

# **Fishes of the Shallow Rapids and Riffles of the Pizhma River, Pechora River Basin, Russia.**

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## ABSTRACT

The Pechora River drains into the Barents Sea and, at a length of 1,827 km, is the longest Atlantic salmon river in the world. The Atlantic salmon is the most important fish species in the Pechora River, being heavily exploited by both commercial and local fisheries. There has been a significant decline in the Barents Sea and in the Pechora River commercial fishery to the point that the fishery in the Pechora River has been closed since 1989. The Pizhma River is a tributary of the lower Pechora River. The objectives of the 1993 expedition were to study the fish populations of the shallow rapids and riffles of the Pizhma River with emphasis on the abundance and biological characteristics of the Atlantic salmon juveniles. The Pizhma River is a low gradient stream flowing through extensive calcareous marine deposits. The most abundant fishes in the shallow rapids and riffles, in decreasing order, were the sculpin (*Cottus gobio*), the stone loach (*Nemacheilus barbatulus*), the minnow (*Phoxinus phoxinus*) and Atlantic salmon (*Salmo salar*). Grayling (*Thymallus thymallus*) were the most abundant fish angled. Sculpins were present at all sites, whereas stone loach increased in abundance in a downstream direction while salmon juveniles were rare at all stations. The biomass of fish in the riffles increased in a downstream direction with the sculpins dominating in the upper sites and stone loach being more abundant in the lower stations. Salmon juveniles were most abundant in the middle sites, distant from villages, but the abundance was low indicating that spawning escapement in 1992 was poor. Larger parr are frequently exploited in the local fisheries targeting grayling. Both Atlantic salmon and grayling are overexploited, salmon are frequently exploited on the spawning grounds and enforcement resources are inappropriate to curtail these activities.

## RÉSUMÉ

La rivière Pechora se jette dans la mer de Barents. À 1827 kilomètres, elle est la rivière à saumons de l'Atlantique la plus longue au monde. La plus importante espèce de poisson de la rivière Pechora est le saumon de l'Atlantique qui est fortement exploité à la fois par les pêcheurs commerciaux et les pêcheurs locaux. Depuis quelque temps, la pêche commerciale dans la mer de Barents et la rivière Pechora connaît une baisse importante. La Petchora est même fermée à la pêche depuis 1989. La rivière Pizhma est un tributaire du bas de la rivière Petchora. L'expédition de 1993 avait pour but d'étudier les populations de poissons habitant les seuils et les rapides peu profondes de la rivière Pizhma, et plus particulièrement d'examiner l'abondance et les caractéristiques biologiques des juvéniles du saumon de l'Atlantique. La rivière Pizhma est un cours d'eau à faible pente qui traverse d'importants dépôts marins calcaires. Voici les poissons les plus abondants observés dans ses seuils et rapides peu profondes, par ordre d'importance décroissante : le chabot (*Cottus gobio*), la loche franche (*Nemacheilus barbatulus*), le mené (*Phoxinus phoxinus*) et le saumon de l'Atlantique (*Salmo salar*). L'ombre (*Thymallus thymallus*) était le poisson le plus souvent capturé à la ligne. On a retrouvé du chabot à toutes les stations. La loche franche était plus abondante vers l'aval et le saumon juvénile était rare à toutes les stations. La biomasse des poissons dans les seuils augmentait à mesure que l'on descendait, le chabot étant l'espèce dominante dans les stations d'amont et la loche franche étant plus abondante dans les stations d'aval. On a retrouvé davantage de saumons juvéniles dans les stations du cours intermédiaire, loin des villages, mais il n'était abondant nulle part, ce qui indique un faible taux de survie des géniteurs en 1992. Les plus gros tacons sont souvent capturés par les pêcheurs locaux qui exploitent l'ombre. Le saumon de l'Atlantique et l'ombre sont tous deux surexploités. Le saumon est souvent pêché directement dans les frayères et les ressources pour l'application des règlements ne sont pas suffisantes pour y mettre fin.



## INTRODUCTION

A bilateral agreement between Canada and Russia (Canada-Russia Mixed Commission on the Environment) provided an opportunity for a cooperative project on the Atlantic salmon of the Pechora River in the Komi Region of northern Russia. The Pechora River Salmon Project was developed within Working Group IV of the bilateral agreement, and as part of the much larger Komi Region Project.

The objective of the Pechora Salmon Project is to restore salmon populations to a level which will sustain a well-managed recreational fishery based on sound scientific and sustainable development principles. The recreational fishery is considered to be a most appropriate economic development strategy for the Pechora River region potentially attracting tourists from Europe and North America. Because fish, including salmon, are an essential component of the diet of the local people in the barter economy in this remote area, management plans would also have to provide for a limited subsistence fishery for salmon.

The objectives of the 1993 Pechora River expedition were to study the fish populations in the shallow rapids and riffles of the Pizhma River, with emphasis on the abundance and biological characteristics of Atlantic salmon juveniles. The Pizhma River was selected because it is a lower Pechora River tributary whose fish resources were poorly studied. In 1959, an expedition to the Pizhma collected limited data related to the ecology of Atlantic salmon to ascertain possible impacts of water diversion from the Pechora River into the Volga River. The diversion never occurred. An expedition in 1992 did some habitat classification of the lower section of the Pizhma River and opportunistic juvenile salmon sampling. These previous studies had relied on angling and beach seining to collect juvenile fishes.

The purpose of this report is to present the results of the 1993 expedition to the Pizhma River and to compare the abundance of Atlantic salmon juveniles with that of the largest Atlantic salmon river in Canada, the Miramichi River. In addition, background information regarding the Atlantic salmon of the Pechora River basin is presented, for the first time in english.

## BACKGROUND

The Pechora River, at a total river length of 1,827 km, is the world's longest Atlantic salmon river. It originates in the Ural mountains of north central Russia and empties north-eastward into the Barents Sea (Fig. 1). Its drainage basin covers an area of 324,000 km<sup>2</sup> and extends from 61°30' N to 68°15'N by 49°00'E to 66°00'E. The lower section of the river has a width in the summer of 1.5 to 2 km and breaks up into a delta with a total channel width greater than 3 km before emptying into the Barents Sea. Oceangoing vessels navigate 70 km upstream while smaller river ships and barges (up to 20 m) navigate as far as 1,080 km inland.

The Pechora River basin is populated by about 1/2 million people with sixty percent of the population concentrated in three main cities (Vorkuta, Inta, Usinsk) in the upper part of the basin along the Usa River (Fig. 2). The Usa River is the largest polar Ural tributary of the Pechora. The main industrial developments in the basin are related to natural resources: coal, oil, natural gas, and forestry. Other impacts related to the industrial development include the excavation of gravel directly from the river beds as well as those impacts normally associated with urbanization (i.e. municipal and industrial sewage and related canalization of rivers). Agriculture is well developed in the region, mostly dairy farming. These activities also contribute to chemical nutrient loading in the aquatic system. People inhabiting the lower reaches of the Pechora River do not have access to purified water and use the water directly from the river.

### Fish Species Within the Pechora River

A total of 29 freshwater fish species are native to the Pechora River and its tributaries and lakes, including 11 salmonid species of which 5 are anadromous. Several of the salmonids encountered in the Pechora River basin have related genera or species on the North American continent.

	<u>In Pechora River</u>	<u>In North America (common name)</u>
Freshwater:	<i>Coregonus nasus</i>	Broad Whitefish
	<i>Coregonus peled</i>	
	<i>Thymallus thymallus</i>	
	<i>Thymallus arcticus</i>	Arctic Grayling
	<i>Hucho taimen</i>	
	<i>Salvelinus lepechini</i>	
Anadromous:	<i>Salmo salar</i>	Atlantic Salmon
	<i>Coregonus autumnalis</i>	Arctic Cisco
	<i>Coregonus albula</i>	
	<i>Coregonus lavaretus pidschian</i>	
	<i>Stenodus leucichthys nelma</i>	Inconnu

## Commercial and Local Importance of Fish Species

The salmonid species are of commercial and local importance. The Atlantic salmon, *Salmo salar*, is the most important fish species of the Pechora River basin. It is harvested not only in the river itself but also in the Barents Sea. The total commercial harvests of Atlantic salmon reached a maximum of 1,100 t in 1954 but declined to less than 300 t in the late 1980's (Fig. 3). The Pechora River fishery comprised the largest percentage of the total Barents Sea catch and declines since 1960 are largely the result of declines in the Pechora River catches.

Pechora River salmon are also harvested in the northern part of the Barents Sea by European vessels and have been estimated to comprise 30% of the high seas catch (Yakovenko 1987). Drift netting in the Pechora River for *S. leucichthys* (inconnu) in June also captured salmon. These are included in the total harvest statistics for the Pechora River.

The coregonids are fished mostly for local use. These fisheries use drift nets for harvesting *S. leucichthys*. Stake nets are used to harvest the other species within the river, along with Atlantic salmon. Fine mesh drift nets are used to capture the much smaller *C. albula*.

The European grayling, *Thymallus thymallus*, is extensively utilized and is an important food for the local populations along the various tributaries of the Pechora River. Fisheries for grayling are officially closed on some salmon rivers, as a conservation measure for salmon juveniles, but extensive local exploitation continues. Angling is the most favoured fishing method, either with dry flies or with baited lures. Investigations indicate that the populations of grayling are declining (V. Martynov, unpubl. data).

## Atlantic Salmon of the Pechora River

The trend in catches at the commercial trapnets at the mouth of the Pechora illustrate the decline in abundance of the Pechora River salmon (Martynov 1990) (Fig. 4). The commercial nets, set in two of three river channels in the lower Pechora, are generally fished from the 25 July to the end of September. Peak catches occur in August through the first half of September.

Commercial nets harvested approximately half of the catch. The remainder were released for migration upstream. In spite of this management measure, catches and escapements continued to decline between 1964 and 1988. It was estimated that the minimum required releases from the trapnet to sustain the stocks should be 40,000 to 50,000 fish. This objective was achieved in only 7 of the 25 years.

In 1989, the first year of the commercial trapnet closure, the estimates of illegal removals (poaching) were upwards of 24,000 fish. In addition, a total of 6,149 specimens were also removed from the mouth of the Pechora River, apparently for "scientific purposes" (Martynov and Zakharov 1990).

## **Biology of Atlantic Salmon from the Pechora River**

The Atlantic salmon of the Pechora River have been extensively studied. Just under 100 communications (conference proceedings, scientific publications, etc.) dealing with Atlantic salmon populations of the Pechora River have been prepared, almost exclusively in Russian. Various subjects have been studied including the population structure, feeding of juveniles, species interactions, physiology, and genetics.

