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DYNAMICS OF THE NUMBERS AND DISTRIBUTION OF JUVENILE PIKEPERCH IN THE SZCZECIN LAGOON AND POMERANIAN BAY IN 1995-1996

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ABSTRACT. Seasonal migrations and preliminary assessment of the numbers of pikeperch fry are presented for the Oder River estuary (Szczecin Lagoon and Pomeranian Bay). The data were obtained using the computer programme „Surfer for Windows". Observations embraced fish generation born in 1995, represented by age groups 0 and 1, and that born in 1996, represented as age group 0, and were carried out in summer and autumn of the two years. Fish numbers differed considerably depending on the generation: 1995 generation was very numerous, so that 1996 one was only 4 % of the 1995. Juveniles of numerous 1995 generation showed strong tendency to migrate to Pomerania Lagoon, while no such trend was observed in the case of 1996 generation. The materials suggest that more numerous generation was born at higher water salinity, while weak generation of 1996 was born at high nitrogen content in water. Also average water temperature in May-June was a little lower in the case of strong generation than of the weak one. Weak generations of 1993 and 1996 resulted in low pikeperch catches and pessimistic outlook as regards pikeperch landings until 1999.

INTRODUCTION

Pikeperch is a typical predator playing an important role in the ichthyocenosis of the Oder River estuary as it regulates excessive numbers of such species as perch, roach or ruffe. Thanks to technological value and high market price, pikeperch and eel were the two major species ensuring economic profits for the fishery in the Szczecin Lagoon and Pomeranian Bay. According to the statistics for the past 6 years (Wysokiński et al. 1997), pikeperch landings in Polish part of the Oder estuary decreased systematically, from 550 t in 1990 to 220 t in 1996, the respective numbers for the Szczecin Lagoon only being 330 t and 180 t (Garbacik-Wesołowska et al. 1995).

It is well known that pikeperch landings tend to show considerable variations. According to Ciepielewski (1992) increased landings of this fish in Lake Jamno (West Pomerania), which lasted for some 3-4 years, had been usually preceded by 1-5 years of low catches. Also, landings increased very rapidly, suggesting appearance of a strong generation. No such cycles were observed in the Oder estuary, but it does seem that fry numbers may determine pikeperch landings during the subsequent 3 to

5 years. The above described decrease of pikeperch catches was undoubtedly due to a very weak generation of 1993, with fairly stable fry numbers in the earlier years.

Biró (1983) found that variations of pikeperch population in Lake Balaton could be observed even at low fishing intensities, and concluded that fishing should be adapted to the current state of the population.

These observations, as well as the facts that the concept of Beverton and Holt on optimal fish catch is not supported by the fishery practice (e.g. Backiel 1991) while the model recruitment-parental stock is unrealistic, have induced the authors to accept Biró's thesis, and to agree that generation strength should be the basic element used to forecast future catches and their permissible levels, and - consequently - to undertake studies on the dynamics of pikeperch fry population in the Oder River estuary, with attention paid to fry distribution in time and space.

The Sea Fisheries Institute has been observing pikeperch juveniles in the Szczecin Lagoon for some years now. These works, however, concentrated on the estimates of the fish resources using the methods which are out of use now (archival data of the Sea Fisheries Institute from 1985, 1986, 1989), as well as showing the disadvantages of using some fishing gear able to catch masses of pikeperch fry (deep-water fyke nets, Wysokiński et al. 1984, Wysokiński and Garbacik-Wesołowska 1995b). Numbers of pikeperch fry in the Szczecin Lagoon were estimated for the last time by Sołtysik in 1995, but the author selected an oversimplified method based on the mean fry numbers in a haul and assuming uniform fish distribution over the whole lagoon.

Proper studies of pikeperch fry resources are fairly difficult as this fish tends to migrate; this necessitates that works extend also over Pomeranian Bay. In addition, interpretation of the results is complicated by changing environmental conditions, the effect of which on pikeperch fry is not unequivocal.

As regards migrations of pikeperch fry, Sołtysik (1995) is of the opinion that pikeperch population in the Szczecin Lagoon is stationary. Observations of this author seem to be confirmed by the results of Willemsen (1977) obtained on a similarly big (1200 km^2) water body viz. Lake Ijssel in Holland. On the other hand, pikeperch fry was found in Pomeranian Bay, which contradicts stationary character of its population, and Willemsen did not pay attention to the fact that Lake Ijssel was separated from the sea by a dam, which might have hampered pikeperch migrations, the more so that it was observed that fry gathered in north lake part, close to the dam.

As regards the environmental factors, the effects of thermal conditions on pikeperch fry numbers are still unclear. According to Willemsen (1977), strength of a ge-

