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SHORT COMMUNICATION

Occurrence of juvenile salmon, *Salmo salar* L., from natural spawning in the Słupia River (northern Poland)

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Abstract. The native population of the salmon, *Salmo salar* L., in the Słupia River probably became extinct in the 1960s. The restoration of this species began in 1986, and is based on the population in the Daugava River. As indicated by historic data, salmon was decidedly less abundant than was sea trout, *Salmo trutta* L. This remains unchanged today. To date, it has been impossible to differentiate positively smolts of stocking origin from those of natural spawning. Since 2006, all salmon smolts released into the Słupia River have had their adipose fins clipped, which allows for easy identification. The aim of the current study was to present how many of the juvenile individuals caught in the Słupia River originate from natural spawning. During the 1999-2008 period, a total of 25 juveniles were caught that were classified as wild specimens. Although salmon spawning and redds were observed earlier, the catch of juvenile species is evidence of successful salmon spawning in the Słupia River.

Keywords: salmon, natural spawning, wild fingerlings, Słupia River

The occurrence of salmon, *Salmo salar* L., in the Słupia catchment was reported as early as in the 1920s (Henking 1929), and later by Chrzan (1947). The analysis of contemporary fishery catches lacks data that would distinguish decidedly between the sea trout, *Salmo trutta* L., and the salmon. Certain conclusions regarding abundance can only be drawn by comparing the sizes of the spawners caught. This indicates that salmon comprised just a small percentage. Although Kaj (1954) describes the Słupia as a salmon river; however, calculations indicate again that the catch statistics regarding catches of salmon and sea trout lack distinct differentiation between the two species. Based on catches of spawners, Chełkowski (1966) concluded that the share of salmon in comparison to that of sea trout in Pomeranian rivers was slight. The first full description of the ichthyofauna of the Słupia River was not published until 2000 (Dębowski et al. 2000), which means that detailed data is lacking from earlier years. Thus, it is difficult to determine in what quantities salmon spawned, and what the population abundance was prior to and after the construction of the hydroelectric power plant in the Słupia basin.

The last population of salmon in Poland became extinct at the end of the 1980s (Bartel 2001). Because of the lack of data, it is difficult to pinpoint when this occurred in the Słupia River, but it probably happened in the 1960s (Bartel 2001). The salmon restoration program in Poland was based on the Lithuanian population, which is relatively close in geographical terms. Stocking the Słupia with salmon, which is part of the restoration program, was

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begun in 1986 when 840 salmon smolts (1+) were released. These were the progeny of spawners from the Neva River that had been reared in fresh water at the Lauba Fish Farm (Finnish Game and Fisheries Research Institute). Also in 1986 a small number of salmon fry were introduced to the streams in the Parsęta, Wieprza, Reda and Słupia rivers drainage are (Bartel 2001). The fish released in recent years originate from the Daugava River. Since 1990, no fry stocking has been undertaken and juveniles were released only in the 1996-1998 period. By 2008, a total of 558,952 smolts (1+) and juveniles had been released (Fig. 1).

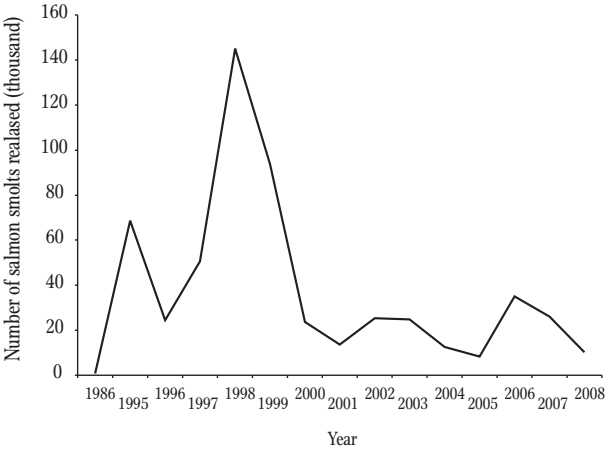

Figure 1. Stocking the Słupia River with salmon smolts in the 1986-2008 period.

