

# Historical occurrence and extinction of Atlantic salmon in the River Elbe from the fourteenth to the twentieth centuries

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*Dedicated to Professor Ota Oliva (1926-1994), inspiring teacher and Czech ichthyologist, and Professor Eugene Balon (1930-2013), world-famous ichthyologist*

**Abstract.** Data on the occurrence, biology, and historical background of the Atlantic salmon, *Salmo salar* L., (Pisces, Salmoniformes) in the Elbe river basin (Europe, North Sea drainage area) with a focus on Bohemian territory (Central Europe) from the fourteenth to twentieth centuries are summarized in this paper. Historical methods of salmon fishing in Central Europe and historical legal protection of salmon in Bohemia are presented. The salmon is a model example of species which was extirpated as a result of anthropogenic changes in the landscape and rivers in some water systems. The human activities, such as stream bed regulation, dam system construction, other migration barriers, water pollution, fisheries exploitation, that led to the extirpation of Atlantic salmon in the Elbe river basin (are discussed. The last sporadic migrating native salmon were registered in the Bohemian section of the Elbe river basin in the mid twentieth century.

**Keywords:** Atlantic salmon, Elbe River, fishing methods, historical data

## Introduction

The Atlantic salmon *Salmo salar* L. is a great example of a widely-known fish species that is very important to humans. Also known as a “flagship species”, it can be used to reestablish populations in different river systems today (Ingendahl and Beeck 2011, Monnerjahn 2011). Formerly, natural salmon migration occurred in two river systems in the the Czech regions of Bohemia, Moravia, and Silesia in Central Europe. The first migration route led through the Oder river basin (Baltic Sea drainage area) and into the Oder (Odra), Olza (Olše) and Opava rivers. During migration, salmon were caught in Ostrava (49°47'38" N, 18°15'3" E), Bohumín (49°54'18.95"N, 18°21'23.65" E), and in several other areas (Heinrich, 1856, Baruš and Oliva 1995). Balon (1952), however, did not confirm the occurrence of salmon in the Olza River. In the Oder River only, native salmon were observed in Głogów, an area below Wrocław, Poland, in the 1970s (Chełkowski and Chełkowska 1996). The German population of Atlantic salmon was extirpated and the genetic heritage lost in the 1950s (Monnerjahn 2011). On the other hand, migrations of salmon, which are seen as much more significant from the historical perspective, led from the Elbe basin (North Sea drainage area) to Bohemia. Therefore, the majority of historical knowledge about their occurrence are derived from just this region.

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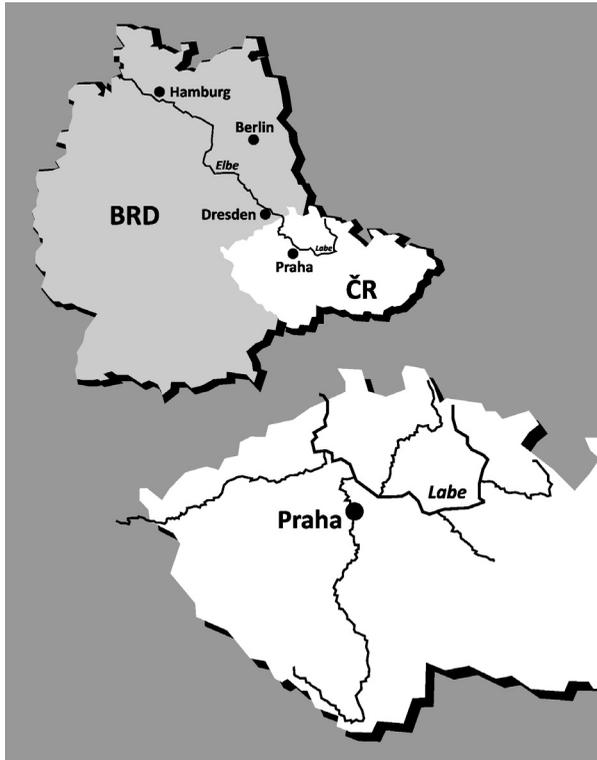


Figure 1. Map of the Elbe (Labe) drainage basin in the Czech Republic (ČR) and Germany (BRD), Central Europe.

One of the longest salmon migration routes to the European continent is from the North Sea through the Labe (Elbe) River to Bohemia (Czech: *Čechy*; German: *Böhmen*; Polish: *Czechy*; French: *Bohême*; Latin: *Bohemia*). This is a historical region in Central Europe with an area of 52,065 km<sup>2</sup>. It is bordered by Germany to the west, Poland to the northeast, the historical region of Moravia to the east, and Austria to the south (Fig. 1). A great deal of historical information exists about the occurrence of salmon in connection with its spawning in the Bohemian section of the Elbe River and in some of its tributaries. This is the main focus of this paper. The Elbe (Czech: *Labe*; German: *Elbe*; Low German: *Elv*) is one of the major rivers of Central Europe. Its source lies at an elevation of about 1,400 m in the Krkonoše Mountains (also known as the Giant Mountains or, in German, *Riesengebirge*) of the northern Czech Republic, and it flowing through Germany into the North Sea at Cuxhaven, 110 km northwest of Hamburg. Its total length is 1,094 km. The major tributaries of the Elbe

include the Vltava (Moldau), the Saale, the Havel, the Mulde, the Schwarze Elster, and the Ohře (Eger) rivers. According to Frič (1879), salmon could cover the distance between Hamburg and Prague in 42 days.