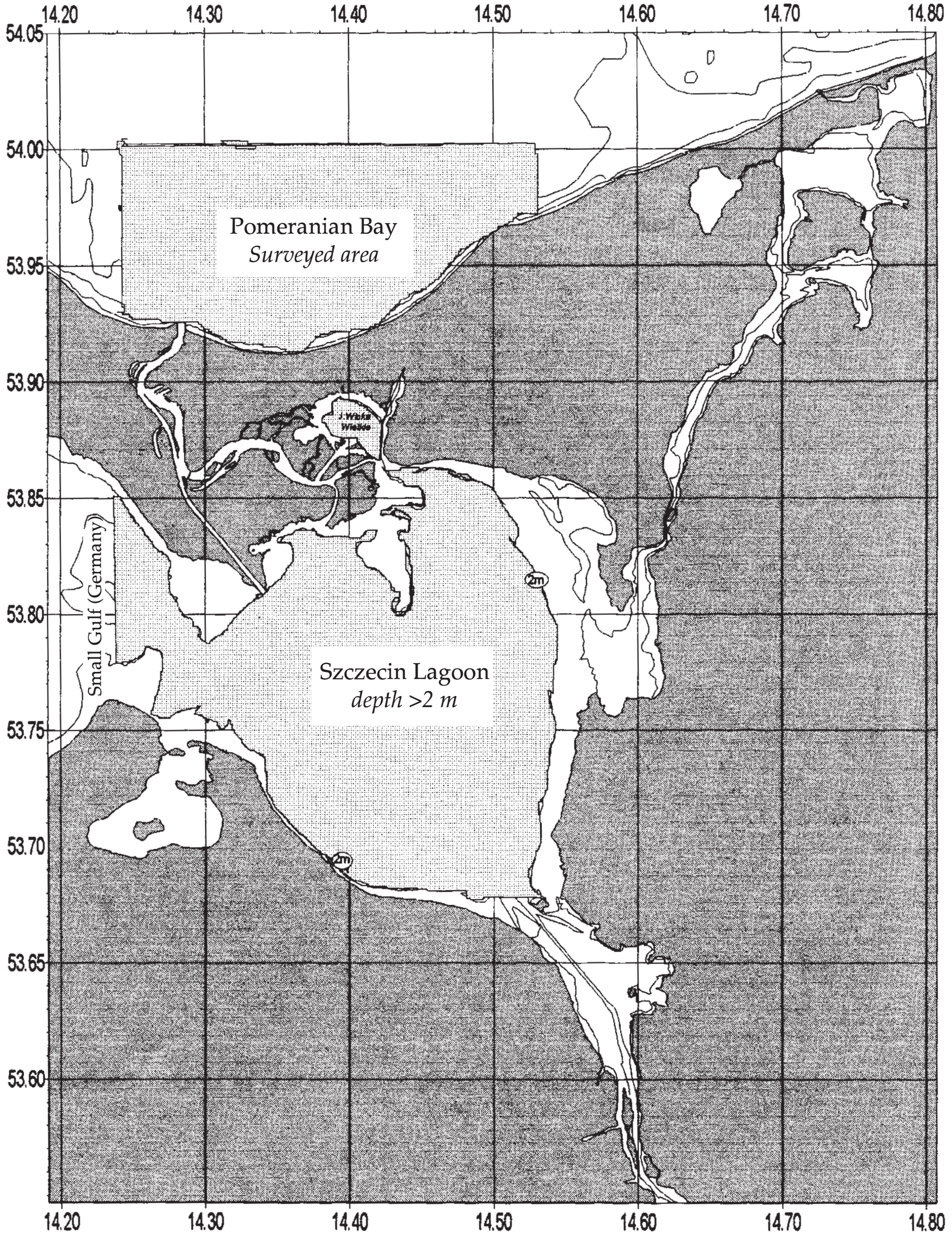

Fig. 1. Region of surveying pikeperch fry stocks in the Pomeranian Bay and the Szczecin Lagoon in 1995-1996

neration is not determined by mean monthly temperatures, but by the sum of temperatures in June-August. Also, strong generations were born in those years when water temperature during spawning was 1^0C lower than in the years when weak generations were born. The first conclusion was not confirmed by the data of Carlander and Payn (1977) who found no correlation between the temperature expressed in degree-days and generation strength of American pikeperch (*Stizostedion vitreum vitreum*). Also Koonce et al. (1977) are of the opinion that thermal regime does not necessarily affect directly survival of the early stages of American perch and pikeperch.

MATERIAL AND METHOD

Pikeperch catches performed in 1995 and 1996 from a research boat STYNKA II were used as the basic material to assess population of juvenile pikeperch (archival materials of the Sea Fisheries Institute, Department in Świnoujście, also Koronkiewicz et al. 1996). These catches were performed with a bottom fry trawl, mesh size 6 mm, which was not selective for the fish longer than 6 cm (Lt). Fishing was performed in the Szczecin Lagoon and in the mouth zone of the Świna River in Pomeranian Bay (Fig. 1). Planned period of an observation series of 2 weeks was extended to about 2 months due to bad weather and unavailability of the boat. Consequently, data from two series of observations were collected each year: a summer series (July-August) and an autumn series (September-October, exceptionally also November). Totally 52 hauls were carried out in 1995 and 87 in 1996 (Tab. 1). Places of fishing were randomly selected in each of the 13 fishing zones differing as to the depth, location, and accessibility. Area up to 2 m depth was omitted (Fig. 1) because pikeperch fry usually did occur in these waters. The surveyed area (depth over 2 m) amounted to 22134 ha in the major part of the Lagoon, and to 14300 ha at Świna River estuary in Pomeranian Bay.

Each haul lasted from about 10 to about 30 min, and fish landings (numbers of pikeperch aged 0 and 1) were recalculated to a standard 15 min. haul, corresponding to about 2 ha of the fishing area. The recalculation was based on the data by Sparre et al. (1989) which had already been used in an earlier study (Wysokiński 1996). Due to the fact that pikeperch juveniles inhabit over-bottom layer, it was assumed that all fish present in the area have been caught..

Pikeperch caught in each haul were counted and measured. Rapid growth rate of pikeperch juveniles made it possible to sort the fish into age groups based on the dif-

TABLE 1

Original data and the results of the estimates of pikeperch fry numbers (fish aged 0 and 1) in the Szczecin Lagoon and Pomeranian Bay in 1995 and 1996 (constant surveyed area of 22134 ha in the gulf and 14300 ha in the lagoon)

Region	Observation period	Results of sampling				Estimates of generation numbers				
		Number of hauls	Mean fish number in one haul	Range of fish number in one haul	Standard deviation	Fish number in thousands	Relative estimation error (%)	Residual values		Fish/ha
								Mean	Standard deviation	
A. 1995 generation										
Age group 0 – observations summer 1995										
Szcz. Lagoon	28.06-29.08	23	508.09	0–8934	1848.38	8587.9	0.14	2.5	266.5	388
Pom. Bay	21.07-11.08	5	2.00	0–8	3.39	19.0	0.3	0.0095	0.031	1.34
Total	summer 1995	28				8606.9				
Age group 0 – observations autumn 1995										
Szcz. Lagoon	5.09-30.10	11	56.27	0–282	93.4	884.5	0.23	7.85	27.5	39.96
Pom. Bay	6.09-31.10	13	14.57	0–125	33.5	102.6	0.14	1.56	3.44	7.18
Total	autumn 1995	24				987.1				
Age group 1– observations summer 1996										
Szcz. Lagoon	22.07-28.08	38	2.55	0–20	4.26	26.8	0.91	0.19	0.86	1.21
Pom. Bay	14.08-30.08	13	16.23	0–112	34.28	1023.7	0.32	0.47	7.27	7.12
Total	summer 1996	51								
Age group 1 – observations autumn 1996										
Szcz. Lagoon	18.09-19.11	32	9.19	0–225	39.6	170.1	0.07	0.3	4.12	7.69
Pom. Bay	1.09-15.10	4	2.75	0–7	3.4	7.2	0.74	1.76	2.96	1.48
Total	autumn 1996	36				177.3				
B. 1996 generation										
Age group 0 – observations summer 1996										
Szcz. Lagoon	22.07-28.08	37	19.1	0–150	31.5	322.4	0.79	1.49	6.73	14.56
Pom. Bay	14.08-30.08	8	0	0		0.0				0
Total	summer 1996	45				322.4				
Age group 0 – observations autumn 1996										
Szcz. Lagoon	18.09-19.11	28	28.8	0–593	111.5	397.6	0.95	0.72	17.52	17.96
Pom. Bay	1.09-15.10	2	0	0		0.0				0
Total	autumn 1996	30				397.6				

ferences in body lengths, with almost no errors. Age group 0 contained fish from 4-6 cm long in July to maximally 23 cm in November, and age group 1 - fish up to about 32 cm in late autumn.

