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Status of exploited Baltic flounder stocks in the southern Baltic area (ICES SD 26)

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Key words: selectivity, stock assessment, *Platichthys flesus*, Baltic Sea

Abstract

Flounder is the target of directed fisheries in coastal waters and is a bycatch of cod fishing. Flounder were fished in the Baltic region ICES Subdivision 26 (SD 26) by Polish and Soviet fleets until 1991. Since that time political and economic changes have altered the exploitation structure of that area, leading to increased fishing effort and flounder catches. This report, which is based on Polish, Russian and Lithuanian data, presents a review of long term changes in flounder fisheries in SD 26, and describes the current status of flounder exploitation there. The eXtended Survival Analysis (XSA) method was used to assess the stock. The results indicate that the flounder stock in SD 26 is in good condition and that the spawning stock biomass (SSB) is at a consistently high level. However, the estimated mean fishing mortality (F_{bar}), with reference to Biological Reference Points, indicates that the stock is being exploited too intensely to be sustainable.

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INTRODUCTION

Flounder, *Platichthys flesus* (L.), is one of the most commercially important flatfishes in the Baltic Sea. It is distributed throughout the Baltic, except in the Bothnian Bay, the eastern part of the Gulf of Finland, and the deepest areas of the Gotland Deep (Bagge 1966, Bagge and Steffensen 1989, Bonsdorff and Norkko 1994, Florin 2005). This paper reports an investigation into the flounder stock status in the ICES Sub-division 26 (SD 26) (Fig. 1).

SD 26 is located in the eastern part of the southern Baltic and includes the Gulf of Gdańsk, the Gdańsk Deep, and the eastern part of the Gotland Deep (54°14'–56°39' N and 18°00'–21°30' E) (ICES 2006). The Gotland basin, with its low oxygen content, seems to act as a boundary preventing eastern and western stocks of flounder from mixing (Aro 1989, Bagge and Steffensen 1989). The physicochemical conditions of SD 26 are typical of the Baltic proper, with a salinity of 7-8 PSU and oxygen depletion in deeper basins. These physicochemical conditions are impacted by inflows from rivers. In the Gulf of Gdańsk the Vistula River has a particularly significant impact, with an annual freshwater input of about 34 km^3 (Majewski and Lauer 1994). Flounder spawning grounds are located in deeper parts of the Gdańsk Deep and southern Gotland Deep (Cięglewicz 1963). After spawning, flounder in SD 26 migrate to feeding grounds in the coastal waters of the Gulf of Gdańsk, to the west along the southern Baltic coast, and as far as to the south of Bornholm Deep. Current knowledge of Baltic flounder genetics is considered to be insufficient to be applied as a criterion for separating biological stocks. The results of tagging experiments (Cięglewicz 1947, Cięglewicz 1961, Kuczyński 1984) and preliminary results of genetic research (Florin et al. 2005) provide some evidence to support the separation of flounder stocks. The analysis of genetic versus geographical distance indicates that the main differences occurring between stocks from SD 26 and SD 25. For the sake of simplicity, the flounder inhabiting SD 26 are assumed in this instance to belong to a homogenous assessment unit, as there is no premise by which to establish the exact borders that separate disparate stocks.

The flounder fishery is concentrated in the southern part of the Baltic (ICES SD 24, 25 and 26) (Fig. 1) and is dominated by Poland, Denmark, and Germany, but catches in SD 26 (Fig. 2) are conducted by fishermen from Poland, Russia, Lithuania, and Latvia. Since the beginning of assessment attempts in 1978, the ICES has declared the stock in the southern Baltic Sea to be stable (ICES 2005a).

Even though SD 26 occupies the third position in the rank of flounder catch volume in the Baltic (with landings of approximately 4,000 tons p.a.), stock abundance at the international level is assessed for stock in SD 24 and 25 only

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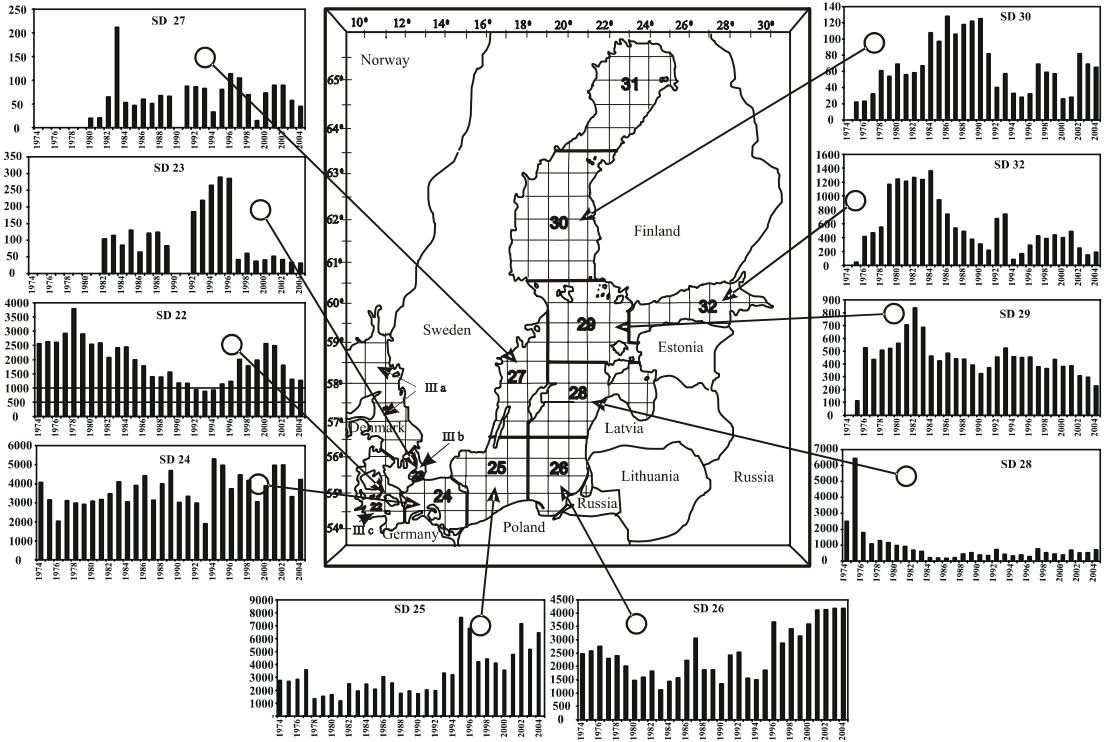


