

ON THE NASE, *CHONDROSTOMA NASUS* SPAWNING AREA SITUATION IN SWITZERLAND

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Received March 25, 1997
Accepted November 19, 1997

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Abstract

The present study describes results of a survey performed in 1993 on the distribution of the nase, *Chondrostoma nasus* (Linnaeus, 1758) and the condition of its spawning areas in Switzerland. Characteristic features of the spawning habitat and observations about spawning behaviour are described. Using the available data base, 48 registered spawning areas were compared according to their importance for reproduction of the nase in former and present times. It is estimated that the number of spawners which using these areas nowadays represent less than two per cent of the spawning runs in former times. This drastic decline of the nase population is regarded as a result of progressive anthropogenous water development. Comparing the former with the present situation a significant shift of the vertical range in which the main reproduction takes place is noticed. In former times, the main spawning runs were observed below 300 m above sea-level. Because of anthropogenous development and water power use, however, these areas are now practically lost and of little significance. Now main reproduction takes place about 100 meters higher in altitude. The consequences of these changes for the success of reproduction are discussed.

Key words: *Chondrostoma nasus*, reproduction, spawning area, Switzerland

Introduction

Three species of the genus *Chondrostoma* occur in Switzerland: sofie (*C. toxostoma*), savetta (*C. soetta*), and nase (*C. nasus*). The sofie occurs only in the River Doubs (Rhône drainage), whereas the savetta is restricted to Lake Maggiore, Lake Lugano, and some of their tributaries (Tessin, Po River drainage). The widest distributed species is the nase, which occupies the drainage area of the River Rhine (Fig. 1). The nase is found in altitudes up to 780 meters above sea level (Pedroli et al. 1991). But it prefers the deeper stretches of the greater rivers Aare, Saane, Reuss, Limmat, Thur, and especially the River Rhine. Many historical sources (e.g. Siebold 1863, Borné v. d. 1883, Anonymous 1902, 1917a, 1917b, Bachmann 1907, Schaad 1971, Käser 1988) note that the nase was very numerous before anthropogenous development of these rivers took place, with massive spawning runs up most of their tributaries. Because large numbers of nases could easily be caught in the shallow spawning-beds using simple methods, this fishery was very common in the past centuries. In a few areas it even lasted until the 1960s.

In the past the nase was an important source of food for many people living along the rivers mentioned above, especially for the poorer one. Historic sources

mention as well, that sometimes a part of the nase catch was used as fertiliser for potatoes or as food for pigs and chickens (e.g. H o f e r 1906, L e l e k & B u h s e 1992, M a i e r et al. 1995).

Because of intensive fishing for nase in Switzerland, a good knowledge about spawning areas of the nase has been developed. Numerous historical sources (eg. B r u c k n e r 1751, A n o n y m o u s 1816, 1902, 1903, 1916, W e y 1887, A s p e r 1890, H o f e r 1911) report about huge catches of nase, from which the condition and location of the important reproduction areas in the past can be inferred.

The most significant spawning area in Switzerland was in the Birs, where, for example, in 1624 a catch of 40.000 nase was registered, but it was noted that the total catch was much higher. Also in 1664, around 200.000 nase were sold at the fish market in Basel, mainly taken from the Birs (H o f e r 1906).

As a direct result of progressive anthropogenous water development nowadays these spawning sites and many over reproduction areas are totally extinct, and the nase population declined. Over the last few decades a drastic collapse of the population has been observed nationwide. Nowadays, nase have virtually disappeared in many waters and river stretches and various observers have concluded that the primary cause of the decline is insufficient reproduction.

In order to create a data base for developing adequate measures to restore nase populations, the Swiss Federal Office of Forest and Landscape (FOEFL) supported the inventory of nase spawning areas in 1993.

The survey of the spawning areas focused on three problems: Firstly to gain accurate knowledge of the present spawning sites, to enable the fishery management to develop protective measures and improvements. Secondly, through registration of the main spawning locations and their importance for reproduction, general information about the present condition of the nase population in Switzerland was expected. Thirdly, it should be tested if a rational multi-year monitoring of the nase spawning areas could take place.

Material and Methods

The study was carried out in the River Rhine and its tributaries which drains about 2/3 of the Swiss territory. Information about distribution, population conditions and spawning areas of the nase were gained chiefly through questionnaires distributed among fishery research stations, fishery authorities, commercial and sport-fishermen. Further information has been received from catch statistics and literature. There is also a significant amount of data which has been gratefully gleaned from the database of the „Distribution Atlas of Fish and Lampreys of Switzerland“ (P e d r o l i et al. 1991) by Dr. A. K i r c h h o f e r (University of Bern).