Table 1 presents ranges, mean numbers and standard deviation of pikeperch caught during 15 min. hauls in each region and season, separately for 1995 and 1996 generations and age groups 0 and 1.

To present the results, the programme „Surfer for Windows" has been adapted (Keckler 1994). Its adaptation consisted of assuming that the depth points (which are the original variables in the programme) will be used to represent fish numbers. The programme uses a geostatic „Kriging" method, which covers the surveyed region with a net of squares (each 12.6 ha in area in the lagoon, and a little bit more in the bay), shows places and results of fish catches on this map, and based on interpolation and approximation - draws isolines reflecting fish densities, and calculates fish numbers. Geographic minutes and seconds are given in the decimal system (e.g. $1^0 = 100'$).

The final results have been presented as the mean density expressed in pikeperch numbers caught during 15 min per unit of geographic area (in degrees of geographic latitude and longitude), separately for each water body and season. Differences between the observed and calculated fish densities reflect residuals; they are presented in Table 1 together with standard deviations. Calculated pikeperch densities were recalculated to area in metres and hectares, assuming that 1/100 of a geographical latitude x = 659.492 m, and for 1/100 of a geographical longitude y = 1111.908 m. To obtain fish densities per 1 ha, the result was divided by 2 because a 15 min haul was equivalent to the area of about 2 ha. Percentage, relative error of the estimates of mean pikeperch densities was determined based on three approximation methods (trapezoidal, Simpson's and Simpron's 3/8). The mean fish density per 1 ha multiplied by the surveyed area gave total number of fish in the population of the given age group in the given basin and season.

Looking for the reasons of strong 1995 and weak 1996 generations, hydrochemical data pertaining to the Szczecin Lagoon in the two seasons (Sitek 1995, 1996) were also taken into consideration, comprising mean monthly water temperatures, mean levels of chlorides (salinity), nitrates and nitrites.

RESULTS

The results of sample catches in particular areas and seasons are presented in Table 1, and their location and numbers of pikeperch caught during 15 min - in the maps

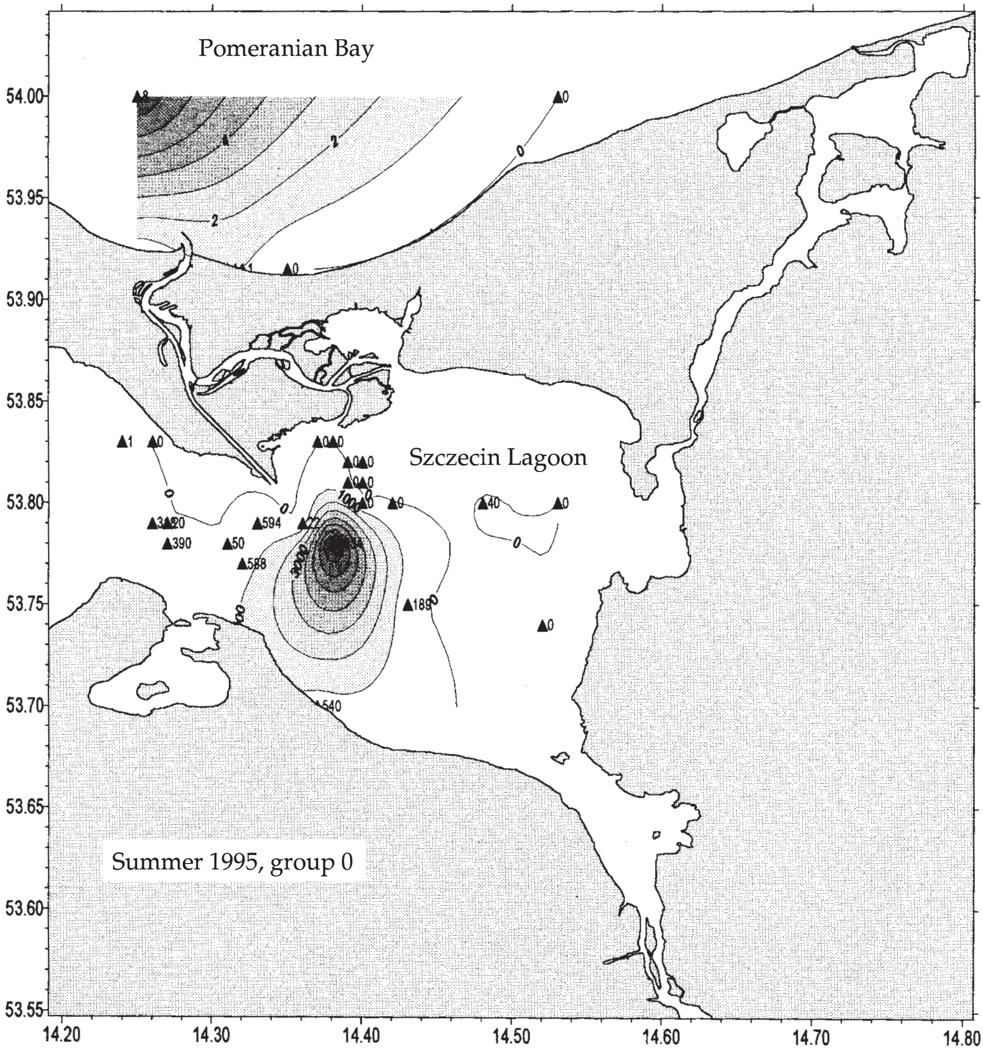

Fig. 2A. Distribution and density of pikeperch fry, generation 1995, 28 June-29 August 1995. Triangles - fishing places, numbers - fish number/15 min haul

