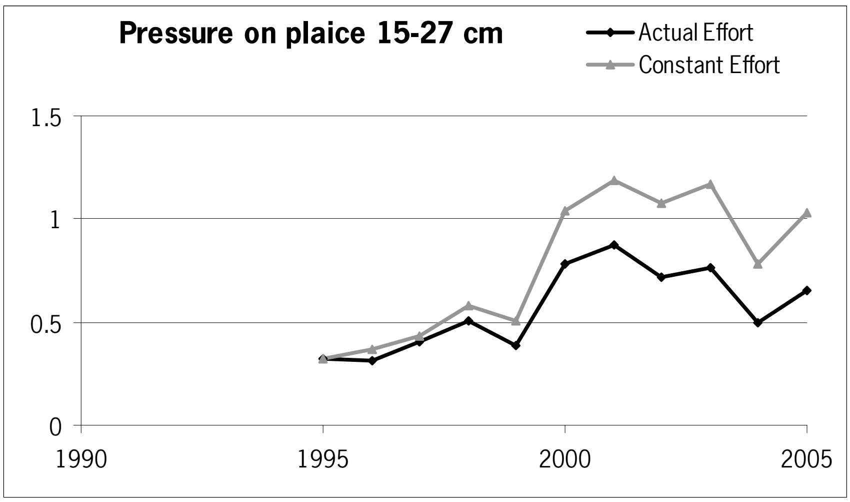


Figure 7. Fishing pressure on under-sized plaice, total of Dutch fleet and UK flag vessels. Calculated with actual effort (black) and constant effort (grey). Fishing pressure estimates were divided by 100.000 in order to obtain values around 1.

Fishing pressure on **marketable plaice** (Figure 8) increased between 1995 and 1998, and decreased up to present. A similar pattern is observed for actual pressure and pressure (black) at constant effort (grey). This means that the decrease in total fishing effort since 1995 has contributed to the reduction the fishing pressure on marketable plaice. Actual fishing pressure is currently at 2/3 of the level in 1995.

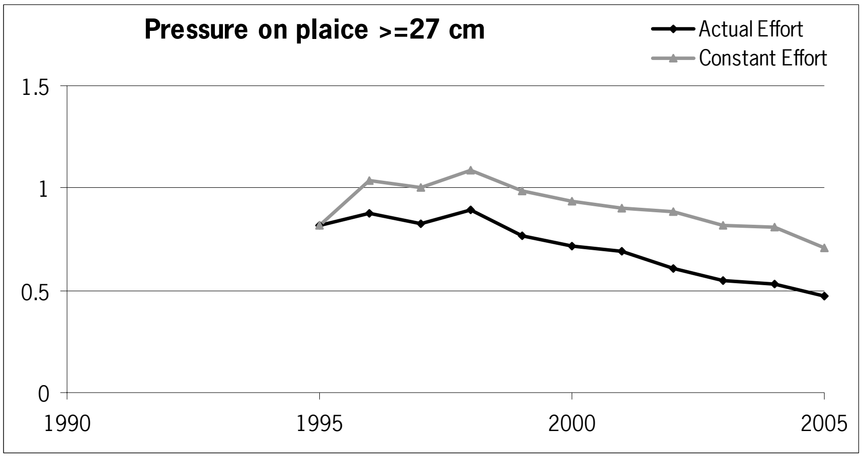


Figure 8. Fishing pressure on marketable plaice, total of Dutch fleet and UK flag vessels. Calculated with actual effort (black) and constant effort (grey).

Actual fishing pressure on **marketable sole** (Figure 9: black line) decreased slightly from 1995-2005. If effort would have staid at a constant level (of that of 1995), fishing pressure would have increased steadily with 75% (grey line). This shows that the reduction on fishing pressure on sole is caused by effort reduction that has counteracted other effects.

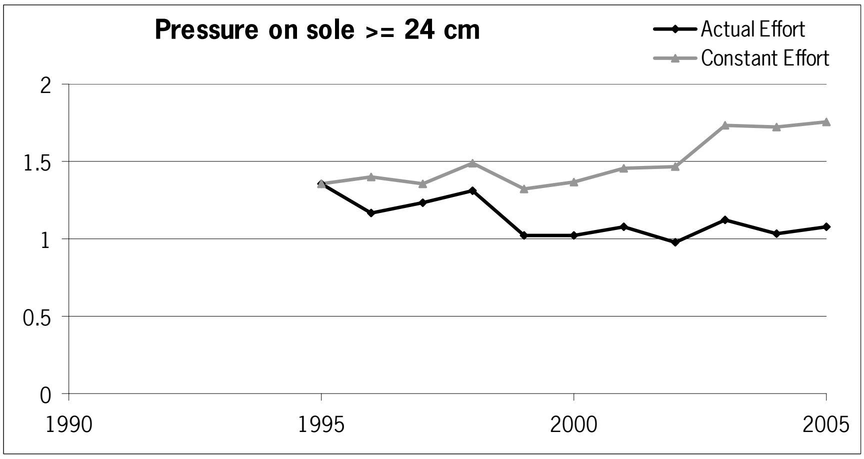


Figure 9. Fishing pressure on marketable sole, total of Dutch fleet and UK flag vessels. Calculated with actual effort (black) and constant effort (grey).

Effect of proposed management measures on plaice and sole

It is difficult to assess the effects of the management measure proposed by the industry on the stock, because many factors are interrelated: days at sea, TAC, fuel prices, mesh sizes, distribution of the stock etc. Below, some remarks are given for each of the suggested scenarios.

1. More fishing days for vessels using larger mesh sizes
The rationale behind this scenario is that if vessels fishing with larger mesh sizes get more days at sea per month, it might lead to a larger part of the fleet fishing in the north with 100 mm. However, it is uncertain how large a part this will be. TAC and fuel prices also play a significant role in determining the location of fishing grounds. Therefore, the proposed measure is not specific enough to be evaluated in this stage.

