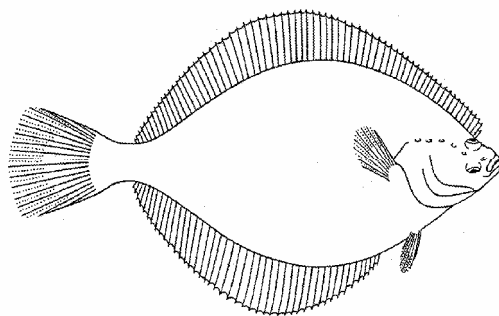


**Plaice*****Pleuronectes platessa***  
**Family Pleuronectidae**Max size: 100 cm  
Max age: 50 years

## Introduction

**Taxonomy:** Plaice *Pleuronectes platessa* Linnaeus, 1758 (Order Pleuronectiformes; Family Pleuronectidae), is the sole member of its genus, and one of seven species within the family occurring in the North Sea and Skagerrak. Pleuronectids are flatfishes characterised by the eyes being (in general) on the right side of the body (in contrast to Scotthalmidae) and by having a well-developed lateral line on both sides of the body (in contrast to Soleidae).

common names			
<i>Danish</i>	Rødspætte	<i>Icelandic</i>	Skarkoli
<i>Dutch</i>	Schol	<i>Latvian</i>	Jūras zeltplekste
<i>English</i>	Plaice	<i>Norwegian</i>	Rødspette
<i>Estonian</i>	Merilest	<i>Polish</i>	Gładzica
<i>Faeroese</i>	Reyðsprøka	<i>Portuguese</i>	Solha
<i>Finnish</i>	Punakampela	<i>Russian</i>	морская камбала
<i>French</i>	Plie	<i>Spanish</i>	Solla
<i>German</i>	Scholle	<i>Swedish</i>	Rödspätta

**General:** Plaice is an important species in European waters that has been exploited for centuries. It is also one of the best studied species in the North Sea. Plaice spawn offshore in restricted areas from where the eggs and larvae are transported effectively to the coastal nurseries. Tagging experiments have shown a strong ‘fidelity’ behaviour, individual fish returning to the same spawning and feeding areas, where they had been before [1,2].

**Minimum Landing Size:** 27 cm.

## Distribution

**Biogeographical distribution:** Plaice may be found from the western Mediterranean Sea, along the coast of Europe as far north as the White Sea and Iceland. Occasionally they occur off Greenland [3].

Juveniles are found in shallow coastal waters and outer estuaries. As they grow older they gradually move into deeper water (‘Heinckes Law’).



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**Spatial distribution in the North Sea:** During summer, juvenile plaice are concentrated in the Southern and German Bights (Fig. 1), and also occur along the east coast of Britain, and in the Skagerrak and Kattegat. Juveniles are found at lower densities in the central North Sea, and are virtually absent from the north-eastern part. Additional survey information indicates seasonal changes in distribution pattern with 0- and 1-group fish leaving the estuaries and shallow coastal zone in winter and returning in spring. In recent years, there have been changes in the distribution of juvenile plaice, and juveniles now seem to occur in deeper waters than before [4] (see also Box 2).

