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The stability of fish assemblages under unstable conditions: A ten-year series from the Polish part of the Vistula Lagoon

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Abstract. Time-series of the species caught in a complex of four fyke nets that were monitored and recorded by a team of volunteer fishers provided the basis for identifying trends in the changes of fish assemblages during the 1995-2006 period. The fish assemblages exhibited strong seasonality with herring, *Clupea harengus* L. domination during spring. In the summer season, juvenile pikeperch, *Sander lucioperca* (L.) and ruffe, *Gymnocephalus cernuus* (L.), were dominant in number. The relative abundance of eel, *Anguilla anguilla* (L.) exhibited a clearly decreasing trend due to fishery exploitation and the lack of stocking. The decreased share of the largest pikeperch individuals suggested that this species is being overexploited. Ruffe exhibited a strong decline more probably due to strong impact from numerous black cormorants. Increased abundance was observed in the case of roach, *Rutilus rutilus* (L.), flounder, *Platichthys flesus* (L.) and round goby, *Neogobius melanostomus* (Pall.), a new species in ecosystem.

Keywords: herring, bream, eel, pikeperch, round goby, ruffe, fyke net

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Introduction

The principal cause underlying the stressed ecological environment of the Vistula Lagoon is the mixing of fresh water and saline water from the Baltic Sea. The most important change effected by humans was when the main flow of the Nogat River was redirected from the lagoon in 1914, which caused increased salinity. Until 1945, the Vistula Lagoon was situated in Germany, but after World War II it was divided between Poland and the USSR. Rapid urbanization and the development of industry and tourism without adequate wastewater management subjected the Vistula Lagoon environment to new disturbances including eutrophication, massive algae blooming, and the decline of macrophytes. Decreases in catches of the most valuable fish species occurred simultaneously. The transition to a market economy after 1989 intensified this trend, but not only fishery exploitation impacted the fish assemblages. Other potentially important factors included alien species, the drastic increase of the black cormorant, *Phalacrocorax carbo* (L.) breeding colony, and herring, *Clupea harengus* L. reproduction issues.

The intensive mixing in the Vistula Lagoon creates favorable conditions for primary production and the respective development of consumer assemblages on the trophic pyramid. This means that the lagoon provides spawning grounds for 'typically marine' species, such as herring as well as different freshwater species, including pikeperch, *Sander* *lucioperca* (L.), bream, *Abramis brama* (L.), roach, *Rutilus rutilus* (L.), and perch, *Perca fluviatilis* L. (Wilkońska and Kapusta 2007). The observations conducted in the Vistula Lagoon confirmed that this basin supports over forty fish species from various ecotypes. The mixing of freshwater and marine water inflows causes high environmental stress for the organisms that inhabit this basin. Together with anthropogenic pressure caused by fishery and pollution, the fish assemblages in these transitional waters are believed to be sensitive to changes.

Catches in the Vistula Lagoon are conducted mainly with gill nets and fyke nets. The latter is used throughout the fishing season from March to October. The annual fishing yield from the Polish part of the Vistula Lagoon is approximately 500 tons of freshwater and diadromous fish and about 1,000 tons of herring. The latter vary significantly over periods of several years. Traditionally, four fish species (eel, *Anguilla anguilla* (L.), common bream, pikeperch, roach) have always dominated Vistula Lagoon fisheries (Bartel et al. 1996), and, to date, the variability of commercial fish distribution and abundance in the Vistula Lagoon has been evaluated by analyzing these species. With the aim of optimizing the exploitation of the lagoon's fish productivity, the annual total allowable catch (TAC) of pikeperch and bream is regulated by the Polish-Russian commission for the management of fish resources in the Vistula Lagoon. This precludes using fishing statistics to evaluate changes in the abundances of these fish. Official monthly fishing reports regarding other fish species are also regarded as unreliable.

The aim of the present work was to evaluate the changes in the indicators of fish abundance in the Vistula Lagoon based on catches made with a fyke net complex and monitored and recorded by a team of fishers in the 1995-2006 period.

