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THE RESTORATION OF ATLANTIC SALMON (*SALMO SALAR* L.) IN POLAND

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ABSTRACT. The last remaining salmon population in Poland went extinct in the mid 1980s. The salmon restoration program in Poland in based on Daugava salmon, and the first eyed Daugava salmon eggs were imported to Poland in 1985, and they continued to be imported in subsequent years. Spawners were reared in net cages in the Gulf of Gdańsk. Salmon smolts have been released into Pomeranian rivers and the Vistula River since 1994. Between 1994 and 1999, 1,644,936 salmon smolts were released, of which 63,602 were tagged. Overall, there was a low recovery rate of tagged specimens, and from many experiments there were no recoveries at all. The highest recovery rate was 4.5%. Tagged salmon migrated throughout the Baltic Sea, but the highest concentration of catches were in the Gulf of Gdańsk, near Bornholm and in the Gulf of Finland. In the first winter, the tagged salmon attained an average length of 62.9 cm and an average weight of 2.9 kg, in the second winter theses figures were 76.1 cm and 5.3 kg, and in the third they were 90.7 cm and 7.6 kg.

Key words: *SALMO SALAR*, SMOLT, RESTORATION OF POPULATION, TAGGING, MIGRATION

INTRODUCTION

Although salmon (*Salmo salar* L.) was present in many Polish rivers (Fig. 1), it was less numerous than sea trout (*Salmo trutta* L.). In the Pomeranian rivers, its catch did not exceed 0.64% compared to sea trout (Chełkowski 1966). In the Drawa River in 1951-1965, the autumn catches of spawner salmon were 92.6% in comparison with sea trout (Iwaszkiewicz 1966). However, according to Chełkowski (1966), the share of salmon was 86.6%. Two salmon populations, the winter and summer, were distinguished in the Vistula River. The first of them entered the Vistula mouth in late autumn and during winter they migrated to the tributaries of the upper Vistula River and spawned in the next season, but the summer population entered the Vistula River in summer and spawned in the same season in the tributaries of the lower Vistula (Żarnecki 1963, 1964).

The deterioration of the ecological state of the river, especially from damming, overexploitation and poaching caused a decrease in the salmon populations in all Polish rivers. To counteract this, alevin, parr and smolt stocking programs were undertaken in all of the Polish salmon rivers. Mainly alevins were released; smolt were very