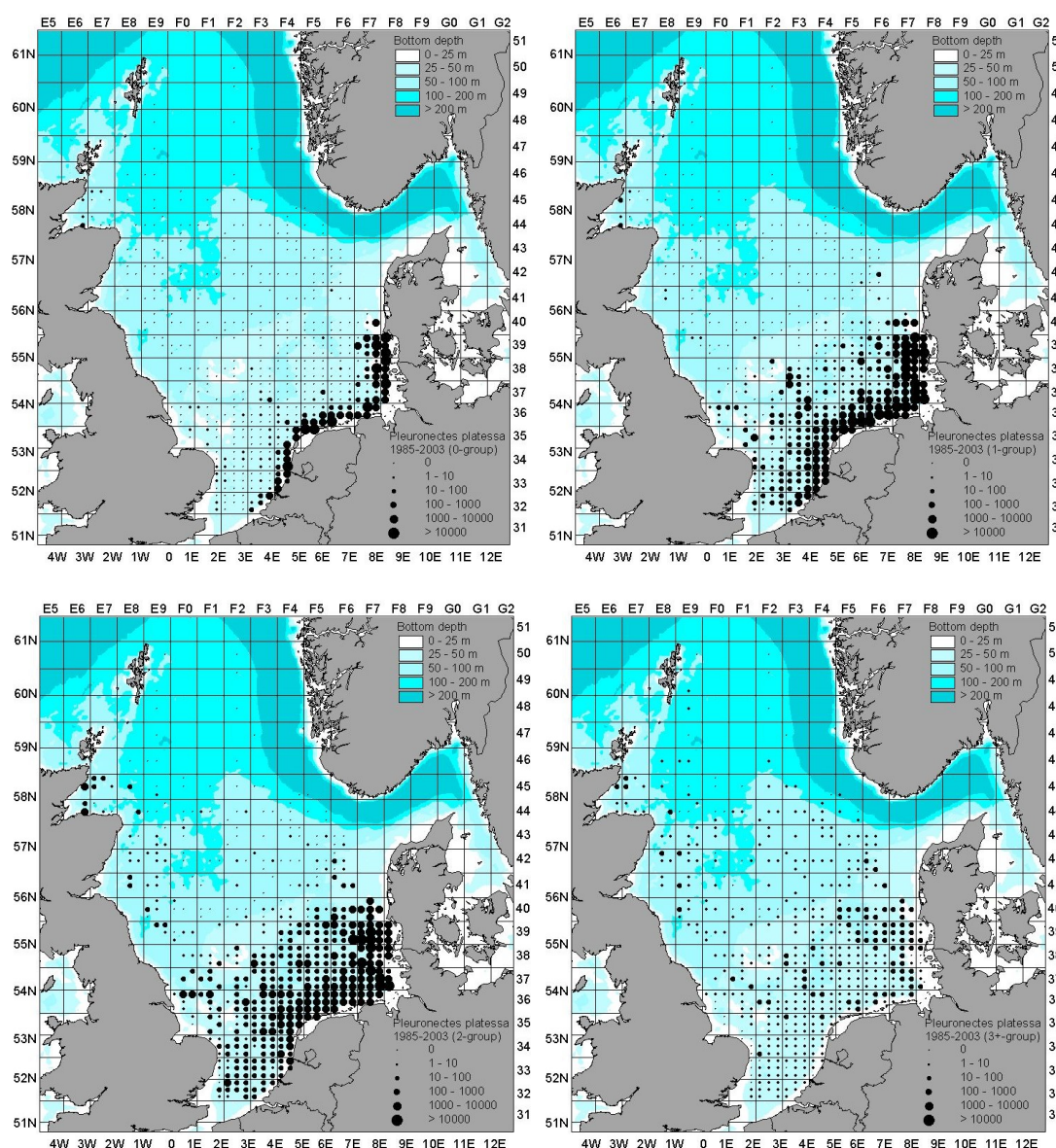
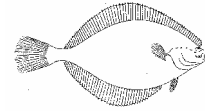


Figure 1. Average annual catch (number per fishing hour) for 0-, 1-, 2- and 3+group *P. platessa* in the quarter 3 BTS survey, 1985–2003.



Plaice

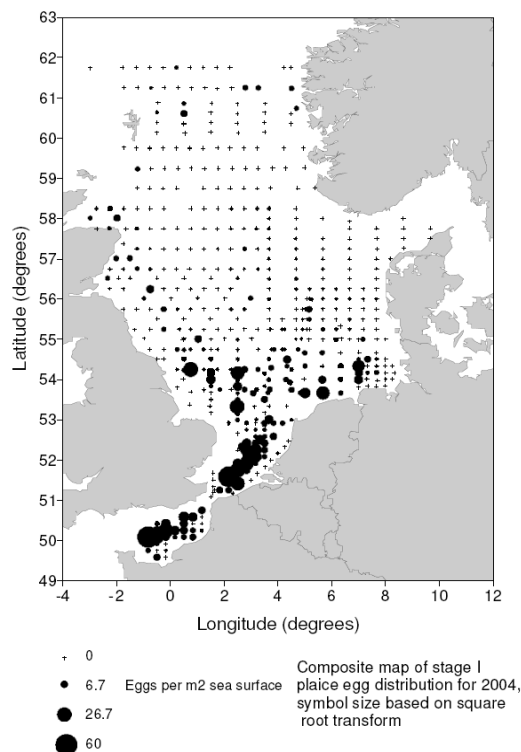
*Pleuronectes  
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Coastal and inshore waters of the North Sea represent essential nursery areas, with the Wadden Sea being the most important one [5]. One-year-old plaice show a strictly coastal distribution while the older age classes gradually disperse further offshore, away from the nursery areas [6,7].