Material and methods

Study area

The Vistula Lagoon is a brackish water reservoir in the southern Baltic Sea. The surface area of the lagoon is 838 km^2, and 39% of the basin lies within Polish borders (Fig. 1). The habitat of the fish assemblage is shaped by the variability of its physical parameters:

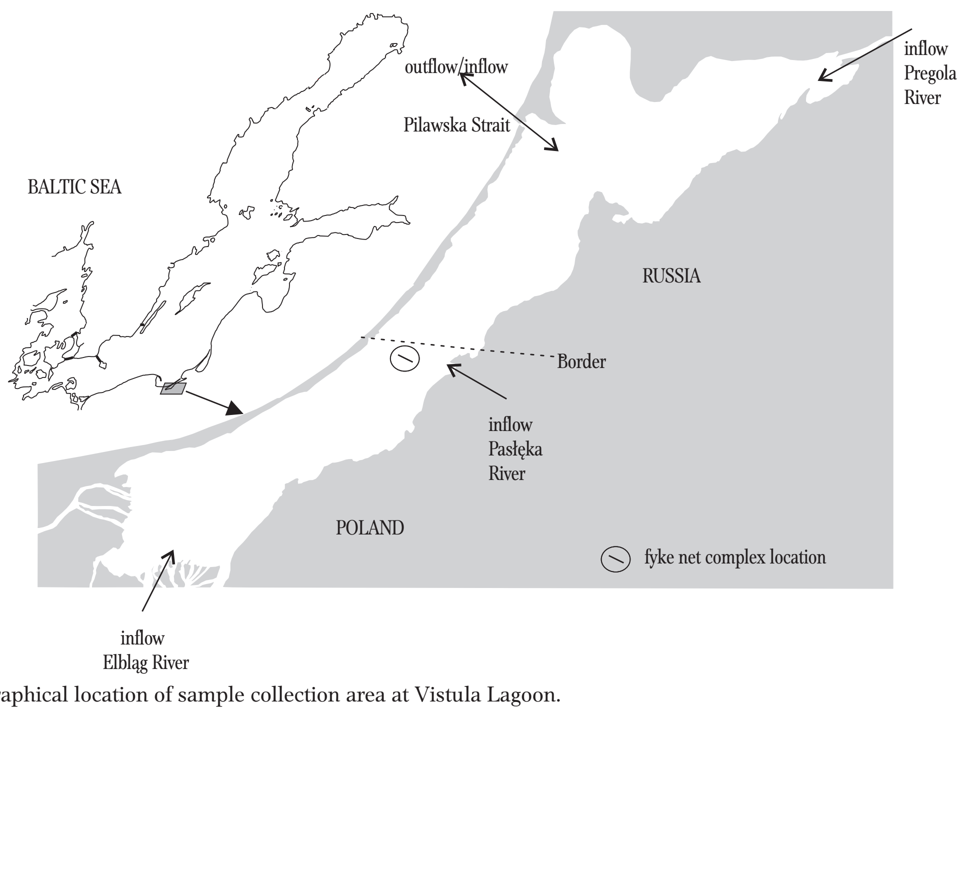

Figure 1. Geographical location of sample collection area at Vistula Lagoon.

salinity (0.1 psu in the southwestern area and 4.7 psu near the border; Łazarienko and Majewski 1975), the mixing intensity of water and open sediments, and the content of organic matter in the water. The catchment area is 23,871 km^2, and the volume of water supplied by the main rivers (Pregoła, Pasłęka, Elbląg) ensures that the lagoon water is exchanged every six months. The only opening between the lagoon and the Baltic Sea is the Pilawska Strait (approximately 400 m wide), located in the Russian part of the basin. The shallowness of the basin (2.7 m average depth), polymixing, and the varied character of the transitional water type render the Vistula Lagoon susceptible to invasive species. In the past twenty years, species that have appeared include *Marenzellaria neglecta* Sikorski and Bick in the benthos, *Palaemon elegans* Rathke in the epibenthos, and *Cercopagis pengoi* (Ostrumov) in the plankton assemblage (Telesh and Ojaveer 2002, Jażdżewski et al 2005).

Gear deployed

The fishing gear was comprised of a fence 120 m in length (24 mm mesh size) and four fyke nets (two on each side of the fence) and was deployed in the so-called free water of the border zone to avoid disturbance from other fishing gear. This region, known colloquially as the “corridor”, is 1580 m wide, and fishing is forbidden here to allow fish free passage between the Polish and Russian sides of the Vistula Lagoon. The fyke nets deployed were constructed in the same way as those used in the Vistula Lagoon fishery, which means they were comprised of five rings, four chambers, and 16 mm mesh size in the last chamber of the bunt. The fyke net complex used was described in detail by Wilkońska and Psuty (2008).

