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RESEARCH ARTICLE

# Ichthyofauna of a mountain stream dammed by beaver

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**Abstract**. The aim of the study was to examine the impact of the European beaver, *Castor fiber* L., on the ichthyofauna of Negrylów Stream. Three study sites were designated in segments of the stream with running waters and two in beaver ponds. The waters at all the sites were characteristic of naturally polluted mountain streams. The occurrence of brown trout, *Salmo trutta trutta* m. *fario* L.; Siberian sculpin, *Cottus poecilopus* Heckel; common minnow, *Phoxinus phoxinus* (L.); and stone loach, *Barbatula barbatula* (L.), was confirmed. The highest density and abundance of brown trout was noted in the ponds, where the mean lengths and weights of brown trout were also the highest noted in the current study. Large trout occurred only in the ponds. In the shallow, running segments of the stream mostly brown trout fry were caught. Differences among fish assemblages in the segments of the stream and the ponds were statistically significant. After the introduction of the beavers, the state of the ichthyofauna in Negrylów Stream, which had suffered substantial degradation from forestry works, improved markedly. In comparison to analagous segments of other streams in the Bieszczady Mountains, fish density and biomass here were very high.

**Keywords**: fish, *Castor fiber*, Bieszczady, brown trout

## Introduction

A characteristic indication of beaver occurrence are the dams they build to impound stream waters (Pucek 1984, Dzięciołowski 1996, Derwich et al. 2007). These animals monitor water levels in ponds continually. Any damage to dams is repaired immediately, and when water levels are high, beaver regulate them by releasing waters through relief canals. The engineering activities of beaver change the character of streams fundamentally by creating new habitats and increasing water retention (Dzięciołowski 1996, Czech 2000). The ponds collect huge amounts of sediment, and microorganism activity increases (Skinner et al. 1984, Butler and Malanson 2005, Rosell et al. 2005). Beaver activity creates environments that are suitable for hydrophytes and hygrophytes, as well as invertebrates, birds, and amphibians associated with standing waters (Dzięciołowski 1996, Rosell et al. 2005).

The change in conditions caused by dam construction and the creation of ponds also impacts the ichthyofauna. The abundance of some fish species increases, while that of others decreases in streams inhabited by beaver (Hägglund and Sjöberg 1999). Dams can pose physical barriers to migratory fish that prevent them from swimming upstream (Collen and Gibson 2001). However, the disappearance of the beaver most frequently leads to worsening conditions for the occurrence of fish (Pollock et al. 2003). Despite the rapid expansion of beaver in Poland, few studies have been conducted that focus on the impact these animals have on aquatic ecosystems.

The aim of the current study was to determine the impact beaver dams have on mountain streams.

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The hypothesis that beaver dams have a negative impact on the ichthyofauna of streams was tested.

## Materials and Methods

Negrylów Stream in the Bieszczady Mountains is a left tributary of the upper San River and is 4.8 km in total length (Fig. 1). The source of this stream is at an elevation of 1156 m above sea level. This stream has been inhabited by beaver for the past few years. Five study stations were designated (Table 1). Station 1 was located in the upper running segment of the stream that was outside the immediate area of influence of the beaver ponds. In this segment the stream was as wide as 3.5 m. Shade cover was 50%, and the bottom substrate comprised rocks and gravel. Anthropogenic changes apparent in the area included substrate destruction and significant deforestation along the stream banks. From site one until the end of the stream, the banks were heavily deforested because of an infestation of bark beetle, *Ips typographus* L. The substrates in the drainage area and the stream bed were seriously damaged during clearing. Station 2 included the upper pond with a surface area of 1550 $m^2$ and the highest dam on Negrylów Stream (about 2 m). The pond was filled with a substantial number of large-sized wood debris, while the sediment thickness did not exceed 5 cm. Pond shade cover was minimal, and the dominant vegetation along the shores comprised bushes and young trees. Station 3 was located in the stream between the ponds, and the character of the substrate in this segment was similar to that in the upper