This population of Atlantic salmon is considered to be the most easterly population of significant size. It is composed of spring (8% of total run) and autumn (92% of total run) salmon (Antonova 1976). Spring salmon spawn in the same year as the year of entry in the river. Autumn fish undertake a migration and residence of more than one year in freshwater before spawning. Many of the autumn salmon overwinter in the Pechora River and in the lower parts of the tributaries before continuing their spawning migrations the following spring. Salmon are able to ascend almost the entire length of the Pechora River tributaries, generally attaining the 300 m elevation isopleth in most tributaries, but reaching as high as 400 m in the Shchugor River (Martynov 1983). The gradients of the rivers level off quickly after a rapid descent from 1000 m to 400 m within 20 km from the source in the Ural mountains. Salmon spawn in 9 main tributaries of the Pechora River, eleven if the main tributaries of the Usa River are considered (Martynov 1983) (Fig. 5). The total Atlantic salmon spawning and rearing area of habitat of the Pechora River is estimated at 14,371 ha.

The adult populations of specific tributaries have been studied (Table 1) (Martynov 1983). Salmon return to spawn mostly as 2+ sea-winter fish but sea ages vary between 1+ and 4+. Salmon go to sea as smolts at river ages of 2 to 6 years, mostly 4. The average smolt age in the Ural tributaries, which contribute to more than 80% of the total salmon production, is 3.8 to 4.0 years (Martynov 1983). The average duration of a life cycle is 8 years (hatch to hatch).

## MATERIALS AND METHODS

A total of 29 electrofishing stations were sampled between Aug. 3 and 12, 1993 along that section of the Pizhma River between km 100 and 232 (Fig. 2 & 6). Stream width and logistics precluded the use of barrier nets for sampling within closed sites. Therefore densities and biomass were calculated relative to a standardized unit of electrofishing effort. Sampling effort consisted of three people, one with the electroshocking unit, a second person with a 1 m wide fine mesh apron seine, and a third person with a dipnet and live fish container. Sampling proceeded systematically at right angle to shore towards the middle of the river, in parallel transects upstream. The electrofisher was a Smith-Root Model 15B POW powered with a Honda Model EX-350 generator. All electrofishing was conducted at settings of 60kHz at 450 V DC. Total electrofishing time was determined with a counter on the shocking unit and individual sites were sampled with a minimum of 300 seconds. Samples of larger fish were obtained by angling in the faster and deeper reaches of the river.

Physical and chemical characteristics of the site were collected including: stream width, minimum and maximum depths of sampling sites, water temperature, pH and surface velocity of sampled area. Substrate composition was also described.

All fish collected were identified to species and measured for standard length, fork length or total length (depending on species). Subsamples were kept for measurement of weight, sex, diet, meristic, morphometric and age determinations. Data from grayling and salmon also included gonad weight, gutted weight, meristic and morphometric measurements. Salmon samples collected in 1992 from the lower Pizhma River are also included. Only the data related to length, weight, sex and age are presented in this report.

All analyses were performed using Statistical Analysis Systems software (SAS 1990). The condition factors of the species, expressed as expected weight for a given length, were compared using analysis of covariance under the assumptions of multiplicative error structure (Patterson 1992).

## RESULTS

The Pizhma River is a low gradient stream. It originates from a small lake at 213 m above sea level and descending to 12 m elevation over a distance of 363 km. It empties into the Pechora River 400 km south of the Barents Sea. (Fig. 6). Seven villages are scattered along the Pizhma River. The smallest and furthest upriver, Lovkinskaya, has a year round population of about 30 people. The larger villages located downstream generally have more than 1000 inhabitants. Most of the villages are collective farms of which dairy cattle are the primary animal stock.

The river flows through extensive marine deposits of sandstone and calcareous sediments with pH levels ranging from 8.0 to 8.5. Sections of shallow rapids alternate with long runs of deep, slow flowing water. Within the rapids, the majority of the substrate was gravel size (0.5 to 5 cm diameter). In many areas the gravel was hard-packed because of imbedded silts and sands which filled the interstitial spaces. Nutrient input into the system was high as evidenced by filamentous algae which grew throughout the river and thick borders of aquatic vegetation (hyacinth) along the shore.

Water temperatures during early August 1993 ranged from 12.4° to 18°C. Surface water velocities in the sampled sites ranged between 0.3 and 1.4 m/sec, and maximum depths sampled within the electrofishing sites were less than 90 cm. Stream widths at the sampled locations varied between 5 and 100 m (Table 2).

The fish species sampled by electrofishing were the sculpin (*Cottus gobio*), the stone loach (*Nemacheilus barbatulus*), the minnow (*Phoxinus phoxinus*), as well as Atlantic salmon (*Salmo salar*) and European grayling (*Thymallus thymallus*) juveniles (Appendix I). By angling, the European grayling, Atlantic salmon parr, pike (*Esox lucius*) and perch (*Perca fluviatilis*) were sampled.

The only grayling captured by electrofishing were young-of-the-year. After grayling, *Cottus gobio* and *Phoxinus phoxinus* were the smallest fish sampled during electrofishing, ranging between 16 and 88 mm (Fig. 7). *Salmo salar* and *Nemacheilus barbatulus* were of generally similar size but larger than the other species. Young-of-the-year *N. barbatulus* at 10 to 12 mm were much smaller than *S. salar* young-of-the-year at 36 to 50 mm (Fig. 7). Equations for converting from total length to standard length, from fork length to standard length and for length to weight are given in Table 3. Condition factors differed significantly ( $P < 0.05$ ) among all the species. *C. gobio* had the highest condition factors (weight at length) whereas *T. thymallus* and *N. barbatulus* had the lowest (Fig. 8).

## Distribution and Abundance

*C. gobio* was present at all the sites sampled in 1993 and was by far the most abundant species of fish captured in the shallow rapids and riffles (Fig. 9). *N. barbatulus* was the second most abundant species and its abundance increased in a downstream direction. *S. salar* was rare at all the stations sampled.

The total standardized biomass of fish in the rapids and riffles increased in a downstream direction. In the lower third of the sampling stations, the standardized biomass was more than twice that at the upper stations (sites 1 to 15) (Fig. 10). *C. gobio* was the dominant component of the biomass in the upper section. *N. barbatulus* comprised generally more than 60% of the biomass in the lower section. Site characteristics were similar but agricultural development was greater in the lower half of the river.

## *Salmo salar* Juveniles

Electrofishing techniques combined with angling indicated the wide range in size of Atlantic salmon parr in the river. Electrofishing sampled mostly salmon less than 100 mm fork length while angling provided samples of salmon ranging between 125 and 255 mm (Fig. 11). On average, less than 1.7 salmon juveniles per station, or 0.8 salmon per 300 seconds of effort, were captured by electrofishing. Salmon juveniles were most abundant in the middle sites of the surveyed section in 1993. These sites, 10 to 23, were relatively distant from the villages (Fig. 12). Young-of-the-year salmon were encountered at only seven sites in 1993 which suggests that spawning success in 1992 in the surveyed section of the Pizhma River was poor.

The maximum age of parr sampled in 1992 and 1993 was six years and the maximum size encountered was 251 mm (Fig. 13). Growth of parr in the Pizhma River is good, young-of-the-year averaged 44 mm by August and parr achieved lengths of over 140 mm by age 3. Atlantic salmon from the Pizhma River become smolts at age 3 and 4 as indicated by the rapid change in the sex ratio at age 3 and the absence of female parr older than age 4 (Fig. 13). Precocious maturation of males was common with 100% of the male parr older than 2 years of age being mature.

In precocious male parr, the gonad weight was on average 14% of the total body weight in contrast to less than 0.1% in the immature male parr (Fig. 14). Immature female parr had gonad weights equivalent to 0.3% of the total body weight. The gonadal development of the precocious male parr, as a proportion of total body weight, was independent of length or age. Three male parr of age 1+ had gonadal development intermediate between that of the immature males and the precocious males (Fig. 14). These parr would not likely have matured in the current year.



## Local Angling Fisheries

The exploitation on the grayling by the local people is very intensive. Most of the angling is done with artificial flies but in some cases bait is also used. Grayling are preserved by salting and used as food in the winter. During the expedition, the largest grayling angled measured 48.5 cm fork length. The majority of grayling angled were much smaller and in some cases, 50% were of fork length less than 25 cm (Fig. 15). Atlantic salmon parr are also angled incidentally and often kept by anglers. In the sampled catch from one local fisherman, salmon parr made up 6% of the total catch (Fig. 15).

## DISCUSSION

The Pechora River is the longest Atlantic salmon river in the world and probably had (historically) one of the largest runs of Atlantic salmon. The Rhine and the Loire are about two-thirds as long as the Pechora but Atlantic salmon are either extinct or the runs are now of very small size (Northcote and Larkin 1989). The Miramichi River, Canada, is only about 13% as long as the Pechora River but the run size of salmon is probably more comparable and may presently exceed the size of the run of the Pechora River. The total rearing area of the Miramichi has been estimated at 5500 ha, one-third that of the Pechora River, and the potential production of salmon has been estimated at more than 425,000 salmon (all sea ages) annually (Randall et al. 1989). Atlantic salmon have access to most of the Pechora River and only the upper sections of the tributaries draining the Ural mountains are inaccessible because of the steep gradient. The Miramichi River is also completely accessible to Atlantic salmon and it originates at a much lower maximum elevation than the Pechora River; 470 m for the Miramichi as compared to more than 1000 m for the Pechora (Martynov 1983; Randall et al. 1989). Atlantic salmon juveniles are found throughout the Miramichi River as in the Pechora River although local spawning success may vary annually (Chaput 1994; Chaput et al. MS1994; Martynov 1983). The Pechora River differs from the Miramichi River in that it has fish fauna typical of arctic rivers especially the several species of coregonids and *Esox* sp. which are also abundant in the MacKenzie River, Canada (Bodaly et al. 1989).

The restricted distribution of Atlantic salmon juveniles in the Pizhma River in 1993 indicates that spawning in recent years has occurred in a restricted area of the river, distant from villages. The low catch rates of salmon from the Pizhma in 1993 also indicate that low numbers of salmon spawned in 1992. Similar sampling conducted in the Miramichi River in 1993 resulted in an average estimated abundance of greater than 20 salmon per 300 seconds of effort with an average of 15.7 young-of-the-year salmon and 5.6 older parr (Chaput et al. 1994). These values for the Miramichi are more than 10 times higher than for the Pizhma River in 1993.