2. Fixed weeks where vessels are not allowed to fish, without limiting days at sea
The second scenario is to cancel the days at sea regulation, and in stead of that reduce effort through obliging vessels to stay in the harbours for 2 times (summer and winter) 4 weeks in a row. This leads to more periods of rest for the stock. Although we think that the basic idea is good, an important drawback of this scenario is that when the TAC is still limiting, the motivation for high grading increases. If fishermen have ample days at sea but a limiting TAC, they will select the largest fish and discard marketable fish.

3. Proportion TAC sole : plaice back to 1:5
A change in the TAC ratio of sole : plaice from 1:2 to 1:5 could be useful to stimulate fishermen visiting areas with relatively more plaice . The response of the fishermen, however, will also be influenced by the availability of plaice and the fuel price, as well as the available number of days at sea, and cannot be predicted.

4. 20% reduction in fleet capacity
Reduction in fleet capacity is expected to have the most positive effect on the stocks. The effect will depend on which part of the fleet this reduction is imposed, because the catch efficiency of the fleet increases with engine power and with the vintage of the hull and engine[1]. Reducing engine power of the fleet, will mainly have a positive effect on the sole stock, as the effect of engine power on catchability is largest for sole.

5. Minimum landing size for plaice to 25 cm
Reducing the minimum landing size will reduce the number of under-sized plaice and, if the TAC is not adjusted and is restrictive, lead to a reduction in the fishing mortality on plaice. However, it is also possible that the smallest marketable size classes of plaice (25-27cm) will be high graded in stead of being discarded. That might be the case if TAC is limiting and prices of these size classes are relatively low. If discards size classes change to high grading size classes, no positive effect will be seen.

Discussion

Over the past 16 years, the behaviour of the beam trawl fleet has significantly changed; the fleet shifted its fishery to the southern North Sea; fished at fishing grounds closer to the harbour; used 80 mm mesh sizes more often; and reduced the percentage of trips longer than 1 week. Over the same period, we saw that the fishing pressure on under-sized plaice has increased whereas that of marketable plaice and sole has decreased.

There are several factors that might have had an influence on these changes but it is difficult to pinpoint the actual causes through the current study. We described trends in the fishing pattern of the fleet and in pressure on plaice and sole. From these trends, we can only infer the underlying processes. We think, however, that our description gives a representative view of the observed trends. To validate the method, we compared fishing pressure estimated by our method, with discard percentages measured by the fleet (Figure 10). The results show that the spatial pattern is similar in both datasets with highest fishing pressure/ discard rates in the Dutch coastal zone, German Bight and UK coastal zone.

[1] Rijnsdorp, A.D., Daan, N., Dekker, W. 2006. Partial fishing mortality per fishing trip: a useful indicator for effective fishing effort in management of mixed demersal fisheries. ICES Journal of Marine Science 63: 556-566.

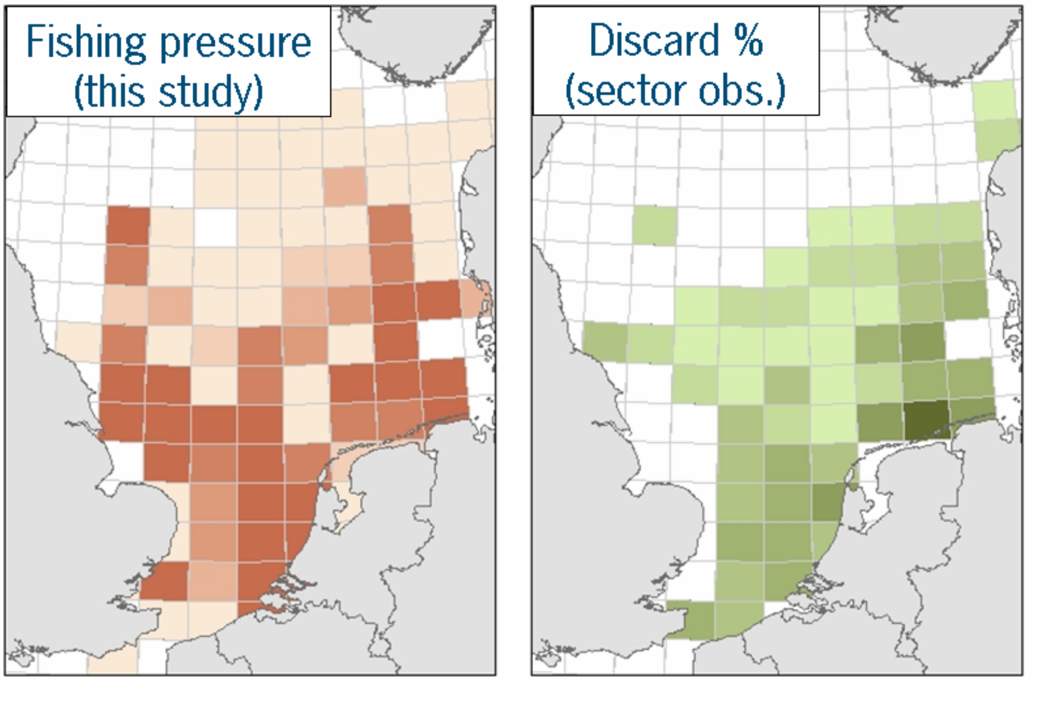


Figure 10. Comparison of results obtained in the current study (spatial pattern of estimated fishing pressure on under-sized plaice, left panel) and discard observations from the beam trawl fleet (spatial pattern in discards as a percentage of the total catch, right panel).

Our estimates of trends in fishing pressure for under-sized and marketable plaice are in line with estimates from fishing mortality from ACFM (Figure 11). This also indicates that our method seems reliable.