Fig. 1. Annual Baltic flounder catch distribution by the Statistical Sub-Division in years 1974-2004 (ICES 2005).

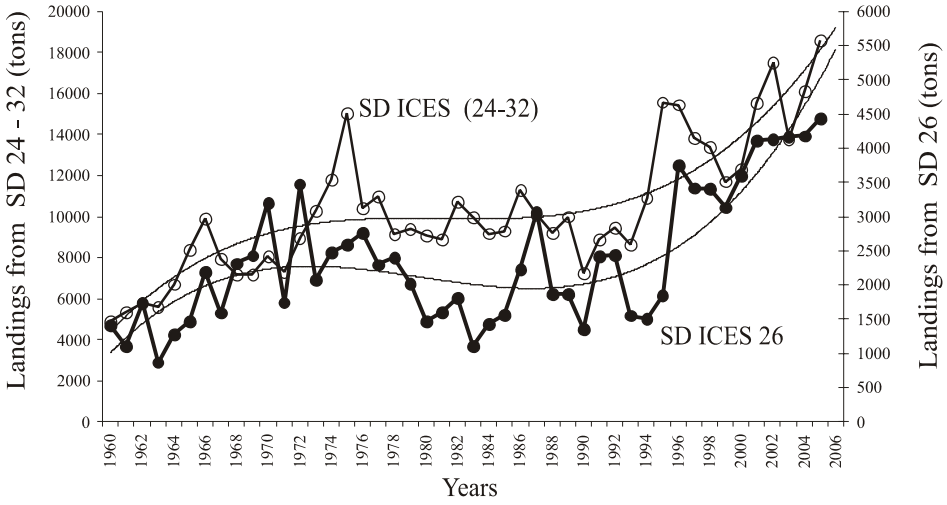


Fig. 2. Trends in flounder catches from the entire Baltic (SD ICES 24-32) and from SD 26 (SD ICES 26), 1960-2004.

(ICES 2005). For comparison, catch amounts were shown in subdivisions other than those investigated, based on ICES data (ICES 2005).

According to an investigation of long-term trends in biomass and catch data, the stocks have been overexploited at least periodically (Rice and Cooper 2003). To date, the catch volume has not been limited, despite the fact that Baltic flounder was one of the first species of which exploitation was the subject of an international treaty on the conservation of Baltic flatfishes (Anon. 1929).

The aim of this work is to describe the current flounder fisheries and assess the flounder stock status in ICES SD 26 based on Polish, Lithuanian, and Russian data from both scientific surveys and commercial catches. This work presents a long-term picture of flounder catches as well as a preliminary assessment of stock dynamics.

MATERIALS AND METHODS

Polish and Russian catch-at-age data were used (ICES 1999), the types of data and year ranges are presented in Table 1. These materials were collected within the framework of fisheries monitoring and were used exclusively to assess the number of flounder caught. This, in turn, provided the foundation for

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Table 1

List of materials used

Data	Years	Origin country	Description
Length distribution of commercial catches	1995-2004	Russia	Gill-net catches-mesh sizes 110, 115, 120, 130, 180, 190, 220, 240, 250 mm
	1998-2001	Poland	Cod-directed gill-nets (110 mm), flounder-directed gill-nets (130 mm), hooks, cod-directed trawl (120 mm or with selective panel), flounder-directed trawl (130 mm)
Length distribution of experimental catches	1995-2005	Lithuania	Monofilament gill-nets: mesh sizes 20, 37.5, 40, 50, 55, 60, 65, 75, 90, 100 mm
Catch in tons	1955-1970	Poland	Polish and Russian data (Draganik 1978)
	1970-2004		ICES data (ICES 2005)
Catch in numbers at age	1955-1977	Poland*	Basis for calculating the catches of other countries
	1978-1994	Poland	Assessed separately; data obtained summed and the catches of other countries were increased proportionally
	1995-2004	Poland Russia	
Individual mean weight in catch	1955-1994	Poland	Basis for calculating the catches of other countries
	1995-2004	Poland Russia	Mean from data obtained for both countries
Individual mean weight in stock	1955-1994	Poland	Basis for calculating the catches of other countries
	1995-2004	Russia	survey data (DATRAS)
Natural mortality of M	1955-2004		assumed (ICES 2005)
Proportion of F before spawning	1955-2004	Poland	assumed
Proportion of M before spawning	1955-2004	Poland	assumed (ICES 2005)
Maturity ogive at age	1955-2004	Poland Russia	Kosior et al. 1996
CPUE tuning fleet	1995-2004	Russia	DATRAS [individuals Nm^{-2}]

* published in Draganik 1978

the SFI annual assessment of the state of the stock in SD 26. Table 1 also describes data used in selectivity analysis.

Flounder assessments in SD 26 were performed using the XSA method from the VPA95 suite (Darby and Flatman 1994). CPUE data from the Russian ground survey in SD 26 (DATabase TRawl Survey – DATRAS) for the period 1995-2004 were used as a tuning fleet. The selectivity analysis was used to determinate catchability for assessment purposes.