The effectiveness of these stocking measures is difficult to assess. Tagging the smolts with Carlin tags does not permit evaluating the effectiveness of stocking because of the low number of returns, which is also why releasing tagged individuals was discontinued in 1998. A certain number of adult salmon are caught annually in the Słupia River by anglers; however, because there is no effective system for registering recreational catches, it is not known precisely how many salmon are caught by these fishers. Salmon spawning has been observed several times in the Słupia (Dębowski et al., unpublished data). The problem has been to confirm positively the presence of wild juveniles, which would, in turn, attest to the effectiveness of natural spawning. Even if it were possible to catch juvenile salmon, the risk of confusing them with fish from stocking exists. The smallest smolts released (sometimes as pre-smolts) are about 14 cm in length, which means that smaller salmon can be considered to be juveniles. Cultivated fish usually have shorter and slightly deformed pectoral fin, which results from being reared at high density, and this is useful in distinguishing their origin (Fleming et al. 1996). Since 2006, all of the salmon and sea trout smolts released into the Słupia have had clipped adipose fins, which permits distinguishing them from fish originating from natural spawning (Dębowski et al. 2008a). The aim of the current work is to present the results of catches in which wild juvenile salmon were caught. This is important evidence of the ability of salmon to spawn naturally in the Słupia River. This is also the first confirmed, effective natural spawning of this restored species in Polish waters.

The Słupia basin is located in northern Poland, and the Słupia River flows into the Baltic Sea (Fig. 2). It is 138.6 km in length, with a catchment area of 1,623 km^2. The mean flow of the Słupia in the city of Słupsk is 15.3 $m^3 s^{-1}$ (Narwojsz 2001). The river is passable for migrating fish for 36 km from the river mouth up to the barriers retaining water for the hydroelectrical plant at Słupsk. Thanks to two fish passes, a further 59 km of the basin is partially passable for migrating fish. This comprises 42.8% of the river's length (Dębowski et al. 2008a). Analyses conducted in 2003-2005 indicate that the water quality of the Słupia River in the vicinity of the city of Słupsk is sufficient. The majority of the water quality parameters are within first class ranges. Improvements in water quality (in comparison to that of the 1980s and 1990s) were noted after the sewage treatment plant went into operation in Słupsk and several factories in the area were closed (Moczulska et al. 2006).

The salmon juvenile caught were classified as wild after stocking on the Słupia had been analyzed and the possibility of confusing them with fish of hatchery origin had been excluded. Fish origin was also confirmed by their appearance and by the fact that juvenile species had been caught at known salmon spawning sites and in the vicinity of older redds with various catch methods. Electro-fishing

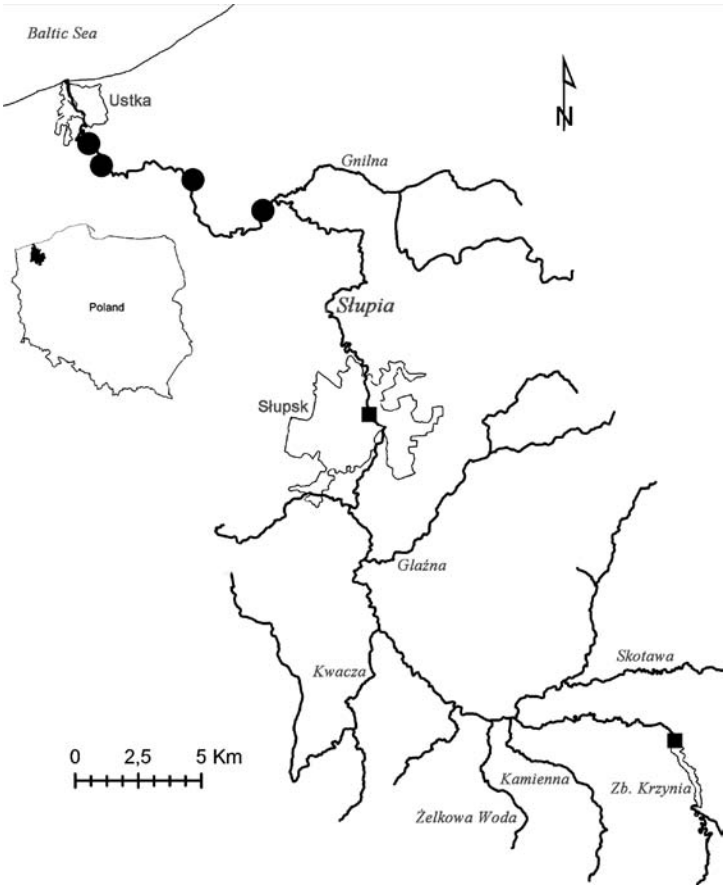

Figure 2. Słupia basin. Sites where salmon juvenile were caught (●) and locations of small hydroelectric power plants (MEW) on the Słupia (■).

was the method used during the ichthyological studies. It was performed from boats on 500 m segments of the river as the boat sailed along one bank as is described by Penczak (1969). However, juvenile catches were performed along sites that were 50 m in length. The caught fish were handled gently, which is why they were neither measured nor weighed, and they were released after being examined and photographed (Photo 1).