## Results

### Salmon fishing methods

Salmon were often caught in holes in weirs, known as a *lososnice* in Czech (Fig. 2), which were fishing traps built into weirs to catch migrating salmon. The top of the weir was traditionally blocked with a fence made of willow wattle in order to prevent salmon from jumping over it. The permitted height of this wooden wall was 30 cm above the water level, but repeated violations of this regulation led to many disputes. These wooden walls could only be installed during the main salmon migration, and they had to be taken down under the threat of penalty after St. James's Day (July 25). The most successful catches were made in the weir lock (the locks and weirs were used for controlling the flow of water down the river). The first written evidence of these salmon traps was published in 1579 at the locality of Hluboká nad Vltavou (49°3'5" N, 14°26'9" E). These constructions, which were often on clerical property, were regularly used for salmon fishing until the extinction of the Bohemian salmon population.

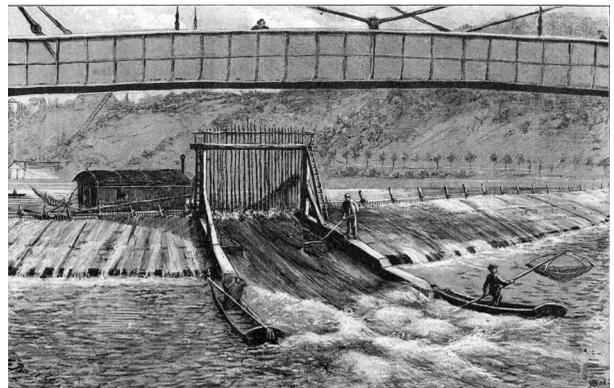


Figure 2. Salmon trap constructed on one of the Prague weirs (Frič 1893).

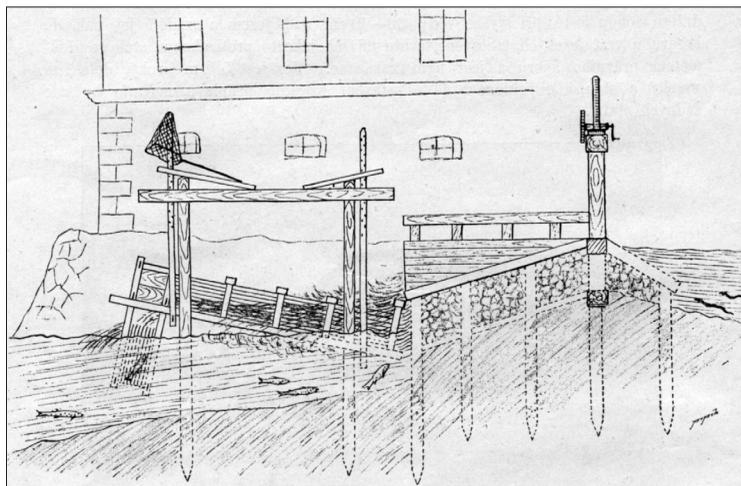


Figure 3. Schematic cross section of a *slup* that was built on weirs and used to catch fish (Frič 1893).

Another type of gear called a fish-sluice (*slup* in Czech) was a progressively narrowing wooden box installed below weirs (Fig. 3) into which fish would be swept by the water current. The oldest reference to this gear dates to 1043 and was published in Cosmas's *Chronica Boemorum* (Chronicle of the Czechs), the oldest extant Czech chronicle in Latin from the twelfth century. This fishing method was used in the Elbe river sections from Obříství to Pardubice, on the Otava River from Písek to Sušice, and in Hluboká on the Moldau River.

Other historical salmon fishing methods used on Czech rivers included large nets, for example between the cities of Lovosice, Litoměřice, and Roudnice, the Prague weirs, and in between Štvanice and Troja. Pendulous nets above weirs were used in Horažďovice and in the mid section of the Elbe River (Vrána 2010). Salmon jumped over the weir, hit the net, fell down to the core net, and then fishermen ran down the walkway and beat the salmon. Drop nets were also used to catch salmon typically at night in areas downstream from weirs or in locks. A large drop net was let down on one side, while noise was being made on the other side with chains attached to rods. As the salmon moved to calmer areas, the drop net was lifted and the fish were caught. Kautský (1940) also mentioned held nets used from boats and from the body of raft gates. Tapping with a special tool called a *kronďle*, which is similar to a trident, was



Figure 4. *Kronďle* – a traditional spear fishing tool from the nineteenth century. Private collection, photograph by Jan Andreska.

used in many places, e.g., in the Kamenice River (Hřensko), the Divoká Orlice River (Žamberk), and the Otava River (Sušice). This tool (Fig. 4) was used either from the river banks or from boats. Salmon fishing was conducted entirely inappropriately, as the fishers tried to catch all salmon they saw in the river. Experienced fishermen were, however, able to throw the *kronďle* successfully from the bank across the width of the river, i.e., 12–15 m, but mostly it was thrown only to the midstream at a distance of about eight meters. The salmon that were hit jumped above the water level and then tried to find shelter. However, the salmon soon became exhausted and they could then be pulled out of the water easily with a *kronďle*. At night fishing boats were fitted with lanterns made of suspended baskets filled with flammable material. The fish were either tapped or covered up using a special kind of short-handled dip net.

Salmon undercutting was also used occasionally. A strong rod, which had a hook and a float tied to it, was fitted with a set of three hooks. This rod was thrown into the current, which ran toward the river banks. After a salmon was caught, the rod was let go, and the fishermen could set off for the boat for pick up. The final fight from the boat lasted until the fish finally lost (Jirák 1950). Another type of fishing gear used was a noose made of copper wire fastened to a stick (Anonymous 1890).