Sites that were known or suspected to be used for spawning were observed prior to the spawning season. On this occasion potential beds were registered on a 1:25.000 scale map and local fishermen were recruited to watch for spawning runs. As soon as the first reports of spawning activity arrived in April, all known spawning areas were surveyed. In areas where no spawning activity (spawning fish, eggs, fry) was observed, the survey was continued until the end of the spawning season (end of May).

In order to compare the quantity of spawning nases at former and present time, adjacent spawning sites were combined into a single spawning area, where they occurred in the same part of the river. The remaining 48 spawning areas were grouped according to their altitude above sea-level (Table 2).

Any estimate of the quantity of spawning fish had to consider great variations unavoidably included in the raw data. This applies particularly to historical data designated as „former times“, which means, data and reports dating from about 1970 back into the 17th century. The quality of these historic reports on spawning fish populations varies greatly, for example, „...a single fisherman at the junction of the River Wiese and River Rhine near Kleinhüningen took 50 kilos,“ (A n o n y m o u s 1904) or, “in the River Broye at Moudon recently, in one afternoon, more than 5.000 pounds of nase were taken,“ (A n o n y m o u s 1900) and general accounts like “...at the mouth near the estate Rheinsfelden, huge masses of nase were taken yearly“ (A n o n y m o u s 1816), or passed-down verbal accounts by oldtimers of large numbers of nase spawning at some locations. Where no detailed information about former spawning runs were available, the former condition was inferred from the frequency of such records, the time they were made, the condition of the water in these days and the potential capacity of the spawning areas.

The estimate of the present situation is based on observations between 1985 and 1995, made by fishermen, fishery authorities and the author himself.

Results

The natural area of nase distribution in Switzerland, the known spawning areas and their present status are shown in Fig. 1. Nowadays, after completion of numerous power plants and dam projects, the nase population has been fragmented into small groups throughout its natural area of distribution. Through damming, water characteristics in the former nase habitat have dramatically changed, and access to tributaries with potential spawning sites is blocked by man-made obstacles across rivers. Many spawning areas that were important in former times are either destroyed or have been severely degraded.

Some characteristic features of the registered nase spawning habitats are shown in Table 1. Spawning sites have been found in altitudes between 249 m and 600 m above sea-level. The spawning time starts normally at mid of April but at higher altitudes spawning fishes has observed up to the end of May.

Nowadays spawning migration is only a small remnant of earlier runs. Research on the age structure of spawning shoals in selected places showed a significant rise in the ratio of old nases to total population (D e d u a l 1990, M a i e r 1993). These results correspondent well with the observations of fishermen that the frequency of juvenile nases in many Swiss waters declined drastically during the last decades (M a i e r et al. 1995). Of the 48 registered spawning areas (Fig. 1) 22 (45.8%) are extinct today, 19 (39.6%) are almost extinct, while only 7 (14.6%) are regularly used. Table 1 shows characteristic features of nase spawning areas in Switzerland and some observations about spawning behaviour.

Estimates of the number of spawning fishes in former and present times related to certain levels in altitude are given in Table 2. Figure 2 shows the