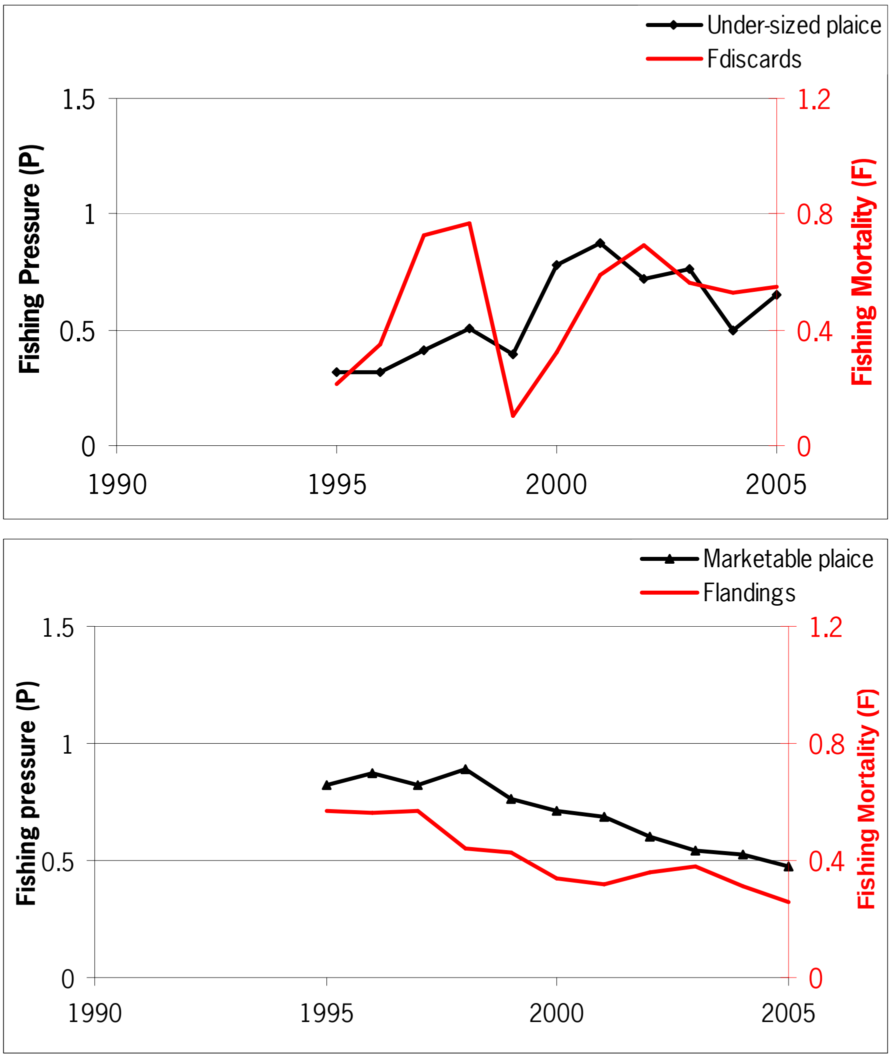


Figure 11. Trends in fishing pressure (black) and fishing mortality (red) on under-sized plaice (top panel) and marketable plaice (lower panel). Fishing pressure estimates from this study, fishing mortality estimates from ACFM[1].

Although we cannot conclusively asses the actual causes and effects of the changed fishing patterns, we can describe the most likely chain of effects. Reduction in the proportion of Dutch quota for sole and plaice from 1:5 to 1:2 stimulated the fleet to shift their fishery to areas with relatively less plaice and more sole, i.e. to more southern areas. As a consequence, the fleet used 80 mm mesh sizes more frequently because these are more efficient for the sole fishery and are also allowed in the southern areas whereas they are not in northern areas. In addition to this change in quota proportion, the available days at sea per vessel strongly decreased between 2002 and 2003 and remained low since then. This, combined with strongly increasing fuel prices (Figure 12), stimulated fishermen to stay closer to their ports and to refrain from making longer trips in areas further away.

1 http://www.ices.dk/committe/acfm/comwork/report/2006/oct/ple-nsea.pdf

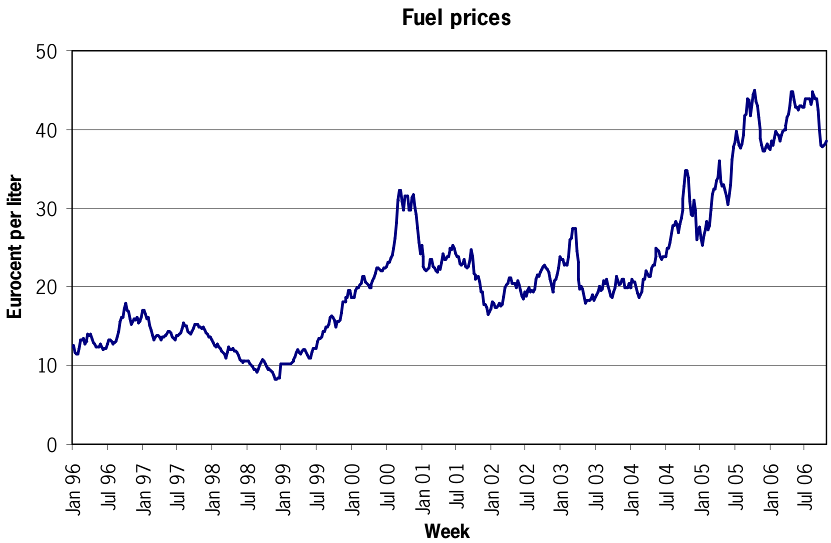


Figure 12. Weekly fuel spot prices, since 1995. In Euro cents per liter.