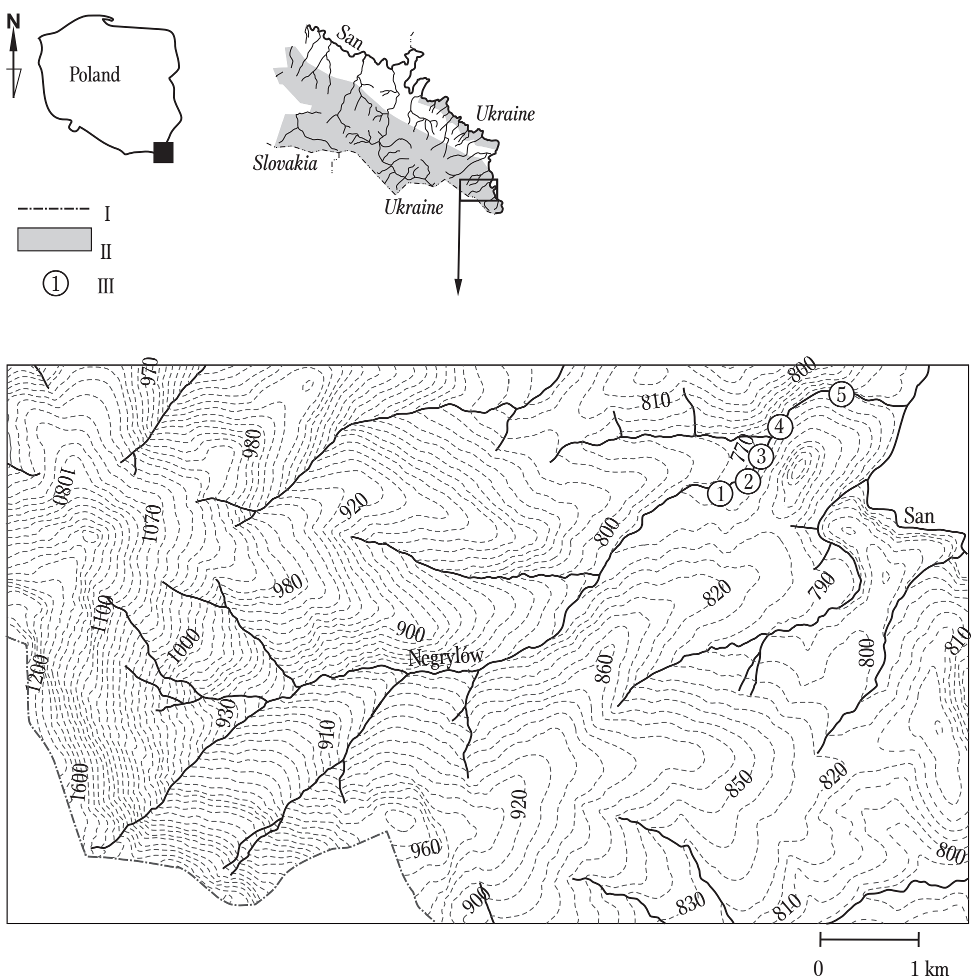


Figure 1. Study area and location of stations in Negrylów stream: I – state borders, II – Bieszczady National Park, III – numbered study stations.

**Table 1**

Morfometric characteristics at study stations in Negrylów Stream: I - station character; II – elevation AMSL (m); III – gradient (‰); IV – stream bed width: mean (max.); V – depth: mean (max.); VI – pond surface area ($m^2$); VII – flow rate ($dm^3 s^{-1}$); VIII – substrate type S/DK/K/Z/P: S – rock, DK – large stones > 25 cm, K – other stones, Z - gravel, P – sand (%); IX – max. mineral sediment thickness (cm); X – max. thickness of detritus layer (cm); XI – degree of anthropogenic changes in stream bed (0 – none, 1 – small, 2 – moderate); XII – character of stream bed changes: WL – deforestation, DD – bottom destruction during deforestation; XIII – shade cover (%); XIV – dominant type of shelters (see Fig. 2): ZB – bank recesses, ZP – submerged tree stumps; RD – wood debris, DKN – large stones with depressions, GW – deep water, KN – large stones in water current; XV – occurrence of shelters: 1 – few, 2 – moderate, 3 – many; XVI – year pond created; XVII – dam height (m)

| | Site | | | | |
|---|---|---|---|---|---|
| Parameter | 1 | 2 | 3 | 4 | 5 |
| I | stream | pond | stream | pond | stream |
| II | 775 | 773 | 771 | 761 | 756 |
| III | 20.6 | - | 21.0 | - | 26.4 |
| IV | 1.7 (3.5) | - | 1.5 (3.5) | - | 2.5 (5.0) |
| V | 0.1 (0.3) | 0.7 (1.4) | 0.2 (0.4) | 0.7 (1.2) | 0.2 (0.3) |
| VI | - | 1550 | - | 2150 | - |
| VII | 119.4 | - | 99.4 | - | 174.5 |
| VIII | 0/30/50/15/5 | - | 0/20/60/15/5 | - | 5/20/60/10/5 |
| IX | - | 5 | - | 30 | - |
| X | - | 0 | - | 1 | - |
| XI | 2 | - | 2 | - | 0 |
| XII | DD/WL | - | DD | - | - |
| XIII | 50 | 5 | 10 | 5 | 60 |
| XIV | RD | ZB/ZP/RD/GW | DKN | ZB/ZP/RD/GW | DKN |
| XV | 1 | 3 | 1 | 3 | 2 |
| XVI | - | 2007 | - | 2005 | - |
| XVII | - | 1.8 | - | 2.0 | - |