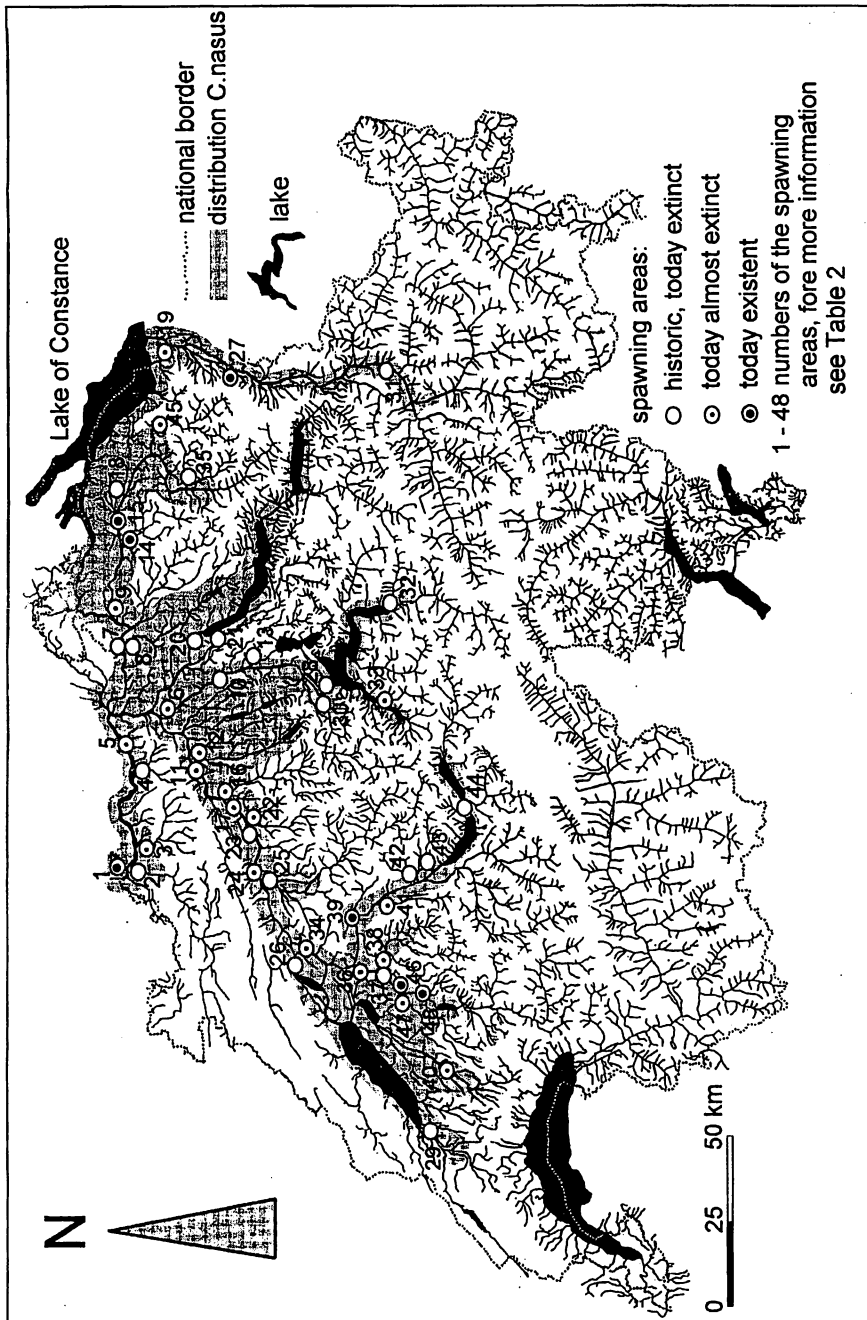


Fig. 1. Natural distribution area and spawning areas of the nase (*Chondrostoma nasus*) in Switzerland.

distribution of the spawning activity between < 300 and < 600 meters over sea-level in the past and nowadays in percentages. Of the registered 48 spawning areas, it is estimated that more than 610.000 nase once visited them for spawning, while now only about 10.000 fish or less arrive at the spawning beds. This is about 1.6% of the former spawners.

Beyond the dramatic decline mentioned above, by comparing the Figs. 2 a) and b) a significant shift in altitude where main reproduction takes place is revealed. As these Figures indicate, in former times the main spawning runs were observed at lower altitude. Because of anthropogenous development and water power use, however, these spawning areas are almost completely lost and of little significance nowadays. As shown by the graph of the cumulative percentage in Figs. 2 and 3, in former times 50 per cent of nase once spawned below 300 meters above sea level, now at about 100 meters higher in altitude.

Discussion

It must be clearly understood that the estimated numbers of former and today spawners are relatively inaccurate. Hence, this work does not want to present precise numbers. It does, however, provide a basis for discussion and it wants to point out man-induced changes which have significant effects to the natural reproduction of the nase population in Switzerland.

A discussion about the uncertainties of this analysis should take into account that the estimation of the numbers of spawning fishes is mainly based on data about spawning areas in the tributaries. Presumably, there was substantial spawning activity also in the main streams Rhine, Aare, Reuss, and Limmat below 350 meters above sea-level, before heavy anthropogenous development took its toll. Mainly due to the presence of power dams, these river stretches have substantially lost their spawning-bed potential nowadays. Hence, the given numbers of spawners in former times at lower altitude should represent minimum values. Even if some of the estimates are inaccurate, this should not influence the statements given in this analysis.

A comparison of former and present numbers of spawners in Table 2 shows the decline of the nase and the acute stress exerted on the population. How strongly the reproduction of the nase population is effected by this shift to higher altitudes is difficult to evaluate, since no research has targeted on this subject up to now. Generally, spawning begins later at higher elevations, and the growth period of 0+ fish is shorter also because of earlier cooling in fall. Further winter conditions last longer, and normally are harsher.