In the 1999-2008 period, catches were made in the following Słupia tributaries, and wild salmon juveniles were caught: 1) 7 individuals were caught at one site near Charnowo during ichthyofauna studies in 1999 (Dębowski et al. 2000, Dębowski 2004); 2) ichthofauna studies in 2003, at three sites in the lower Słupia 4 individuals were caught (Dębowski et al. unpublished data); 3) 2 individuals were caught during juveniles catches in 2007 at one site below Bydlino (Dębowski et al. 2008a); 4) 12 individuals were caught during telemetric studies in 2008 near Charnowo and before Ustka.

The negligible number of juvenile salmon results not only from their low abundance and wide distribution, but also from the difficulties of catching them in a large river. These difficulties also apply to sea trout although populations of them in this river are much more abundant. Because of this, valuable information regarding the numbers of fish migrating to Słupsk are provided by the Riverwatcher automatic counters (Vaki Aquaculture Systems, Iceland) that are installed at the Słupsk fish passes (Dębowski et al. 2008a, 2008b). From October 11 to December 31, 2006, approximately 6,000 sea trout reached the fish pass, and in the following year about 8,000 fish did so (Dębowski et al. 2008a, 2008b). Thus, in accordance with calculations by Chełkowski (1966), which

Photo 1. Juvenile salmons caught in the Słupia River on November 2007.

indicate that the share of salmon in salmon and sea trout catches in the Słupia River did not exceed 1%. Taking into account the certain number of sea trout that did not reach Słupsk, the total number of these fish would indicate that there were about 100 individuals of salmon. It seems that this is relatively few and very close to the minimal effective population size, which, for salmon, is 150 spawners annually (Verspoor et al. 2007). Although the calculations above are only estimations, they do provide a certain picture of the abundance of salmon in consideration of that of sea trout and the difficulty in catching them.

Initially, the salmon were released at the Słupia River mouth in Ustka. This led to the situation in which the fish did not exhibit the appropriate homing reaction (Dębowski and Bartel 1995). Currently, salmon smolts are usually released in Charnowo located 6 km from the river mouth, regarding which, although it appears to be a more rational location, there are consequences. That juvenile salmon individuals are caught only in the lower Słupia might be a result of their release of the smolts in this location (Dębowski et al. 2008a). Everything indicates that the principle salmon spawning grounds are located in the lower Słupia in relatively deep waters, and that a insignificant number of salmon pass the Słupsk area. This is confirmed by catch statistics regarding spawners caught in the Polish Angling Association trap in Słupsk. These data indicate that over the last several years, about fifteen salmon were caught, and that just nine were caught in 2008. Similar data from automatic counters installed in the fish passes in Słupsk, also indicate that a negligible number of salmon pass the barrier in Słupsk (Dębowski et al. 2008b).

Improvements in water quality in recent years in the Słupia River, the construction of fish passes, protective measures and renaturalization measures all contribute to the success of the restoration program. The crucial points here is the availability of spawning grounds and the survival of juvenile individuals, but genetic and environmental factors are also important. The current data indicate that the salmon ascending the Słupia River can spawn successfully. This is significant, but currently there are too few data regarding natural spawning and its effectiveness in the Słupia River to confirm that the population is self-recruiting.

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Streszczenie

Występowanie juwenalnych osobników łososia *Salmo salar* L. pochodzących z naturalnego tarła w Słupi (północna Polska)

Celem tej pracy jest przedstawienie wyników połowów, podczas których złowiono juwenalne osobniki łososia *Salmo salar* L. z naturalnego tarła. W latach 1999, 2003, 2007 i 2008, przy okazji prowadzonych w dorzeczu elektropołowów złowiono 25 osobników juwenalnych łososia, które uznano za pochodzące z naturalnego rozrodu. Fakt ten stanowi zasadniczy dowód, że łosoś potrafi skutecznie odbyć tarło w Słupi choć nie ma wystarczających danych by mówić o samo rekrutującej się populacji.