Sizes-at-age of Atlantic salmon from the Pizhma River were comparable with those from the Miramichi. Young-of-the-year from the Pizhma River have average fork lengths which are similar to those of the Miramichi River in August, at 40 to 45 mm (Randall 1982). Age 1+ parr from the Miramichi River in August had mean fork lengths of 78 to 99 mm (Randall and Paim 1982) which is comparable to the 78 to 95 mm lengths of the Pizhma River parr in 1993. Age 2+ parr from the Miramichi River are smaller, about 110 mm (Randall and Paim 1982) as compared with 141 mm in the Pizhma River. By late September, 2+ parr in Miramichi had attained lengths of 114 mm (Schofield and Peppar 1982). The smaller size of the 2+ parr in the Miramichi compared with the Pizhma River may be due to the emigration, as 2+ smolts, of the fastest growing, largest members of this age class. Salmon from the Miramichi River become smolt in almost equal numbers at age 2 and 3 (Courtenay et al. MS1993) while those from the Pizhma become smolt at ages 3 and 4.

As in the Pizhma River, the sex ratio of the juveniles, up to age 2 is generally 1:1 (Schofield and Peppar 1982). Very few juveniles beyond age 2 are present in the Miramichi River in the electrofishing samples. Larger parr may be present in the Miramichi River in the deeper pools and faster rapids as in the Pizhma but they have not been sampled. Precocious maturation of the males is also prevalent in the Miramichi River salmon. Over 50% of male parr aged 1+ and 2+ sampled in 1978 were precocious (Schofield and Peppar 1982). High proportions of precocious males in the Pizhma River are not related to density since similarly high proportions of precocious males (among large parr, 45% to 52% were precocious males) were also found in 1961 when Pechora River salmon were more abundant (Solovkina 1964).

Other fish species, *Cottus gobio* and *Nemacheilus barbatulus*, were more abundant than salmon in the shallow rapids and riffles of the Pizhma River. Although these could potentially occupy habitat sought by Atlantic salmon juveniles, especially the young-of-the-year, the abundance of Atlantic salmon juveniles is probably more dependent on spawning escapement than on competition. In the Miramichi River, the relative abundance of salmon juveniles has varied annually; in terms of numbers of fish, salmon juveniles have represented from less than 30% up to 70% of total while the biomass of salmon juveniles has varied between 34% and 61% of total (Randall et al. 1989). Other species of importance in the Miramichi were the cyprinid (*Rhinichthys atratulus*) and the sculpin (*Cottus cognatus*) (Randall et al. 1989).

Low abundance of Atlantic salmon juveniles suggests that spawning escapement to the Pizhma River has been deficient. Low adult escapements are in part the result of excessive fisheries exploitation. Habitat perturbations also have an impact on recruitment. Mineral developments on the Pizhma River use outdated technologies with no environmental mitigation. Gold mining operations on the Umba, tributary of the Pizhma, have resulted in excessive siltation of the stream and salmon have not spawned in that tributary for five years (pers. comm. V.V. Reizer, professional trapper). Farming, mainly dairy cattle, is of major importance in all the villages along the Pizhma. As a result of cattle access to the river, there is extensive bank erosion

throughout the lower section of the river and nutrient inputs into the stream are high as evidenced by the large growths of filamentous algae in the lower sections, nearest the villages. This extensive growth of algae may favour the stone loach, which prefers weedy habitats, over the sculpin (Appendix I).

Atlantic salmon and grayling are overexploited and this above all else is the critical issue to be addressed. These two fish species are the major protein source for the local people. Atlantic salmon are frequently harvested directly on the spawning grounds and enforcement resources are inappropriate to curtail such activities. Sport fisheries are undeveloped and licensing of fishing activity is non-existent. Until the economic concerns of the local populations are addressed, overexploitation of grayling and salmon will continue.

#### ACKNOWLEDGEMENTS

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Table 1. Biological characteristics of Atlantic salmon from selected tributary and commercial fisheries sampling of the Pechora River.

Sample Size	Weight (kg)				Length (cm)			
	Mean	Std.Dev.	Min.	Max	Mean	Std.Dev.	Min.	Max.
Shchugor River (Martynov 1983) <sup>1</sup>								
227	3.9	1.4	0.8	11.2	76.8	8.6	40	103
Podcherem River (Martynov 1983 - cited Pshchelko et al. 1938) <sup>1</sup>								
51	2.6	1.3	1.4	9.7	72.6	7.3	61	105
Upper Pechora River (Valdimirskaya 1957) <sup>1</sup>								
162	7.7	1.5	3.5	20.1	94.9	12.4	77	132
Ilych River (Kulida 1976) <sup>1</sup>								
43	7.7	n.a.	n.a.	n.a.	97.8	n.a.	n.a.	n.a.
Commercial catches from Pechora River (Antonova 1976)								
13,508	6.8	n.a.	2.1	32.0	84.9	n.a.	40	133
<sup>1</sup> - weight of mature fish and of kelts from spawning grounds (weight loss due to migration from 23% to 43% - Martynov 1983)								

Table 2. Characteristics of the sites sampled on the Pizhma River, Pechora River basin, 1993.

Site	Date	Fishing Effort (seconds)	Water Temp. (Celsius)	Surface Velocity (m/sec)	Stream Width (m)	Depth Max (m)	Substrate Composition
1	Aug. 3	306	.	0.34	.	.	.
2	Aug. 3	370	15.4	0.92	5.5	.	sand, gravel
3	Aug. 4	459	14.2	0.87	35	.	gravel, occasional cobble, filamentous algae
4	Aug. 3	1069	15.6	0.95	50	.	gravel, occasional cobble, filamentous algae
5	Aug. 4	583	13.0	0.87	51	0.9	gravel, cobble, riffle area
6	Aug. 5	307	12.4	1.37	50	0.75	gravel, cobble, riffle area
7	Aug. 5	302	13.7	0.71	40	0.8	gravel, upper part before pool
8	Aug. 5	463	18.0	1.08	11	0.7	gravel
9	Aug. 5	428	18.0	0.95	18	0.7	gravel, cobble, bedrock outcrop
10	Aug. 6	211	16.0	1.00	30	0.8	gravel, fast riffle
11	Aug. 6	431	16.0	0.90	30	0.8	gravel, 10% cobble at center of channel
12	Aug. 7	879	15.7	1.16	43	0.5	gravel, sand, occasional cobble, fast riffle
13	Aug. 8	581	14.5	0.66	60	0.5	30% cobble, gravel, sand & silt, filamentous algae
14	Aug. 8	526	14.7	0.73	100	0.5	shallow riffle with gravel, sparse cobble, sand, filamentous algae
15	Aug. 8	516	15.2	0.83	100	0.75	riffle, cobble, gravel and algae, gravel and silt towards shore
16	Aug. 8	705	.	0.87	85	0.75	gravel and algae, some cobble
17	Aug. 9	481	13.3	1.05	50	0.8	gravel, algae towards centre
18	Aug. 9	613	.	0.55	30	0.75	shallow gravel riffle with sand near shore, occasional cobble towards centre
19	Aug. 9	177	.	0.95	5	0.4	gravel, undercut on one bank, fast run to small rapid
20	Aug. 10	656	12.9	0.83	50	0.8	cobble, gravel, algae, some boulder
21	Aug. 10	292	13.3	.	50	.	100% gravel, sand & silt in interstitial, hard bottom, no algae
22	Aug. 10	360	13.5	0.69	40	0.7	light riffle, 100% gravel
23	Aug. 11	451	12.6	0.69	60	0.7	gravel, centre half with cobble and algae
24	Aug. 11	400	12.6	0.91	90	0.8	sharp flat cobble near shore, gravel over bedrock, algae on cobble towards far shore
25	Aug. 11	495	12.6	0.69	.	0.8	hard packed gravel and sand, algae over substrate in centre
26	Aug. 11	648	12.8	0.76	40	0.8	gravel 100%, sand & silt in spaces
27	Aug. 11	329	13.0	1.05	50	0.7	flat gravel, sand and silt, no algae
28	Aug. 12	427	13.0	0.53	50	0.8	gravel 90%, 10% cobble, algae, pastures on shore
29	Aug. 12	388	13.2	0.60	50	0.5	steep riffle, 70% cobble, 20% gravel, 10% sand & silt, some algae



Table 3. Conversion relationships for length and weight measurements of five fish species encountered in the Pizhma River, Pechora River basin, Russia. \* = multiply, ^ = exponent.

	Sample Size	R-square
<b><i>Cottus gobio</i></b>		
Standard Length (mm) = 0.861 * Total Length (mm) - 1.38	1061	0.988
Whole weight (g) = 0.000012 * Standard Length (mm) ^ 3.138	128	0.996
<b><i>Nemacheilus barbatulus</i></b>		
Standard Length (mm) = 0.836 * Total Length (mm) + 0.70	183	0.977
Whole weight (g) = 0.000009 * Standard Length (mm) ^ 3.076	31	0.995
<b><i>Phoxinus phoxinus</i></b>		
Standard Length (mm) = 0.877 * Total Length (mm) - 0.41	438	0.991
Whole weight (g) = 0.000004 * Standard Length (mm) ^ 3.311	47	0.960
<b><i>Salmo salar</i></b>		
Standard Length (mm) = 0.954 * Fork Length (mm) - 2.85	81	0.997
Whole weight (g) = 0.000018 * Standard Length (mm) ^ 2.965	75	0.998
Whole weight (g) = 0.000008 * Fork Length (mm) ^ 3.082	75	0.998
Gutted weight (g) = 0.000089 * Standard Length (mm) ^ 2.566	41	0.908
<b><i>Thymallus thymallus</i></b>		
Standard Length (mm) = 0.959 * Fork Length (mm) - 3.90	173	0.999
Whole weight (g) = 0.000023 * Standard Length (mm) ^ 2.863	157	0.987
Whole weight (g) = 0.000011 * Fork Length (mm) ^ 2.969	157	0.986
Gutted weight (g) = 0.000073 * Standard Length (mm) ^ 2.637	30	0.972