The settings of XSA (Table 2) were based on those used in the stock assessment in SD 24 and 25 (ICES 2005). However, the catchability dependent on stock size for ages <3 was assumed, and the proportion of fishing mortality before spawning was set at 0.16. This value was assumed since the spawning season in this subdivision starts in March. A fixed natural mortality of 0.2 was applied in the assessment (ICES 2005). The maturity proportion was calculated based on the maturity ogive equation (Kosior et al. 1996).

To depict the current exploitation rate, SSB-equilibrium-curve and Biological Reference Points (BRP) ($F_{0.1}$, $F_{35\%SPR}$, F_{max}, F_{bar}, F_{med}, F_{loss}) were estimated by PAsoft (CEFAS 1999).

Table 2

XSA settings used in the analysis

Catch data for 50 years (1955-2004) ages 2 to 8

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Standardized R/V CPU	1995	2004	2	7	0.16	0.25

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis:

Catchability dependent on stock size for ages <3

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 3

Catchability independent of age for ages >= 4

Terminal population estimation:

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.

SE of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

RESULTS

Flounder fishery

Over the years the landings from SD 26 have tended to be analogous to those from catches throughout the Baltic (Fig. 2). Based on the flounder landing data reported to ICES in SD 26 since 1960, it is possible to identify three long-term trends over the 45 year span. During the first period, 1960 until the mid 1970s, there were successive increases in catches. Decreasing catches were then seen from the late 1970s until the early 1990s. Following 1994, another increase in catches was reported, reaching the highest levels seen at any time during the 45 year span.

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Since 1995 increased total flounder catches have been observed in SD 26 (Fig. 3). Gillnets are nearly exclusively deployed in this type of fishery, although pre-spawning individuals are the target of larger vessels that deploy bottom trawls (or, less frequently, benthic pair trawls; Table 3).

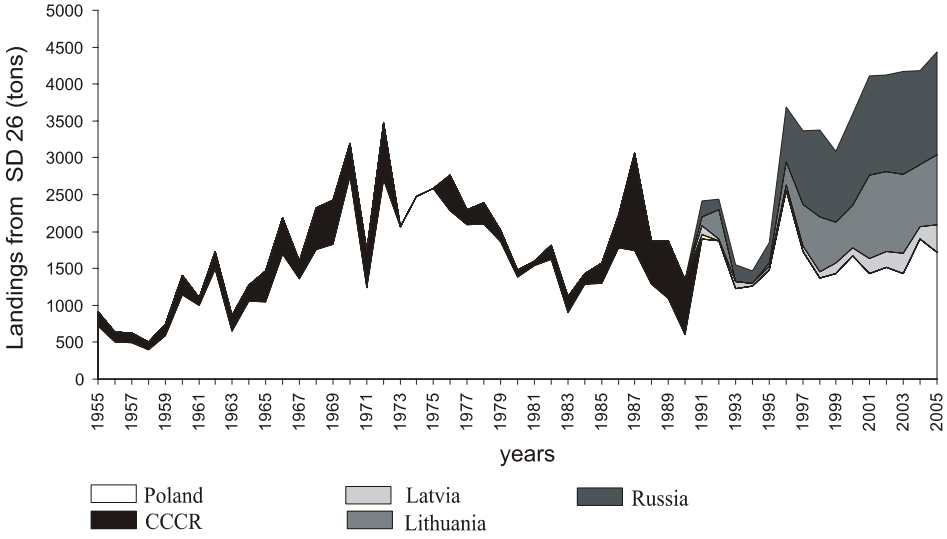


Fig. 3. Flounder catches from SD 26, 1955–2005, by country.

Table 3

Proportion of flounder catches at small-scale coastal fisheries and open-sea fisheries, based on Polish data

Year	Type of fishery	Quarter			
		I	II	III	IV
2001	open-sea	75.0%	5.5%	3.2%	41.3%
	coastal	25.0%	94.5	96.8%	58.7%
		100	100	100	100
2002	open-sea	91.3%	1.0%	6.5%	20.3%
	coastal	8.7%	99.0%	93.5%	79.7%
		100	100	100	100
2003	open-sea	88.5%	10.5%	9.4%	23.8%
	coastal	11.5%	89.5%	90.6%	76.2%
		100	100	100	100
2004	open-sea	82.9%	15.7%	9.0%	32.6%
	coastal	17.1%	84.3%	91.0%	67.4%
		100	100	100	100

One of the principle characteristics of flounder catches in SD 26, in comparison to those conducted in the neighboring SD 25, is the different catch season. Maximum catches are registered from June to September in SD 26, while in SD 25 approximately 65% of the flounder mass is landed in the first three months of the year (Fig. 4).

The average annual flounder landing from SD 26 made in the Baltic countries that were part of the USSR during the 1960-1990 period was 390 tons. Currently, Russian Baltic fisheries target flounder only in SD 26, and the average landing in the 1992-2005 period was 960 tons.

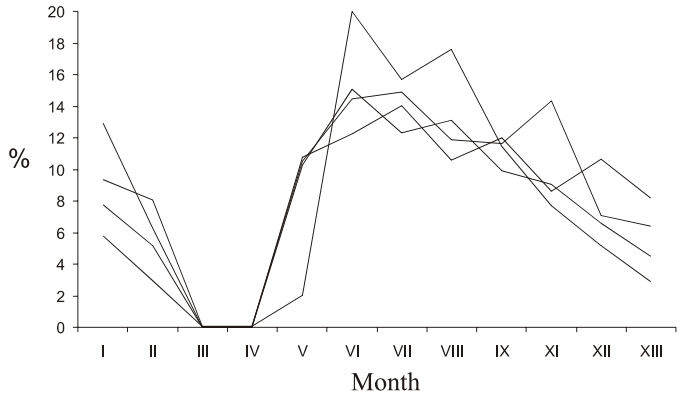


Fig. 4. Seasonal variations in Polish flounder catches in SD 26 (based on data 2001-2004).