The fishing gear complex was monitored by one team of fishers from the beginning of the study. The frequency at which the fyke nets were monitored depended on the season of the year and fish abundance. During the spring herring spawning stock migration, the gear was cleared as often as twice daily. In the summer season, the uninterrupted deployment of the gear extended to 5-6 days, while in the fall this period decreased to 3-5 days. The fish removed from the gear were sorted by species and variety and then counted. The larger fish were removed from the catches first, as were species that were observed less frequently. Two sub-samples were taken from the remainder of the catch that was comprised of the small-sized fish of a few species (usually ruffe, *Gymnocephalus cernuus* (L.), juvenile pikeperch, ziege, *Pelecus cultratus* (L), and bream). These were divided into two subsamples, and the number of particular species was determined in each. These figures were then extrapolated to the whole catch. In the case of eel, pikeperch, and bream, the variety concurred with the category types that are recognized according to the rules presented in Table 1. The number of fish found in each fyke net was recorded on a plastic sheet, and then recorded on forms once the boat reached the port. During spring catches, the abundance of herring was determined by dividing the landed weight by the average individual weight (100 g).

Fish abundance was standardized to the catch per unit effort of 1 fyke net day^{-1}. As a reference, the

Table 1
The size classes of fish noted during sample collection. MLL – minimum landing length

	Commercial classes			Not commercial classes	
Species	D	M	S	U	0+
Eel	> 500 g	300-500 g	200-300	< 200 g (or < 50 cm TL)	
Pikeperch	> 1500 g	from MLL (46 cm TL) to ~ 1500 g	from ~ 36 to 45 cm TL	to 35 cm TL	juveniles from this year spawning (5-15 cm TL)
Bream	> 1000 g	from MLL (35 cm TL) to ~ 1000 g	from ~ 25 to 34 cm TL (~ 500 g)	to 25 cm TL	

Table 2
The number of samples in the subsequent years

Month/Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2005	2006
March	0	0	17	0	4	0	0	4	0	0	0
April	0	7	14	0	18	23	18	24	17	0	18
May	2	11	7	8	9	7	7	10	15	0	10
June	5	9	7	7	6	6	6	6	0	0	6
July	7	5	1	3	0	5	5	6	0	0	0
August	7	6	2	2	1	4	3	7	0	4	4
September	9	7	7	8	8	6	7	7	8	7	7
October	9	8	7	7	7	7	7	5	6	6	7
November	2	1	0	2	2	1	2	2	1	3	7
December	0	0	0	0	0	0	0	0	0	0	2
Total	41	54	62	37	55	59	55	71	47	20	61

months of May or September were chosen depending on the average monthly percentage of fish species in order to make comparisons of relative abundance and the share of categories. May and September were the most representative time periods with regard to stability of fishing techniques (except in May 1995, the gear was deployed all month and the times between fyke net clearing were almost the same). An exception was made for herring relative abundance, which was taken from the April catches. The number of samples in subsequent years is presented in Table 2.

Results

A total of 18 fish species were recorded during the study period (Table 3). Catches comprised of herring, ruffe, and pikeperch were the most numerous. The species with the highest frequency of occurrence (over 90%) in the catches were pikeperch, bream, ruffe, and ziege. Perch and roach were recorded slightly less frequently (frequency of occurrence 60-90%). During the initial stage of the study (1995-1999), flounder, *Platichthys flesus* (L.) occurred less frequently (30-40%) in comparison with the last two years of the study (55-70%).

The composition of the fish assemblage was characterized by high seasonal variability. The highest average catch weight and the highest average number were recorded in the spring months (March-May). This was due to the massive influx of herring that gather in the Vistula Lagoon to spawn. They comprised nearly 100% of the catch weight (Table 4).

Table 3
The numbers of fish species caught and registered during the study period

Scientific name	Common name	Individuals
Anguilla anguilla (L.)	Eel	22,556
Sander lucioperca (L.)	Pikeperch	198,479
Abramis brama (L.)	Common bream	46,732
Rutilus rutilus (L.)	Roach	9546
Perca fluviatilis L.	Perch	14,349
Pelecus cultratus (L.)	Ziege	51,201
Clupea harengus membras L.	Baltic herring	3,147,406
Gymnocephalus cernuus (L.)	Ruffe	198,496
Neogobius melanostomus (Pall.)	Round goby	1737
Osmerus eperlanus (L.)	Smelt	823
Platichthys flesus (L.)	Flounder	9500
Lota lota (L.)	Burbot	200
Salmo trutta trutta L.	Trout	67
Vimba vimba (L.)	Vimba	152
Abramis bjoerkna (L.)	White bream	2
Aspius aspius (L.)	Asp	1
Carassius gibelio (Bloch)	Prusian carp	4
Silurus glanis L.	Wels catfish	1
Total		3,701,252

Although the most herring were caught in April, in some years the fishing season for this species lasted until mid May. The abundance indicator for