Basket traps (Fig. 5) placed inside holes in weirs were also used, e.g., in Prague and Opatovice (Čermáková 1973). Sometimes, basket traps were also deployed directly on the river-bed. Fishermen

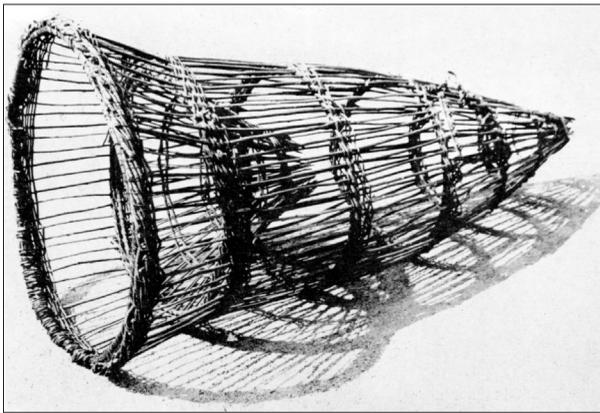


Figure 5. Wickerwork fish basket (Andreska 1997).

installed poles into the river bed using pile drivers; then they would intertwine wicker around them. The structures then formed a letter V, the tip of which faced the current (Fig. 6). A large salmon basket was placed at the tip of the fence to catch the salmon (Andreska 1972).

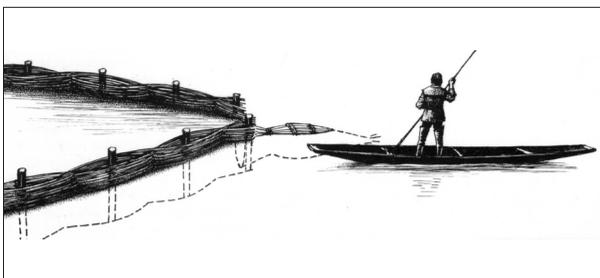


Figure 6. Wickerwork salmon trap (Andreska 1997).

These fences were problematic; floating ice frequently destroyed them, and spring catches of salmon were poor. These fences obstructed other vessels and rafts, which resulted in their eventual official ban. Salmon fishing in the upper Elbe River was performed mostly with seines, which were made from fine-grained hemp twines and were equipped with corks and loads. Three seines were usually joined together forming a total gear length of about 70 m. In Germany, great numbers of salmon returning from the sea were caught using thick nets (Frič 1871). In some places in Germany salmon was also caught in traps baited with live bait fastened to the gear by the lower jaw with fishing lines. Sometimes wooden salmon decoys were also used. These traps worked on the principle of folding traps with strong springs, where iron toothed arms or frames work with fishnet to catch salmon. Large drop nets were also sometimes used. A beam mechanism sprang up quickly from the drop net so the salmon was trapped in the deep heart of the net. The sounding of a bell signaled a salmon catch. A giant drop net, installed on a beam mechanism on a boat, also functioned as a kind of mobile salmon trap (Steinborn and Retterath 1998).

### Information on salmon in sources from the fourteenth to the sixteenth centuries

Some Bohemian rivers in Central Europe were formerly traditional breeding places for Atlantic salmon. Up to 1935 the native occurrence of salmon in Bohemia was noted in 33 rivers, rivulets, and brooks (Fig. 7). The oldest reports concerning the definite occurrence of living salmon in Bohemia are mentioned by Bartoloměj z Chlumce (Magister Bartholomaeus de Solencia dictus Claretus, also called Klaret, 1320-1370) in his rhymed Latin-Czech dictionaries from the beginning of the second half of the fourteenth century (Andreska 2011).

One of the chronicle writings registered a mass of migrating salmon through the Elbe River in the town of Hradec Králové (50°12'40" N, 15°50'15" E). Balbinus (1679) commented this migration in 1432

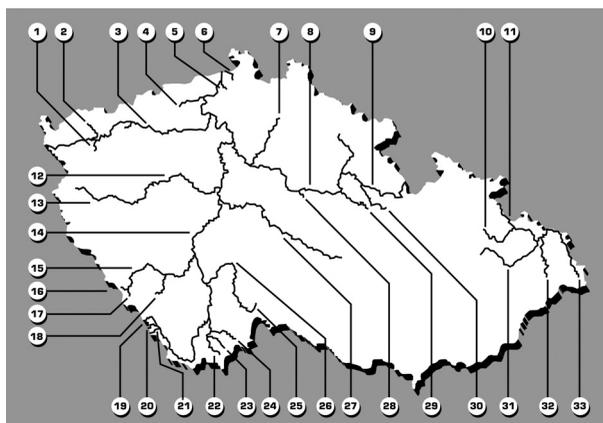


Figure 7. Historical occurrence of Atlantic salmon in Bohemia, Moravia, and Silesia up to 1935 (see Vrána, 2010). This map was modified by the authors. Rivers and rivulets: 1. Teplá, 2. Rolava, 3. Ohře, 4. Bílina, 5. Ploučnice, 6. Kamenice, 7. Jizera, 8. Labe, 9. Divoká Orlice, 10. Moravice, 11. Opava, 12. Berounka, 13. Mže, 14. Vltava, 15. Otava, 16. Křemelná, 17. Vydra, 18. Volyňka, 19. Teplá Vltava, 20. Rásnice, 21. Studená Vltava, 22. Malše, 23. Černá, 24. Stropnice, 25. Nežárka, 26. Lužnice, 27. Sázava, 28. Doubrava, 29. Loučná, 30. Tichá Orlice, 31. Odra, 32. Ostravice, 33. Olše.