The available Lithuanian flounder catch statistics date back to 1926 (Table 4). The average annual catch for the 1926-1938 period was 194 tons. For the period following World War II until 1991 it is impossible to determine the magnitude of flounder caught by Lithuanian fisheries in SD 26. However, flounder exploitation in SD 26 that is assigned to the fisheries of the USSR in the 1960-1990 period ranged from 110 to 780 tons with the exception of 1987 when it was 1,300 tons. After 1991 flounder landings in Lithuania increased rapidly from several hundred tons in 1990 to 1,127 in 2001. However, since then catches have declined slightly, though steadily, to 950 tons in 2005.

Gear selectivity

The length distribution of flounder catches depends on the type of gear employed (Fig. 5). The smallest flounder are caught with bottom trawls used in cod-directed fisheries (bar length 120 mm or 105 mm equipped with selective windows). A high bycatch of undersized fish occurs in cod-directed catches

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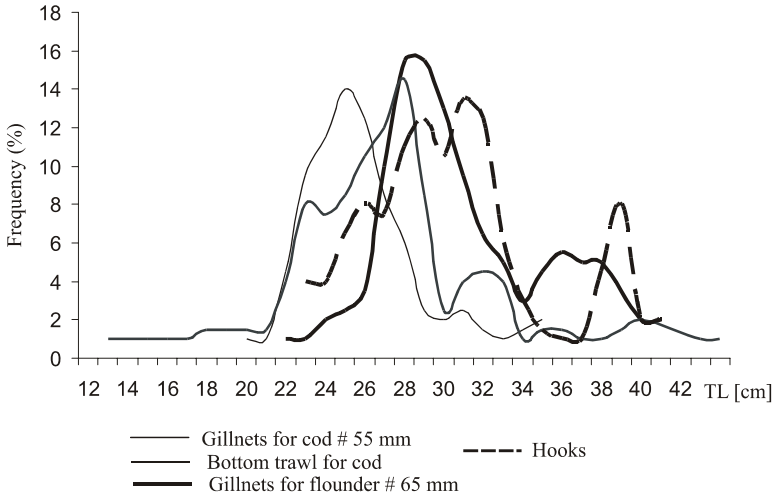


Fig. 5. Effect of gear type on the length structure of flounder fished.

Table 4

XSA settings used in the analysis

Year	Total catch	Inshore catch
1926	86.4	No information
1927	78.4	
1928	182.7	
1929	299.8	
1930	250.1	
1931	395.6	
1932	273.6	
1936	141.5	
1937	126.2	
1938	105.9	
1990	162.6	-
1991	141.4	-
1992	484.3	1.7
1993	154.7	34.5
1994	262.4	28.8
1995	194.2	29.0
1996	329.6	35.6
1997	623.7	35.3
1998	706.8	29.9
1999	547.3	49.7
2000	573.0	28.1
2001	1126.7	25.5
2002	1077.3	36.3
2003	1099.5	22.6
2004	854.8	21.1
2005	9489.6	21.8

with nets (bar length 55 mm). Catches made with hooks are characterized by a wide length distribution; this is also the gear employed in directed cod catches. The most selective gear, used to catch fish in the narrowest length distribution range, are gillnets with a mesh bar length of 65 mm, which is the gear employed in directed flounder catches.

The result of measurements of flounder caught in Lithuanian experimental catches indicate that the bycatch of undersized fish (under 21 cm TL) is acceptable (under 4% of the abundance) with mesh as small as 60 mm (Fig. 6). This value decreases to zero when netting with larger mesh sizes is employed.

The mesh size of gillnets in Russian fisheries has changed in the past six years. In 2000 and 2001, the mesh size (bar length) in most nets was from 110 mm to 120 mm. In the 2002-2004 period the range was widened to include smaller mesh sizes, from 55 mm to 120 mm, and in 2005 the size range was from 85 mm to 90 mm. The results from