Table 4
Average monthly percentage of fish species in numbers

Species	March	April	May	June	July	August	September	October	November	December
Eel	0.0	0.0	1.7	5.7	6.1	5.4	5.3	2.3	0.3	0.0
Pikeperch	0.0	0.3	8.4	34.0	29.9	46.7	42.8	36.2	27.7	48.0
Bream	0.0	0.1	2.6	15.3	14.4	12.3	6.9	5.5	5.5	4.4
Roach	0.0	0.0	0.6	4.7	2.7	2.7	1.1	0.7	0.7	0.9
Perch	0.0	0.1	0.7	3.2	5.1	7.9	1.9	0.8	0.6	0.7
Ziege	0.0	0.1	3.0	12.5	23.5	15.8	8.0	5.9	6.4	11.1
Herring	96.3	97.6	76.5	1.3	0.2	0.0	0.4	16.3	34.3	4.2
Ruffe	3.7	1.7	6.2	16.6	11.4	7.2	32.9	31.5	22.8	28.5
Smelt	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.0
Flounder	0.0	0.0	0.3	6.6	6.6	1.9	0.7	0.7	1.4	2.4

this species calculated based on April catches was highly variable (Fig. 2). Following the herring period, the species diversity of the catches increased. The greatest share of the catch weight in May and June was of pikeperch, ziege, and ruffe. Only in 1997 was there a very high share of flounder (50% of the catch in numbers, 29% in weight). In the fall months, the majority of the catches were comprised of pikeperch, ruffe, and herring. Fall-spawning herring usually appeared in the catches from the end of September with the peak of the season occurring in November. A significant number of eel were registered in the catches made from May to October with the peak season in September. The relative abundance indicated a decreasing trend in catch numbers during the study period (Fig. 3).

In the case of bream, the relative abundance of fish caught in September was stable and oscillated around the long-term mean. High variability in the case of pikeperch was indicated by the relative abundance of the smallest fish that had hatched in the spring of that same year (Fig. 4). The relative abundance of the year classes from 1995 and 2002 deviated significantly from the long-term mean at 30 individuals. Only the 2002 cohort was noted to be numerous in May of the subsequent year as undersized fish. In September 2003 it was also expected to be noted numerously in the same class, but it was

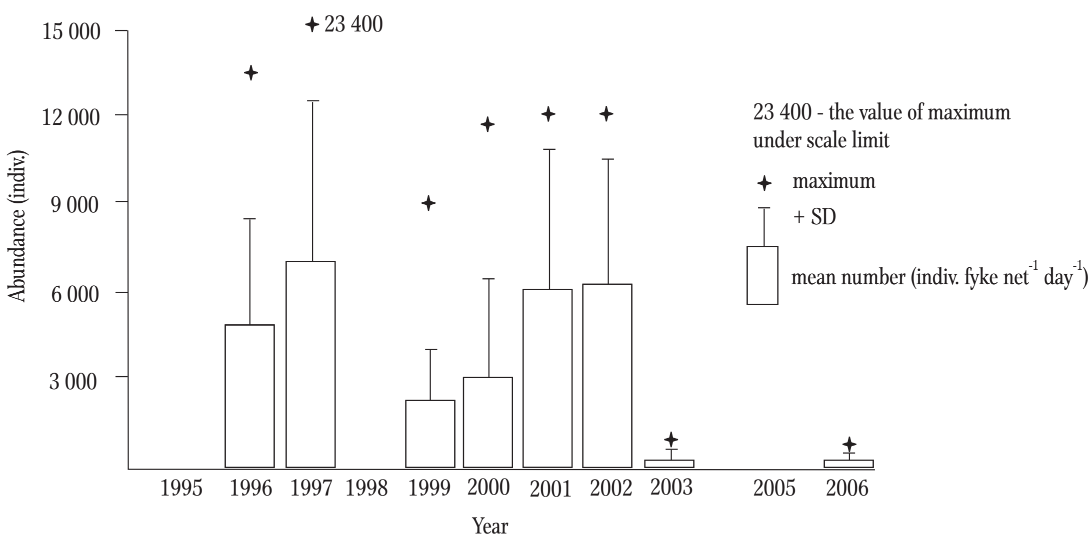

Figure 2. Mean abundance of herring in Aprils in subsequent years (fish day^{-1} fyke net^{-1}).

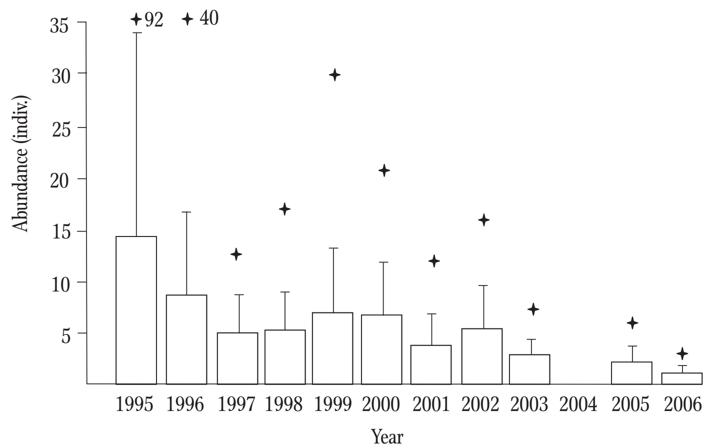

Figure 3. Mean abundance of eel in Septembers in subsequent years (fish day^{-1} fyke net^{-1}). See Figure 2 for further explanation.

not. High numbers were recorded, however, in September 2003 in commercial pikeperch catches.