with the words “the river bed was not able to accommodate them.” Balbinus addressed salmon in separate chapter (Caput III., *De Salmonum a Mari adventu, itineribus per Fluvios Bohemiae De Salmunculis, ubi nascantur*) in his book, and he mentioned their occurrence in the Moldau River and their migration into the Otava River, where small individuals of salmon were observed in the town of Písek (49°18'23" N, 14°8'42" E). Salmon were also mentioned in the writings of Master Pavel Žídek (Paulus de Praga or Paulerinus, 1413-1471), and in the Czech-language treatise *Správcovna* (1471) he gives nutritional recommendation regarding salmon for the Bohemian king Jiří z Podběbrad (George of Podiebrad, 1420-1471). Further, Žídek's data about salmon are presented in his encyclopedia *Liber viginti arcium*. A massive salmon migration was observed in 1507 in the village of Nelahozeves (50°16'27" N, 14°18'18" E) near Prague (Elbe River). This spotting was registered in the annals entitled *Staré letopisy české* (Old Czech Annals). Information about an interesting Bohemian habit called “honour with fish” was registered as early as in the fifteenth century. Aristocrats used to give salmon as

a present, often with accompanying letters. A second habit of sending the year's first salmon caught to the nobility was also registered. Such striking migrations in some years could not pass without being noticed by inhabitants, owners and operators of weirs, which were successively built in the Elbe and Moldau rivers and their tributaries. There were 35 important historical transverse obstacles (weirs) known on Bohemian rivers (Vrána 2010). Earlier, the weirs were wooden and low, later stone weirs or mobile steel weirs were built (in the town of Klecany on the Moldau River 5 km north of Prague).

George Handsch von Limus (1529-1578) wrote in his unfinished writings *Historia animalis*: “Salmon migrates upstream from the sea, in Germany to the Rhine River, in France to the Loire and Seine rivers, in England to the Thames River, in Sachsen and Bohemia to the Elbe River in spring. In Bohemia, salmon are mostly caught in the river Elbe in the town of Litoměřice, mainly in March, April and May, when their taste is the most delicious. Salmon are not only caught in Litoměřice, but also elsewhere in Bohemia, e.g., in the town of Mělník, in the village Chvatěruby and in Libeň near the city of Prague. The abundance of salmon is richer where the rivers are closer to the sea. This phenomenon was observed in the port of Hamburg (Lower Sachsen in Germany), where salmon were caught in extremely large numbers. Besides gastronomical use, salmon were also used in medicine. Their bile was sometimes used to treat conjunctivitis (pink-eye) or suppurating inflammation of the middle ear. Its fat was used to treat earache, and salted, raw meat was used to treat boils on the head”.

### Information on salmon catches from the sixteenth to the nineteenth century

Beginning in the sixteenth century, there are many more written records of salmon catches. For example, the archivist František Teplý (1867-1945) published data about salmon catches in the town Hluboká nad Vltavou (in German Frauenberg) located on the Moldau River (49°3'2" N, 14°26'24" E):

1574 – eight salmon caught, 1577 – two salmon caught. Dyk (1974) reports that salmon were not rare in the Volyňka River (Moldau River drainage basin) in 1645, but by 1713 the catch of two fish is noted as an exception. In the past, miners used their own installation to catch salmon in Dolní Rejštejn (now Rejštejn, 49°8'7" N, 13°30'43" E) in the upper part of the Otava River. Wenzig and Krejčí (1860) also note that salmon migrated the Moldau and Otava rivers every year up to the mountain regions where they spawned. Formerly, salmon occurred more frequently, and declines in their number were caused by, among other factors, transporting lumber in waterways which was especially dangerous for salmon fry (Oliva 1982). Records exist regarding salmon caught at a large farm in Roudnice nad Labem (Raudnitz an der Elbe in German) located on the Elbe River (50°25'31" N, 14°15'42" E). A total of 60 salmon were kept in the local weir in 1750, 1757, 1762, and 1776, while 113 salmon were caught on a large farm in Dolní Beřkovice (Unter Berschkowitz in German, 50°23'29" N, 14°26'43" E) in 1747, 1750, 1752, 1753, 1754, 1755, and 1756. The first evidence of salmon fishing on a large farm in Mělník (Melnik in German), at the weir in Vrbno (50°19'28" N, 14°27'6" E) dates to 1619. During a period of 43 years (1732-1778), 3176 salmon were caught (annual average of 74 fish). Remarkable catches were reported in the following years: 1750 – 437 salmon; 1751 – 496 salmon; 1755 – 146 salmon; 1775 – 103 salmon; 1776 – 335 salmon; 1778 – 180 salmon, with the average salmon weighing about 13 pounds (1 Czech pound equals 0.513 g). After 1778, this inventory was apparently discontinued as a consequence of the removal of the local weir. The village of Nelahozeves (in German Mühlhausen an der Moldau) located on the Moldau River (50°16'27" N, 14° 18'18" E) was another important locality according to the inventory from 1588. The number of salmon caught was highly variable with the largest catches of 200 to 400 salmon registered in the following years: 1645-1647, 1664, 1679, 1737, 1744, 1752-1754, 1756, 1780, 1761, 1774, 1775, 1777. An average of 90 salmon caught annually were registered during the period from 1624 to 1776, and the

weight of an average fish was 12.7 pounds (no distinct variation in average fish weight was noted among the years in this period). One harvest of 102 salmon caught from April 23 to October 10, 1679 in this area was analyzed in detail. Fish weight ranged from 3.5 to 21 Czech pounds (at an average of 13.6 Czech pounds). Firstly, the largest salmon migrated to this location in March and April (at an average fish weight of 15.5 Czech pounds). A frequency of migration increased until May, but it subsided in subsequent months along with fish weight (the average weight during July and September was 9 Czech pounds; Čermáková 1973). Recorded salmon catches at a large farm in Chvatěruby (Chwatierub in German) on the Moldau River (50°13'58" N, 14°20'32" E) are available for the period of 1656-1665, and estimations made from incomplete documents indicate the annual average catch was 20-30 salmon. Plentiful catches were recorded in 1660 at a large farm in Kamýk (Kamaik an der Moldau in German) located on the Moldau River (50°0'55" N, 14°26'18" E) with 112 salmon being transported to the Prague markets for sale. The last written document about local salmon migration dates to 1770. Records pertaining to a large farm in Drhovle (Dürhowel in German) located on the Otava River indicate that salmon fishing during the period 1741-1825 was successful at the weirs in the villages of Jistec (49°23'14" N, 14°8'41" E) and Smetiprach (49°21'56,15" N, 14°8'51,6" E), where 1021 salmon were caught in total (annual average of 20 fish with the maximum of 145 salmon caught in 1782 and no salmon caught in 1790, 1795, 1798-1800). In the long-term perspective, declines in average catches are apparent. The weight of average fish was 9.5 Czech pounds. Salmon fishing in Jistec ended in 1803 when the local weir was damaged by floating lumber, and the last salmon caught in Smetiprach was recorded in 1825.