Spawning may occur over most of the offshore and deeper parts of the southern North Sea and off the east coast of Britain from Flamborough Head to the Moray Firth (see also Box 1). Centres of high egg production are the eastern Channel and the Southern Bight, while egg production around the Dogger Bank and in the German Bight is more diffuse [8,9,10].

**Box 1: PLACES**



In 2004 the spawning area of plaice was mapped in the PLACES project (PLAice and Cod Egg Survey). PLACES was an ichthyoplankton survey covering the entire North Sea, conducted by an international consortium comprising England, Scotland, the Netherlands, Germany, Denmark and Norway [6]. The distribution of early-stage plaice eggs in 2004 is shown in the map.

*Habitat characteristics:* Nursery grounds for plaice tend to be very shallow, 0-group even staying behind in pools on the tidal flats in estuaries during ebb. Sediment characteristics are thought to be of importance during larval settlement and positive relationships have been found between grain size and plaice densities [11]. For example in the Wadden Sea, protected muddy areas are less populated by plaice than more exposed sandy flats [12]. The preference for sandy sediments remains during the entire lifespan, although older age groups may be found on coarser sand.



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## Life history

**Age, growth rates:** Female plaice grow faster and to a greater length than male plaice (Fig. 2). The mean annual relationship between (total-)length (L) and weight (W) for plaice in the North Sea, based on recent survey data, is estimated to be:  $W=0.009*L^{3.031}$ . Juvenile growth rate showed an increase in the 1960s and 1970s, and a decrease since the late 1980s. Large year classes exhibit a reduced growth. The trends in juvenile growth coincided with a trend in nutrient runoff, in particular phosphates, by the major rivers, and an increase in bottom disturbance by beam trawls. [13].

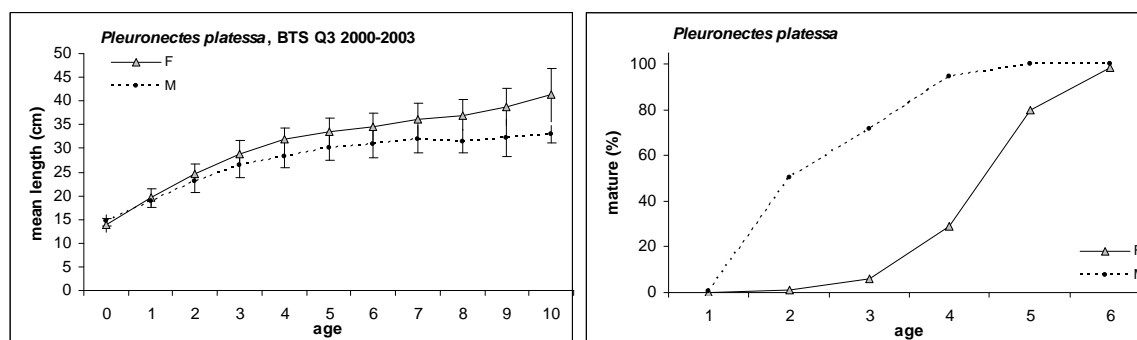


Figure 2 (left panel). Mean length per age group in the North Sea in August 2000-2003, based on BTS-data.

Figure 3 (right panel). Percentage of mature fish per age group in the North Sea in 1985-1986, based on Dutch survey-data and market samples [6].