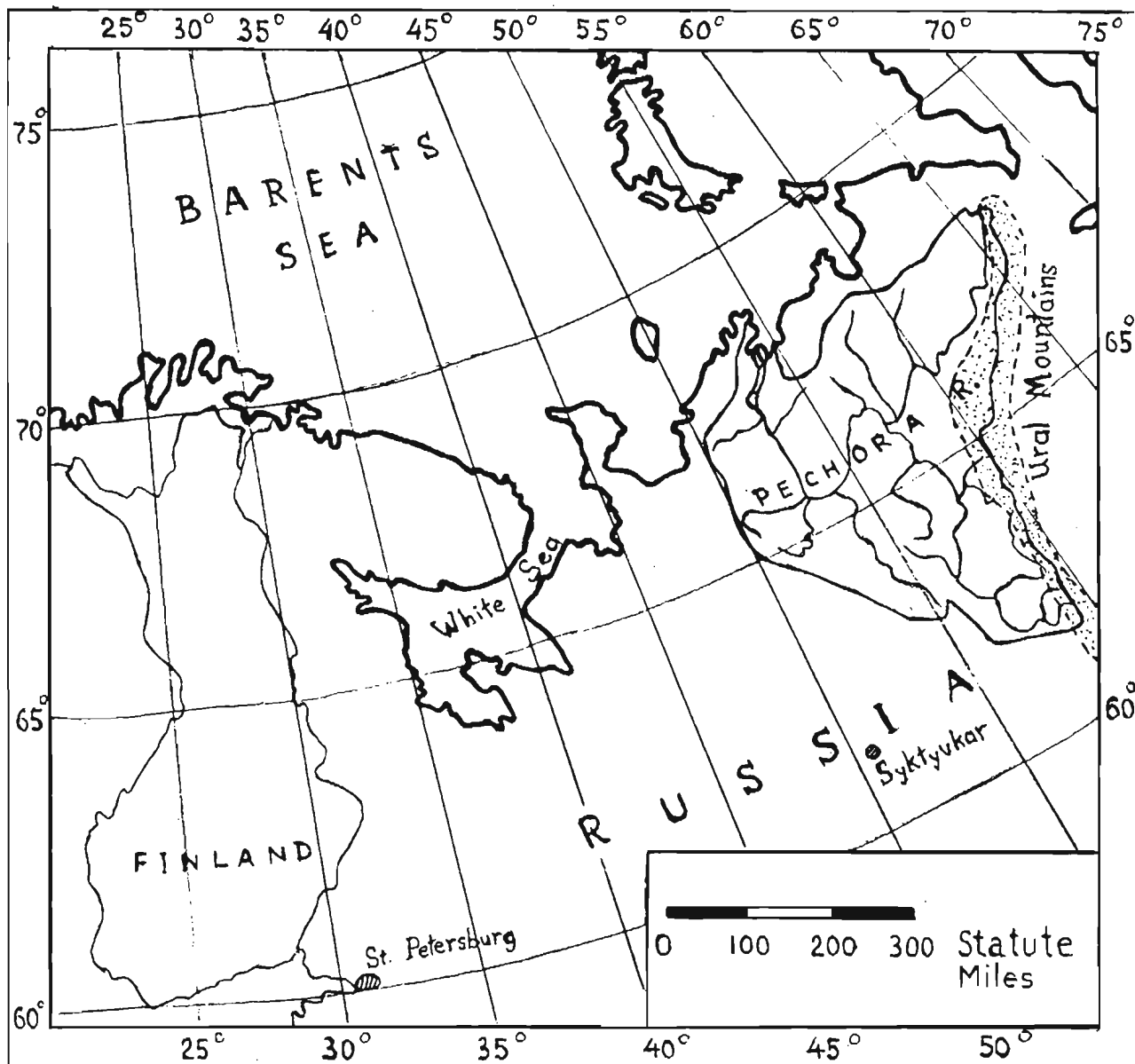


Figure 1. Location of Pechora River within the Barents Sea region of Russia.



Figure 2. Location of electrofishing stations on the Pizhma River, Pechora River basin, Russia.

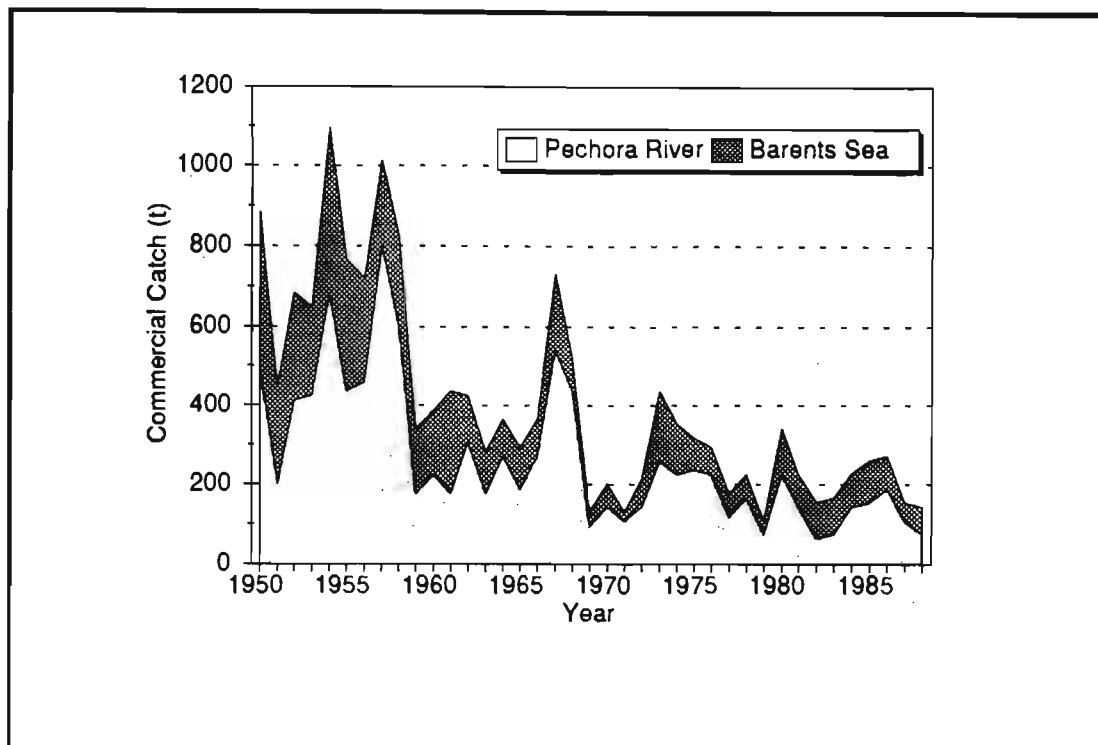


Figure 3. Total commercial catch (t) of Atlantic salmon in the Barents Sea basin (including Pechora River) and in the Pechora River itself, 1950 to 1988 (from Martynov 1990).

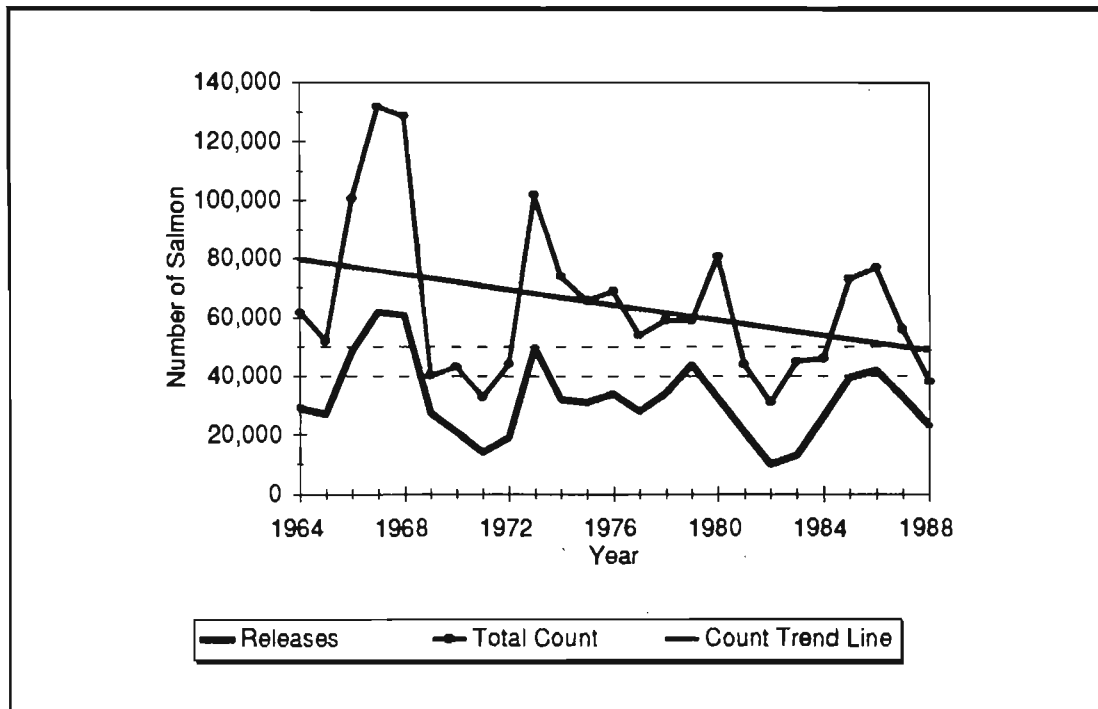


Figure 4. Total count, releases and trend in the total count of Atlantic salmon from the Pechora River commercial trapnets, 1964 to 1988 (from Martynov 1990).