Until the 1780s, salmon catches were considerable at large farms, nevertheless, salmon was a rare, highly valued fish that was available only to the richer social strata of that time. Salmon fishing ceased at the end of the eighteenth century when weirs were demolished to improve river navigation.

A subsequent decrease in salmon populations in Bohemian rivers occurred in the first half of the nineteenth century and was the result of the negative impact of developing civilization (Čermáková 1973).

The first migrating salmon recorded in Prague (see Frič 1875, 1893, 1908) in March were fish about 1 m long weighing 7.5-15 kg, silver in color with bluish backs and small black stars. The second migration came in May and June and comprised smaller fish (3-8.5 kg) that were more colorful with a reddish shade. The third migration wave in October included fish of various lengths. Salmon do not feed migration, which is why they are rarely caught by angling. A salmon weighing 8 kg was caught with angling gear and minnow bait on June 5, 1928 (Báča 1929), while another salmon (92 cm, 4.6 kg) was caught with earthworm bait below the Střekov dam in 1947. Salmon spawn were common in Bohemian rivers from the end of October to the end of December (Frič 1893).

According to Dyk (1952), an average of two to three salmon were caught annually in the 1870s in Prague. Over 1000 salmon were caught in 1883 between Litoměřice and Kolín on the Elbe River. About 600 salmon were recorded as having been caught in the section of the Otava River above the towns of Sušice (Schüttenhofen in German), Baruš, and Oliva (1995). A total of 300 salmon weighing 6-14 kg were caught near the town of Sušice on the Otava river. Overall, 414 salmon were caught in Prague from March to May in 1899 (Dyk 1952). Salmon catches in Prague (50°4'7" N, 14°25'3" E) made beneath one of the bridges (now the Švermův most) were recorded mostly in May at 99 fish in 1877, 352 fish in 1878, and 298 fish in 1879; minimal catches were recorded in March and September. Frič (1893) used material from 245 salmon in his monograph, and his precise statistical data on catches in Bohemian rivers are also of great interest, but the number of salmon is not as high as expected. From just five (1862) to 179 (1872) salmon were caught annually in the 1850-1884 period in the Opatovice dam (50°8'52" N, 15°47'21" E) in eastern Bohemia on the Elbe river.

### Salmon artificial spawning, stocking, and catches since the 1890s

As Andreska (1973) reports, Antonín Frič (1832-1913), a well-known Czech zoologist, organized the stocking of more than 7 million salmon fry produced in 40 hatcheries; this material was released mostly in southern Bohemia in the upper reaches of the Moldau, Otava, Volyňka, and Blanice rivers between 1871-1893. The most important salmon hatchery was located near the town of Sušice (Frič 1874). It was established in 1871 first on the Kantůrka brook, a tributary of the Otava River, later it was moved to a location on the right bank of the Otava River in the town of Sušice. Annual production reached 3 million salmon fingerlings (Smíšek 1958). This hatchery was open until 1912 (Anonymous 1925), and the last salmon were stripped there in 1927 (Andreska 1997). Artificial salmon spawning, according to Frič's own records, was largely successful, and as the number of salmon caught increased, their market price decreased. Salmon reappeared again in places where it had been unknown for long periods, e.g., in 1880 one specimen was caught in Horní Vltavice (Ober Moldau) (48°57'44" N, 13°47'30" E) in Lenora, and in 1883 (Eleonorenhain in German) another was caught in the Teplá Vltava River (48°55' 29" N, 13°47'57" E ) (see Andreska 1973).

Strong salmon migrations were noted in the 1922-1927 period, but they are impossible to explain precisely. This phenomenon was probably related to previous salmon stocking and to the period of the First World War when the absence of labor and total economic decline led to the degradation of weirs. Since salmon fishing was legal in this period, there are records concerning salmon catches. Salmon were recorded directly in Prague, and they were, for example, caught below a newly constructed high weir at the southern tip of Štvanice Island (50°05'43" N, 14°26'25" E). According to the statistics of the First Angling Club in Prague, a total of 322 kg of salmon was caught at this location in 1922, 35 kg in 1923, 53 kg in 1924, 116 kg in 1925, 1326 kg (369 fish) in 1926 and 1742 kg in 1927.

Frič (1912) observed salmon in running water shallows in the Prague section of the Moldau River in November. He also observed plentiful numbers of parr (young salmon aged from one to four years that inhabit fresh water) in places where the water column depth was from 0.5 to 1 m and the river bed was stony with turbulent water flow along large boulders in the Otava River upstream from the town of Sušice. About a hundred fish were caught daily at Páteček, a local mill (49°20'81" N, 13°50'24" E), and about 500 parr were estimated to inhabit the river section known as the 500 steps (Frič 1893). One specimen of salmon was caught in a net near the town of Strakonice (Strakonitz in German), which is located at the confluence of the Otava and Volyňka rivers in 1912 (Baruš and Oliva 1995); about 300 salmon were caught downstream from the lock in the town of Litoměřice (Leitmeritz in German), which is located at the confluence of the Elbe and Eger rivers in 1914. Overall, nine salmon weighing 52 kg in total were caught downstream from the weir in the town of Písek on the Otava River in early June 1927 (Dyk 1952).