stream segment, but there was less shade cover. The stream bed exhibited signs of damage from forestry works. Station 4 comprised the main pond, which is larger with a surface area of about 2150 $m^2$. Trees, bushes, and greenery grew on its shores, and similarly to station 2 there was also a substantial amount of wood debris. The layer of sediments in this pond were 30 cm thick. Station 5 was designated about 300 m downstream from the last dam. The stream bed was about 5 m wide, and the substrate comprised gravel and rock. The bank vegetation was mainly trees and bushes, and the mean shade cover was about 60%. No apparent anthropogenic impact was noted at this station (Table 1). At each study station, the area of different habitat features that could serve as shelter for large fish was determined (Fig. 2).

The study was conducted in 2007-2009. Catches were made four times at each station with electric fishing (22.08.2007, 3.06.2008, 2.09.2008, 14.05.2009). The catches were conducted in an upstream direction in the streams, while they were made from a large pontoon in the ponds. The fish were caught from the entire surface area of the ponds. In the running waters, the fish were caught in segments that were approximately 100 to 200 m in length. An IUP-12 impulse device was used to make the catches (350 V, 3.5 A, 20-100 Hz). After the fish had been measured to the nearest mm and weighed

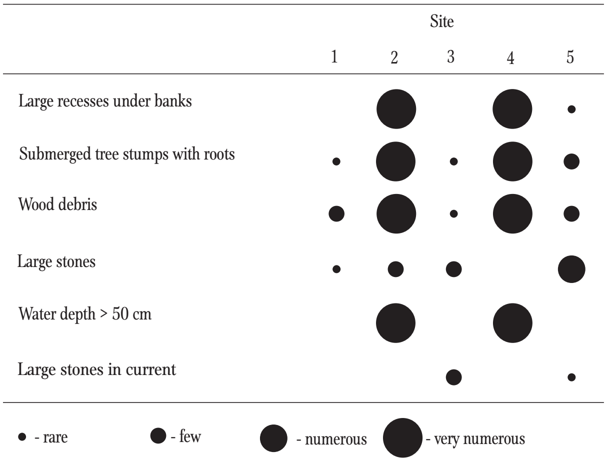


Figure 2. Potential shelters for large fish (> 20 cm Tl) at stations in running segments and in beaver ponds in Negrylów Stream.

to the nearest 0.1 g, they were released. The abundance and biomass of the fish was extrapolated to a fishing area of 100 $m^2$.

Water temperature, conductivity, pH, and oxygen saturation was measure by HQ40D (Hach Lange, Germany). The water flow rate was measured with a BLH-03 (Biomix, Poland) hydrometric mill. The ion content was measured with photometer LF 300 (Slandi, Poland).

Crosstabulation analysis was used to compare the goodness to fit of the distributions of the number of fish species in the running segments of the stream and the ponds. Differences between the mean length and biomass of brown trout, *Salmo trutta trutta* m. *fario* L. at individual stations and the differences between mean values of the physicochemical water parameters were analyzed with nonparametric single-factor analysis of variance (Kruskal-Wallis test) and the post-hoc test for Kruskal-Wallis ANOVA. The mean length and mean biomass of brown trout from the running water segments of the stream and the ponds were compared with the Mann-Whitney U-test (Stanisz 2006). Statistical analysis of the results was performed using the Statistica 8.0 (StatSoft Inc., Tulsa, OK, USA).

## Results

### Physicochemical parameters

The water oxygen content was the highest at stations 2 and 4 in the beaver ponds. The concentration of ammonium ions at station 4 was 0.13 mg $dm^{-3}$, which was higher than at the other stations. The values of other parameters were similar at the various stations. A lack of statistical differences among the mean values of all the physicochemical parameters measured was confirmed ($P < 0.05$). These parameters also indicated that the waters at each of the study stations were typical of naturally polluted mountain streams (Table 2).

### Fish assemblage

Four fish species were caught in Negrylów Stream: brown trout; Siberian sculpin, *Cottus poecilopus* Heckel, common minnow, *Phoxinus phoxinus* (L.), and stone loach, *Barbatula barbatula* (L.) (Table 3). In total, 2419 fish weighing 21484.1 g were caught. The most fish were caught at station 5 (1235 indiv.), and the least at station 4 (213). The numbers of fish caught at stations 1, 2, and 3 was 367, 234, and 370 individuals, respectively. The fish from the two ponds had the highest biomass. In the upper pond (station 2) more than 7.1 kg of fish were caught, and at station 4 (the main pond) 6.5 kg of fish were caught. The biomass of fish caught at station 5 was just under 4.5 kg, while at the two other stations just slightly more than 1.4 kg of fish was caught.