(fig. 2, 3 and 4). Pikeperch generation born in 1995 should be regarded as numerous. Fry originating from spawning taking place at the turn of April and May appeared in the control catches already on 28 June, its length range being 4-5 cm. It spread out becoming abundant in August, mostly in deeper water, in west grounds, at the border with the German part of the Szczecin Lagoon, and along the water routes, the depth of which was more than 5 m (fig. 2A). This fry was also found (although in small num-

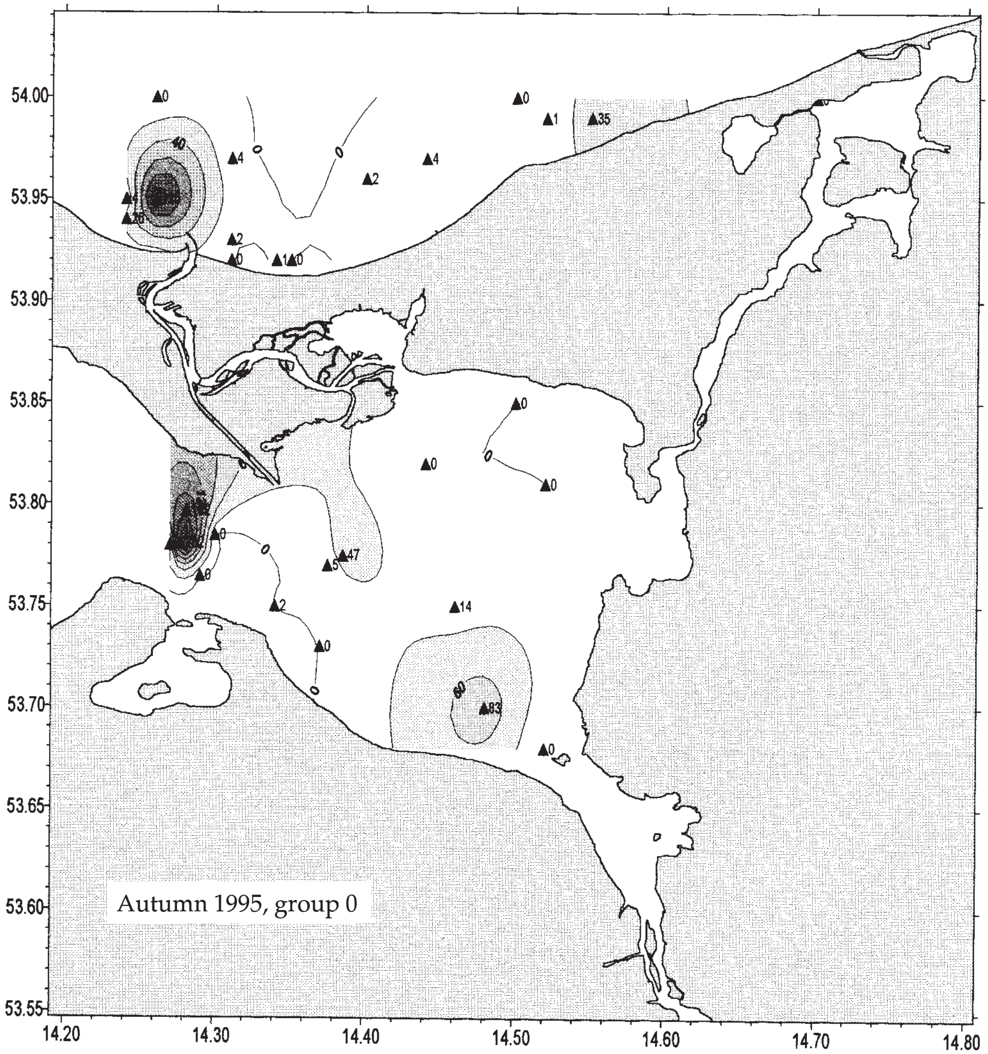

Fig. 2B. Distribution and density of pikeperch fry, % September-30 October 1995. Denotations as in fig. 2A

bers) in August in Swina River and its outlet to Pomeranian Bay, where the fish migrated already at body length of 10 cm. Fish growth was very rapid from hatching till the end of August, when the fish attained 7-14 cm (10.5 cm on the average).

In September and October the discussed generation was present in the Pomeranian Bay, from the border with Germany to Wisełka locality. It stayed mostly in coastal zone, east and west of Swina River (mouth), only exceptionally moving below 10