Intense catches of migrating salmon combined with high dams prevented salmon from reaching spawning grounds located in the upper reaches of the Moldau and Elbe rivers. Frič (1912) was aware of the declining salmon numbers in the Prague district of the Moldau River. Another spawning ground in Prague was located near Štvanice Island where young parrs were seen. As mentioned above, despite catch reports of single salmon over the last century, the total number of salmon caught in Bohemia every year was not high, and, according to Frič (1872, 1879), it was about 500 annually on average. This concurs with Siebold (1863) who pointed out that salmon numbers decreased because many river dams were constructed.

The following is a review of the last Bohemian salmon caught. One fully mature female (98 cm and 7.2 kg) was caught in Černá Brook, a tributary of the Malše River, in the village of Soběnov (Oemau in German, 48°45'46" N, 14°32'45" E) in 1925 (Tejčka 1925, Anonymus 1951). A well known water bailiff from Žichovice, Matěj Hlavsa, caught the last eight

salmon of his life in the Otava River in 1935 according to his memoirs. A mature female salmon was caught in the village of Žichovice (49°15'60" N, 13°37'23" E) in 1936 (Andreska 1973, Baruš and Oliva 1995). A salmon was beaten in the town Horažďovice (Horaschdowitz in German, 49°19'43,49" N, 13°42'14,4" E) on the Otava River in 1940 (Andreska 1997), while another was registered in Sušice (49°13'52" N, 13°31'13" E) on the Otava River on June 19, 1941 (Andreska 1997). One female (92 cm and 4.6 kg) was caught with angling gear in Sřekov (the Elbe River) in 1947 (Volf 1954), and another salmon (54 cm and 1.3 kg) was caught in Lovosice (50°30'54" N, 14°3'3" E) on the Elbe River on November 14, 1948 (see Volf 1954). A female weighing 3 kg was caught in a net in the town Ústí nad Labem (the Elbe River) on December 22, 1949 (see Flasar and Flasarová 1974). This very last Bohemian salmon was caught in the river kilometer 767.5 (50°38'19" N, 14°02'53" E). The last young salmon, or parr, caught in Bohemian rivers were recorded in Žichovice (49°15'60" N, 13°37'23" E) in 1948, and in Sušice (49°13'52" N, 13°31'13" E) in 1949 and 1953 (Andreska 1997).

### Fishing rights and other legal issues

The oldest legal document associated with salmon and fishing is the Charter of King Ottokar I from 1226, in which the privileges of the female Premonstratensian convent in Doksany are bestowed (Prusík 1885). One of the privileges concerns salmon fishing in the village of Zálezly: “...*salmones nostri juris in Zalezli et in aliis aquis, ipsorum ditionis subjectis, perpetuo condonamus...*” (...thus (to the convent in Doksany) we give our rights for all salmon in Zálezly and other waters belonging to this dominion...). Granting privileges for salmon fishing stems from universal sovereign ownership rights, i.e., the sovereign enjoyed the right to fish salmon.

The Provincial Maximilian Establishment (dated from 1563) was very important for salmon migration. The chapter “On Water Flow” indicates that the making walls on weirs to catch salmon and other fishes

migrating upstream is prohibited in localities where they had not been built previously. Efforts to catch the maximum number of salmon in the lower reaches of rivers, while understandable from an economic perspective, caused various disputes that were remedied by this prohibition. Salmon fences were also addressed in correspondence among nobles; an example is a letter written by Benigna Catherine of Lobkovicz, who complains to the Nelahozeves Governor (April 2, 1643): "...that his predecessor raised the weir fence so that she could not catch salmon this last year in her dominion of Chvatěruby. Therefore, the determined height of the fence (half of a cubit) must be observed, otherwise she would have to turn to his uncle, Vaclav Eusebius of Lobkowitz, the owner of Nelahozeves village, to rectify this situation".

It is not clear to which fence height regulation the author refers. Fence height is not mentioned in the Provincial Maximilian Establishment, and no other regulation is known from that time. Nelahozeves Instruction is another frequently cited reference regarding salmon legislation. Florian Griesbeck of Griesbach (1504-1588), a highly-educated Tyrolean aristocrat and owner of the Nelahozeves dominion, describes in his Instruction from 1588 the use of a local fish trap known as a *lososnice*. Griesbeck orders optimal use of salmon traps with the aim of maximizing catch, as follows: 1) immediate installation after the termination of the spring flood; 2) opening the weir door only twice daily so salmon do not escape via the open door whenever raftsmen open it and forgot to close it because this was not part of their assigned duties.

In retrospect, it seems inconceivable that salmon populations were not destroyed within several years or decades as a consequence of the intense fishing equipment deployed (salmon traps were installed on nearly every weir). Salmon spawning migrations occurred in three waves in Czech territory, and salmon had the best chance of overcoming both natural and artificial obstacles without losses during spring floods that damaged salmon fences and traps and made it easier for salmon to migrate upstream (repairs to them were long-term projects). Economic reforms during the reign of Maria Theresa

(1717-1780) introduced restrictions on the use of salmon traps. A sailing patent from 1777 allowed for the demolition of weirs on the Moldau River section between Prague and Mělník. These alterations led to increased salmon catches in the city of Prague. The intention, however, was not to protect salmon, but to make the river downstream from Prague navigable. The transformation of rivers was achieved in several ways, the oldest of which was to fence river banks with wooden pales. Naturally wide river beds in which shallows occurred mostly in summer were channelized into narrow channels with rapid water currents. Embankments, anastomosed channels, dead arms, and river islands were artificially connected to river banks, and the impact on river ecosystems is visible even today.