Trout were the most numerous in the beaver ponds comprising just under 65% of all the individuals of this species caught in the stream studied (Table 3, Fig. 3). The biomass of this species was also the highest at stations 2 and 4 and comprised nearly 90% of the overall biomass of fish caught at these stations (Fig. 3). The mean length (18.1 cm; $Z = -13.16$ $P < 0.01$) and weight (73.0 g; $Z = -13.29$ $P < 0.01$) of the trout caught in the ponds was also significantly higher.

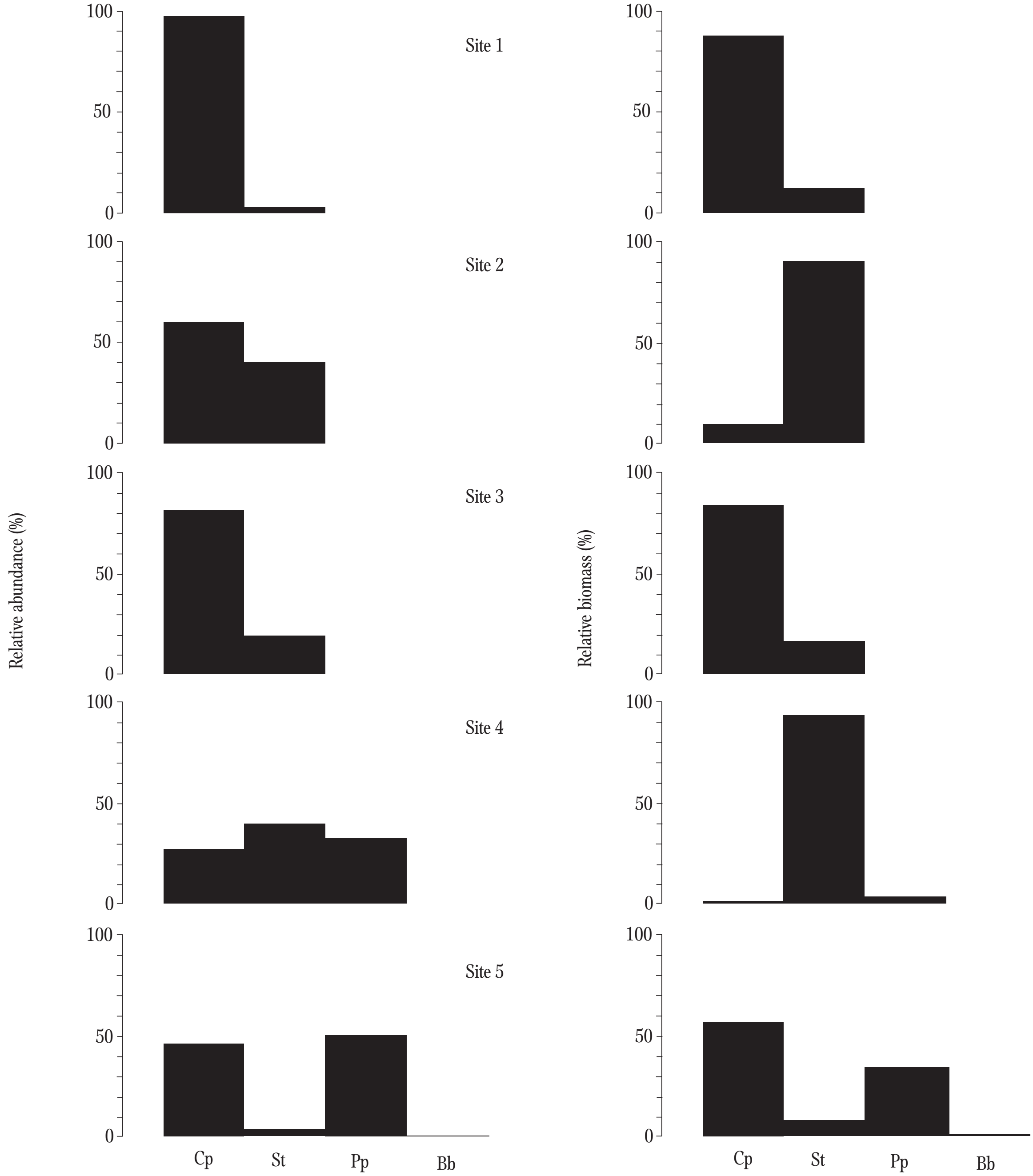


Figure 3. Comparison of the relative abundance, and biomass of fish species in the ichthyofauna at the study stations in Negrylów Stream: Cp – *C. poecilopus*, St – *S. trutta* m. *fario*, Pp – *P. phoxinus*, Bb – *B. barbatula*.