Observations of passive downstream drifting fishes in wintertime (Schmassmann 1940) or winter thinning in trout populations at higher altitudes (Marrer 1985) indicate that also a significant number of 0+ nase will migrate downstream to lower elevations during winter. But their return to the upstream locations with spawning sites which are still intact is hardly possible, due to numerous power dams. This thinning effect may be the main reason for the disappearance, or absence of juvenile fish in many Swiss waters. If young nase will survive and grow up to sexual maturity in the lower stretches, they will not find adequate spawning areas to reproduce successfully.

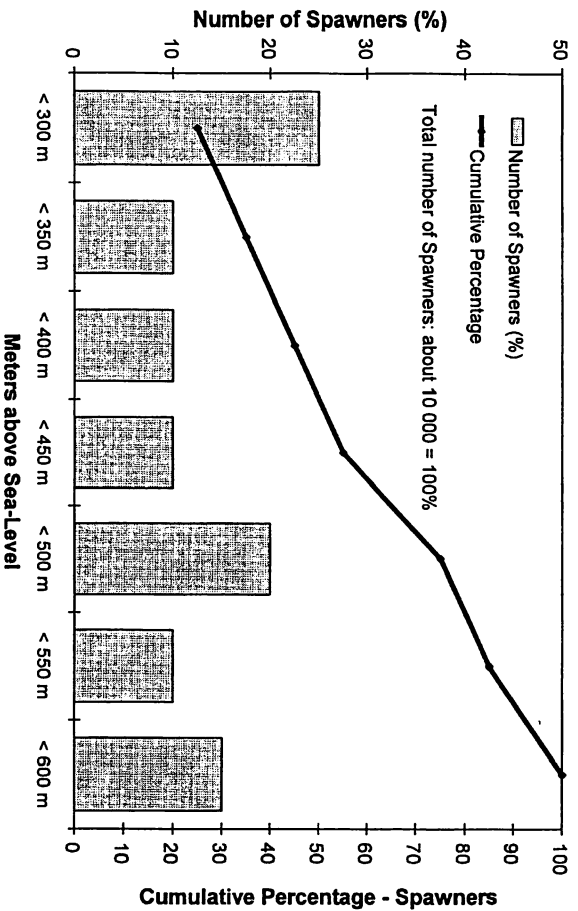
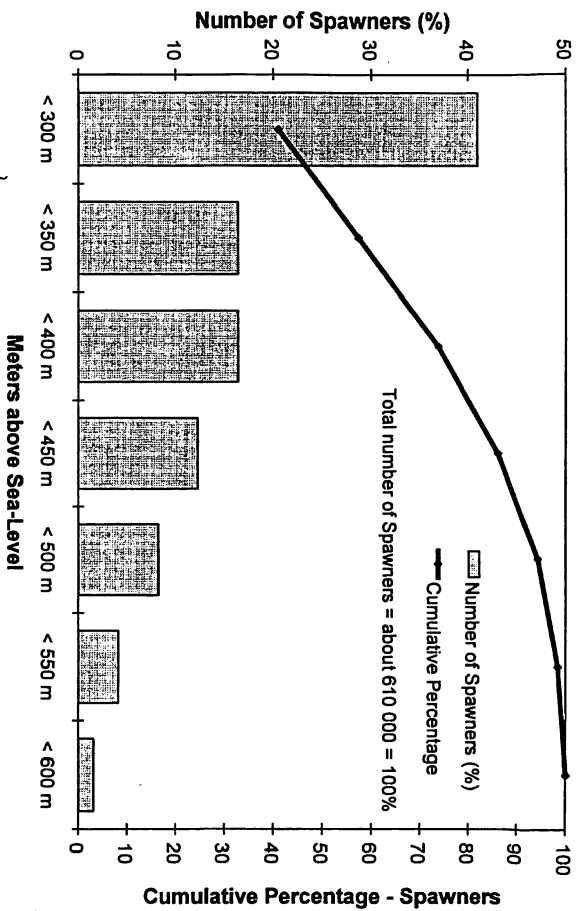


Fig. 2. Vertical distribution of spawning activity of the nase population in Switzerland: a) Situation in former times, b) Situation in present time. The graph of the cumulative percentage of the spawners shows the shift of spawning activity to higher altitudes.

Table 1. Characteristics of spawning sites and spawning behaviour of nase (*C. nasus*) in Switzerland.