The relative abundance of three fish species indicates that there has been an increasing trend in recent years. This was noted with regard to flounder, roach, and round goby, *Neogobius melanostomus* (Pall.). In the case of flounder, the jump in registered abundance occurred in the last two years of the study. The trend of increasing abundance of roach became apparent in 2001 following a period of decline that began in 1996. The round goby was first recorded in the catches in spring 2003, and by September 2006 the relative abundance of this species had reached 3 individuals. Perch and ziege exhibited the greatest instability in the catches without demonstrating any trends during the analyzed period. The last species that was analyzed in detail was ruffe. Very high abundance was recorded followed by recorded catches in September 1996 (Fig. 5).

Changes in the composition between 1996 and 2006 were observed with fish that are of commercial interests. The most evident differences were noted in the categories of the eel caught in May (Table 5). In 2006 the bulk of the catches consisted of larger fish (category D), which was not common in May 1996. The category composition of pikeperch remained relatively stable; only the largest category (D) had a significantly higher share in 1996 than in 2006 (Table 5). The largest category of bream exhibited the

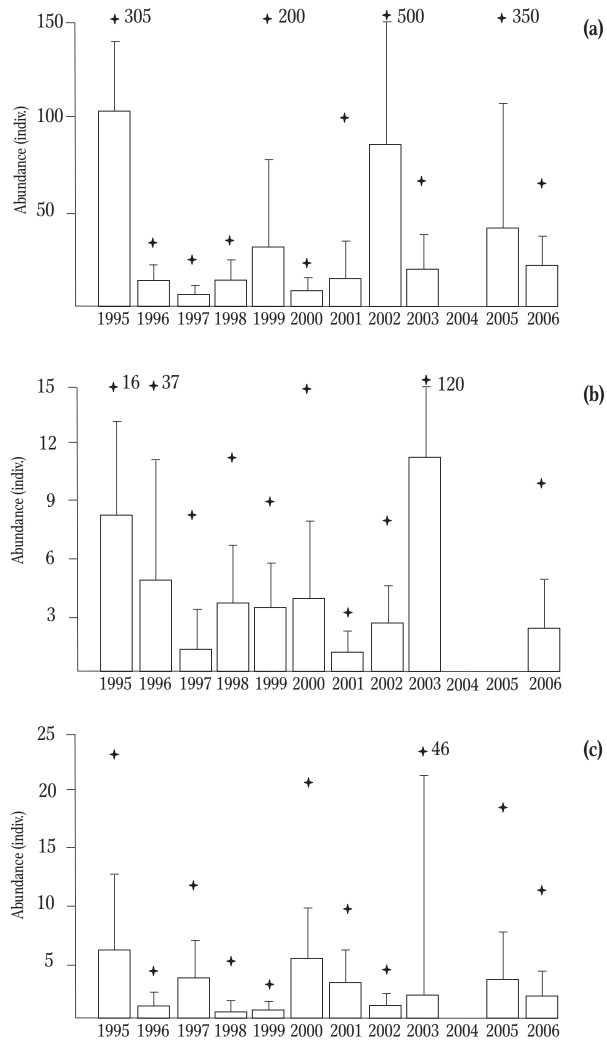

Figure 4. Mean abundance of 0+ pikeperch caught in September (a), juvenile pikeperch caught in May (b), and juvenile pikeperch caught in September (c) (fish day^{-1} fyke net^{-1}). See Figure 2 for further explanation.