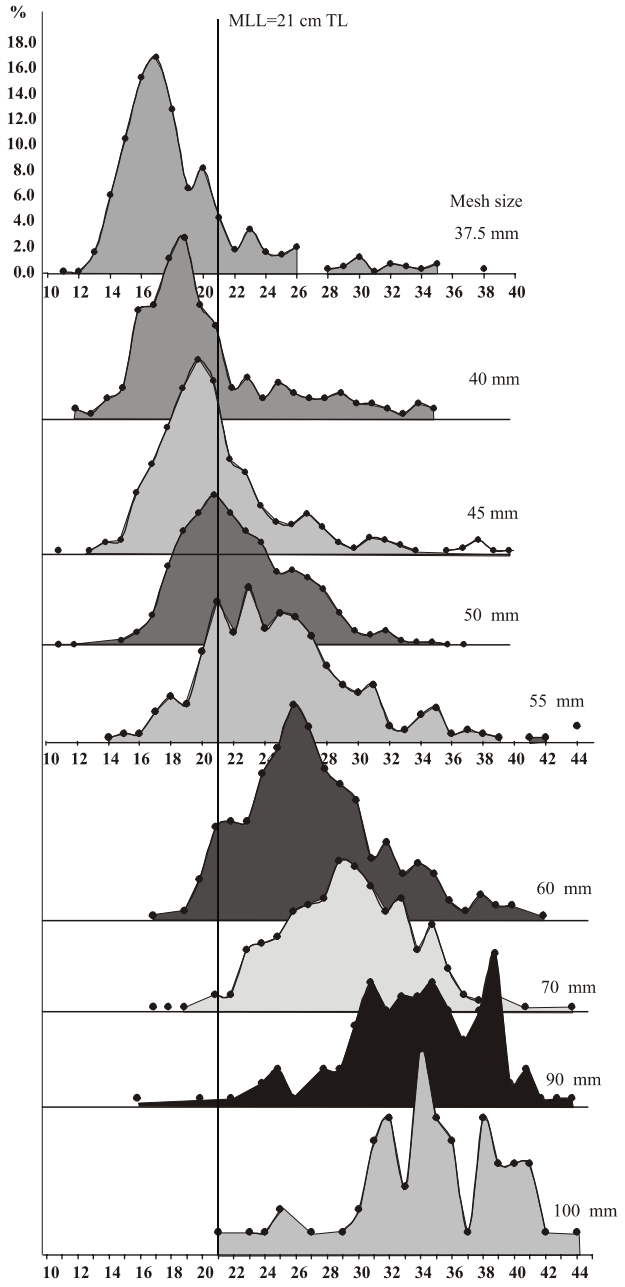


Fig. 6. Flounder catch in relation to mesh size. Data from Lithuanian experimental catches with gillnets, 2001-2005.

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net catches made by Russian fishermen that were recalculated as the share of flounder in various age groups (Table 5) indicate that there is relationship between the characteristics of the fishing gear employed and the stock of the exploited flounder. The youngest flounder from age group 2 are usually caught at the end of the calendar year, and were only recorded in catches made with gear with the smallest mesh size. The first age group that begins to dominate in catches made with 65 mm mesh bar length netting is age group 4. In gear with larger mesh sizes this group gives way to older year classes. The share of age group 5 fish in nets of all mesh sizes is comparable. In nets with meshes over 90 mm, in which the share of age group 4 fish decreases, there is co-dominance of older year classes (age groups 5 to 9).

Assessment of the state of resources

Two periods of high levels of flounder resource in SD 26 can be identified during the 1955-2004 period (Fig. 7). The first was in the 1958-1975 period, after which the spawning stock biomass declined from 7,000 to 2,500 tons by 1983. The biomass oscillated between 2,600 and 5,000 tons in the decade spanning 1984 to 1994. In 1994 there was an increase that attained the maximum biomass noted for the entire 56-year period, in excess of 9,000 tons. Recruitment of fish of age group 2 to the flounder stock in SD 26 followed the trend of the spawning stock biomass; from 1994 there was an increase, which in 1998-2002 reached the maximum value recorded of the entire period under consideration.

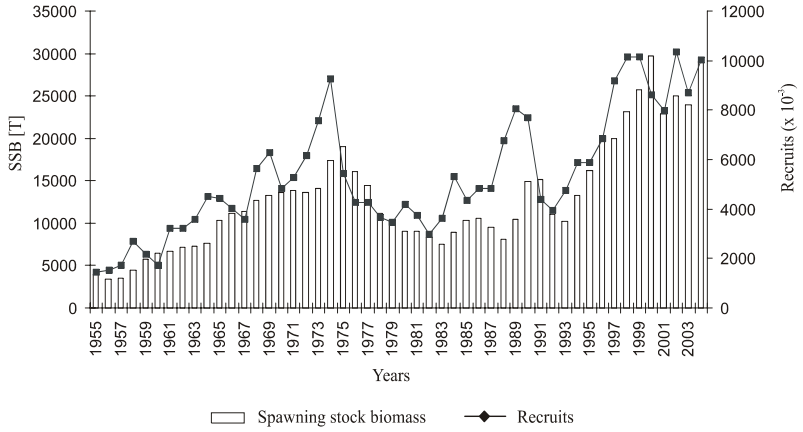


Fig. 7. Recruitment and spawning stock biomass of flounder in SD 26, 1955-2004.

An examination of catch magnitude reveals two periods of intense exploitation; the first was in 1974-1977, when catches reached a maximum of 3,500 tons, and the second was in 1996-2004, when catches were approximately 4,000 tons p.a.. In most years examined the fishing mortality F_{bar} reflects intense exploitation (Fig. 8). However, in 1973-1981 and 1995-2004, catches were high and the value of coefficient F did not follow the catch trend. A high recruitment, of 3 million individuals, was calculated during these periods.

The selected biological reference points, based on the assessment of the state of resources, are presented in Table 6. The value of the fishing mortality

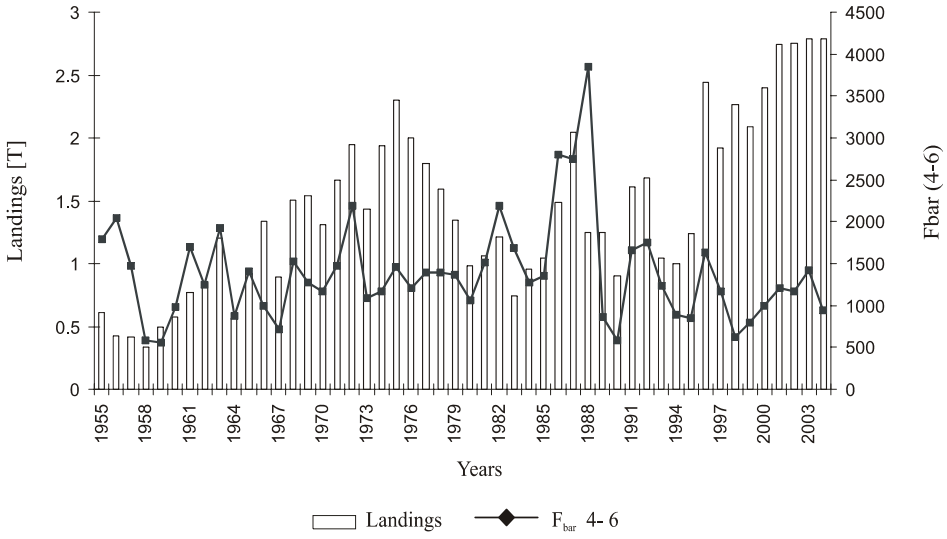


Fig. 8. Fishing mortality and landings of flounder in SD 26, 1955-2004.