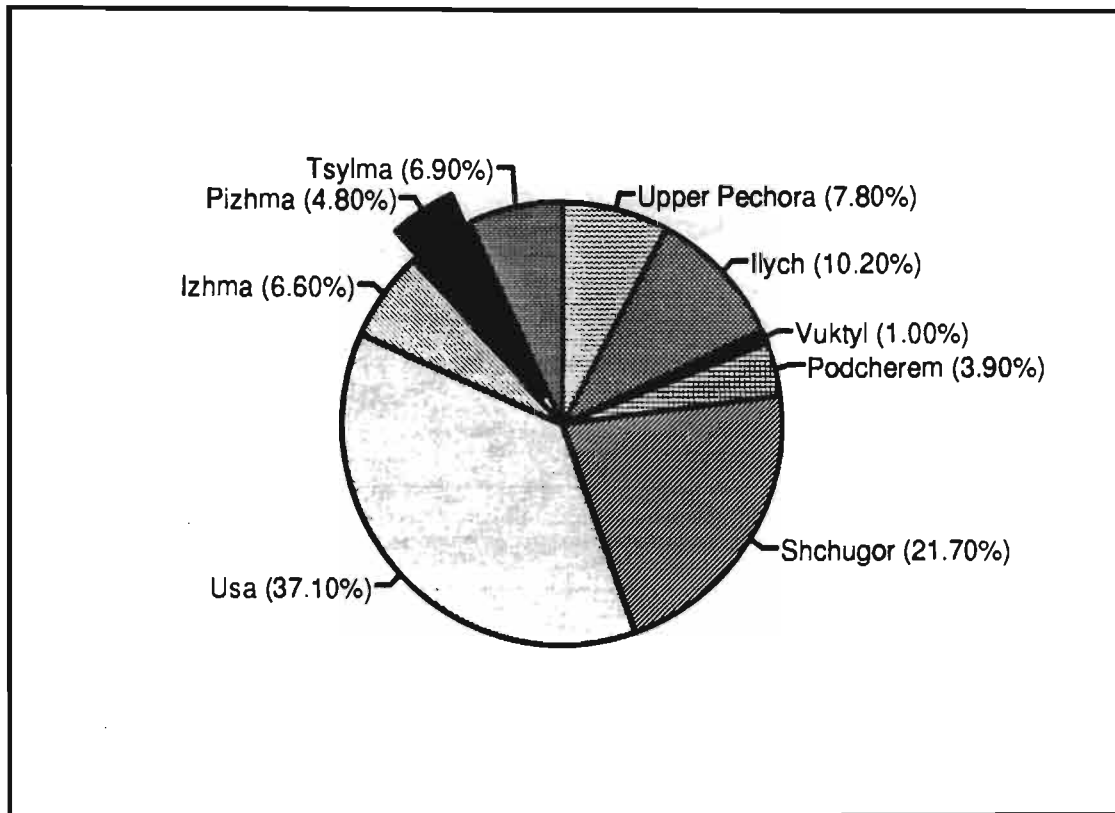


Figure 5. Distribution of spawning and rearing areas in the Pechora River basin. The total spawning and rearing area has been estimated at 14,371 ha (from Martynov 1983).

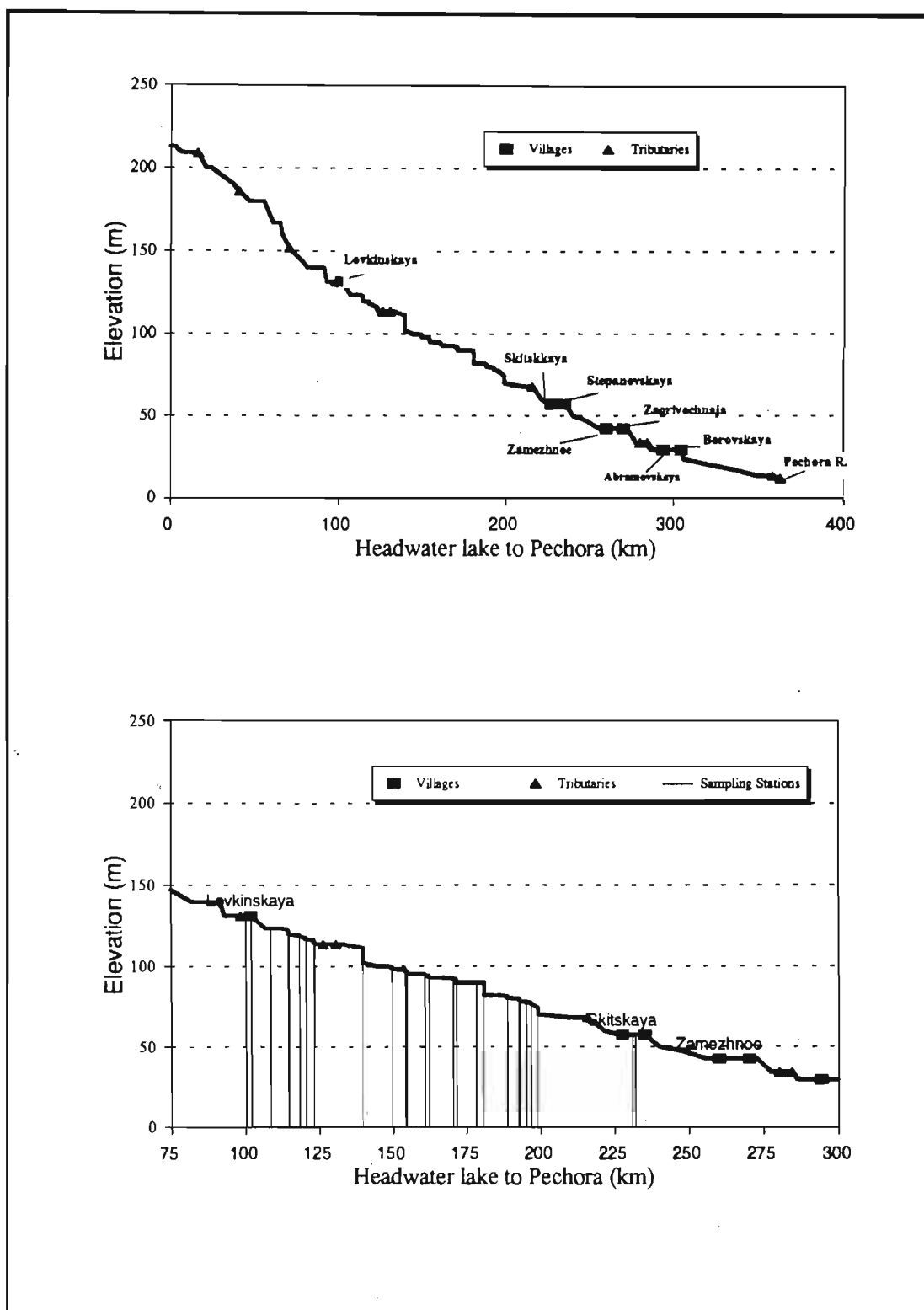


Figure 6. Pizhma River gradient profile with location of 1993 electrofishing stations.

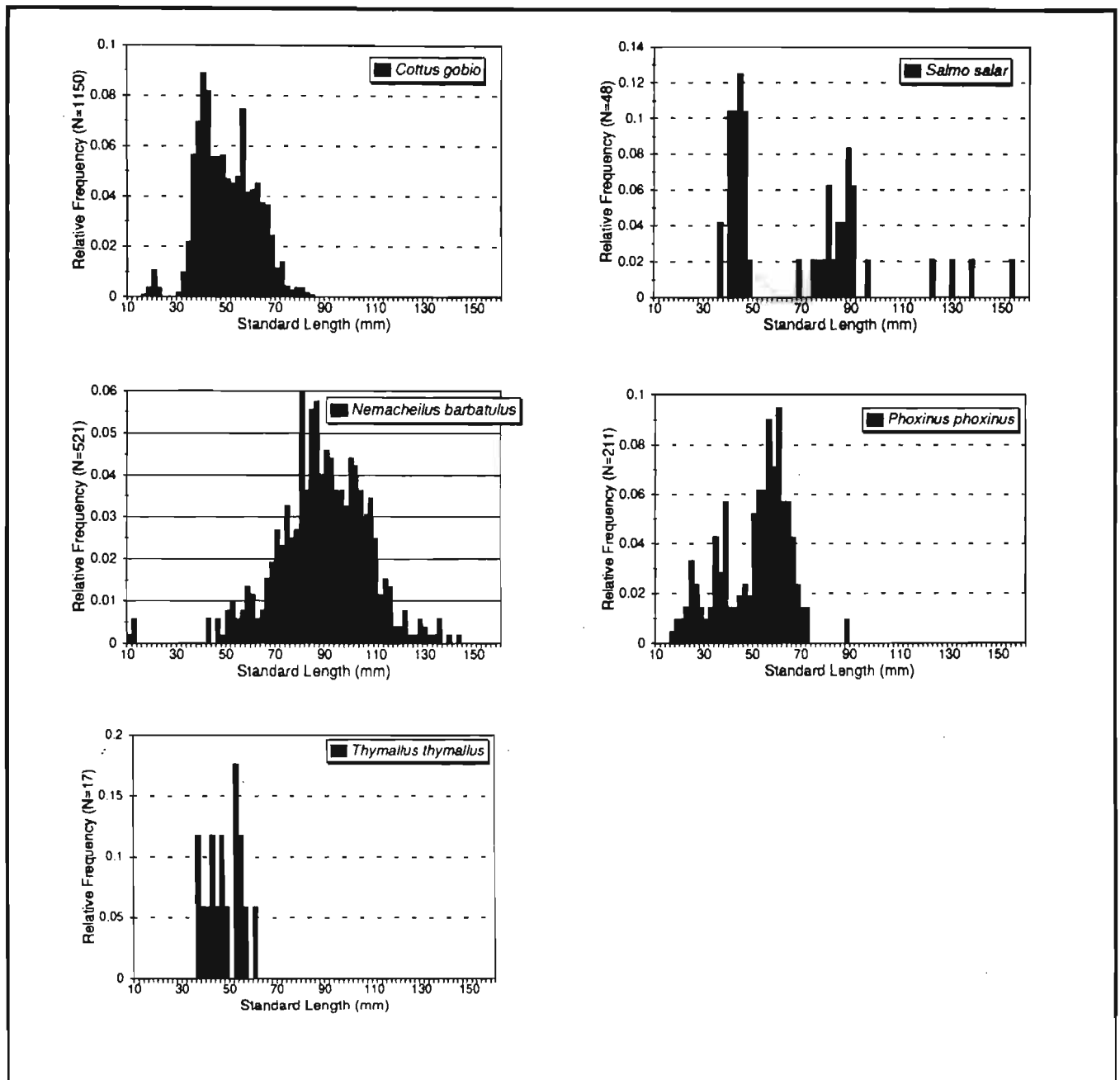


Figure 7. Absolute number of fish by species and standard length sampled by electrofishing from the shallow rapids and riffles of the Pizhma River, Pechora River basin, August 1993.