In spring sampling events (3.06.2008, 14.05.2009), only 42 brown trout were caught. Half of these were caught at station 2, and only 3 fish caught in Negrylów Stream in spring were longer than 20 cm; these were caught in the ponds. The largest trout from this period was 23.9 cm in length and weighed 143.7 g (station 2). During the summer sampling events (22.08.2007, 2.09.2008), 247 brown trout were caught. The smallest share of these fish was caught at station 1 (3.2%), and most of these individuals were longer than 10 cm. Only one trout was larger at 18.0 cm. In the lower segment of the stream (station 5), substantially more brown trout were caught than at station 1 (15.4% of all trout

**Table 2**
Mean values of physicochemical water parameters at study stations in Negrylów Stream. n – number of samples, x – mean, SD – standard deviation

| | | Site | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | 2 | | 3 | | 4 | | 5 | |
| Parameter | n | x | SD | x | SD | x | SD | x | SD | x | SD |
| Temperature ($^oC$) | 9 | 14.1 | 5.4 | 12.0 | 5.2 | 14.0 | 4.3 | 13.5 | 5.6 | 13.1 | 4.5 |
| Oxygen (mg $m^{-3}$) | 9 | 9.79 | 0.68 | 9.84 | 1.09 | 9.59 | 0.97 | 10.27 | 0.88 | 9.41 | 0.64 |
| Oxygen saturation (%) | 9 | 101.8 | 3.9 | 99.4 | 8.7 | 99.2 | 5.3 | 106.2 | 6.0 | 99.4 | 3.5 |
| $BOD_5$ (mg $O_2$ $dm^{-3}$) | 5 | 0.87 | 0.32 | 1.38 | 0.20 | 0.95 | 0.34 | 1.52 | 0.34 | 1.12 | 0.06 |
| Water conductivity (μS) | 9 | 198.7 | 44.6 | 186.2 | 41.0 | 188.1 | 45.0 | 195.4 | 49.9 | 194.5 | 49.8 |
| pH | 9 | 8.27 | 0.32 | 8.12 | 0.38 | 8.13 | 0.22 | 8.05 | 0.24 | 8.15 | 0.22 |
| $NH_4^+$ (mg $dm^{-3}$) | 7 | 0.06 | 0.07 | 0.03 | 0.02 | 0.05 | 0.07 | 0.13 | 0.07 | 0.05 | 0.07 |
| $NO_2^-$ (mg $dm^{-3}$) | 7 | 0.02 | 0.005 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 | 0.005 | 0.03 | 0.006 |
| $NO_3^-$ (mg $dm^{-3}$) | 7 | 0.99 | 1.15 | 0.70 | 1.14 | 0.59 | 1.00 | 0.66 | 0.38 | 0.79 | 0.65 |
| $PO_4^{3-}$ (mg $dm^{-3}$) | 7 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 | 0.004 | 0.01 | 0.009 | 0.01 | 0.015 |
| $Cl^-$ (mg $dm^{-3}$) | 7 | 2.53 | 0.70 | 1.64 | 1.10 | 1.95 | 1.14 | 2.55 | 1.46 | 2.01 | 0.46 |
| $SO_4^{2-}$ (mg $dm^{-3}$) | 7 | 13.23 | 7.56 | 17.02 | 3.24 | 15.85 | 1.70 | 13.35 | 7.50 | 16.03 | 2.38 |
| $Si^{2+}$ (mg $dm^{-3}$) | 5 | 2.67 | 0.78 | 2.45 | 0.32 | 2.38 | 0.22 | 2.30 | 0.31 | 2.18 | 0.34 |
| Water hardness (dH) | 5 | 8.51 | 1.25 | 9.47 | 1.35 | 9.58 | 1.46 | 10.18 | 3.05 | 9.55 | 2.48 |

**Table 3**
Density (N – indiv. 100 $m^{-2}$) and biomass (B – g 100 $m^{-2}$) and percentage share of fish species at study stations of total number (N%) and biomass (B%) of the ichthyofauna of Negrylów Stream

| | | Site | | | | | |
|---|---|---|---|---|---|---|---|
| Species | | 1 | 2 | 3 | 4 | 5 | Total (%) |
| *Cottus poecilopus* | N/N% | 37.8/23.9 | 2.9/8.1 | 24.0/21.8 | 0.4/4.4 | 33.3/41.8 | 100 |
| | B/B% | 136.7/18.1 | 18.2/6.9 | 95.4/20.0 | 1.1/2.0 | 127.0/53.0 | 100 |
| *Salmo trutta* m. *fario* | N/N% | 1.4/6.8 | 8.5/36.8 | 8.7/15.9 | 1.0/27.5 | 2.1/13.0 | 100 |
| | B/B% | 18.6/1.4 | 633.6/46.8 | 28.8/1.2 | 81.5/47.1 | 21.5/3.5 | 100 |
| *Phoxinus phoxinus* | N/N% | | | | 1.2/10.0 | 27.5/90.0 | 100 |
| | B/B% | | | | 4.2/15.0 | 85.1/85.0 | 100 |
| *Barbatula barbatula* | N/N% | | | | | 0.3/100.0 | 100 |
| | B/B% | | | | | 3.1/100.0 | 100 |
| Total (species, in %) | N/N% | 39.2/15.2 | 11.4/8.2 | 32.7/14.1 | 2.6/8.3 | 63.2/54.2 | 100 |
| | B/B% | 155.3/6.6 | 651.8/28.7 | 124.2/7.1 | 86.8/28.6 | 236.7/29.0 | 100 |