Under the current implementation of the effort limitation, the available days at sea correspond to the period between the moment that the vessel leaves the harbour until the moment when it returns in the harbour. The days at sea thus includes both fishing time as well as the time needed to steam to the fishing ground. Under this definition, it will be more profitable to fish closer to the harbour as the proportion of the days at sea that is spent fishing increases. The profitability of a fishing ground will thus be a function of its location (how much time does a vessel need to reach the fishing ground), the catch rate of the target species and the fuel cost during fishing and steaming. In economic terms, the choice of the fishing ground will therefore not be affected by the days at sea regulation only.

Hence, a reduction in days at sea does not necessarily influence the location choice of the fleet as the fleet may continue to fish the distant grounds at the expense of a reduction in the number of fishing trips. However, the decreased average duration of fishing trips could be a response of the fleet to the reduction in the available days at sea.

Due to the change in fleet behaviour, also fishing pressure on the plaice and sole stock has changed. The pressure on marketable plaice and sole decreased, but pressure on under-sized plaice has increased. The analyses show that there is a strong effect of the decrease in total fishing effort: if total fishing effort would have remained constant since 1995, pressure on under-sized plaice would have increased further, pressure on marketable plaice would have decreased less and pressure on sole would have increased in stead of decreased. The increase in pressure on under-sized plaice is probably further enhanced by a movement of under-sized plaice to deeper water (Van Keeken et al.[1]).

To improve the status of the plaice stock, it is required to reduce fishing pressure on under-sized plaice. In its October 2006 advice, ACFM states that “reducing discards would improve landings opportunities in the longer term”.

One way to achieve a decreased fishing pressure on under-sized plaice, is a movement of the fleet away from areas with a high density of under-sized plaice. That would mean a shift of the fleet to northern and more offshore areas. Incentives for the fleet to fish in those areas are the following:

[1]Van Keeken, O.A., Van Hoppe, M., Grift, R. E., & Rijnsdorp, A.D. In press. Changes in the spatial distribution of North Sea plaice (*Pleuronectes platessa*) and implications for fisheries management. Journal of Sea Research.

- advantages when fishing with larger mesh sizes (e.g. more fishing days per month)
- no loss of fishing days due to longer distances that need to be covered (e.g. subtraction of time for steaming from days at sea)
- TACs that allow fishermen to catch relatively more (marketable) plaice than in the current situation (restoration of TAC sole : plaice proportion of 1:5.

However, it should be noted that such changes should not lead to an increase in fishing pressure on both stocks of plaice and sole.

Another means to achieve lower fishing pressure on under-sized plaice, is reducing capacity of the beam trawl fleet. Reduction of the number of large beam trawl vessels will be most effective.

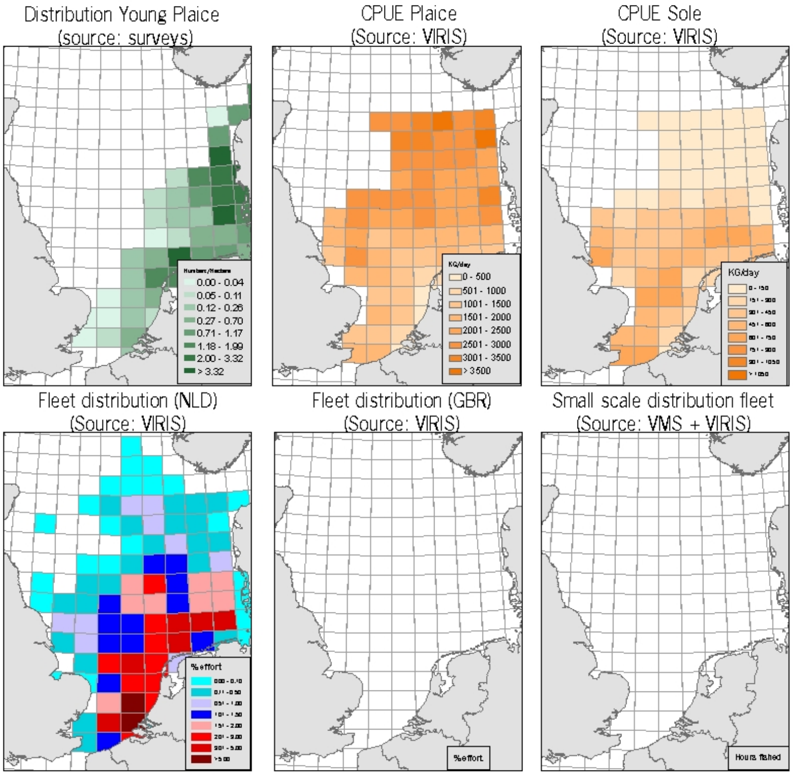
It is important to keep in mind that, when long term management measures are decided upon, all factors – TAC, individual quota, fuel process, days at sea- are interrelated and it is complicated to predict the exact result of a certain measure. Therefore, we advise to only take very specific measures that will undoubtedly lead to the desired result.