Table 6

Biological reference points for flounder stock in Sub-division 26

Reference point	Deterministic	Median	25th percentile	5th percentile
F_{Bar}	0.63	0.63	0.60	0.56
F_{max}	0.44	0.43	0.39	0.34
$F_{0.1}$	0.20	0.20	0.19	0.17
F_{low}	0.60	0.54	0.49	0.42
F_{med}	1.16	0.96	0.87	0.75
F_{high}	1.89	1.80	1.57	1.33
$F_{35\%SPR}$	0.27	0.27	0.24	0.21

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coefficient ($F_{bar\ (4-6)}$) ranged from 0.43 to 1.8 (Fig. 9). The only outlier is 1998 (F=2.5). The dependence of SSB - F_{bar}, in the light of the equilibrium curve, highlights the fact that stock production does not always replenish fishery losses (the point to the right of the equilibrium curve).

The rate of fishing estimated for 2004 (F_{bar} = 0.63) is the closest to the biological reference point F_{low} and is substantially higher than F_{max} and $F_{35\%SPR}$. The location of the biological reference point on the yield-per-recruit curve (Fig. 10), with reference to the line of the curve, indicates that the points of reference F_{max}, $F_{35\%SPR}$, and $F_{0.1}$ reflect a low F value.

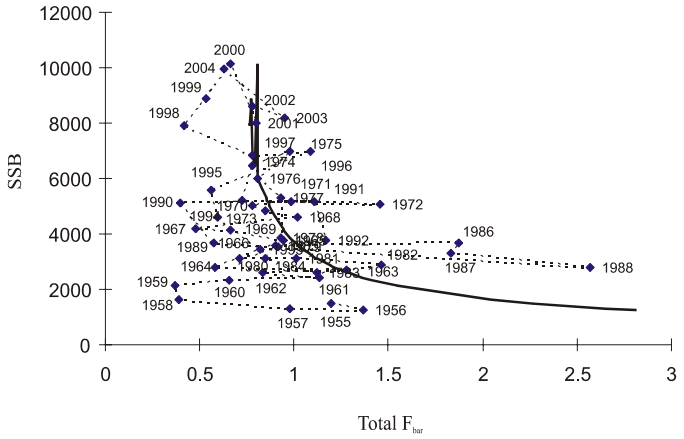


Fig. 9. Relationship between fishing mortality and spawning stock biomass with equilibrium curve for stock SD 26, 1955-2004.

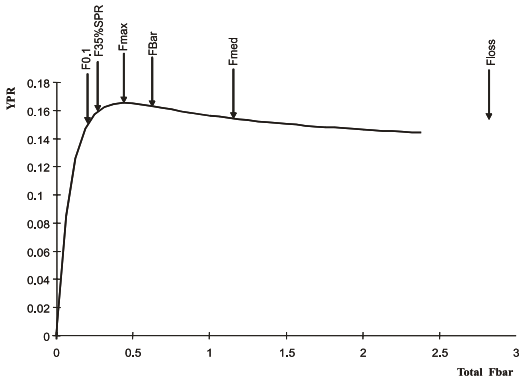


Fig. 10. Yield/Recruit curve for flounder stock in SD 26 with reference points marked.

DISCUSSION

The structure of Polish flounder-directed fisheries has been shaped by history. In contrast to the fleets catching flounder in the other two areas of the Southern Baltic (ICES SD 24 and 25), the stabilized coastal fisheries in the region of SD 26 operate using fishing boats, the flounder resources enabling the maintenance of this type of fishery (Romański 1968). In the period 1920-1929 Polish flounder catches were conducted almost exclusively near the shoreline (Borowik 1930). During the postwar period, coastal boat fisheries in SD 26 landed in excess of 60% of Polish flounder catches.

Despite the common use of gill nets during the 1950s and 1960s, a substantial portion of flounder catches were made with hook lines (Romański 1968). The coastal fisheries continue to make a significant contribution to flounder catches in SD 26 to this day.

The longest flounder catch statistics are archived in Lithuania. The quality of Lithuanian catch statistics confirm Pakštas (1934), who reported that the average annual flounder catch between 1927 and 1931 was 241.3 tons, what is close to data show in Table 4.

Economic and political changes that occurred in the late twentieth century had a great impact on flounder fisheries in SD 26. The collapse of the Soviet Union, changes in ownership structure, and the privatization of the national fleets of the various Baltic countries contributed to increased total flounder catches (Fig. 3). Flounder catches made prior to 1991 by the Baltic countries that were part of the USSR were exclusively the bycatch of trawling. Limited access to inshore waters made conducting coastal fisheries from boats impossible, which is why gillnets were not used. Following 1991, restrictions limiting coastline access were lifted and boat fisheries began to develop with the gradual deployment of gillnets in the cod and flounder fisheries. Currently, Russian Baltic fisheries target flounder only in SD 26. The considerable increase in flounder catches is not the result of directed fisheries, rather catches of this species remain largely as the bycatch of the directed cod fishery. Nonetheless, flounder landings are increasing, and in 2005 they comprised more than 40% of the catch weight.