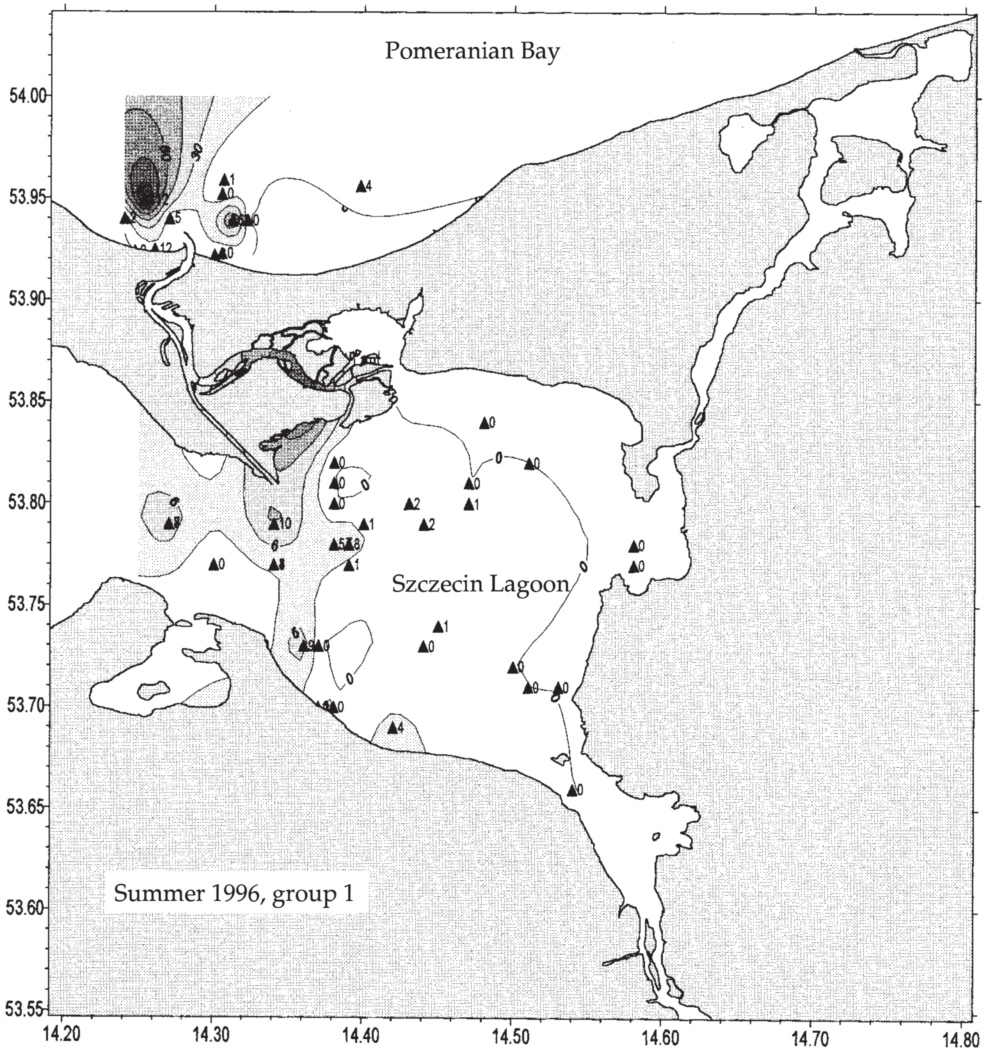

Fig. 3A. Distribution and density of pikeperch fry, generation 1995, 22 July-28 August 1996. Denotations as in fig. 2A

m depth. At the same time its abundance in the Szczecin Lagoon decreased, and two aggregations were formed: in south-east region and at the border with the German part of the lagoon, while it was not present in the Kamieński Lagoon. By the end of the vegetation season, the most rapidly growing individuals attained 21 cm, and the smallest were 14 cm long.

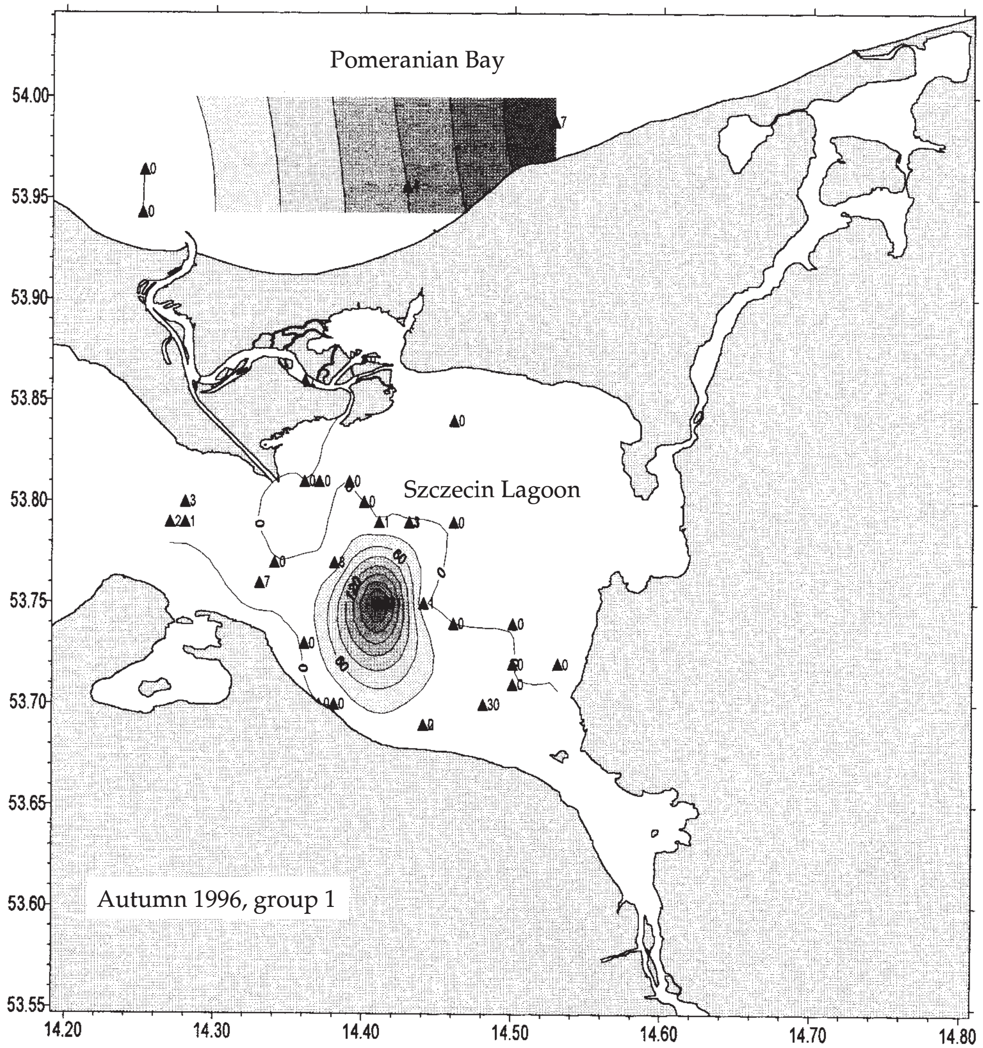

Fig. 3B. Distribution and density of pikeperch fry, generation 1995, 18 September-19 November 1996. Denotations as in fig. 2A.

Estimated total numbers of pikeperch fry of age group 0 born in 1995 decreased in the Szczecin Lagoon from 8588 thousand fish in summer to less than a million in autumn. This decrease reflected natural mortality as well as fish emigration to Pomeranian Bay. At the same time, fish migrations resulted in an almost 5-fold increase of fry numbers in the bay: from 19 thousand in August to 103 thousand in autumn (tab. 1). These values are certainly underestimated as no attention was given to fry in German and western parts of the Pomeranian Bay, where fry congregations near the border (fig. 2B) were found.