caught in summer), but again the decided majority of fish were under 10 cm in length. Only 6 fish measured from between 13 and 18 cm, and only one individual was 20 cm in length. In the running segments of the stream between the ponds (station 3), all of the trout measured from 6 to 10 cm. In both of the beaver ponds studied, a total of 69 trout were caught in summer. Of these, only 8 individuals were less than 10 cm in length. Over 50 individuals were longer than 20 cm in length. The largest brown trout was caught at station 4 and measured 38.9 cm in length and weighed 505.8 g. Based on the measurements of all the fish caught in 2007-2009 at the various stations (Fig. 4), the mean brown trout body

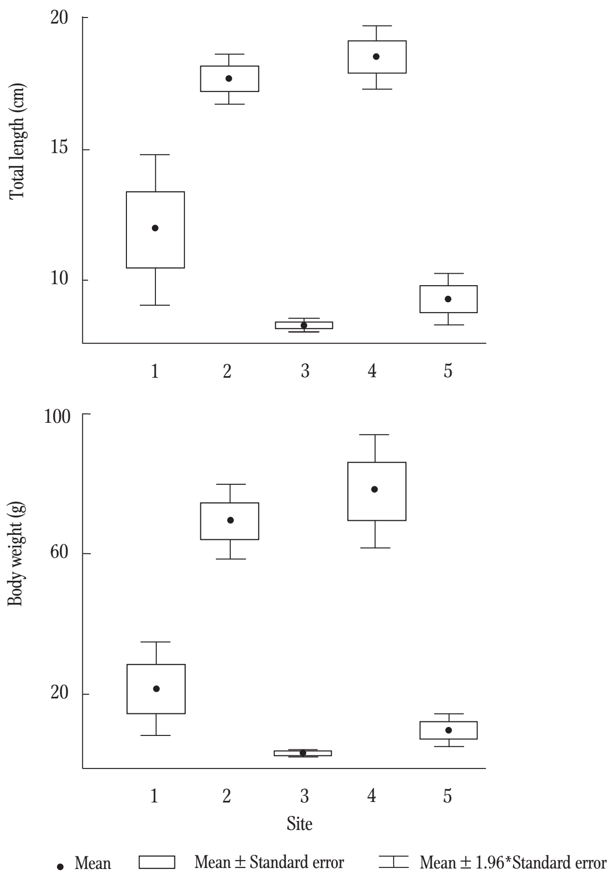


Figure 4. Mean body length and weight of brown trout at study stations in Negrylów Stream (statistically significant differences, body length H = 174.35, P < 0.001; body weight H = 181.23, P < 0.001).

length and weight differed significantly, and the means from stations 2 and 4 differed significantly from those at the remaining stations (P < 0.05).

The highest number and weight of Siberian sculpin was noted at the upper (1) and lower (5) stations (Table 3). In the fish assemblages at the stations in the running segments of the stream (stations 1, 3, 5), sculpin comprised 62.9% of all the fish caught (Table 4). Of all the individuals of this species noted in the stream, only 12.5 % were caught in the ponds (Table 3). The common minnow occurred only in the main pond (station 4) and in the lower segment of the stream (station 5), where it was more than 22 times more numerous comprising 50.2% of the fish caught (Fig. 3, Table 3). Stone loach was confirmed only in the lower segment of the stream (station 5), where it comprised barely 1% of the number and biomass of the fish caught (Fig. 3, Table 3). The fish assemblages in the running segments of the stream and the ponds differed significantly statistically in the number share of the various species (Table 4).

**Table 4**
Percentage share and comparison of fish assemblages from the running water segments and the beaver ponds on Negrylów Stream using crosstabulation analysis. Values in the rows with different letter indexes differ significantly statistically (P < 0.001)

| Species | Running water segments | Beaver ponds |
|---|---|---|
| *Cottus poecilopus* | 62.9[a] | 44.1[b] |
| *Salmo trutta* m. *fario* | 6.2[a] | 37.1[b] |
| *Phoxinus phoxinus* | 30.7[a] | 18.8[b] |
| *Barbatula barbatula* | 0.2 | 0 |
| $\chi 2$ | 341.2 | |
| df | 3 | |
| p | < 0.0001 | |

## Discussion

The European beaver in Poland was nearly extirpated in the nineteenth century, and only a few isolated populations survived (Pucek 1984). The dams constructed by these animals disappeared from running streams causing significant changes in hydrological conditions and impacting the occurrence of aquatic organisms in them. In recent years, there has been rapid growth in beaver populations in both Poland and Europe. In southeast Poland, beaver now inhabit most streams in which they had not been noted for centuries. Beaver dams have appeared in small streams in the lowlands of the Low Beskid and Bieszczady mountains (Czech 2000, Derwich 2000, Derwich et al. 2007).