Baltic flounder growth depends on geographical area as well as gender. Drevs et al. (1999) studied length and age structure data for flounder collected along the south and southeastern Baltic coasts, from the Mecklenburg Bight to the Bay of Finland (SD 22 to 32). They demonstrated that there is a gradual decrease in length at age from southwestern to northeastern areas, in both males and females. The length and age structure of the exploited flounder stock has undergone substantial change over the span of the last 70 years, depending on exploitation conditions and binding catch regulation measures. In the 1930s,

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when recruitment was large (Thurow 1997) and the minimum landing length (18 cm TL) was the smallest in history, flounder from 18 to 25 cm were crucial in the success of the fishery. Limitations in the catch effort during World War II resulted in higher survival and, as a consequence, the predominance of flounder measuring 26 cm and over. In the 1950s larger and older fish were caught thus shifting pressure to the younger year classes. This led the Polish fisheries authority to increase the minimum landing length in 1963, to limit the removal of young fish without interfering in the fishing effort expenditure. In effect, the length distribution of caught fish assumed a parabolic shape, and its apex changed position depending on the size of the population that was exploited. Not until recent years has the distribution shifted towards larger sizes, despite the fact that the minimum landing length has been reduced by 4 cm. This is a result of demands of the market, where flounder of length 25 cm TL and above have been required. Differences in the length of fish caught are reflected in the age group divisions. From the early 1950s the flounder fishery in SD 26 was primarily supported by fish assigned to age groups 3 and 4 (in the 1930s it was age group 2), while in SD 24 and 25 it was age groups 4 and 5 that comprised the majority of the catch. In the last decade a positive change has occurred, namely that the fishing effort has shifted to older fish, assigned to age groups 4 and 5.

Suitable fishing gear requires determining the characteristics that have an impact on the structure of the stock retained in the light of regulations, in order to ensure renewal of the exploited population. As early as the 1930s the relationship between trawl mesh size and the size structure of the retained flounder population was described (Borowik 1931), and this permitted the choice of mesh size corresponding to gear that provided suitable protection. Giedz (1970) described the relationship between the mean selection length of flounder and the mean length of fish retained by gear of a determined mesh size, and maintained that gillnets with a mesh bar length of 60 mm ensured the rational protection of fish at the binding protected length of 21 cm. Similar conclusions can be drawn from the analysis of the results presented in the current work; sufficient protection can be ensured by using nets with a mesh size of 60 mm (Fig. 6).

Some assessment in SD 26 was conducted by AtlantNIRO (Russia) based on the age-structure model, and the results (trends) were presented in the Study Group of Baltic Fish and Fisheries Issues (SGBFFI) report (ICES 2006). The comparison of those results with the results of the assessment presented in this work highlights substantial differences in recruitment and biomass trends. Based on the current analysis, the authors ascertained that R and SSB exhibit a growth tendency, while SGBFFI reported declined trends in the 2000-2004 period. Only fishing mortality (F_{bar}) in the studied years exhibits a similar trend in both assessments.

The 2005 ICES stock assessments for SD 26 and SD 24-25 indicate increased catches (ICES 2005), but growth is far more pronounced in SD 26. The total flounder stock biomass reached 10,000 to 12,000 tons (the highest recorded level in history) in 2000 and 2003. The picture is slightly different when comparing the assessment results for the flounder stocks in the combined area of SD 24-25 (ICES 2005), where the biomass of the spawning stock in 2000-2004 was smaller than the corresponding biomass index in 1993-1996. The values of F in the assessment period are higher in SD 26 than in SD 24-25. In the assessments of SD 24-25, SSB and F_{bar} do not exhibit such high fluctuations as results show, during the analyzed period. One cause for greater fluctuations in these values might be the fact that second age groups were regarded as recruits. In light of the results regarding the selectivity of the most frequently employed gear, catchability dependent on stock size for ages <3 (recruitment age group 2) and catchability independent of age ≥4 were assumed. Another factor influencing the assessment might be the magnitude of flounder discards, which is unknown. The author's observations indicate that the phenomenon of flounder discard is growing as a result of the refusal of the market to accept fish under approximately 25 cm TL.

The large catches are indicated in the high value of the fishing mortality coefficient F_{bar} (ranging from 0.9 – 2.56) of flounder, especially in the 1980s. However, observations of catches in the 1970s and increases that began in the mid 1990s did not cause such significant increases in $F_{bar.}$ This can be explained by exceptionally high recruitment that increased stock abundance while simultaneously lowering the value of F, the determination of which is based on the quantitative relationship between subsequent generations (Pope 1972). This phenomenon is also described by the SSB-F graph (Fig. 9), in which the SSB value was the farthest from the equilibrium curve that illustrates balance between biomass and exploitation. This suggests that the production of the stock in the 1986-1988 period did not compensate for losses caused by fisheries. The extremely high values of F may be explained by cod catches having been recorded as flounder in the fisheries reports at the time.

The current rate of exploitation F_{bar} against the BRP indicates that the level of exploitation is between the values of F_{max} and F_{low}, which may suggests that the exploitation of SD 26 exceeds the level of maximum yield per recruit. At current exploitation levels, in less than 10% of cases, stock recruitment does not compensate for fisheries losses. For the purpose of comparison, the level of stock exploitation assessed in SD 24-25 corresponds to F_{med} (ICES 2005a). The calculated results indicate that the stock in SD 26 is in good condition and that its SBB is at a consistently high level. As reported by Mace (2001), the biological reference point of $F_{0.1}$ is a good approximation of F_{msy} (Maximum Sustainable Yield - MSY), which can be assumed to be optimal exploitation.

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The current exploitation rate of F_{bar} in comparison to $F_{0.1}$ suggests that the exploitation of the stock exceeds the MSY.

The diagnostics of a range of assessments obtained within the scope of the XSA runs indicate that the assumed arrangement describes the discussed assessment with the least error and the highest correlation coefficient from the survey (shrinkage to SE = 0.5) and exhibits better consistency than other options. Log catchability residuals also show no trend. A similar situation is found in the Working Group of Baltic Fisheries Assessment report (WGBFAS) (ICES 2005). The quality of the assessment is close to that of the 2005 assessment of SD 24-25.