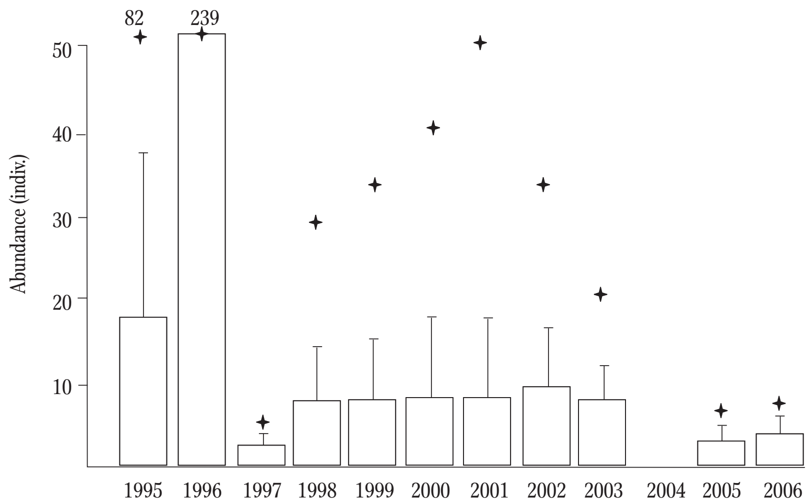

Figure 5. Mean abundance of ruffe in Septembers in subsequent years (fish day^{-1} fyke net^{-1}). See Figure 2 for further explanation.

opposite trend; its share increased from 1996 to 2006. The largest share of the catch composition was noted in September 2003, when 27% of the bream individuals caught belonged to category D. The catch composition in May was highly unstable during the study period, as was reflected by the results from 1996 and 2006, as well as the mean estimated from the entire study period (Table 5).

Table 5

The share (%) of fish categories in 1996 and 2006 reference months. For details see Table 1

	May			September		
	1996	2006	Mean 1996-2006	1996	2006	Mean 1996-2006
Eel, total count	323	160		1296	122	
Eel D	1.2	20.6	5.2	74.5	48.4	66.6
Eel M	54.5	20.0	16.5	13.5	15.6	17.2
Eel S	12.1	38.1	40.6	8.1	29.5	11.2
Eel U	32.2	21.3	37.8	3.9	6.6	5.0
Pikeperch, total count	613	599		299	820	
Pikeperch D	9.5	1.3	13.5	11.4	0.2	5.0
Pikeperch M	18.9	30.6	18.1	25.4	18.4	16.8
Pikeperch S	5.5	12.7	10.0	2.0	9.4	5.0
Pikeperch U*	66.1	55.4	58.4	61.2	72.0	73.2
Bream, total count	396	748		1444	565	
Bream D	8.6	4.3	19.1	1.1	15.9	7.5
Bream M	15.9	39.7	20.9	19.6	25.1	24.8
Bream S	10.4	15.9	28.8	3.2	8.8	6.3
Bream U	59.3	40.1	31.3	76.1	50.1	61.3

*without pikeperch 0+ category.

Discussion

The Vistula Lagoon is naturally a highly stressed aquatic basin because of the unstable mixing of marine and fresh water. With the exception of the declines in eel and large pikeperch abundance, the ichthyofauna of the Vistula Lagoon exhibits characteristics of a system of biological integrity. Angermeier and Karr (1994) and Cairns (1995) defined biological integrity as a system's ability to support and maintain balanced complexity even when faced with disturbances from the outside. The biological integrity of the Vistula Lagoon is based on continuous but not permanently directed changes in salinity and water mass currency. Shallowness, the development of the shoreline, and the diversified catchment area play important roles. This means the environment of the Vistula Lagoon is open to the migration of fish from rivers as well as from the sea and that these are eurytopic species (and mainly euryhaline). New species originating from other basins join this system without effecting notable changes in the complex; however, some influence on particular life stages or species may eventually become apparent.

The round goby, an alien species from the Ponto-Caspian basin (Skóra and Stolarski 1993), was noted for the first time in the Polish part of the Vistula Lagoon in fyke net catches in 1999 (Borowski 1999). The fish was noted simultaneously in the northwest corner of the lagoon (near Kąty Rybackie) and near the Russian border. According to the authors' own observations, the best habitat for the round goby is the hard rocky bottom of the pikeperch spawning grounds at Różaniec. As an alien species settling into a new basin, the round goby increased its abundance in the 2003-2006 period. The round goby CPUE in the Gulf of Gdańsk obtained during bottom trawl surveys was at its peak in 2002, a decade following the first record of this species in the catches (Grygiel 2007). In subsequent years, the same author also observed higher species frequency in the hauls at a lower CPUE. These observations suggest that the saturation level is reached by a round goby invasion after about a decade. Since the area of the Vistula Lagoon is smaller than that of the Gulf of Gdańsk, it it possible that this level will be achieved faster.