**Reproduction:** Male plaice become sexually mature at two or three years of age, females mature later when they are four or five years old (Fig. 3). In general, plaice from northern areas mature at an older age and larger size than plaice from the south [6]. Time series have shown that the percentage of mature four-year-old females changed from 20% in the mid-1960s to 70% during the early 1980s, coinciding with a substantial increase in growth rate during the first four years of life [7,14]. The earlier maturation is likely due to an evolutionary response to fishing mortality [15]. Peak spawning time shifts from early January in the eastern Channel to mid-February in the German Bight and off Flamborough [6].

The number of eggs that a 35 cm female produces may vary from 60 000 to 100 000, corresponding to about 265 eggs per gram body weight [16]. Fecundity of medium-sized females ( $\leq 40$  cm) has increased since the 1950s [16]. The pelagic eggs are 1.7-2.2 mm in diameter [17] and the duration of the planktonic egg and larval stages of plaice (three to four months) is long compared to, for example, sole (about one month). This results in long exposure to residual currents, and the young plaice may settle in areas far away from the spawning area. Settling on the bottom happens only after complete metamorphosis, i.e. when the left eye has shifted to the right side at a length of 13 – 14 mm [17].

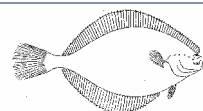
Variability in year-class strength is determined during the pelagic phase until the time when metamorphosing larvae enter the coastal nursery areas [18]. Density-dependent processes appear to fine-tune year-class strength mainly during the first weeks after settling in the nurseries [19].

**Migrations:** Plaice make selective use of tidal currents in various stages of their life. Metamorphosing larvae enter estuarine nursery areas by migrating to midwater during the flood tide and settling at the bottom during ebb [18,20]; juvenile plaice in the Wadden Sea move with the flood tide onto sandy flats to feed and move back to the surrounding channels on the ebb tide [21]. Adult plaice are also known to make use of tidal stream transport during their seasonal migrations between spawning and feeding grounds; they move downstream with the tide in mid-water, and stay on the bottom during the opposing tide, showing little or no movement [22,23].



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Part of the North Sea plaice population spawns in the Channel and returns to its feeding grounds in the North Sea afterwards. Progeny of this group enters the North Sea as eggs and early larvae by passive drift [24].

In the North Sea, spawning-feeding migrations occur along a north-south axis. The distances over which the plaice migrate increase with size. Tagging experiments revealed that several spawning populations that mix during the summer feeding season and separate during spawning can be distinguished [1,25]. Despite the occurrence of separate sub-populations of plaice within the geographical distribution area, analysis of microsatellites (DNA) did not reveal significant distinction among populations along the continental coast between the Bay of Biscay in the south and the Lofoten area in the north [26]. Only plaice from the Faroese and Iceland showed a different pattern.

**Food habits:** The diet of plaice larvae in the Southern Bight consists of appendicularians such as *Oikopleura dioica* and *Fritillaria borealis*, but several stages of copepods, algae, and bivalve post-larvae are also eaten [27]. Polychaete worms, especially sessile species such as *Pectinaria koreni* and tails of *Arenicola*, and bivalves are important food groups for larger plaice. Other important prey includes small crustaceans (e.g. amphipods, mysids and small shrimps), siphons of bivalve molluscs (e.g. *Abra* spp., *Mya* spp. and *Venus* spp.), and, in certain areas, brittle stars (*Ophiura* spp.) [28,29]. Plaice are typical daylight feeders. The adults do not feed during the spawning period [28,6].

**Predators:** Although fish eggs do not seem an important prey item in the food of herring and sprat, significant numbers of plaice eggs have been found in the stomachs of these species and the large variations in their abundance may have caused long-term changes in egg-mortality [30].

## Population structure

**Age and length composition:** The length-frequency distribution in the North Sea shows two peaks, one around 10 cm and the other one around 20–25 cm, corresponding with age groups 1 and 2 (Fig. 2). Very few 1-group are caught in the Skagerrak/Kattegat area. In order to enable the comparison of the length composition of plaice in the North Sea with the one in the Skagerrak/Kattegat, data from the IBTS were used, since this is the only survey that covers both areas. However, it needs to be mentioned that the IBTS uses the less efficient GOV trawl.