Approximately twenty species of fish are noted in the basin of the upper San River in the Bieszczady Mountains, but in the smaller streams where beaver choose to live, the most commonly occurring species are stone loach, brown trout, and common minnow (Kukuła and Bylak 2009). The brown trout holds a special position in mountain streams as it is recognized as a key species in the Bieszczady aquatic ecosystem (Głowaciński 1994). The ichthyofauna composition confirmed in the current study was very similar to that confirmed previously in other small Bieszczady streams (Kukuła 1999).

Among mammals, the beaver is unique in its ability to transform its environment. Regardless of the character of a habitat, the activities of beaver result in sweeping changes. All aquatic organisms react to these changes (Collen and Gibson 2001). The constructions beaver build increase water retention, slow erosion, and increase the variety of habitats in streams. Additionally, when streams are in high water stages, beaver dams reduce flood waves, and when water levels are low they help maintain ground water at relatively high levels above the dams. This helps to stabilize hydrological parameters in drainages (Allan 1995, Collen and Gibson 2001).

The data collected for the current study indicate that changes in the bed of Negrylów Stream caused by beaver had an impact on the fish assemblages. The amounts of larger pieces of wood debris, which are considered to be essential elements of the habitat, increased significantly in beaver ponds (Table 1). These help rebuild the natural shape of the stream bed, but they also provide shelter and new substrates for invertebrates that are the prey of fish (Wyżga et al. 2009). Submerged branches and the roots of trees growing along stream banks provide a shelter system for brown trout (Fig. 2). Exceptionally high densities of this species were confirmed in these places (Fig. 3, Table 3). Presumably, these numerous shelters allowed trout to survive despite high numbers of European otter, *Lutra lutra* (L.), which is the main predator of brown trout.

The natural character of stream beds is important for all fish species. While fish survival is dependent on the availability of shelters, fish life cycles are possible if there are appropriate spawning grounds, fry growth, feeding, and overwintering (Cunjak 1996, Scruton 1998). This is possible if the natural, varied course of stream beds is maintained to some degree (Wyżga et al. 2009). Changes in the course of stream beds or the destruction of the ecotone zone are two factors that contribute significantly to the degradation of fish assemblages. It is also important for fish to be able to find refuge during droughts (Lammert and Allan 1999). Large ponds formed by beaver dams are often the only place where large fish can survive (Collen and Gibson 2001). Numerous large trout were noted in both ponds located on Negrylów Stream. In many drainage basins, beaver ponds are the only habitats available to large fish, and although these are usually salmonids, pike, *Esox lucius* L., and burbot, *Lota lota* (L.), are also noted (Collen and Gibson 2001).

Fish species have different environmental requirements with regard to substrate composition, water depth, temperature, and oxygen content, as well as to water purity and the availability of shelter (Elliott 1994). These factors have been disrupted to various degrees in many streams in the upper Vistula drainage, and this has impacted the abundance of fish (Kukuła 2003). Beaver activities alter the character of stream beds and the shapes of banks significantly. Deeper areas occur alternately with shallows, and ecotone zones appear. The stream beds become littered with felled trees (Naiman et al. 1988, Pollock et al. 2003), and natural erosion processes hasten the re-naturalization of streams. Effectively, in streams that were degraded by human activity, fish assemblages begin to rebuild. Beaver ponds also provide refuge for fish when water levels are low (Collen and Gibson 2001).

The problem of stream bed degradation also applies to areas that are generally regarded as "natural". In the drainage basin of the upper San River in the Bieszczady Mountains, many stream beds were destroyed during preparations for and then exploitation as transport routes for lumber. Rock knickpoints are removed, as are large rocks, fallen trees, large amounts of rock rubble, and organic material. Using streams as means of transport extirpated the ichthyofauna. Natural fish shelters and invertebrate habitats were destroyed (Kukuła and Szczęsny 2000). This happened in tributaries of the San River near Sianki including in the Niedźwiedzi, Negrylów, and Bobrowiec streams. After the introduction of the beaver, the state of the ichthyofauna improved in Negrylów Stream, which had previously been degraded. In relation to comparable segments of streams in the Bieszczady Mountains (Kukuła 1999), densities of fish and their biomass in Negrylów Stream were very high.