The Vistula Lagoon is one of the main spawning grounds for Baltic herring in the southeastern Baltic, and during herring spawning all other fish species feed on them or their spawning products. The main factors determining spawning time include the time of ice breakup and clearing from the lagoon, which is related to the severity of the preceding winter, other warming processes, and water salinity values (Krasovskaya 1996, 2002). The level of herring biomass in lagoon waters is hardly predictable, nor is the mortality of larvae and young-of-the-year before they leave the lagoon in the summer. Such great numbers of herring do have an impact on the whole food-web in the lagoon. During spawning, all other fish feed on herring or its gonadal products. Herring larvae compete with smelt, *Osmerus eperlanus* (L.) juveniles for the same food items. The instability of the herring spawning biomass has a crucial impact on the stability of fish assemblages in the Vistula Lagoon. ICES data on herring stocks in ICES Baltic Sub-Divisions 25 to 29 and 32, which constitutes one assessment unit, indicated that spawning stock biomass reached its historical minimum in the 1999-2002 period (ICES 2008). The forecast for this herring stock today is rather optimistic, despite the results of international acoustic surveys that showed a great decrease in 2007.

Eel occupies a special position in the Vistula Lagoon fishery (Filuk 1984). Since this fish does not breed in the lagoon, many environmental factors outside of the lagoon impact its population size (Moriarty 1996, Dekker 2003, Knights 2003). Eel stocking in the Vistula Lagoon was initiated in 1970 and was continued, with some interruptions, until 1994 (Psuty and Draganik 2008). The economic effectiveness of stocking was estimated assuming that the survival of an age group over a series of years remained unchanged; thus, one glass eel biomass unit introduced into the Vistula Lagoon returned 120 units of marketable eel after nine years (Filuk and Draganik 1980). The effects of stocking were evident until the early twenty-first century, then eel biomass decreased rapidly (Psuty and Draganik 2008). Not until 2005 was a new stocking procedure started with reared eel (30 thou. indiv. in 2005 and 68.8 thou. indiv. in 2006). Compared with the quantity stocked previously (a mean of 6 million glass eel individuals in the 1970s), and the stocking norms applied in inland waters (100 indiv. ha^{-1}), the current stocking effort is negligible (2 indiv. ha^{-1}).

Ziege was listed in the Polish Red Book of Animals as an endangered semi-migratory species (Wieser 1992). The Vistula Lagoon is the only place where ziege has been found regularly since the mid 1970s. Protective measures regarding the Vistula Lagoon ziege were lifted in 1995 because of consistent increasing trends in both ziege abundance and bycatch in the fyke net fishery. Peak ziege catches were observed in May and June and coincided with the spawning season (Stolarski 1995). A sharp increase in the ziege biomass index was recorded beginning in 1987 in the trawl surveys conducted annually by AtlantNIRO of Russia (Keida 1998). According to Keida and Golubkova (2001), this trend is the result of strong year-classes appearing as a result of favorable reproduction conditions. However, no distinct dependencies between the hydrological characteristics of the lagoon (water temperature, salinity, wind regime) and ziege abundance have been revealed. The appearance of strong year classes could also have resulted from successful food-web competition during early life development.

As a marine species, flounder was rare in the Polish part of the Vistula Lagoon. The largest individual noted before 2003 was 24 cm TL and was from age class 6 (Dąbrowski, personal communication). In 2006 individuals measuring 26 cm became common (Psuty, unpublished data). The stomachs of larger individuals were filled mainly with mussels and shrimp (Ramutkowski, unpublished data). This second dietary component of the flounder diet appeared in the Vistula Lagoon recently, and it is probably due to the invasion of *P. elegans* (Jażdżewski et al. 2005) that flounder has been able to expand. The flounder increase could be an effect of a free niche following the decline of eel since both species can feed on the same food items. However, this hypothesis must be verified in further studies.

Although pikeperch catches have been limited since 1958 according the Polish-Russian Commission on Fishery Resources of the Vistula Lagoon, this has not prevented the decline of this species (Golubkova et al. 2005). The decrease in the share of the largest category in the current studies is a sign of the poor condition of the stock and increasing overfishing. Substantial quantities of juvenile pikeperch from age classes 1 and 2 become entangles in fyke nets (Borowski and Dąbrowski 1998). Although the pikeperch caught in fyke nets are alive when the gear is hauled on board, many of them die after being thrown back into the water as a result of manipulation wounds or from shock and weakness. They are also easy prey for predatory marine fowl. Since 2002 fishers have been required to install metal or plastic sieves with holes in the last fyke net chamber that permit the youngest pikeperch up to 15-16 cm TL to escape (age class 1) (Draganik and Psuty-Lipska 2004). By the peak of fall fishing, the young-of-the-year pikeperch have become larger and are entangled in the gear. The second source of mortality before maturation is from roach-perch gill nets (36 mm mesh size) that became popular in the early twenty-first century because other fishery gear was not profitable. A problem appeared when the bycatch of juvenile pikeperch from age classes 2 and 3 (mean length 39 cm TL, Psuty-Lipska 2003) became notable. In recent years, fishery inspectors from the Regional Maritime Fishery Inspectorate have noted increased numbers of poaching nets, most of which are constructed of small mesh netting (from 36 to 40 mm mesh size).