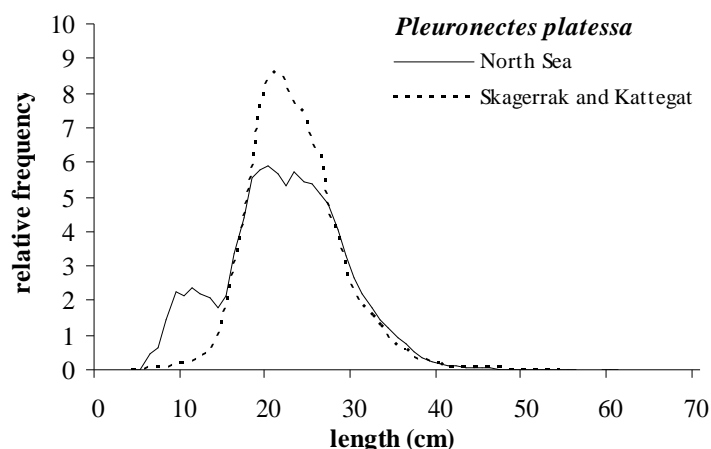


Figure 4. Relative length-frequency of plaice in the North Sea and Skagerrak/Kattegat, based on IBTS Q1, 1985–2005.





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**Sex ratio:** The sex ratio of the North Sea plaice stock has been investigated using Dutch landings as observed in the market samples collected during the whole year in the period 1958–1999 [31]. No apparent trends in sex ratio were observed although there may be a slight increase in the number of females over the latter years. In the youngest age groups represented in the market samples, the proportions of males and females are similar. As there is a sexual dimorphism in growth, maturation and mortality, the proportion of females increases with age and size. Due to the intensive fishing pressure, the proportion males at larger sizes has gradually decreased since the 1950s [32].

**Changes in abundance:** The stock has been fairly stable from the late 1950s to the mid 1980s. Year-class strength has not fluctuated strongly from year to year, although occasional strong year classes recruit to the fisheries (year class 1963, 1985). A strong decrease in abundance occurred between the mid 1980s and the mid 1990s.

**Stock structure:** Despite the existence of major spawning concentrations and the clear homing of individuals to specific spawning grounds, it is uncertain whether the offspring from each spawning ground return to the same ground to spawn and thus these ‘subpopulations’ are to some extent reproductively isolated units. A genetic study on the population structure of plaice in northern Europe, however, revealed that the North Sea Basin constitutes a random-mating unit with high gene flow among geographically recognizable stocks [26]. Therefore, plaice in the North Sea (ICES sub-area IV) is assessed as one unit stock.

## Exploitation in the North Sea

**Main métiers targeting the stock:** North Sea plaice is mainly taken in a mixed flatfish fishery for sole and plaice by beam trawls in the southern and central North Sea, the Netherlands being responsible for approximately 42% of the catch. Directed fisheries are also carried out with Danish seine (‘snurrevaad’) and gillnet in the central North Sea, and plaice is a by-catch in otter trawl fisheries. After a long-term increase in fishing mortality after World War II, fishing effort of the major fleets exploiting plaice has decreased since the mid-1990s.

**Landings:** Annual landings have been rather stable since the beginning of the 20<sup>th</sup> century at around 60 000 t, but increased gradually after World War II from 70 000 in the late 1950s to 170 000 t in the late 1980s. Since 1989 landings have decreased to less than 60 000 t in 2005 [33]. The mixed beam-trawl fishery targets both sole and plaice, but the mesh size used is inappropriate for plaice and results in a large catch of plaice below the minimum landing size. The amount of plaice discarded has gradually increased with the gradual decline in the stock of marketable plaice (see also below).

**Spawning Stock Biomass and fishing mortality:** The size of the spawning stock varied around 300 000 t between 1957 and 1989. It then declined sharply to just above the limit reference point ( $B_{lim} = 160\,000$  t). The fishing mortality gradually increased from the 1950s until the late 1990s, but is now estimated to be below the limit reference point ( $F_{lim}$ ) of 52% per year [33].