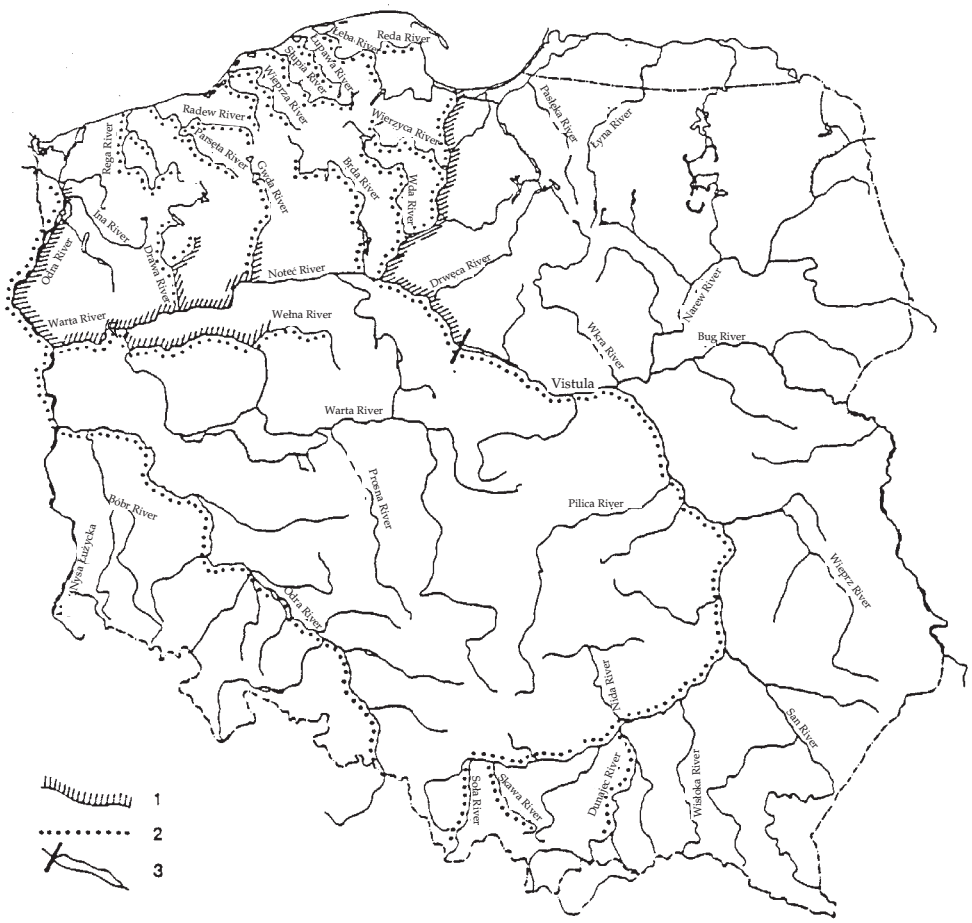

Fig. 1. Occurance of salmon in Polish rivers. 1 - after World War II, 2 - in former times, 3 - the dam built in 1968.

rare and their numbers small. These efforts were not intensive enough and the decline in salmon populations in Polish rivers was not halted. The number of spawners in spawning grounds continued to fall and was especially apparent after World War II. The last salmon in the Skawa River (a tributary of the upper Vistula River) was caught in 1952 (Bieniarz and Łysak 1975). Salmon was so rare in the lower Vistula River that by the end of the 1960s attempts to catch spawners were unsuccessful (Bartel 1993). In the 1970s, no salmon was caught in the lower Vistula River. Salmon also vanished from the Pomeranian rivers during the same period. The last salmon population in

existence was that of the Drawa River (a tributary of the Noteć River in the Odra River catchment area), but the number of salmon in spawning grounds there was lower each year and the last spawners were reported in the river in 1985 (Chełkowski 1986). No spawners were caught in 1987, and only seven parrs were observed (Chełkowski 1988).

These facts were the basis for declaring salmon in Polish rivers to be a fully protected species.

MATERIAL AND METHODS

The situation described above was the main reason a salmon restoration program was undertaken in Polish rivers.

SALMON RESTORATION PROGRAM IN POLAND

The first attempt was undertaken in 1985 when we received 10,000 eyed Neva salmon eggs from pond-reared spawners from the Finnish Game and Fisheries Research Institute in Helsinki. The Sea Fisheries Institute in Gdynia bought 50,000 and 30,000 eyed Daugava eggs from salmon caught in the Daugava River in 1985 and 1987, respectively (Wiktor 1989, Grudniewska and Grudniewski 1990).

It was decided that eggs from spawners caught in the Daugava River would be used for restoration since this is the nearest river to Poland with a natural salmon population.

In 1994, another 50,000 eyed Daugava salmon eggs were bought, and in 1995-1999 from 150,000 to 300,000 eyed Daugava salmon eggs were imported from Latvia. In 1997, 150,000 autumn parrs were bought from Latvia.

REARING OF SALMON SPAWNERS

One-year-old salmon smolts were reared from eyed eggs in the Department of Salmonid Research of the Inland Fisheries Institute at Rutki in northern Poland. These smolts were used for rearing salmon spawners in net cages in the Gulf of Gdańsk. Spawners from 3+ to 6+ year classes were stripped. Approximately 0.8 - 1 million eggs were collected annually and used to rear one-year-old smolts in the Rutki Hatchery. These smolts were used for rearing spawners. Some eggs were hatched in hatcheries and alevins or fry were released into some tributaries.