Observations of the 1995 generation in the following years (1996), when the fish were aged 1+ (length range 10-24 cm in April), show that Pomeranian Bay in summer 1996 was still the major feeding ground (fig. 3A). In the Szczecin Lagoon share of this fraction was very small notwithstanding dense sampling, so that its numbers dropped from 885 thousand fish in autumn of the preceding year to only 27 thousand in July-August 1996. On the other hand, numbers of the same generation in the bay increased from 103 thousand in autumn 1995 to over 1 million in summer 1996 notwithstanding undoubtedly high natural mortality (Tab. 1). These numbers show that there was a stable trend in 1995-1996 of fry migration from the lagoon to the bay, lasting since the end of metamorphosis till fish age of more than 1 year.

Interpretation of the results obtained in autumn 1996 and pertaining to pikeperch generation of 1995 is not easy. Fish aged over 1 year practically disappeared from coastal areas of the Pomeranian Bay (fig. 3B), where their numbers dropped from 1 million to less than 7 thousand, probably due to further migration to open sea waters and German part of the bay, where no observations were carried out. It is also possible that numbers of this generation decreased in the bay due to fish return to the lagoon for the wintering. Numbers of pikeperch fry in the Szczecin Lagoon increased from 27 thousand in summer 1996 to 170 thousand in autumn. That the age group 1 (fish length 23-33 cm, mean 27.3 cm) returned to the lagoon to pass winter there is also confirmed by the fact of increased catches of this fraction by the fishermen, as well as by our own observations performed on 12 December 1996, when large aggregation of pikeperch was seen at the water route Świnoujście-Szczecin.

General decrease of fry numbers since summer 1995 (fish length 4-14 cm) till autumn 1996 (fish length 26-32 cm) totally in the Szczecin Lagoon and Świna River mouth amounted to about 98 %. In reality there was no such a decrease, as no attention was given to this fraction of the stock which in autumn 1996 had moved to the whole area of the Pomeranian Bay.

As regards the generation born in 1996, the results are quite different. Notwithstanding favourable thermal conditions, better than in 1995 (Tab. 2), pikeperch fry hatched in this year appeared for the first time only in the last decade of July, the fish being 4-6 cm long, i.e. a month later than in 1995. Similarly as in the previous year, the fish were distributed almost over the whole area of the lagoon, but there were no noticeable fish aggregations (fig. 4A). Maximal catch during 15 min. hauling was only

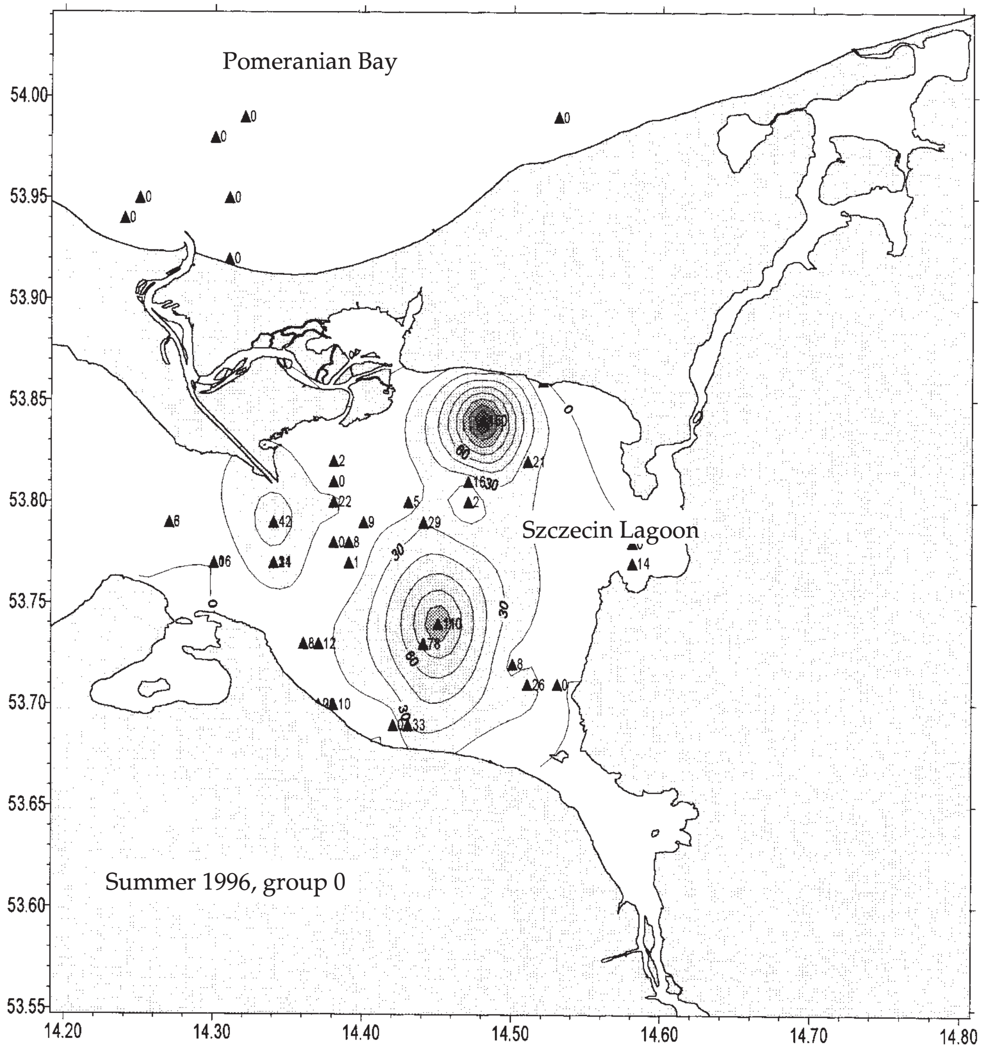

Fig. 4A. Distribution and density of pikeperch fry, generation 1996, 22 July-28 August 1996. Denotations as in fig. 2A.

150 fish (compared to 8934 in 1995). There was also no fish gathering at the border with Small Lagoon, and it was not present in the Pomeranian Bay. Total numbers of pikeperch aged 0 at the beginning of observations in summer amounted to 322 thousand fish, i.e. less than 4 % of the comparable numbers in 1995.