Characteristics	Recorded Data and Remarks
Water depth	normally 0,15 - 0,30 m, maximum 0,4 m
Water current	0,7 - 1,1 m/sec. At spawning sites males always positioned themselves in the stronger currents. This is where eggs were deposited. Females waited in somewhat slower and deeper flows upstream. Ripe females then ready to spawn drifted downstream into the school of waiting males.
Spawning substrate	Rounded gravel and stones with a mean diameter of 2,7 to 6,7 cm, mostly 3,2 - 4,2 cm. The spawning beds were normally without vegetation, and fine sediments and growth were cleared by males. Only at one very small spawning site was the surface was covered with moss and aquatic plants.
Spawning time	20 th of April to 28 th of May (recorded in 1993). The current observations indicate the main spawning period of nase in Switzerland - given normal weather conditions - occurs between 20 th of April and 10 th of May.
Number of spawning runs	Between 1 to 4 runs has been observed at between April and end of may 1993. The number of runs at a spawning site during the spawning season seems to be dependant on the character of the river stretch, and to be influenced by discharge, catchment area, water temperature, and weather conditions. Own observations indicate that, for example, on the Petite Sarine, most fish spawned on the first run in April, but there has been registrated a second and a third run in May.
Spawning run duration	The spawning runs in 1993 lasted only a few days. The run up the river Murg to spawning areas near Frauenfeld was observed on 20 th April. By 25 th April the egg deposition had practically ended, and most nase had left the spawning area. Earlier observations in the 60s (e.g. on the Sense near Laupen) showed large schools of spawners over the beds and remaining for two to three weeks in the spawning area.
Water temperature	10,5 °C - 14 °C. The temperatures were measured at spawning sites when spawners were present.
Altitude	249 - 590 m above sea-level. The most significant historical spawning areas such as the Wiese (≈249 m), Birs (252 m), Glatt (345 m), however are found at lower elevations.
Position of the spawning sites in the streams	The inner side of river bends; near small stream-bed breaks, above or below small islands or gravel bars; near mouths of streams entering the river
Anthropogenous influences on the spawning areas	Interference with migration through dam and weir construction; destruction of spawning beds through dredging, channelizing, streamflow fluctuations by hydropower facilities, and temperature lowering by use of hydropower reservoirs

Table 2. Registered spawning areas of nase (*Chondrostoma nasus*) according to altitude and estimates of the number of spawners in former times (before 1970) and present (1985 - 95).

Nr.	River with spawning area (location nearby)	Altitude (m above sea level)	Number of Spawners (roughly estimates)	
			former times	present
1	Wiese (Kleinhüningen)	< 300	≈ 250.000	≈ 2.500
2	Birs (Basel)			
3	Ergolz (Augst)			
4	Sissle (Sisseln)			
5	Rhein (Laufenburg)			
6	Reuss (Gebensdorf)	< 350	≈ 100.000	≈ 1.000
7	Rhein (Rheinsfelden)			
8	Glatt (Glattfelden)			
9	Thur (Ellikon)	< 400	≈ 100.000	≈ 1.000
10	Reuss (Bremgarten)			
11	Aare (Schönenwerd - Aarau)			
12	Suhre (Aarau)			
13	Lorze (Marschwanden)			
14	Murg (Frauenfeld)			
15	Thur (Frauenfeld)			
16	Wigger (Aarburg)	< 450	≈ 75.000	≈ 1.000
17	Aare (Olten)			
18	Chemiebach (Märstetten)			
19	Alter Rhein (St. Margreten)			
20	Limmat (Zürich)			
21	Sihl (Zürich)			
22	Önz (Graben)			
23	Aare (Fullenbach - Wolfwil)			
24	Aare (Solothurn - Attisholz)			
25	Emme (Solothurn)			
26	Alte Zihl (Biel)			
27	Schluch (Oberriet)			
28	Reuss (Luzern)			
29	La Thielle / Le Talent (Yverdon)			
30	Kleine Emme (Luzern)			
31	Rhein (Untervax)			
32	Reussdelta (Vierwaldstättersee)			
33	Sarner Aa (Sarnen)			
34	Alte Aare (Lyss)			
35	Glatt (Utzwil)	< 500	≈ 50.000	≈ 2.000
36	Saane/Aare (Oltigen)			
37	Saane (Laupen)			
38	Sense (Laupen)			
39	Aare (Bern)			
40	Broye (Moudon - Lucens)			
41	Giesse (Belp)	< 550	≈ 25.000	≈ 1.000
42	Chise (Thun)			
43	Rotache (Thun)			
44	inlet to Thunersee (Interlaken)			
45	Sitter (Rothenbrücke)			
46	Saane (Fribourg)			
47	Glâne (Fribourg)	< 600	≈ 10.000	1.500
48	Petite Sarine (Hauterive)			
Total number of spawners			≈ 610.000	≈ 10.000

Acknowledgements

The data shown in this paper are results of a project supported by the Swiss Federal Office of Forest and Landscape (FOEFL) and are published with friendly permission.

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