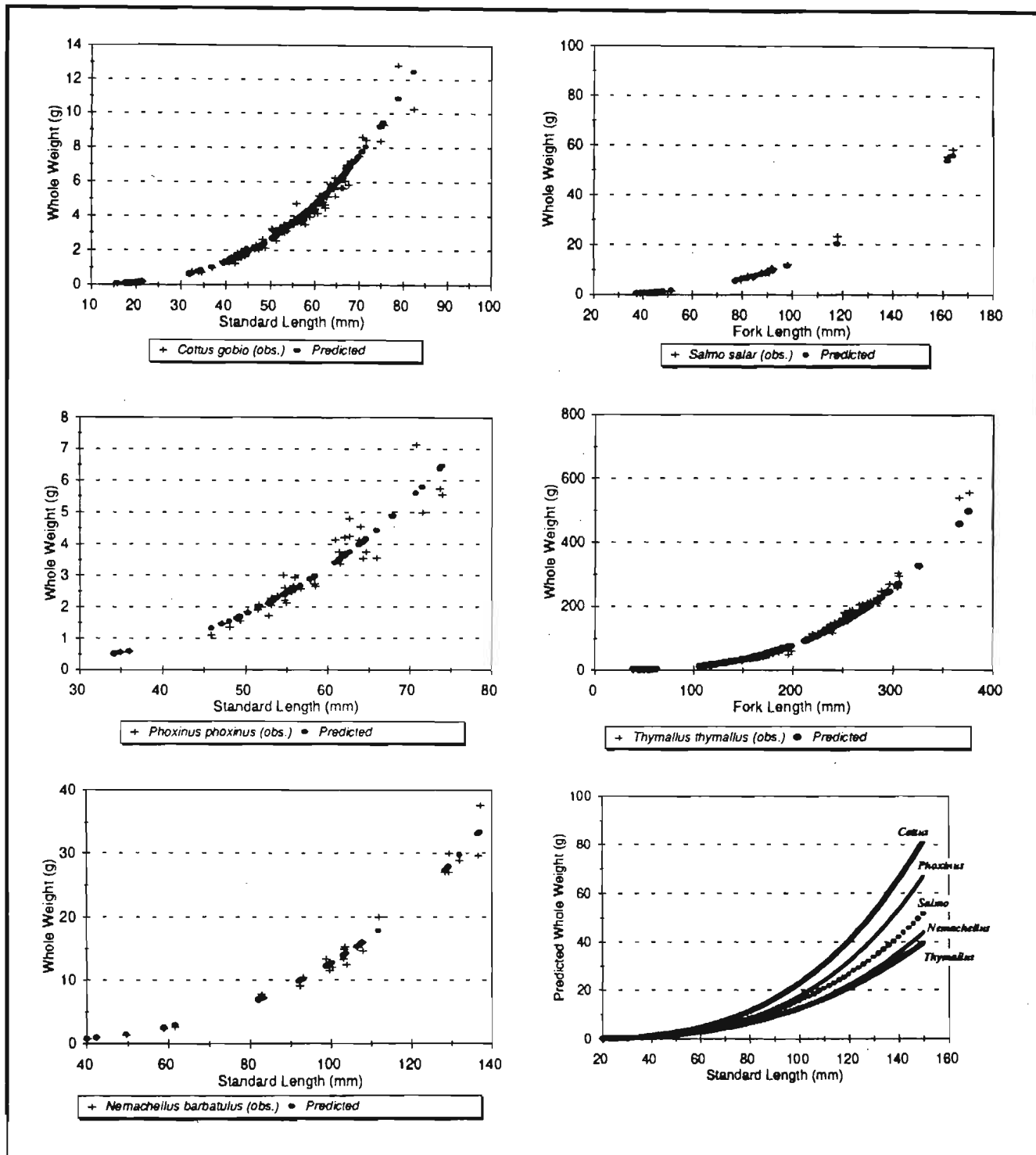


Figure 8. Weight/length relationships for the five fish species encountered in the shallow rapids and riffles of the Pizhma River, Pechora River basin, Russia, 1993.

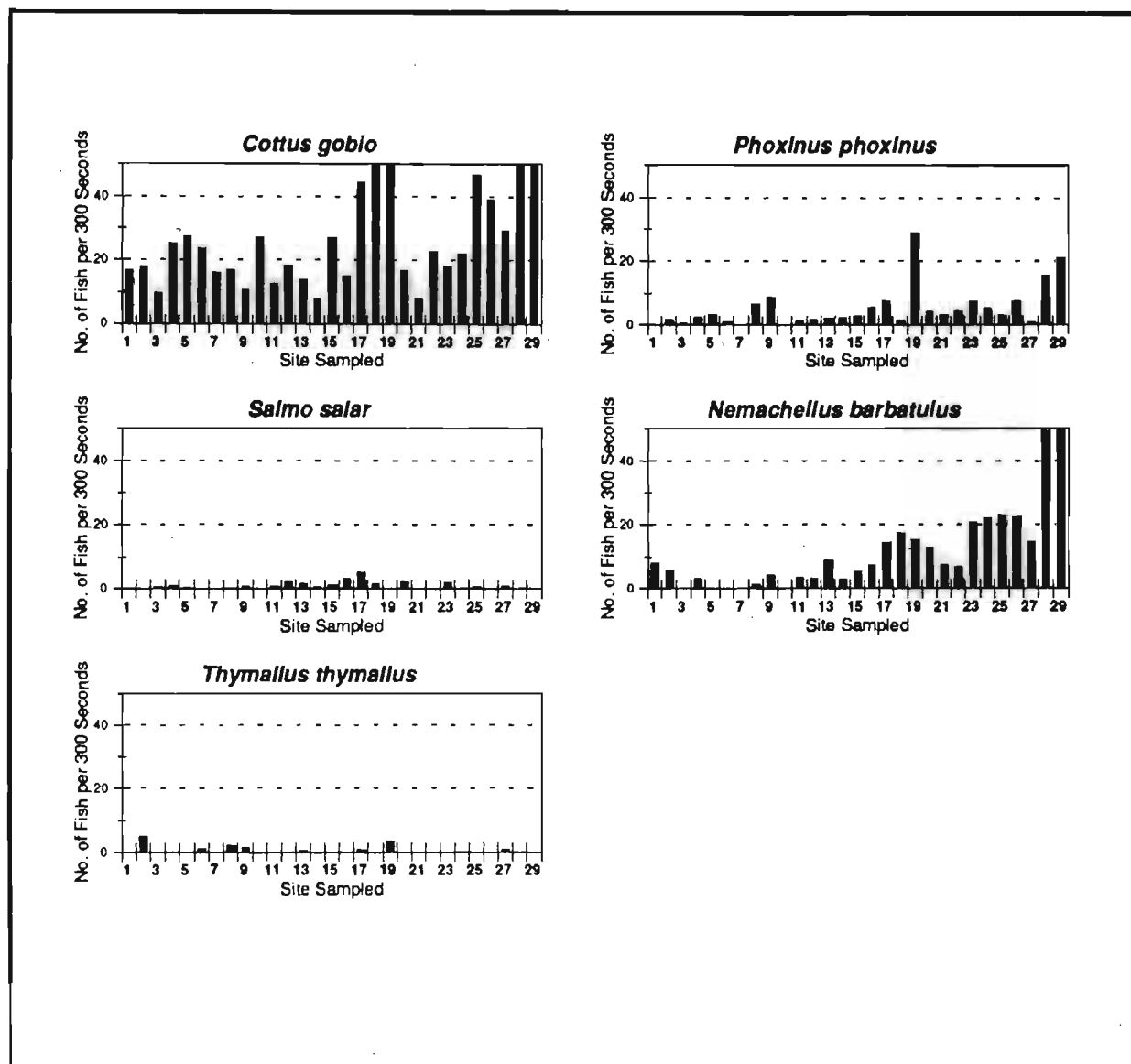
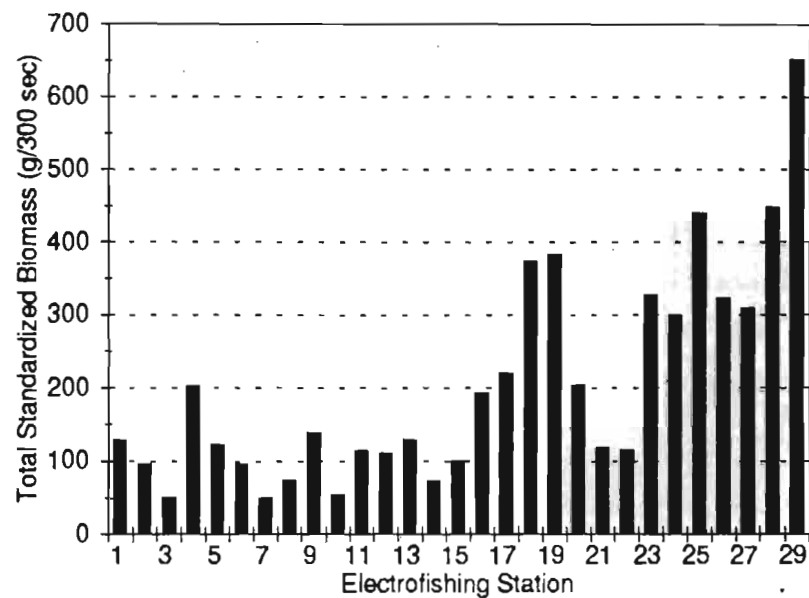


Figure 9. Abundance (number of fish per 300 seconds of fishing effort) of the five fish species encountered during the electrofishing surveys of the shallow rapids and riffles, Pizhma River, Pechora River basin, 1993.



Proportion of total biomass

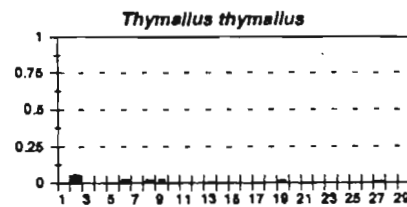
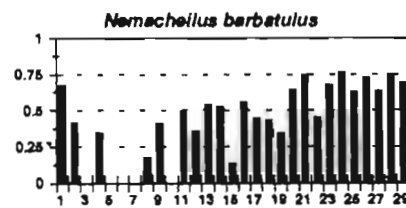
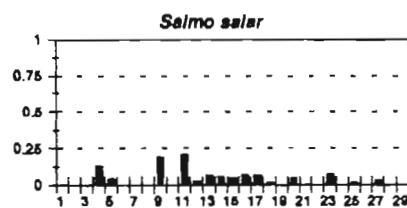
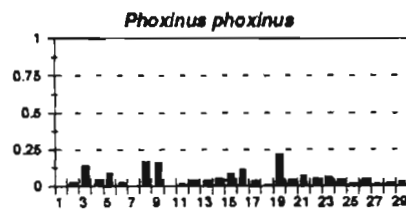
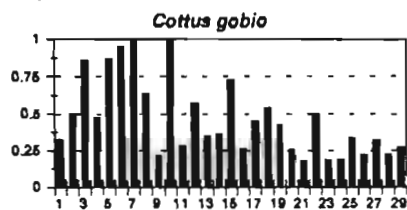


Figure 10. Total biomass and proportion of total biomass of the five species of fish sampled from the shallow rapids and riffles of the Pizhma River, Pechora River basin, 1993.