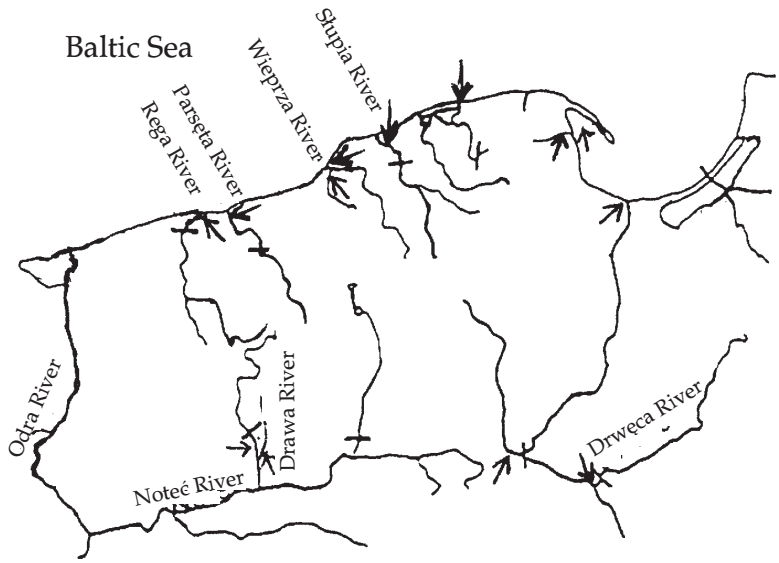

Fig. 2. Sites of smolt release (arrows).

In autumn 1995, after artificial spawning, salmon spawners aged 3+, 4+ and 6+ were moved to the Aquamar Fish Farm in Miastko where they were reared in fresh water. There were no dead fish after transport.

In 1994, smolt for rearing salmon spawners in fresh water in a hatchery were selected from the two-year-old smolt reared in Miastko (northern Poland).

REARING OF SALMON SMOLTS

Salmon smolts were reared in five hatcheries in the northwest of Poland. Four hatcheries produced from 50,000 to 85,000 one- or two-year-old smolts annually. The Miastko Hatchery alone produced from 200,000 to 350,000 smolts annually.

SITES OF SMOLT RELEASE

Salmon smolts were released into the Vistula River mouth and two of its tributaries, the Drwęca River with its tributary the Wel River, and the Brda River (since 2000). They were also released into Pomeranian rivers – the Rega, Parsęta, Wieprza with its tributary the Grabowa, and the Słupia, Łeba and Reda. These last two rivers have been stocked since 2000. Salmon smolts were also released into the Drawa River and its tributary the Płociczna River (Fig. 2).

NUMBER OF RELEASED SALMON SMOLTS

From 1994 to 1999, 1,644,936 one- and two-year-old salmon smolts were released. In 1995-1999, the number of released smolts annually varied from 132,283 to 537,850 (Table 1).

TABLE 1

Number of salmon smolt relased into Polish rivers in 1986-1996

Site	1986	1994	1995	1996	1997	1998	1999	total
Słupia River	840	-	68,678	24,403	50,570	145,025	93,333	382,849
Wieprza River	-	22,647	47,004	35,922	109,298	120,183	99,458	434,512
Drwęca River	-	-	25,019	13,675	-	67,011	16,837	122,542
Drawa River	-	-	22,843	11,403	75,443	49,987	38,614	198,290
Parsęta River	-	-	46,254	24,427	30,600	92,380	44,738	238,399
Płociczna River	-	-	13,470	-	-	-	-	13,470
Grabowa River	-	22,719	-	15,500	-	-	-	38219
Wel River	-	-	-	6,953	-	-	-	6,953
Vistula River	-	-	18,053	-	26,700	19,360	46,058	110,171
Rega River	-	-	-	-	27,562	43,904	27,075	98,541
Puck Bay	-	-	-	-	-	-	-	990
Total	840	45,366	242,311	132,283	320,173	537,850	366,713	1,644,936

The largest number of smolts were released into the Wieprza and Słupia rivers. Other rivers which were heavily stocked with salmon smolts were the Parsęta, Drawa and Drwęca.

TAGGING EXPERIMENTS

Some of the salmon smolts released were tagged. In 1994-1999, 63,602 tagged one- and two-year-old salmon smolts were released. The tagged fish were released at nearly all the sites where untagged salmon smolts were released (Table 2). Of the smolts caught at the end of June of the first year following release, 95 recoveries of young fish were obtained, while 265 older fish were caught after June of the first year following release.