All water retention constructions in streams influence the thermal regime of the water, its chemical composition, and its flow rate (Allan and Flecker 1993, Lusk 1995, Penczak et al. 1998). These factors have an direct impact on fish and an indirect impact on their food base. Decreasing the flow of water through and beneath dams results in greater sedimentation and prevents the dispersal of organic material. Thus, changes in water chemistry occur. These are usually accompanied by a decrease in saturated oxygen, which leads to the disappearance of sensitive species. Decreasing the quantity of water flowing through a stream is often accompanied by increased temperature and a consequent further decrease in oxygen content. There was no discernible difference in the chemical composition of the standing and running waters of the mountain stream that was the focus of the current study. The oxygen content was high everywhere, and was substantially higher than the minimal requirements of fish in mountain streams (Brylińska 2000).

Technical constructions on streams pose particular threats to the resident ichthyofauna, and changes happen in the ichthyofauna both above and below dams (Allan and Flecker 1993, Penczak et al. 1998, Heese 2001, Kukuła 2003). Even small-scale water retention constructions can cause changes in hydrological conditions and limit fish migration (Kukuła 2006). The same applies to beaver dams (Collen and Gibson 2001, Pollock et al. 2003). However, dams built by beavers are not usually watertight, since the animals generally leave channels through which excess water can flow. These can also be used by fish to negotiate the barrier. Observations made during the current study indicate that beaver dams are not permanent barriers for fish. In the mountains in spring, fish can negotiate most dams without difficulty. When waters are high every few years some dams are either destroyed or they are abandoned by beaver (Collen and Gibson 2001, Kukuła et al. 2008).

The beaver dams changed the fundamental character of the mountain stream. They created new habitats with deep, well oxygenated standing waters. Large fish measuring (Tl) > 20 cm occurred almost exclusively in the ponds, where deeper waters, eroded areas around roots, and submerged trees provided numerous shelters. Mainly trout fry were caught in the shallow, running segments of the stream. The availability of shelter was the decisive factor in the distribution of the brown trout population. According to the method used to evaluate the suitability of shelter, advantageous shelter was available only in the beaver ponds.

It was confirmed that the environmental changes initiated by beaver had a positive impact on the ichthyofauna of the streams studied. The study also revealed that beaver clearly influence the renewal of degraded aquatic ecosystems and hasten their re-naturalization. The data collected did not indicate that beaver had a negative impact on the fish, as has been suggested by other authors (Collen and Gibson 2001). The greatest potential negative impact beaver dams can have is to limit fish migration; however, this appeared to be only a minor problem.

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## Streszczenie


### Ichtiofauna potoku górskiego zabudowanego przez bobry

Celem pracy było zbadanie wpływu bobra europejskiego, *Castor fiber* L. na ichtiofaunę potoku Negrylów. Badania prowadzono w latach 2007-2009 na 5 wyznaczonych stanowiskach. Przeprowadzono czterokrotne elektropołowy ryb i wykonano pomiary 19 parametrów fizyko-chemicznych wody. Dla wszystkich badanych parametrów wykazano brak istotnych statystycznie różnic pomiędzy średnimi wartościami. Stwierdzono cztery gatunki ryb: pstrąga potokowego, *Salmo trutta trutta* m. *fario* L., głowacza pręgopłetwego, *Cottus poecilopus* Heckel, strzebli potokowej, *Phoxinus phoxinus* (L.) i śliza, *Barbatula barbatula* (L.) Najwięcej ryb złowiono w dolnej części potoku a największą biomasę miały ryby złowione w stawach. Zagęszczenie, biomasa oraz średnia długość i masa pstrąga potokowego była największa w stawach bobrowych. Głowacz pręgopłetwy w stawach spotykany był rzadko, a strzebla potokowa występowała tylko w stawie głównym i w odcinku dolnym potoku, gdzie była bardzo liczna. Różnice pomiędzy zespołami ryb z odcinków płynących i stawów były istotne. Zbudowane przez bobry tamy przyczyniły się do powstania siedliska z głęboką, dobrze natlenioną, stojącą wodą. Ryby o długości całkowitej > 20 cm występowały prawie wyłącznie w stawach, gdzie głębsze miejsca, podmyte korzenie i zatopione drzewa utworzyły liczne kryjówki. W płytkich, płynących odcinkach potoku dominowały stadia juwenalne o długości 6-11 cm (90%). Zmiany w korycie potoku wywołane działalnością bobrów wpłynęły na zespoły ryb. Stan ichtiofauny w zniszczonym wcześniej w wyniku prac leśnych potoku Negrylów po wprowadzeniu bobrów wyraźnie się poprawił. W stosunku do porównywalnych odcinków potoków bieszczadzkich zagęszczenie ryb i biomasa były tu bardzo wysokie.