Signature: __________________________

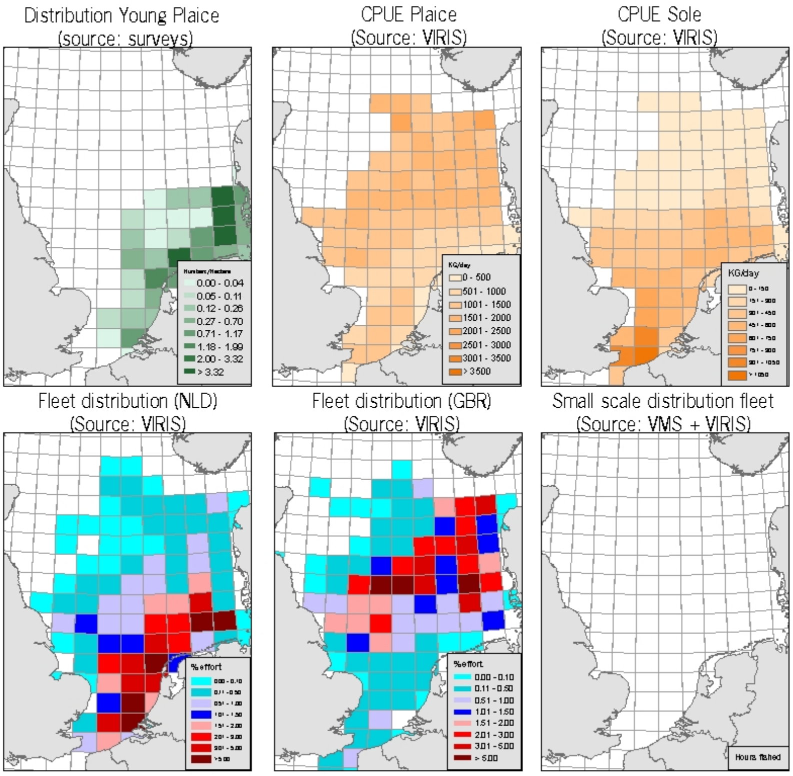
Date: 2 November 2006

Appendix 1. Spatial distribution of fleet and fish

Year: 1990



Year: 1995



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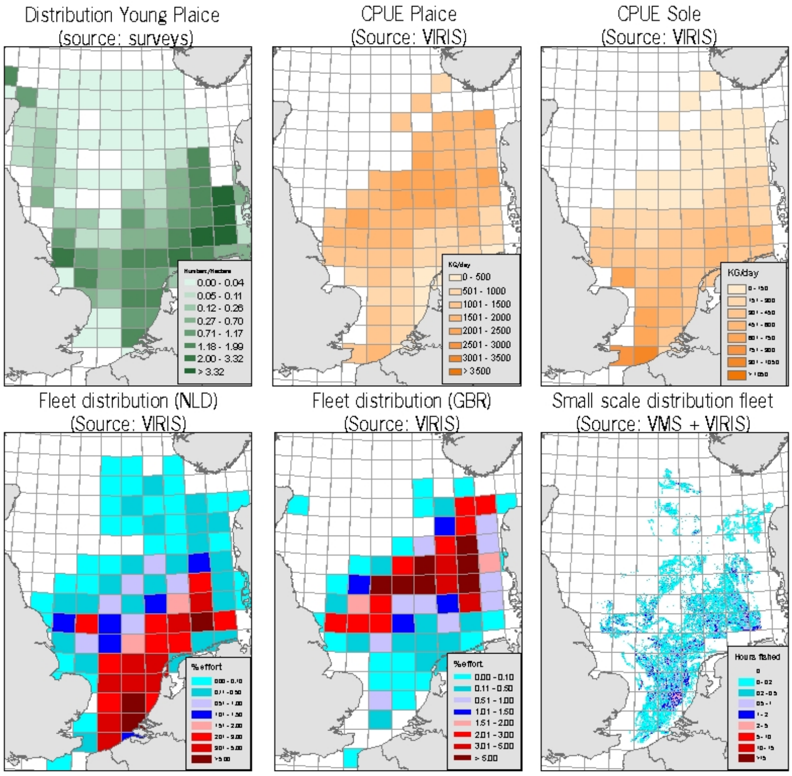