RESULTS AND DISCUSSION

CATCHING SALMON SPAWNERS IN POLISH RIVERS

The first salmon entering Polish rivers were observed in 1996 in the Drwęca River where three salmon were caught. In 1997, the first salmon were caught in the Vistula

TABLE 2

Tagging experiments of salmon smolts released into Polish rivers in 1994-1999

Year	Site	Number of smolts	Fish age	Recoveries (number of fish)	
				young fish[1]	older fish[2]
1994	Wieprza River	1,080	2	-	22
1995	Wieprza River	2,999	2	6	6
	Wieprza River	996	1	1	-
	Drwęca River	1,997	2	1	2
	Drawa River	1,999	2	-	1
	Słupia River	1,999	2	2	9
	Parsęta River	2,000	2	2	1
	Parsęta River	975	1	-	-
	Gulf of Puck	990	1	-	-
Total 1995		13,955	-	12	19
1996	Wieprza River	3,000	2	1	25
	Drwęca River	3,000	2	1	52
	Drawa River	990	2	7	
	Słupia River	1,900	2	1	22
	Parsęta River	931	2	6	10
Total 1996		9,821	-	16	109
1997	Drawa River	3,995	2	3	-
	Rega River	1,996	1	-	1
	Wieprza River	996	1	-	-
	Słupia River	1,000	1	-	-
	Vistula mouth	1000	1	13	1
	Vistula mouth	1,000	1	9	-
Total 1997		9,987		25	2
1998	Drawa River	3,995	2	3	-
	Płociczna River	1,000	2	2	-
	Parsęta River	1,000	2	-	-
	Wieprza River	1,000	2	1	-
	Wieprza River	1,996	1	-	-
	Słupia River	1,000	1	-	-
	Słupia River	1,000	2	2	-
	Drwęca River	1,148	2	-	-
	Drwęca River	1,999	2	6	90
Total 1998		14,138	-	14	90
1999	Płociczna River	1,000	2	6	-
	Drawa River	1,904	2	9	-
	Rega River	1,859	2	5	6
	Parsęta River	4,000	2	3	6
	Wieprza River	3,858	2	4	10
	Drwęca River	1,000	2	-	-
	Vistula mouth	1,000	2	1	1
Total 1999		14,621	-	28	23
Grand total		63,602	-	95	265

[1] *fish caught before the end of June of the first year after release*

[2] *fish caught after June of the first year after release*

mouth in July. In September of the same year, more and larger salmon were caught. A male specimen aged 4+ attained a fork length of 106 cm and a body weight of 13.9 kg, while a female specimen attained a length of 89 cm and a weight of 7.3 kg at age 3+. Salmon were still being caught in the Vistula mouth in October. The situation in the Pomeranian rivers, where salmon spawners for artificial spawning were collected, was similar. Thirty-six females and seven males were caught in the Wieprza (29 females and 7 males), Grabowa (2 females), Parsęta (4 females), and Rega (1 female) rivers.

Salmon spawners also gathered in the Drwęca River where seven females and three males were caught. The length of the females ranged from 79 cm to 105 cm, with an average of 91.4 cm, and their body weight ranged from 3.0 kg to 13.2 kg, with an average of 8.6 kg. The length of males ranged from 72 cm to 105 cm, with an average of 85.6 cm, and their weight ranged from 2.9 kg to 11 kg, with an average of 5.9 kg. From these fishes, 301,000 eggs were spawned from females caught in the Pomeranian rivers and 81,000 from females caught in the Drwęca River (Bartel 1998).

In the Pomeranian rivers in 1998, 47 females were caught mainly in the Wieprza River. More than 0.5 million eggs were collected from these fishes. The largest female weighed 14.5 kg at a fork length of 109 cm, and the largest male weighed 14.9 kg. Most of the females measured from 91 to 97 cm in length and had an average weight of 8 kg. Of these females, one was released as smolt into the Wieprza River in 1995. The males caught in the Pomeranian rivers in 1998 were smaller than in 1997 and they weighed from 1.7 kg to 3.5 kg. Salmon spawners were collected from the Drwęca River and the Vistula mouth and artificial spawning was also carried out. In 1998, more than 700,000 salmon eggs were obtained. The same number of eggs were also collected from salmon spawners reared in fresh water. Spawners reared in ponds were much smaller than those from natural conditions and their length varied from 30 cm to 92 cm. The eggs from salmon spawners caught in the rivers were also much larger than those from spawners reared in ponds.