Since pikeperch is the main predatory fish species that feeds on smelt, ruffe, and other non-commercial species, its permanent decrease has caused a shift in the ecosystem toward another trophic balance. Due to plentiful fish food, the size of the black cormorant breeding colony near Kąty Rybackie increased to 11 500 nests in 2004 (Goc, personal communication) although in the mid 1990s experts predicted that growth would not exceed 5 000 nests. The main cormorant food is ruffe within the length range of 3-13 cm TL (~ 75% in numbers) (Stempniewicz et al. 2003). It is possible that the sharp decreasing trend in ruffe numbers observed in the fyke net complex is the result of strong cormorant pressure.

Environmental conditions for cyprinid species inhabiting the Vistula Lagoon are good thanks to its shallowness and abundance of aquatic plants. Interestingly, neither roach nor even bream are valuable although they are commercial species. Individuals of these species are often discarded when fyke nets are cleared (Psuty-Lipska 2003). The wide age structure of roach fished on both the Polish (age classes 3-13, Psuty, unpublished data) and Russian (age classes 3-18, Keida 1998) sides of the Vistula Lagoon suggested that the stock is exploited at a low rate. The situation with regard to the bream population in the Vistula Lagoon is similar as it exhibits a stable abundance level, as does the occurrence in the population of old individuals (age class 16).

Fish assemblages inhabiting environments that are highly stressed are accustomed to variable conditions; thus, they are potentially more resilient to anthropogenic stress. The results from the current ten-year series of fish data indicates that continuous, directed stress on commercial species could decrease or even exclude these fish from the assemblage. The estuary ecosystem can cope with this stress, but not sufficiently for commercial fisheries (e.g., by increases in the black cormorant breeding colony). Further research is needed on modeling factors that would permit the recovery of both eel and pikeperch in the Vistula Lagoon.

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Streszczenie

Równowaga zespołów ryb w niestabilnych warunkach: dziesięcioletnia seria danych z polskiej części Zalewu Wiślanego

Celem pracy była ocena zmian w zespole ryb Zalewu Wiślanego na podstawie danych pochodzących z samorejestracji połowów przez załogę rybacką. Dane o połowach całkowitych w eksperymentalnym kompleksie czterech żaków zlokalizowanym w pobliżu granicy polsko-rosyjskiej rejestrowano w latach 1995-2006. Zespół ryb Zalewu Wiślanego charakteryzował się dużymi zmianami w trakcie roku, z silną dominacją śledzia *Clupea harengus* L. przybywającego na tarło w okresie wiosennym. W sezonie letnim dominantem ilościowym była młodzież (ryby w wieku 0+ i 1+) sandacza *Sander lucioperca* (L.) oraz jazgarz *Gymnocephalus cernuus* (L.). Dużą rolę odgrywała również ciosa *Pelecus cultratus* (L.) i młodzież leszcza *Abramis brama* (L.). Analiza trendu względnej wydajności rejestrowanych połowów wykazała drastyczny spadek w przypadku węgorza *Anguilla anguilla* (L.) z poziomu 10-15 w 1995 r. do 0-1 osobn. w 2006 r. Redukcja ta była związana z zaniechaniem zarybień Zalewu Wiślanego węgorzem szklistym przy wysokim poziomie eksploatacji. Spadek względnej wydajności dotyczył również dużego sandacza, co mogło być skutkiem nadmiernej eksploatacji rybackiej oraz jazgarza. Poważna redukcja liczebności tego ostatniego gatunku może być związana z eksplozją liczebności kormorana czarnego z kolonii lęgowej w Kątach Rybackich. Wzrost względnej wydajności zarejestrowano w przypadku płoci *Rutilus rutilus* (L.), storni *Platichthys flesus* (L.) oraz babki byczej *Neogobius melanostomus* (Pall.). Wzrost ilości

storni może być powiązany z korzystnymi warunkami pokarmowymi jakie wytworzyły się przy licznym występowaniu krewetki *Palemon elegans* w Zalewie Wiślanym. Babka bycza, która jest w ekosystemie gatunkiem nowym (od 1999 roku) sukcesywnie zwiększa swoją liczebność opanowując wolną niszę ekologiczną. W przypadku takich gatunków jak okoń *Perca fluviatilis* L. i ciosa, analiza danych w serii analizowanych lat nie wskazuje na istnienie wyraźnego trendu, pomimo dużej zmienności względnej wydajności w poszczególnych okresach.