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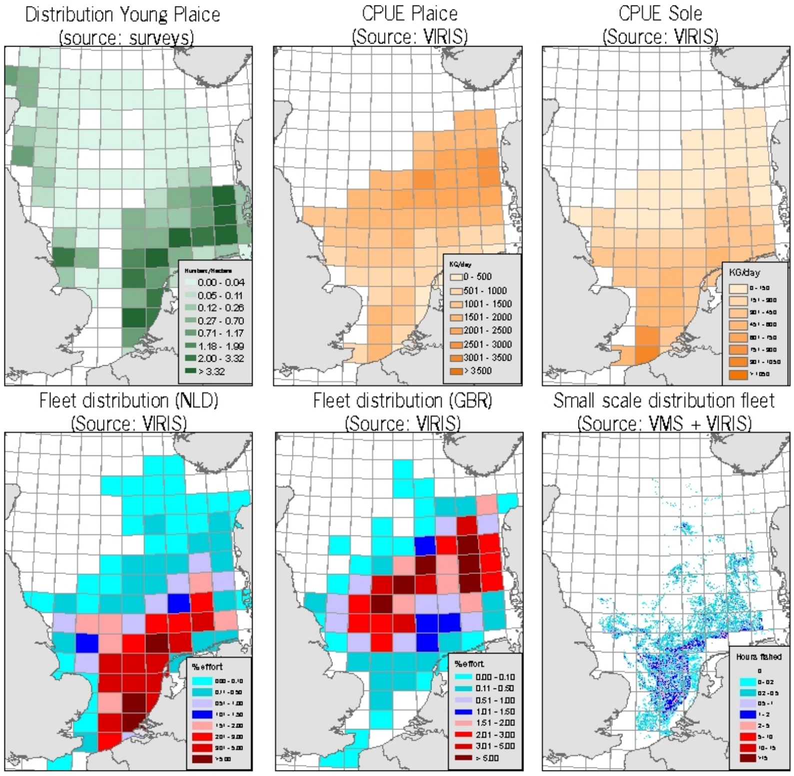
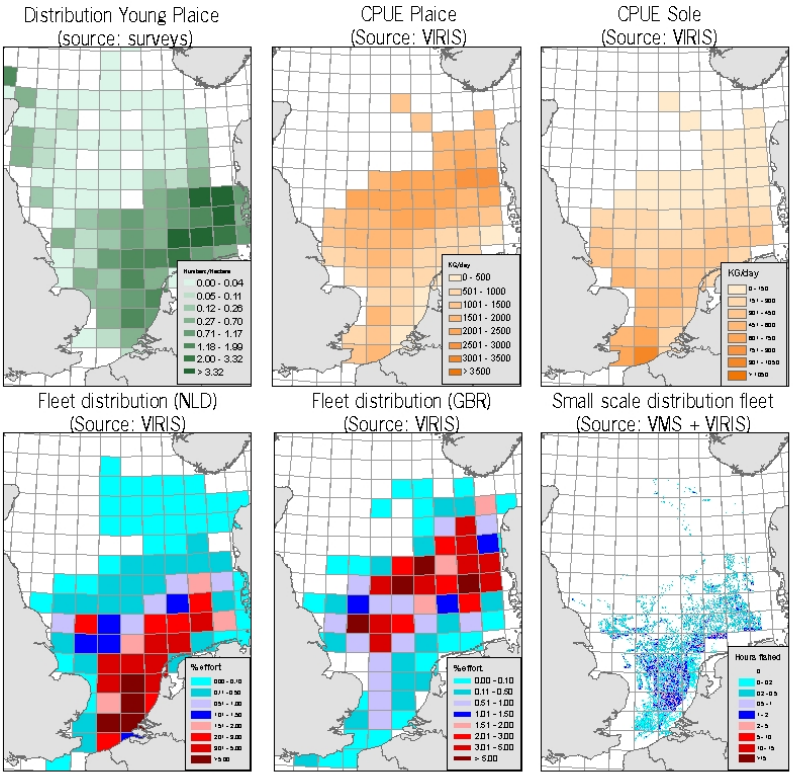
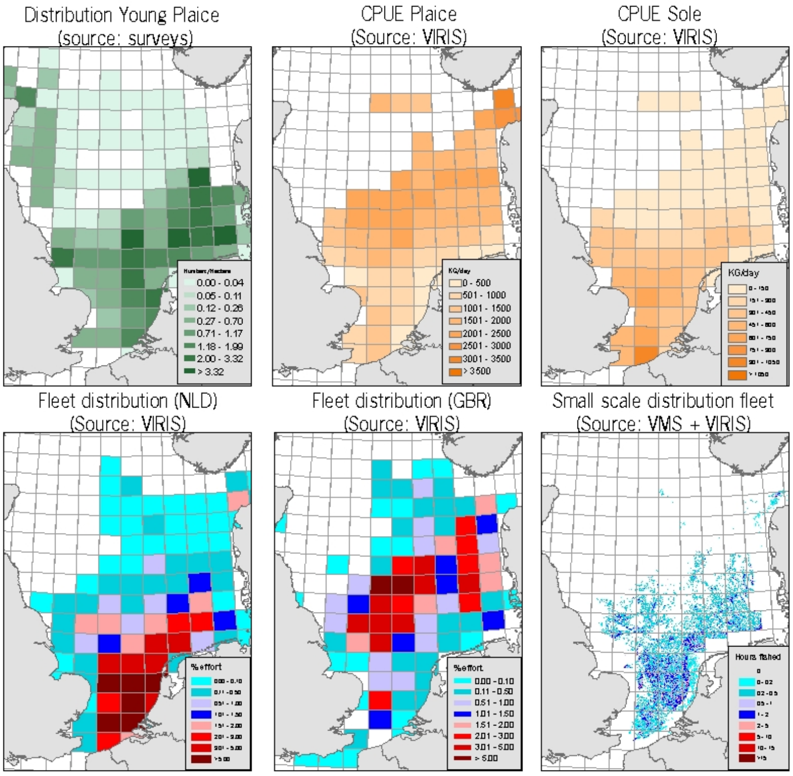