In 1999, salmon spawners were collected from the Pomeranian rivers and in the Vistula mouth and the Drwęca River. Approximately 1 million eggs were spawned from them, the majority of which, over 600,000 eggs, were from specimens from the Vistula mouth. It can be assumed that natural spawning occurred in a few rivers because salmon kelts were observed in the Drwęca, the Parsęta, and the Rega rivers. In the spawning grounds in the Drawa River in 1997 very large nests were observed which can be classified as salmon one (Dębowski and Gancarczyk 1998). Similarly, in 1998, a large nest were observed in the Parsęta River (Dębowski, personal communication).

TAGGED SALMON MIGRATION

After releasing smolts into the rivers, they migrated to the sea and were caught along the Polish coast. Smolts released into the Drawa River migrated to the sea through the western part of the Szczecin Lagoon. Older salmon migrated throughout the Baltic Sea, but they very rarely reached the Gulf of Bothnia. They were caught most frequently in the Gulf of Gdańsk, near Bornholm and in the Gulf of Finland (Fig. 3).

TAGGED SALMON GROWTH

In the first winter (from November to March), the tagged salmon attained an average fork length of 62.6 cm, at a range of 41 cm to 75 cm, and an average body weight of 2.9 g, at a range of 0.5 to 3.8 kg. In the second winter, lengths ranged from 51 cm to 95 cm, with an average of 76.1 cm, and body weight ranged from 1.1 to 8.5 kg, with an average of 5.3 kg. In the third winter, the average length was 90.7 cm (at a range of 82-98 cm) and the average body weight was 7.6 kg.

The largest tagged salmon reached 117 cm after 30 months. Other tagged specimens reached a length of 108 cm and a weight of 16.2 kg after 25 months.

SUMMARY

The migration of restored salmon differed in comparison with the distribution of tagged Drawa salmon (Bartel 1987) and tagged Vistula salmon (Jokiel and Bartel 1984). Catches of the former were concentrated near Gotland, but those of the latter were concentrated in the Gulf of Gdańsk. Very rarely did either of these salmon migrate to the Gulf of Finland.

The average lengths and weights attained in the first winter were much better for the introduced salmon at 62.6 cm and 2.9 kg, respectively, than for either the Drawa salmon (58.2 cm, 1.9 kg), or for the Vistula salmon (47.7 cm, 1.2 kg). In the second winter, the growth of the Drawa salmon and restored salmon were similar; on average, the former attained 78.8 cm and 5.3 kg, while the latter attained 76.1 cm and 5.3 kg. In the third winter, Drawa salmon growth was better reaching 98.5 cm and 9.1 kg (Bartel 1987), while the introduced salmon attained only 90.7 cm and 7.6 kg. The Vistula salmon grew more slowly reaching averages of 57.2 cm and 3.1 kg in the second winter and 77.1 cm and 5.5 kg in the third (Jokiel and Bartel 1984).