**Stock status:** Since its recent decline, the stock is considered to be at risk because of reduced reproductive capacity. Although the stock is considered to be overexploited, the present level of fishing mortality is considered to be sustainable.



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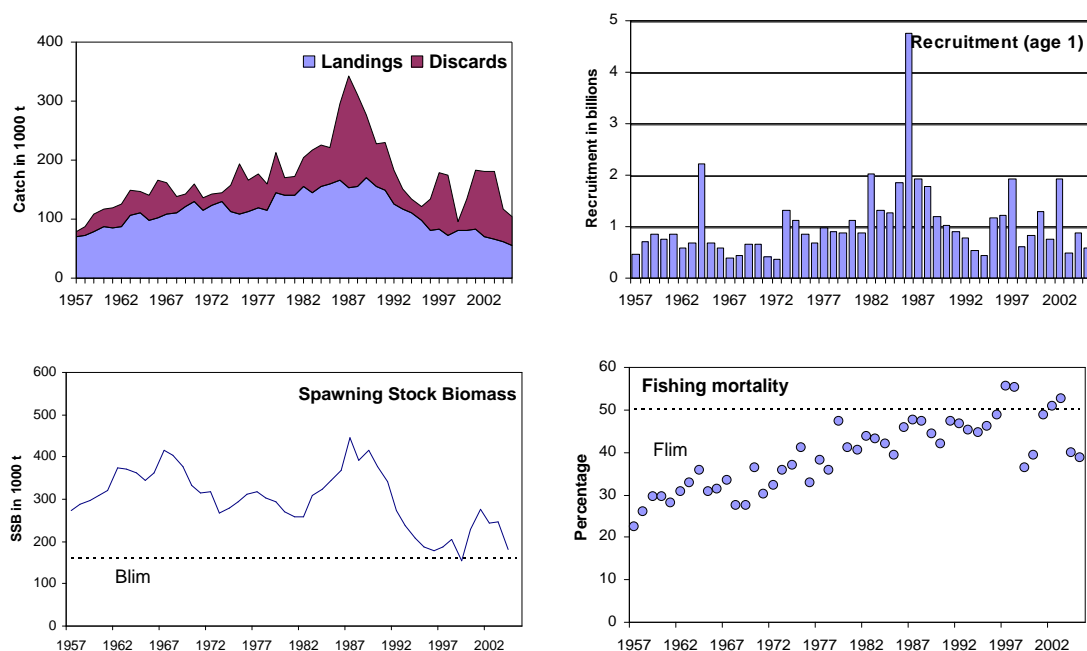


Figure 5. Landings and discards ('000 t), spawning stock biomass ('000 t), recruitment at age 1 (in billions) and average fishing mortality (in %) for ages 2 to 6 for North Sea plaice since 1957 [33].

**Protection and management:** In 1999, the European Union and Norway agreed on a long-term management plan for North Sea plaice, which is consistent with the precautionary approach. The agreement was intended to constrain harvesting of plaice within safe biological limits. It was agreed to maintain the spawning stock size above 210 000 t, and also to agree on TACs consistent with a fishing mortality of 25% per year ( $F = 0.3$ ). The agreement was not renewed for 2005 and is no longer in force. A new management plan is currently (2006) under development.

Several technical measures are applied to the plaice fishery including mesh size regulations, a minimum landing size, gear restrictions and a closed area along the continental coast where large beam trawlers are not allowed to fish (the Plaice Box, see Box 2). North of 55°N (or 56°N east of 5°E, since January 2000) the minimum mesh size is 100 mm. South of this limit, where the majority of the plaice fishery takes place, an 80 mm mesh is allowed. The total length of the beams used by a beam trawler is limited to 24 m, while this is 9 m within the 12 nautical miles zone and in the Plaice Box. The minimum landing size of 27 cm causes high discard levels in the mixed flatfish fishery using an 80 mm mesh size [33].