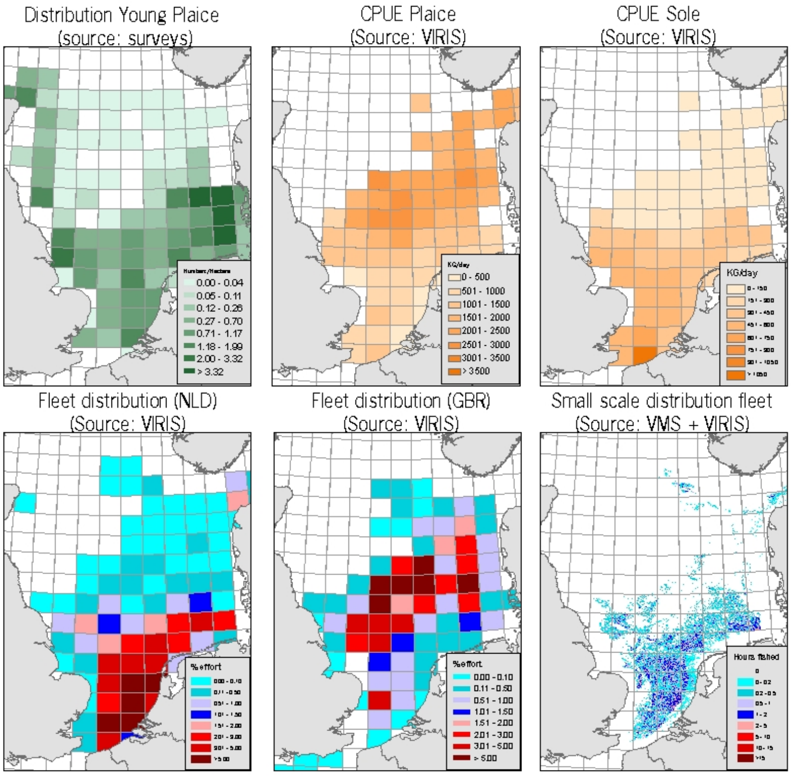
Year: 2002



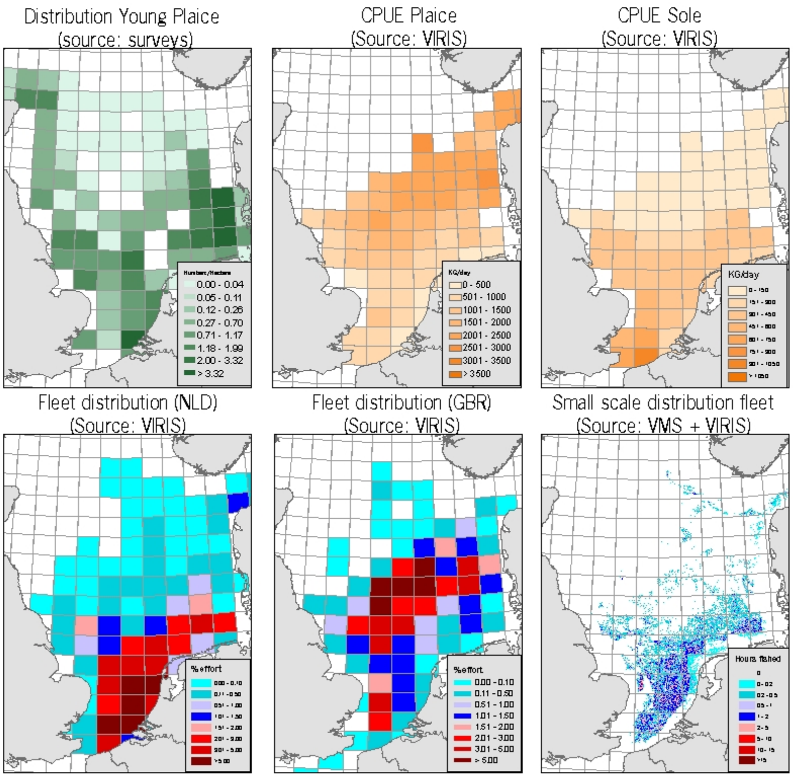
Year: 2003



Year: 2004

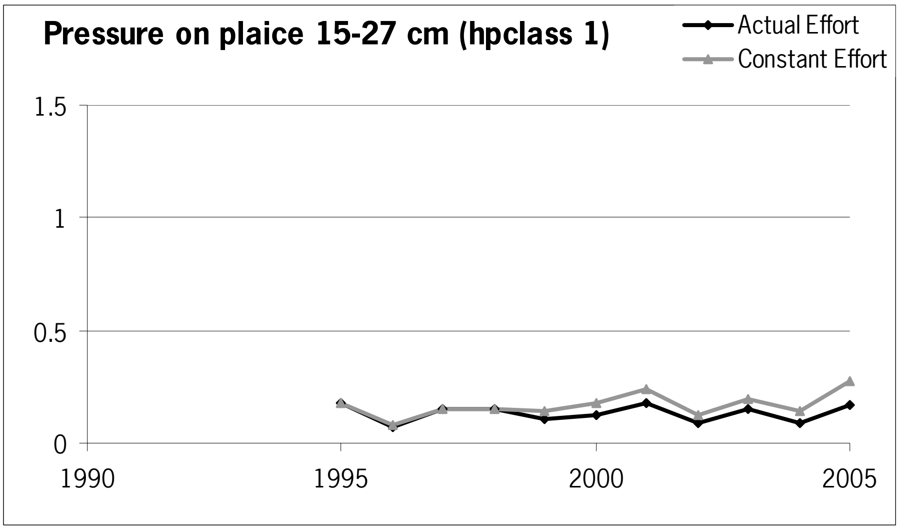


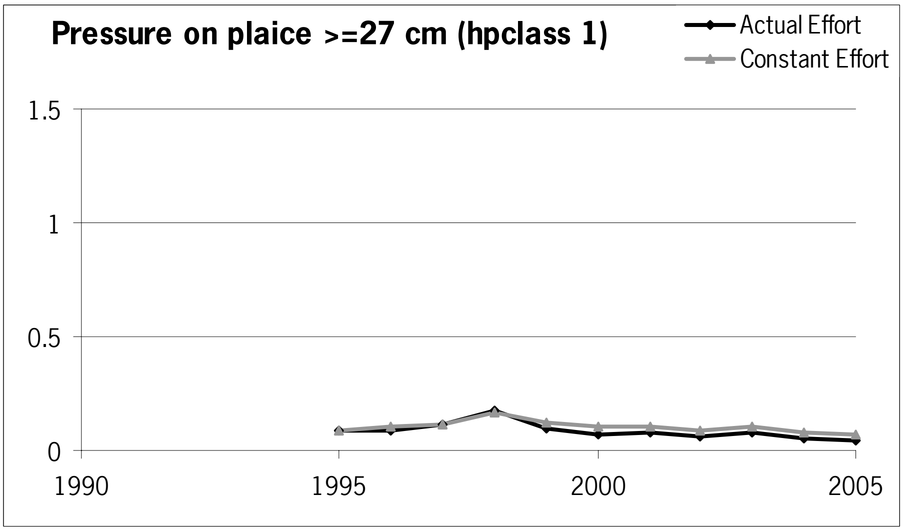
Year: 2005



Appendix 2. Fishing pressure by fleet segment

Figure 2.1 Fishing pressure by Dutch euro cutters (260-300 hp)