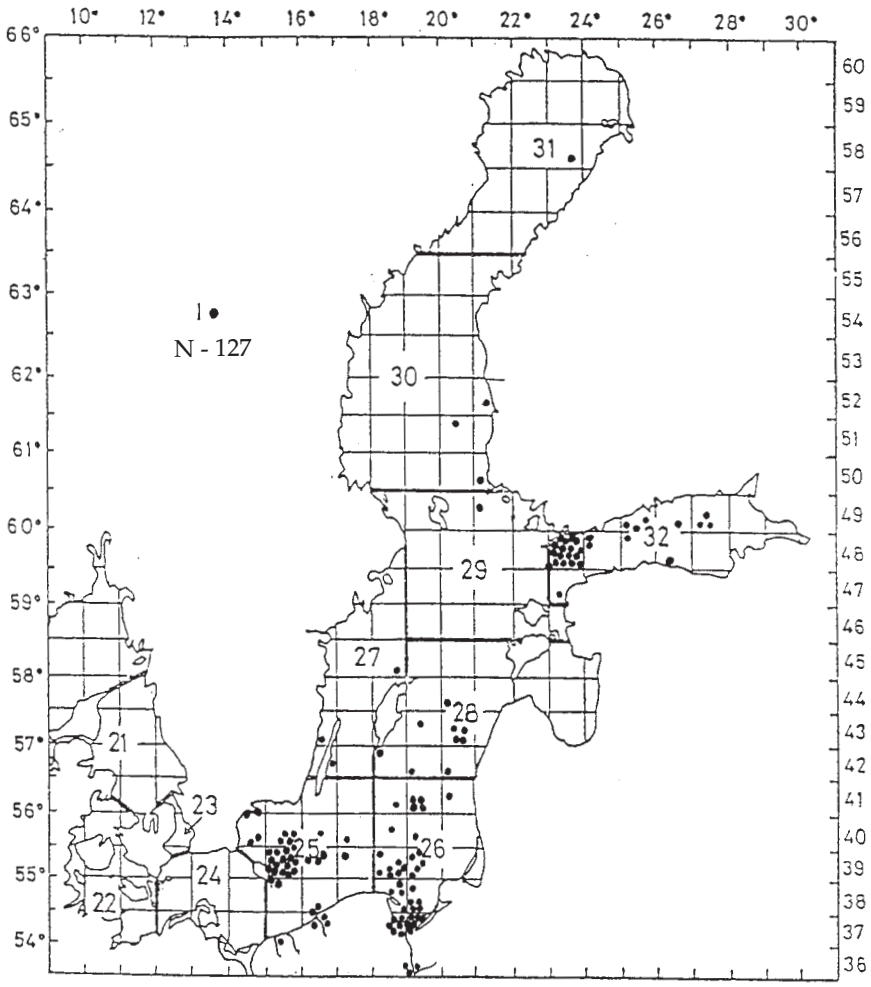

Fig. 3. Sites of catches of tagged salmon released into Polish rivers. 1 - site where one specimen was caught, N - number of recoveries.

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STRESZCZENIE

RESTYTUCJA ŁOSOSIA ATLANTYCKIEGO (*SALMO SALAR* L.) W POLSCE

Łososie w Polsce występowały w wielu rzekach (rys. 1). Ostatnia populacja łososia w Polsce zniknęła w połowie lat osiemdziesiątych. Program restytucji łososia w Polsce bazował na populacji łososi z rzeki Daugawy. Pierwszą zaoczkowaną ikrę łososi z tej rzeki w liczbie 50 000 zakupiono w 1985 r. W latach 1987 i 1994-1999 zakupywano od 30 000 do 300 000 ziarn zaoczkowanej ikry. W pływających sadzach w Zatoce Puckiej do 1995 r. hodowano tarlaki łososia, z których pozyskiwano corocznie od 0,8 do 1 miliona ziaren ikry. Od 1994 r. w Gospodarstwie «Aquamar» w Miastku w wodzie słodkiej hodowane są tarlaki łososi.

Smolty łososia chowane są w 5 gospodarstwach. Smolty wypuszczano do Wisły i jej dopływów, do rzek pomorskich i Drawy (rys. 2). W latach 1994-1999 wypuszczono 1 644 936 smoltów (tabela 1). Wśród tych ryb były 63 602 znakowane smolty, z których otrzymano 360 zwrotów (tabela 2).

Pierwsze tarlaki łososia złowiono w rzekach pomorskich i Drwęcy. Były to głównie ryby w wieku 4+ i 3+. Długość tarlaków wahała się od 79 do 105 cm, a masa od 1,7 kg do 14,5 kg. W 1997 r. pozyskano 382 000 ziarn ikry, a w 1999 r. powyżej 1 miliona sztuk. Tarlaki łososia hodowane w wodzie słodkiej osiągnęły mniejsze długości od 30 cm do 92 cm.

W Drawie i Parsęcie obserwowano duże gniazda, które klasyfikowano jako łososiowe. Znakowane łososie wędrowały po całym Bałtyku. Najczęściej były one poławiane w rejonie Zatoki Gdańskiej, Zatoki Fińskiej w okolicach Bornholmu. Pojedyncze osobniki docierały do Zatoki Botnickiej (rys. 3). Znakowane łososie w zimie pierwszego roku po zarybieniu osiągały średnio 62,6 cm i 2945 g, w drugim roku 76,1 cm i 5316 g, a w trzecim 90,7 cm i 7600 g. Największy znakowany łosoś po 30 miesiącach osiągnął długość 117 cm, inny osobnik po 25 miesiącach osiągnął 108 cm i 16,2 kg.

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