In the light of the cod recovery plan, a days-at-sea regulation has been introduced in the Netherlands. This restriction is an incentive to stay closer to the harbour and as a consequence fishing closer to the coast where smaller plaice are abundant has intensified. This might lead to increased discarding.



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**Box II: The Plaice Box**

North Sea flatfish fisheries generate considerable amounts of discards, especially of plaice. Only few of these discarded plaice survive. To reduce discard mortality, a partially closed area, the Plaice Box, was established in 1989. Beam trawling was prohibited in this area for part of the year for vessels larger than 300 HP. Since 1995 this area has been closed all year round for these vessels while beam trawlers <300 HP were allowed to continue fishing in this area. Because the Plaice Box encompasses the major concentrations of juvenile plaice, the introduction was expected to enhance recruitment, yield and spawning stock biomass.

Following the complete closure to larger beam trawlers, fishing effort inside the Box was reduced to 23% of the pre-Box level. The proportion of the total plaice landings taken inside the Box also decreased, but was still 7% in 2003. This is partly due to an increase in the effort of small beam trawlers in the area.

Despite the Plaice Box and although discard rates inside the Box are still higher than outside, the percentage of plaice discarded (as a percentage of the numbers caught) has increased from 77% in the period 1976–1990 to 87% in 1999–2003.

This may be partly explained by the considerable change in the distribution of juvenile plaice over the last 10 years. Especially 1-year-olds moved to deeper and more offshore waters than before and may now partly be found outside the Box. Similar changes have been noted in the Wadden Sea and in the southern estuaries, starting in 1997 and culminating in 2000 – 2003. The proportion of under-sized plaice present in the Box (including the Wadden Sea) has decreased from 90% in 1990 to less than 70% by 2003.

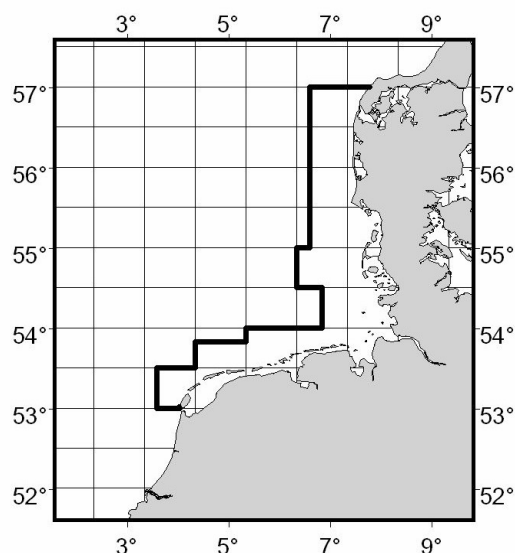
Growth rates as well as condition factors of both plaice and sole have decreased around 1980 and stabilised thereafter. These changes are thought to reflect changes in environmental conditions in the area.

Since the 1950s, the average annual water temperature in and around the Box has increased by 0.5–1°C and 2000–2003 have been extremely ‘warm’ years, especially during winter. In the Dutch coastal zone, both nitrogen and dissolved inorganic phosphorus increased from the 1950s until the early 1980s, after which concentrations declined and stabilized in the early 1990s. Primary production in the Wadden Sea increased from 1970 into the 1980s and declined slowly thereafter. While any of these factors may have affected growth or distribution of plaice, it remains unclear how these processes work and therefore the effects of future changes can not be predicted.

Clearly, the Plaice Box has failed to meet the objectives of enhanced recruitment, spawning stock biomass and yield. Since its establishment in 1989, recruitment has shown a negative overall trend, and spawning stock biomass and yield have decreased by 60%. Nevertheless, a positive effect on the recruitment seems likely, because the majority of undersized plaice (70%) is still found within the Box and discard percentages in the Box are higher than outside. In other words, in the absence of a Plaice Box, the status of the stock might be even worse than it is now.

Further reading: “Assessment of the ecological effects of the Plaice Box” [34].

[http://www.rivo.wag-ur.nl/FTP\\_DIR/Report\\_evaluation\\_plaice\\_box.pdf](http://www.rivo.wag-ur.nl/FTP_DIR/Report_evaluation_plaice_box.pdf)







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