The smallest correlation (coefficient 0.06) and the largest standard error of ages with q-catchability, independent of year class strength, are exhibited by age group 6. This may stem from inappropriate age determinations and is one of the reasons that WGBFAS did not present an assessment for flounder in SD 24-25 in 2006. Due to the low quality of the data and the large error obtained during subsequent XSA runs. It has been recommended that until the problem of age determination is solved, another method should be applied to assess flounder resources. It would be advisable that the same method is applied to assess stock in SD 26, as long as data are available.

REFERENCES

Anon. (1929). Scheme for regulating catches of plaice (*Pleuronectes platessa*) and flounder (*Pleuronectes flesus*) in the Baltic Sea. Berlin. Dz. U. RP Nr 3 (207) 3 December 1933 [in Polish].

Aro, E. (1989). A review of fish migration patterns in the Baltic. ICES J MAR SCI. 190. 72–96.

Bagge, O. (1966). Tagging of flounder in the Western Baltic, the Belt Sea and the Sound in 1960–62. ICES C.M. D: (1) 15 pp.

Bagge, O. and E. Steffensen. (1989). Stock identification of demersal fish in the Baltic. ICES J MAR SCI. 190. 3–16.

Bonsdorff, E. & A. Norkko. (1994). Flounder (*Platichthys flesus*) spawning in Finnish archipelago waters. Memo. Soc. Fauna Flora Fenn. 70: 30–31.

Borowik, J. (1930). On what does the catch of undersized fish depend? First report on the Polish research on saving-trawls. Journal du Conseil. Vol. V. No 2. 197 – 215.

Borowik, J. (1931). Research on effect of fishing gear on catch composition. [in] Polish Sea Fishery 1928-1931. Wyd. Morsk. Urz. Ryb. Gdynia, 1931. 239 – 273 [in Polish].

CEFAS. (1999). Pa Software User Guide. Lowestoft Suffolk UK. CEFAS Lowestoft Lab.

Cięglewicz, W. (1947). The migration and the growth of the marked flounder from the Gulf of Gdansk and the Bornholm Basin. Arch. Hydrobiol. i Ryb. XIII. 105–164.

Cięglewicz, W. (1961). Tagging experiments with flatfish in the southern Baltic. ICES C.M. Baltic-Belt seas Committee No. 95.

Cięglewicz, W. (1963). Flounder migrations and mortality rates in the Southern Baltic. ICES C.M. Baltic-Belt Seas Committee No.78.

Cięglewicz, W. & J. Netzel. (1978). Biological characterization of Polish flounder catches (*Platichthys flesus* L.) in the southern Baltic in 1971-1974. Stud, i Mater. Mor. Inst. Ryb., Gdynia, ser. A, 20. 156-177 [in Polish].

Darby, C.D., & Flatman, S., (1994). Virtual population analysis. In: Windows/DOS User Guide, Version 3.1, vol. 1. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, pp. 1–85.

Draganik, B. (1978). The state of the flounder stocks in the Southern Baltic. ICES C. M./J:11.

Drevs, T., V. Kadakas, T. Lang & S. Mellergaard. (1999). Geographical variation in the age/length relationship in Baltic flounder (*Platichthys flesus*). ICES J MAR SCI. 56. 134–137.

Florin, A-B., T. Aho, & J. Höglund. (2005). Genetic variation and stock identification of flatfishes in the Baltic Sea. ICES C.M. 2005/T:19, poster.

Florin, A-B. (2005). Flatfishes in the Baltic Sea– a review of biology and fishery with a focus on Swedish conditions. Finfo 2005: 14. 56 pp.

Giedz, M. (1970). The effect of mesh size and hanging coefficient of flounder gill-nets upon their selectivity and catch per net. Rep. Sea Fish. Inst. 16, ser. B :143 – 181.

ICES. (1999). Report of the ICES workshop on Standard Assessment Tools for Working Groups. Aberdeen. 3rd-5th March 1999.

ICES. (2005). Report of the Baltic fisheries assessment working group. ICES C.M. ACFM: (19), 607 pp. Ref. H.

ICES. (2005a). Report of the ICES Advisory Committee on Fishery Management, June 2005. ICES, Copenhagen.

ICES. (2006). SGBFFI Report of the Study Group on Baltic Fish and Fisheries Issues in the BSRP (SGBFFI). Baltic Committee ICES CM 2006/BCC:03.

Kosior, M., Grygiel, W. & Kuczynski J. (1996). Changes in the absolute fecundity of the southern Baltic flounder, *Platichthys flesus* (L.). Bull. Sea Fish. Instit. 2(138). 15 – 27.

Kuczyński, J. (1984). Observations on the results and effectiveness of tagging of flounder *Platichthys flesus* L. in 1981 – 1982. Bull. Sea Fish. Instit., 1 - 2(81-82): 22 – 26 [in Polish].

Mace, P.M. (2001). A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management. Fish and Fisheries. 2. 2-32.

Majewski, A. &. Lauer, Z. (1994). Baltic Sea Atlas. IMGW, Warszawa 1994.

Pakštas, K. (1934). The Baltic Sea. Klaipeda, pp. 54. [in Lithuanian]

Pope, J.G. (1972). An investigation of the accuracy of virtual population analysis using cohort analysis. ICNAF. Res. Bull. 9, 65-74.

Rice, J. & Cooper, A.J. (2003). Management of flatfish fisheries—what factors matter? J. Sea Res. 50: (2–3) 227–243.

Romański, J. (1968). Polish boat fishery in the Baltic. Stud. Mater. Mor. Inst. Ryb., Gdynia, Ser. B. 14, 1–47. [In Polish]

Thurow, F. (1997). Estimation of the total fish biomass in the Baltic Sea during the 20th century. ICES J MAR SCI. 54, 444–461.

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