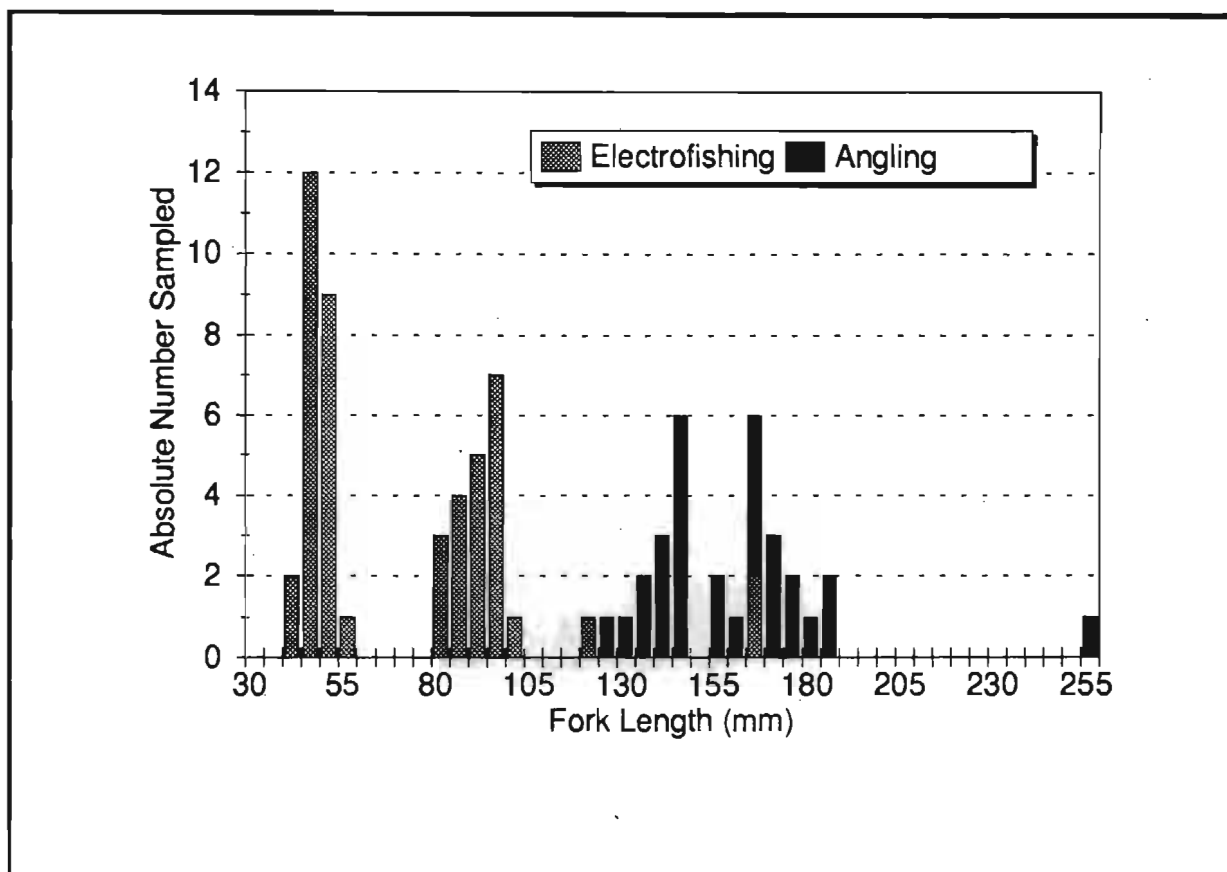


Figure 11. Comparative number of Atlantic salmon juveniles by size sampled by angling and electrofishing in the Pizhma River, Pechora River basin, August 1993.

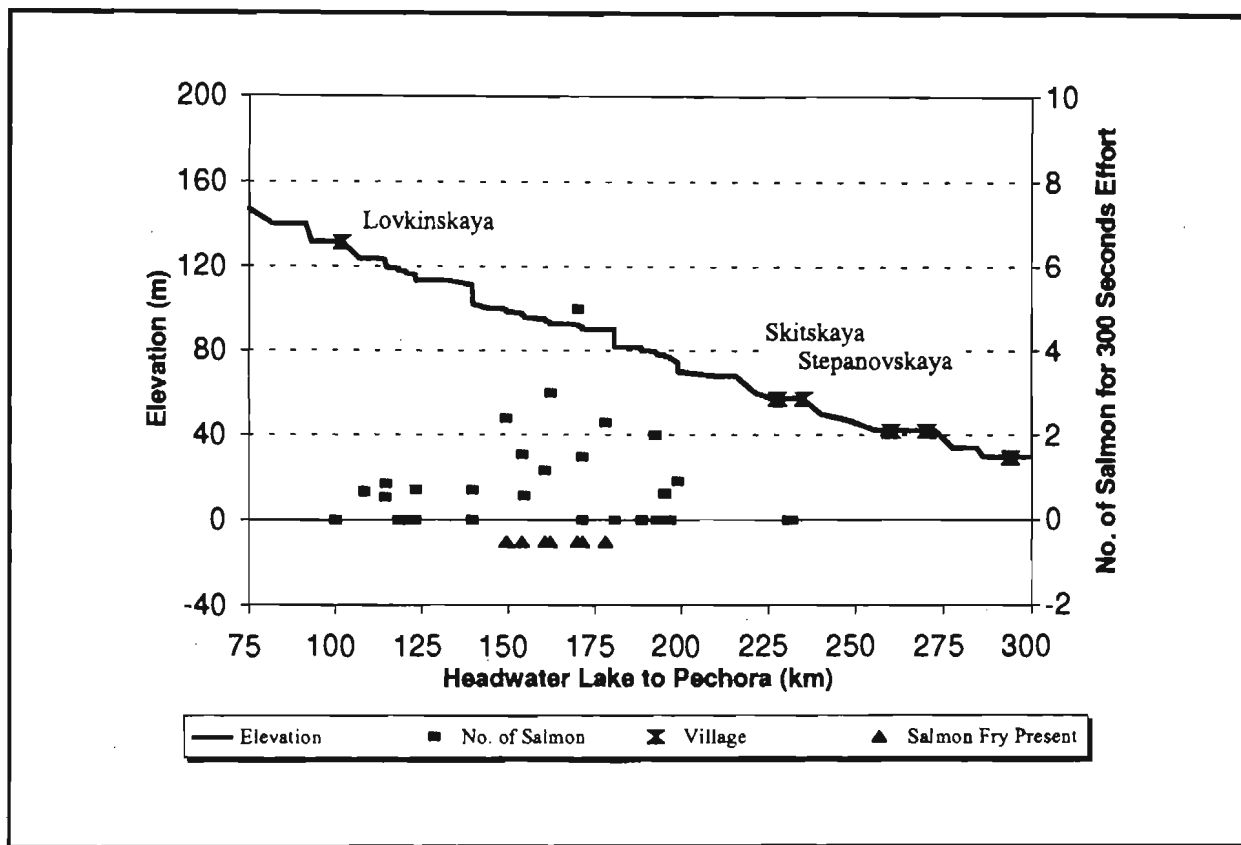
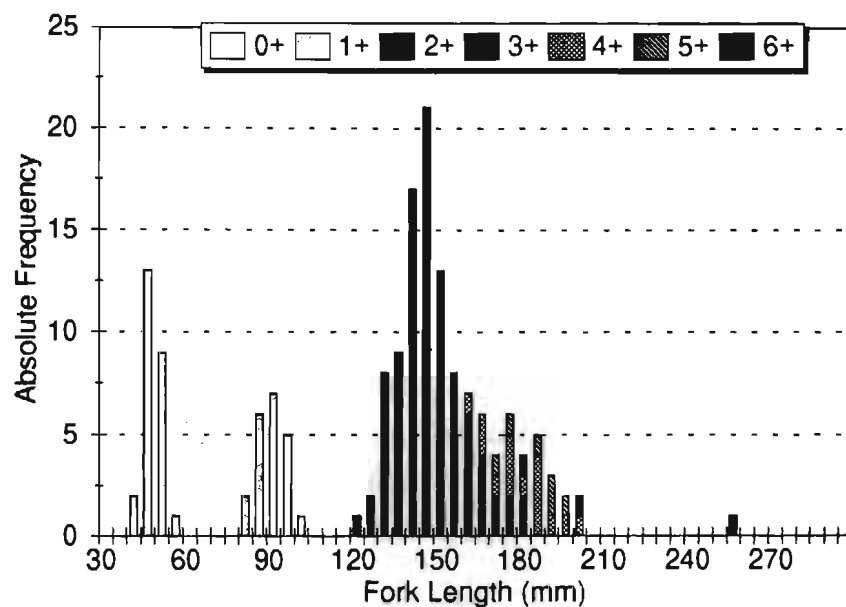


Figure 12. Abundance of Atlantic salmon juveniles at the sampling sites along the Pizhma River, Pechora River basin, August 1993.



Age	Length (mm)			Weight (g)			N	Sex and Maturity (% of Samples)		
	Mean	Min.	Max.	Mean	Min.	Max.		Female	Male	
								Immature	Immature	Precocious
0	44.4	38	51	0.9	0.5	1.5	25	40%	60%	0%
1	87.0	78	95	7.9	5.4	10.8	21	52%	38%	10%
2	140.6	120	160	35.5	35.5	22.0	77	55%	8%	37%
3	160.2	138	180	53.7	36.5	71.7	18	17%	0%	73%
4	176.8	158	200	74.5	57.4	97.0	15	0%	0%	100%
5	182.4	169	195	86.4	69.1	106.1	6	0%	0%	100%
6	209.1	177	251	134.0	77.7	224.1	3	0%	0%	100%

Figure 13. Age, length, weight, sex and maturity of Atlantic salmon parr sampled from the Pizhma River, Pechora River basin, August 1992 and 1993.