Density of the 1996 generation was still small in autumn (fig. 3B), with only a slight increase in southern parts of the lagoon (593 fish/15 min hauling), probably

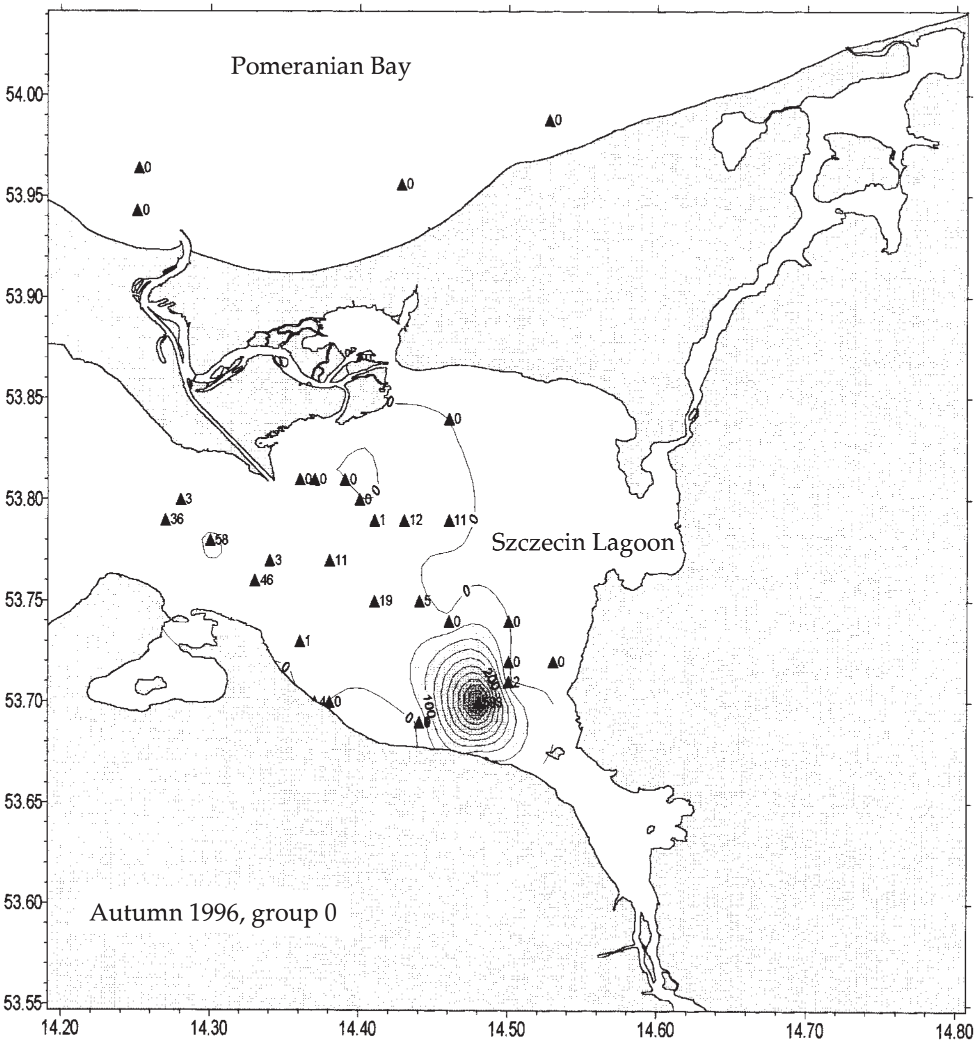

Fig. 4B. Distribution and density of pikeperch fry, generation 1996, 18 September-13 November 1996. Denotations as in fig. 2A.

due to fry immigration from Lake Dąbie. There was also no fry in autumn in Świna River mouth area and in Pomeranian Bay. At the end of the vegetation season, fish of 1996 generation were 7-17 cm long, smaller than in 1995, when the length range amounted to 10-24 cm. These data show that 1996 generation was very weak.

DISCUSSION AND CONCLUSIONS

The method of graphic presentation of the fish distribution and preliminary assessment of fish numbers seams to be very useful for the ichthyologists. It assumes possibility of interpreting a short trawling route as a sampling station and by interpolating of all results on the whole investigated area.

Although sampling stations in the examined water body were not very numerous and were possibly too fragmentary, and this resulting in high values of standard deviation and less reliable estimates (especially when there are high differences as to fish densities per unit of area), the method seems worth adopting for practical use, especially to predict fish densities in fresh water bodies. It takes into consideration differentiation of the fish population densities in time and space, enables observation of migrations (this is important in the case of pikeperch which shows migratory instinct) over a definite area. Some drawbacks have been described, mostly due to technical reasons (prolonged series of observations in the Szczecin Lagoon and Pomeranian Bay), but the method still seems to be better than the one used so far, when relative values were taken to estimate fry population numbers, obtained multiplying the mean fish number in a standard haul in the whole season by water area (Sołtysik 1995). Hence, the method enables more accurate estimates of the recruitment and future fish landings. It should be underlined that reliability of the results depends most of all on the number of samples collected from a water body and duration of one series of the control catches, which should be as short as possible. In 1995/96 it was not possible to fully comply to these conditions. Still the obtained data sufficed for revealing the scale of changes and their course.

The obtained picture of the dynamics of fry distribution in 0 and 1 age groups confirmed the initial assumption that Szczecin Lagoon and Pomeranian Bay should be treated as one integrated habitat for pikeperch juveniles. Pomeranian Bay, and especially mouth of the Świna River, represents feeding grounds where strong generation of 1995 migrated once the fish attained 10 cm length, and the migration period extended until next summer (1996). Due to intensive migrations, population of 1995 generation of pikeperch fry increased in the bay in summer next year to over 1 million, at a simultaneous decrease to 170 thousand in the Szczecin Lagoon (in autumn). This conclusion contradicts the opinions cited in the introduction (Sołtysik 1995, Willemsen 1977) on stationary character of pikeperch fry. This opinion probably resulted from the lack of data, for Pomeranian Bay in the first case, and about damming of Lake Ijssel in the second one.

It is possible that fry migration to the bay depends on generation strength, and possibly also on food resources. Weak generation of 1996, which amounted to only 320 thousand fish at the beginning of the season (against 8588 thousand in 1995), was not found in Pomeranian Bay in summer and autumn 1996.

Usefulness of estimating fry densities for the fishery managers is illustrated by the exemplary prognosis of pikeperch catches (adult fish) in the Oder River estuary, which according to Wesołowska et al. (1995) consisted of 3 and 4-years old fish (Tab. 2).