The Civil Act of 1811 allowed everyone to fish until 1885. This legislation considered fish in waters as "things without masters", which meant that anyone could appropriate them. This seemingly insignificant formulation had, from a nature conservation perspective, far-reaching consequences that probably led to unregulated fishing of some fish including salmon. The Act on Fisheries in Inland Waters No. 58/1885 of the Imperial Code remained in force, but with amendments, in Bohemia until 1952, and it set aside the privilege of free fishing. This act provided fishing rights to holders of artificial waters in fish meeting places, water beds, or natural waters (in accordance with the Provincial Law). The implementation of provincial law was valid only in Moravia; in Bohemia, Act 22/1885 of the Czech Provincial Code was applied. The rules about rare fish, already resolved in the periods of fish protection, prohibited fishing methods (including dynamite, guns, and other special tools) and also established fishing permits. The implementation of regulations in Act No.22/1885 designated a salmon protection period in during spawning. They are protected from September 15 until the end of December. The declaration of the governor of the Czech Kingdom from 1913 is considered to be an important legislative act. Salmon under 50 cm total length could not be served in public houses. The decree of the provincial president in Prague of May 11, 1938 provides measures

for improving fisheries in inland waters, re-establishes protection, and extends the general ban on salmon fishing from September 1 to the end of February in the subsequent year.

## Discussion

Various circumstances influenced salmon migrations and the decline of abundance in Bohemian rivers in the past. Possibly, extensive deforestation of native deciduous trees, which destabilized and decreased flow, contributed greatly to the early extinction of Elbe salmon stocks. On the other hand, floods had a positive impact on affected salmon migrations, because higher water levels allowed the salmon to overcome transverse obstacles in rivers. Floating tree trunks in streams destroyed the wooden walls of weirs. The Thirty Years' War (1618-1648) led to weir destruction, and since they did not fulfill their technical function, they were unusable for salmon fishing. River navigation and traditional wood rafting were the next important factors. Gates in weirs were opened for these purposes, but because the gates would be open for extended periods of time, it was easy for the salmon to overcome these obstacles. These factors and those discussed previously permitted the long-term survival and occasional revitalization of salmon populations. Salmon leaping over weirs in spring became a spring-time attraction on the rivers. Before the weirs were built, salmon were caught using a variety of techniques. These fishing methods could have decrease salmon population abundance, but not significantly. As transverse technical obstacles, weirs provided new and improved salmon fishing opportunities to fishermen. The Theresian letter patent issued in 1777, which facilitated upstream and downstream fish migration, appears to be an important event for the rehabilitation of the Moldau River. Definitely motivated purely by economic concerns, it stipulated that weirs be demolished to improve river navigation. However, this act only had a local effect in the section of the Moldau River between Prague and Mělník. These alterations

led to an increase in the number of salmon caught in the city of Prague, where weirs had been preserved. Frič (1893) wrote that salmon were not caught from the provincial border through to Saxon Switzerland and the Czech Central Mountains to the town of Lovosice (Lobositz in German) on the Elbe River. This was probably because weirs were absent in this section of the Elbe River, and salmon could not be caught here. This is confirmed in the *urbary*, or official log, of the large Lobkovitz farms from 1642 and 1660 and other accounts of large farms in Sřekov from the seventeenth and eighteenth centuries. Customs duties were abolished on the Elbe River in 1870, which resulted in intense shipping growth. As a consequence of the massive industrial progress in the Czech territory, efforts were undertaken to intensify the channelization of the Moldau and Elbe rivers. In 1894, the large river port Holešovice in Prague was finished, and this necessitated dredging the Moldau river bed to depths of 1.4 m downstream from Prague. The leveling required constructing high modern weirs. Thus, five new weirs were built between Prague and Mělník between 1897-1905. The first one in Klecany (50°10'30" N, 14°25' E) was built between 1897-1899. Karel Klostermann (1848-1933), a famous Czech writer, mentioned this construction in 1910 in connection with the deteriorating state of the salmon population. Compared with the older barriers, these weirs were significantly higher and more complicated for the salmon to overcome. A similar series of five weirs were built on the Elbe River from 1910 to 1914.

Other factors had a negative impact on salmon populations, including the following: river pollution (from domestic and municipal sewage, waste waters from cellulose, paper, saw, sugar, and textile mills, printing works, refineries, tanneries, glue and gelatin factories, factories producing various acids, factories using chloride of lime, gasworks, ore processing facilities, and coal mining), unsuitable river regulation and gravel exploitation (destruction of breeding grounds and pools used as resting places during salmon migrations), river navigation, overfishing, and insufficient stocking with salmon fry or yearlings. The increase of industrial pollution in rivers

during the nineteenth century and local salmon overfishing led to reductions of catches in many fishing grounds. The ancient technique of floating tree trunks down rivers could also damage migrating salmon in smaller streams. This phenomenon was observed on the Otava River, a tributary of the Moldau River, after the Vchynicko-tetovský water channel was constructed and put into operation in 1801.

Various historical salmon fishing methods are presented in this paper, nevertheless, other non-traditional, illegal methods were also employed. The occasional use of dynamite in rivers near construction works, such as railways, was noted, as was shooting migrating fish as they leaped over weirs, and this was not restricted only to Bohemia (Tejčka 1925).