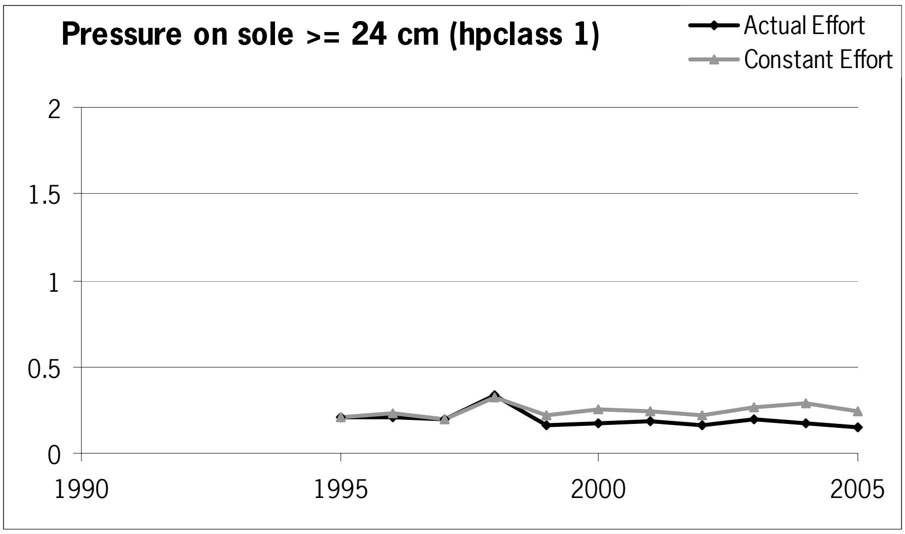
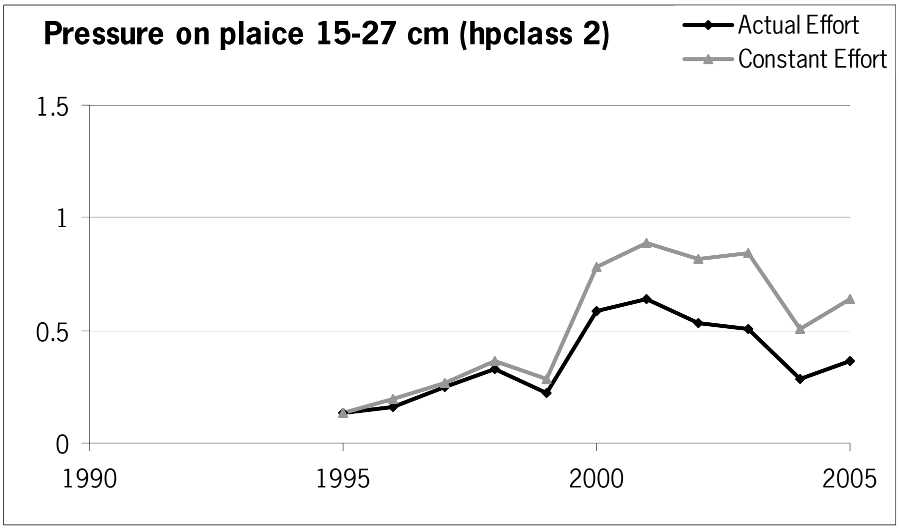
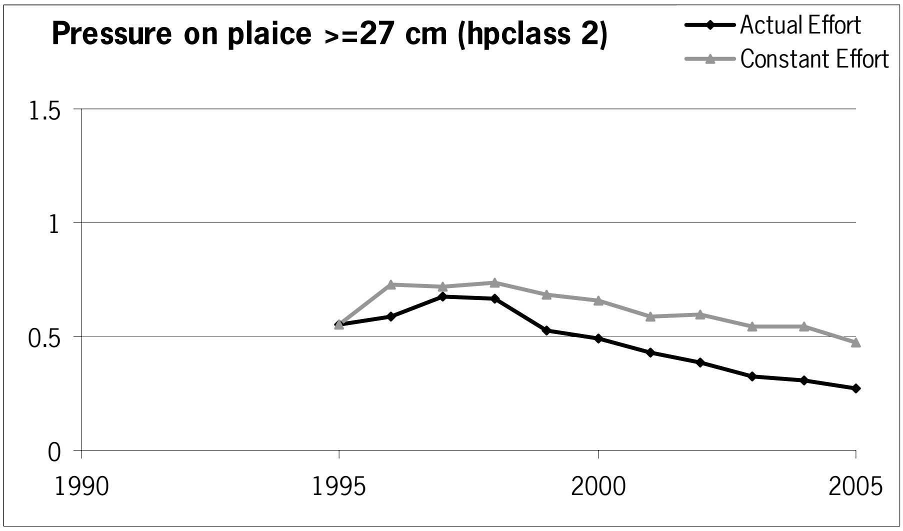


Figure 2.2 Fishing pressure by Dutch large cutters (>300 hp)





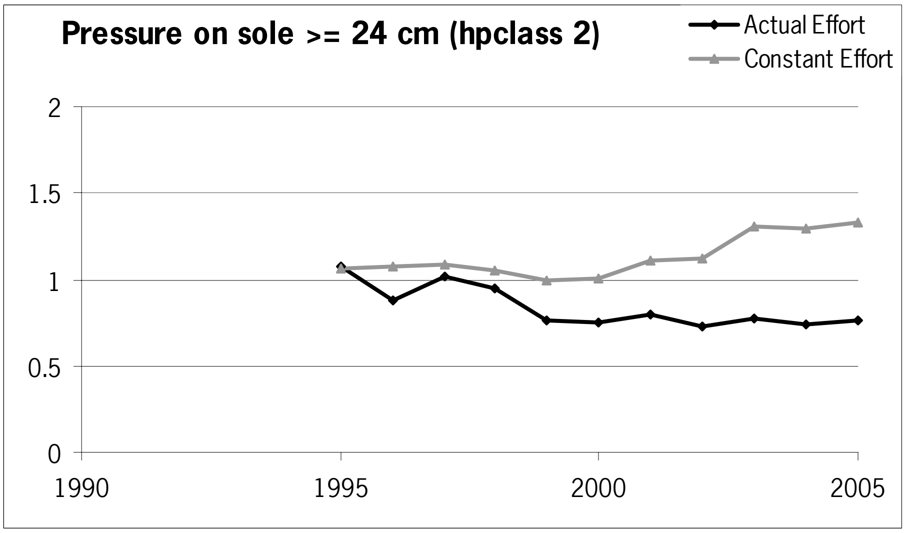


Figure 2.3 Fishing pressure by flag vessels (engine power unknown)