TABLE 2

Estimation of generation strength of pikeperch in 1993-1997 and prognosis of the spawning stock numbers and of commercial pikeperch landings until 1999

Generation (year)	Generation strength (thousands fish)		Generation assessment	Fish catch and its prognosis	Source of data
	Initial (summer)	Final (autumn)			
1993	about 15% of long-term average in July-August 1980-84, 92 and 1994-95*		very weak	Catch 270 t	Wysokiński 1996
1994	19757	5551	very strong	Catch 306 t	Sołtysik 1995
1995	8587	987	strong	Catch 306 t	this paper
1996	322	398	very weak	Catch 223 t (64 % of the average**) caused by a decrease of the share of 3-years old fish	this paper
1997	in preparation		preliminary assessment: very strong	Catch 250-300 t (75-80 % of the average), decrease of 4-years old fish, increase of 3-years old.	own observations
1998	in preparation		no data	Catch at the average level, 300-350 t. No 5-years old fish present	
1999			no data	Catch decrease to about 200 t caused by a decrease of 3-years old fish at average share of 4-years old ones	

** mean fry numbers 750 fish/haul*
*** average catch for 1986-1995 = 350 t*

Looking for the reasons of this high difference between the strength of 1995 and 1996 generation, basic hydrochemical parameters were taken into consideration (tab. 3).

Data presented in Table 3 suggest that strong pikeperch generation of 1995 originated from spawning which had taken place in May-June, and that during the fish reproduction, and egg and larvae development, the mean monthly water salinity was almost twice higher than when weak 1996 generation was born, while levels of nitrates and nitrites were almost twice lower. Hence, it can be suggested that salinity may have a beneficial effect on pikeperch reproduction in the Szczecin Lagoon, whereas

TABLE 3

Comparison of some hydrochemical parameters in the Szczecin Lagoon in the vegetation season of 1995 and 1996 (data after Sitek 1995, 1996)

Parameter	Year	Month						
		April	May	June	July	August	September	October
Surface water temperature	1995	5,7	11,5	18,4	22,7	22,3	16,4	14,2
	1996	–	11,9	23,1	19,5	21,2	11,9	12,2
Chloridesg Cl/dcm^3, bottom	1995	1,15	0,54	0,26	0,33	0,39	0,67	1,15
	1996	–	0,22	0,11	0,23	0,23	0,55	0,46
Nitrates mg – NO_3/dcm^3	1995	2,105	0,822	0,440	0,190	0,055	0,287	0,351
	1996	–	1,707	0,969	0,353	0,346	0,595	0,716
Nitrites mg – NO_2/dcm^3	1995	0,011	0,016	0,027	0,017	0,01	0,026	0,014
	1996	–	0,032	0,037	0,02	0,021	0,015	0,016

spring waters inflowing from the Oder River catchment basin and carrying high loads of nitrogen compounds, in this organic pollutants (domestic sewage, run-offs from agriculture etc.) may have a detrimental effect.

It is worth mentioning that in view of the possible effect of nitrogen and chlorides, the effect of temperature differences (small in May - about 0.4^0C, and high in June - about 4^0C) between the two years were of no greater significance. Mean temperature during pikeperch reproduction in 1995 (strong generation) was lower than in 1996 (weak generation). These phenomena are confirmed by the observations of Carlander and Payne (1977), as well as the conclusions formulated by Willemsen (1977) and Koonce et al. (1977) on limited effects of thermal regime upon generation strength of pikeperch fry.

The conclusion on different effects on pikeperch reproduction of sea water inflows and inflows of spring Oder River waters should be still confirmed. It is, however, quite clear that water quality affects survival of larval stages of pikeperch in coastal waters. This is also confirmed by the comparison between weak generation of 1996 and the results of studies on the numbers of pikeperch larvae (Szkudlarek-Pawełczyk and Porębski 1997). According to our data, numbers of 1996 generation were equivalent to only 4 % of 1995 generation, while density of the larvae was lower in 1996 by only 50 %. These high differences in fry densities were probably caused by high mortality of pikeperch larvae in 1996, caused by negative effect of water containing high levels of nitrates (larvae are especially susceptible to water pollution).

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STRESZCZENIE

DYNAMIKA LICZEBNOŚCI I ROZMIESZCZENIE MŁODZIEŻY SANDACZA W ZALEWIE SZCZECIŃSKIM I ZATOCE POMORSKIEJ W LATACH 1995-1996

Przedstawiono sezonowe przemieszczanie się i wstępną ocenę liczebności narybku sandacza w Zalewie Szczecińskim i Zatoce Pomorskiej korzystając z programu komputerowego Surfer for Windows. Obserwacjami objęto pokolenie urodzone w roku 1995, odpowiednio grupy wieku 0 i 1 oraz pokolenie 1996 r. jako grupę wieku 0 w kolejnych sezonach letnich i jesiennych tych lat. Stwierdzono znaczne różnice w urodzajności pokoleń: wobec urodzajnego rocznika 1995, nieurodzajny rocznik 1996 stanowił zaledwie ok. 4% jego liczebności. Konsekwencją wystąpienia nieurodzajnych roczników 1993 i 1996 były niskie połowy sandacza i pesymistyczne ich prognozy do roku 1999. Wbrew opiniom niektórych autorów o stacjonarnym charakterze populacji sandacza, młodzież urodzajnego rocznika 1995 wykazywała silną tendencję migracji do Zatoki Pomorskiej, choć takiej tendencji nie zaobserwowano u słabego rocznika 1996. Migracja w 1995 r. rozpoczęła się już w końcu czerwca przy długości narybku 10 cm. Intensywność migracji była znaczna. Od lata 1995 do lata 1996 r. liczebność narybku w Zalewie Szczecińskim spadła z około 8,5 miliona osobników do zaledwie 30 tysięcy, podczas gdy w Zatoce Pomorskiej wzrosła w tym samym okresie do prawie 1 miliona sztuk. Z przedstawionych materiałów wynika, że urodzajnemu pokoleniu 1995 towarzyszyło zwiększone zasolenie wód zalewu, a nieurodzajnemu 1996 – zwiększona zawartość w tych wodach związków azotowych, co wynikało z różnic w intensywności wlewów do zalewu wód morskich, znacznie intensywniejszych w 1995 r. Potwierdziły się również opinie wielu autorów o ograniczonym wpływie termiki wód w okresie rozrodu na liczebność pokolenia narybku sandacza. Średnia temperatura wody towarzysząca silnemu pokoleniu 1995 była niższa w maju o 0,4°C, a w czerwcu aż o 4,7°C niż w analogicznych miesiącach nieurodzajnego 1996 roku.

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