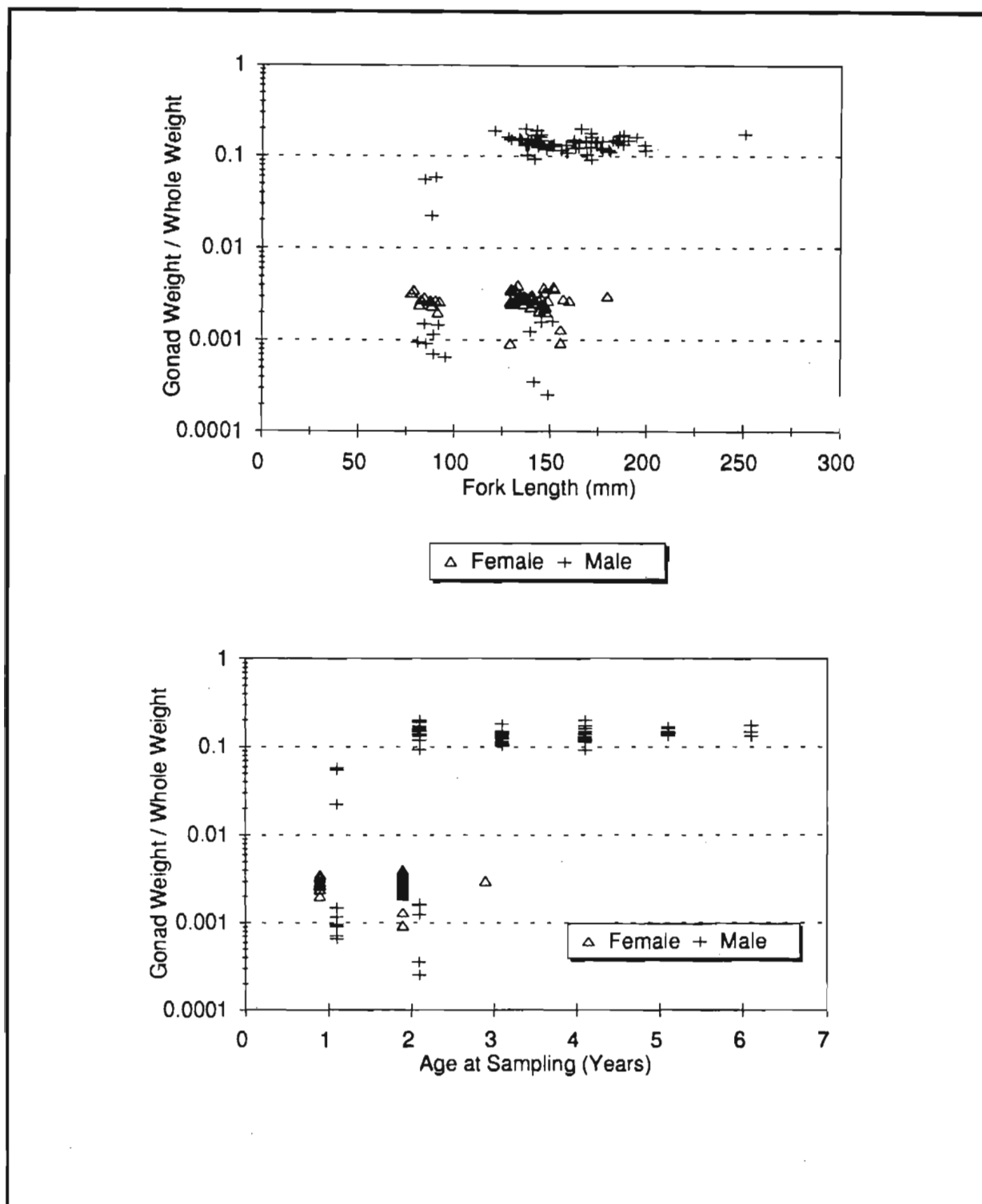


Figure 14. Gonadal development (gonad weight / whole weight) of male and female Atlantic salmon parr according to fork length and age, from the Pizhma River, Pechora River basin, August 1992 and 1993.



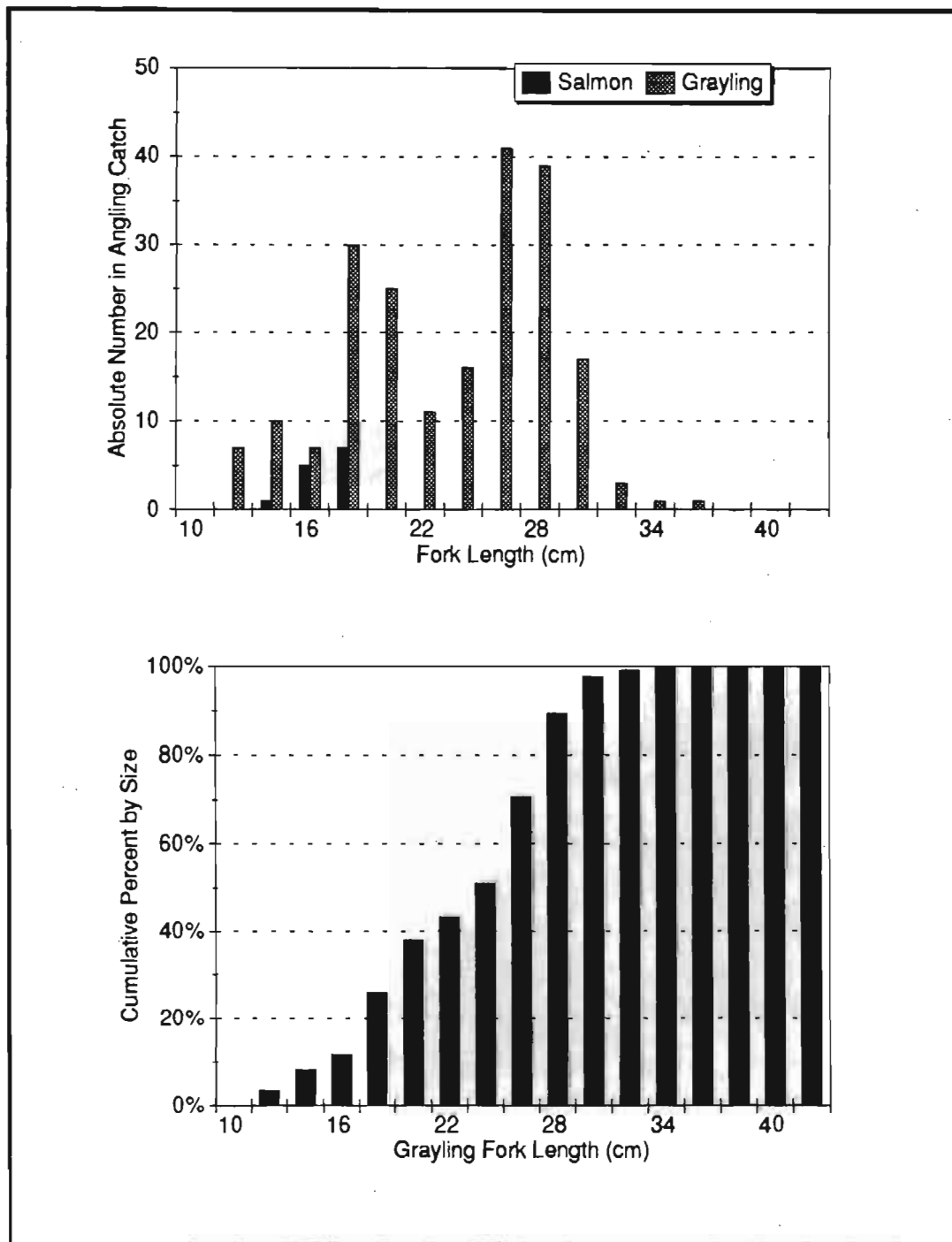


Figure 15. Absolute number of grayling and salmon parr, by size, and cumulative percent, by size, in the angling catch of one local fisherman on the Pizhma River, August 1993. All fish were kept as an indication of the relative size distribution of salmon parr and grayling in the deeper rapids of the river.

**APPENDIX I.** Taxonomic classification and brief life history of fish species encountered in the shallow rapids and riffles of the Pizhma River, Pechora River basin, Russia. Classification based on Banarescu et al. (1971). General life history from Wheeler (1969). Good illustrations of the body form and geographic distribution are available in Banarescu et al. (1971).

Scientific Name	Common Name	
	English	Russian
<i>Salmo salar</i> (Linnaeus 1758)	Atlantic salmon	Losos
F. Salmonidae                      O. Salmoniformes	S.O. Protacanthopterygii	Cl. Teleostei

General life history is described in the present document. Extensive literature available on life history of Atlantic salmon in the Northwestern Atlantic.

<i>Thymallus thymallus</i> (Linnaeus 1758)	Grayling	Kharius
F. Thymallidae                      O. Salmoniformes	S.O. Protacanthopterygii	Cl. Teleostei

Popular angling fish, attaining weights of 2.25 kg. Prefers clear, swift-running waters. Spawns in spring. Food composed of both bottom and drifting fauna including amphipods, molluscs, ephemeroptera nymphs, trichopeteran and simuliid larvae and terrestrial insects. Successfully coexists with trout and salmon.

<i>Esox lucius</i> (Linnaeus 1758)	Pike	Shtschuka
F. Esocidae                      O. Salmoniformes	S.O. Protacanthopterygii	Cl. Teleostei

Favoured sport fish because of its wholly carnivorous diet and its size which can exceed a length of 100 cm and weight of 14 kg. Feeds on all fish species depending on availability. Spawning in early spring.

<i>Phoxinus phoxinus</i> (Linnaeus 1758)	Minnow	Goljan
F. Cyprinidae                      O. Cypriniformes	S.O. Ostariophysi	Cl. Teleostei

Generally found in streams with gravelly bottom and clean flowing water. Spawn in spring. Attain lengths of up to 11 cm. Diet consists of insects and their larvae as well as diatoms, filamentous algae and higher plants. No sport fishing value except as bait.

# APPENDIX I (continued).

Scientific Name	Common Name	
	English	Russian
<i>Nemacheilus barbatulus</i> (Linnaeus 1758)	Stone loach	Goletz
F. Cobitidae                      O. Cypriniformes	S.O. Ostariophysi	Cl. Teleostei

Occurs in clear water of small streams on sandy, mud or stone bottom. Lives under larger stones or in dense weed. Attains lengths of 11 cm. Spawns in spring. Feeds almost entirely on bottom-living invertebrates including chironomid larvae, ephemeropteran and plecopteran nymphs. No direct economic importance but is fairly sensitive to pollution.

<i>Perca fluviatilis</i> (Linnaeus 1758)	Perch	Okun
F. Percidae                      O. Perciformes	S.O. Acanthopterygii	Cl. Teleostei

In ponds, lakes and slow to moderate flowing rivers and streams. Spawn in early spring. Predators throughout their life, at first on invertebrates followed by various aquatic insects, small fish and fry of larger species. May attain lengths exceeding 30 cm. Frequently exploited by anglers.

<i>Cottus gobio</i> (Linnaeus 1758)	Bullhead or sculpin	Podkamenshtschik
F. Cottidae                      O. Scorpaeniformes	S.O. Acanthopterygii	Cl. Teleostei

Common on hard, stony bottoms in streams with moderate to weak flow. Spawns in spring and attains lengths up to 9 cm. Feed mainly on bottom-dwelling invertebrates including crustaceans, nymphs and insect larvae. Lives in places selected by salmonid fishes for spawning but eggs and alevins of salmonids are rare in the diet.