The main reason successful salmon spawning migrations ended was the dam that was constructed in Střekov (50°38'21,5" N, 14°3'4" E, river km 767,484 km). The full name of it was Masaryk Locks downstream from Střekov, about 3 km above the town of Ústí nad Labem (Aussig an der Elbe in German) in Northern Bohemia. This multi-purpose facility was built in 1923-1935 on the Elbe River and included a weir with chamber locks, fish ladders, and a hydroelectric power plant. The power plant and the fish pass were also parts of this dam, but the fish pass was unsuitable for salmon migration because of a design fault. After the Střekov dam reservoir was inundated, salmon reached the river section upstream from Střekov only seldom and in small numbers, and this was reflected immediately in the Elbe and Moldau rivers. The long-term situation which occurred on near the Eger River could have and should have served as a warning about constructing dams that were too high. This salmon river lost its population because the weir constructed on it during the building of Fort Terežín (50°30'36" N, 14°9' E) in approximately in 1780 was too high. Thanks to the efforts of Antonín Frič, a fish pass was constructed there, which was opened on April 26, 1885. Salmon immediately began using the pass and, by the next day - April 27, 1885 - the first salmon were observed jumping there. The Střekov Dam remained the last

one on the Elbe River for 30 years, but then the Geesthacht Dam at Hamburg was built in 1957-1959. This barrier was the final one on the migration routes of salmon and other anadromous ichthyofana species to the Elbe River. In the period when the German Geesthacht on the River Elbe was made passable in 1998, the free migration of diadromous fish to the Střekov lock upstream from Ústí nad Labem is anticipated.

The production of fingerlings in Bohemian hatcheries at the end of the nineteenth century was mentioned in this paper. Some authors raise another issue related to hatching and rearing fish fry in hatcheries under optimal conditions, namely that this reduces the ability of fry or fingerlings to survive under real environmental conditions. The techniques, methods, and quality of rearing conditions in hatcheries are the main factors influencing the characteristics of fish, especially their ability to acclimatize and adapt when released into open waters. Fish from artificial spawning can have different characteristics from fish originating from natural spawning. Weak rheotaxy, insufficient defensive reflexes against predators, and weakened foraging capabilities have all been observed in salmon reared in hatcheries. The negative effect of artificially-bred fish on natural salmon populations is discussed in numerous publications (e.g., Crozier 1993, Clifford et al. 1998, Thorstad et al. 2008). These factors also affected the success of historical salmon stocking in Bohemian rivers.

Salmon parr were also found in Bohemian rivers. Some of them, especially the males, did not migrate to the sea and matured in fresh waters, as seen, for example, in the work of Myers and Hutchings (1987), Aas et al. (2011), and Birt and Greene (2011). The occurrence of this dwarf form of salmon, previously known from some rivers of northern Europe, was also confirmed in the upper reaches of the Elbe River. The presence of sexually mature male parrs increased the effective population size, which can, at least partially, compensate for the reduced number of returning adults (Garant et al. 2000, Martinez et al. 2000). Nevertheless, the gradual decline of the natural Bohemian salmon population is a

definite disaster. Last, but not least, Oliva and Johal (1981) analyzed the age and biometric characteristics of 21 salmon parr collected around 1930 in the Otava River and five collected in 1884. All of the salmon parr examined were ripe and very slow growing. Back-calculated total length in mm with a correction factor of 32 mm (R. Lee's method,  $n = 19$ ) was as follows: 88, 140, 171, 182, 201, 213 mm. Later (Oliva 1982) ten amputated salmon heads deposited at the Zoological Department, Natural History Museum, National Museum in Prague were analyzed. This sample was the remainder of the original study material that Professor Antonín Frič worked on in conjunction with the Moldau and Elbe rivers and that which he used in his monograph (1893).

In many places, salmon is indisputably a favorite food fish, and it has also played a role in traditional Czech gastronomy. Historically, fresh salmon catches were often marinated, and then, as a delicacy, transported to Vienna (Andreska 1997). The most delicious meat came from salmon caught between May to the beginning of June. Additionally, the first Old Czech culinary recipes for salmon came from texts by Jan Severin from Kapí Mountain (about 1520) and later Handsch von Limus (about 1560). Later, Magdalena Dobromila Rettigová (1785-1845) in her popular cookery book (*A Household Cookery Book or a Treatise on Meal and Fasting Dishes for Bohemian and Moravian Ladies*) published for the first time in 1826, presents several different recipes for cooking salmon.

The public at large is generally influenced by the historical point of view concerning the appearance of salmon in Bohemia. A phenomenon presented in Frič's observations (1959) is that "during the reign of Charles IV, salmon in both the Moldau and Elbe rivers was so common that people in the service of Prague demanded, when entering service, that salmon must not be served to them for lunch more than twice a week." Reality, however, is different and is reflected in the lingering memory in the public awareness that salmon is only for special occasions, and it can only be obtained during strong migrations. These data were usually generalized, while the

quantity of salmon in Bohemian rivers was exaggerated (see Teplý 1937). On average, about 500 salmon were caught there annually using various fishing methods.

Despite the stocking performed at the end of the nineteenth century, no sustainable populations of salmon were maintained permanently in Bohemian waters. A large number of long-term factors cited above negatively influenced salmon populations in the Elbe River and its tributaries, and these inevitably led to their extirpation. The last occurrence of native migrating Atlantic salmon (breeding fish and parr) in the upper reaches of the Elbe River in Central Europe (Germany and Bohemia) was recorded in the mid twentieth century.

Another section addresses Atlantic salmon restoration efforts in the Elbe River and in Bohemia that began at the end of the twentieth century and continued into the beginning of the twenty-first century. Salmon restoration is evidently a long process, and large areas of former habitats are definitively lost and problematic barriers to migration still exist. For now it seems that salmon will never again be as abundant in Bohemia as reported in the past. Salmon can also serve as the model of a general approach to species protection in which the protection of a given species and its natural environment is better and more effective than any effort to restore it following extirpation, which is not always successful.

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