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Short communication

Overall changes in the fish species composition of the Kolva River catchment area

By A. M. Zakharov[1], A. A. Lukin[2,3], J. N. Sharova[2], G. N. Christiansen[4], G. A. Dahl-Hansen[4] and L. A. Belicheva[5]

[1]*The Institute of Biology, Komi Science Center, Russian Academy of Sciences, Syktyvkar, Russia;* [2]*Akvaplan-niva Barents, Murmansk, Russia;* [3]*Institute of North Industrial Ecology Problems, Kola Science Centre, Russian Academy of Sciences, Apatity, Russia;* [4]*Akvaplan-niva, Tromso, Norway;* [5]*Northern Water Problems Institute, Karelian Science Center, Russian Academy of Sciences, Petrozavodsk, Russia*

Introduction

The Kolva River flows through the territory of the Nenets Autonomous Area, and is a tributary of the Usa River (Pechora River Basin). With a length of 546 km and catchment area of ca 18 000 km^2, it originates in the Yaneimusyr Elevation and flows through the Bolshezemelskya tundra to the south. Numerous accidents on oil pipelines have occurred in this area since the 1990s, with a major oil accident in August 1994, whereby according to different estimates between 100 and 200 000 tonnes of crude oil entered the environment (Lukin et al., 2000; Zakharov et al., 2002). The accidental discharge resulted in serious damage to the Usa River (first-order tributary of the Pechora River) and its right-bank tributary, the Kolva River (second-order tributary). After this 1994 oil spill, downstream of the Kolva River was the most polluted territory and where an intensive cleaning of the water and river bottom and slopes took place. There are many different – or even opposing – opinions on the consequences of oil spill contamination to natural ecosystems. In our point of view, the actual changes can only be determined based on long-term observations. As a result, the Kolva River, having received such huge crude oil spills (1994–1995), is still under chronic oil pollution and can serve as a model for investigation. The aim of this work is to assess the changes in the fish community of the Kolva River affected by chronic oil pollution.

Materials and methods

Fieldwork in the downstream Kolva River was carried out in 1995, 1997, 2005 and 2007 (Fig. 1). Collected data were compared with that of the mid-20th century, at a time when the water quality was unaffected (Kuchina and Solovkina, 1959; Solovkina, 1962). The Kolva is mainly fed by snowmelt. The river freezes in late October and the ice breaks up in late May or the beginning of June. Thus the period of open water lasts about 5 months. The samplings were carried out during two periods of the open water season: from June to July, and from September to October.

In both sampling times the fish from the two sites were caught by seine (length 50 m; mesh size 6 mm). The fishing grounds were of standard length of about 100 m and approx. 1000 m^2. The drag net covered 20 m of the riverside. The total area of the studied water was about 1000 km^2 for each sampling station. At river sites with low velocity and in creeks, standard nets set with 20, 25, 30, 35, 40 and 45 mm stretched mesh were used in addition to seining. Fish ages were assessed using sqama collected from the base of the dorsal fin. The age of burbot (*Lota lota*) was identified by otoliths. A total of 300 fish specimens were collected each year of the study.

Results and discussion

The Kolva River fish community is represented by 18 species, which demonstrates a non-uniform distribution along the catchment area. Three conventional geographical environments that differ in the dominant fish species can be emphasized:

1. the lake-river systems (e.g. Kolvinskie tundra lakes), where whitefish (*Coregonus lavaretus*), broad whitefish (*Coregonus nasus*), peled (*Coregonus peled*), pike (*Esox lucius*), roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*) make up the principal ichthyofauna;
2. the Kolva River tributaries system, where grayling (*Thymallus thymallus*), pike, perch and minnows (*Phoxinus phoxinus*) are typical fish species;
3. the Kolva River mainstream, where vendace (*Coregonus albula*), ide (*Leuciscus idus*), roach, perch and minnows predominate. At the same time the Kolva mainstream is a spawning area and feeding migration path for coregonid species in the system of lakes, the Kolva River and the Usa River. Therefore a great number of young whitefish is present in the mainstream test-catches.

During the last decade the fish community structure in the downstream area of the Kolva River has changed significantly. In the mid-20th century, the fish community was completely dominated by species of the Coregonidae family: whitefish and vendace. Until the end of the 20th century the fish population structure and species composition remained practically the same. The number of registered fish species was still 18 in the test-fishing catches carried out in 1995 (post-accident period). However, after 1995 the fish species diversity began to decrease, with a tendency continuing to the present. In 2000 the total number of fish species in the catches decreased to 12. Species such as nelma (*Stenodus leucichthys nelma*), peled, stone loach (*Barbatula barbatula*), lamprey (*Lampetra fluviatilis*) and nine-spined stickleback (*Pungitius pungitius*) were no longer found. It should be noted that the aforementioned fish species were not predominant in the fish community, whereas the comparison of species normally dominant in the river mainstream is more interesting. According to the catches until

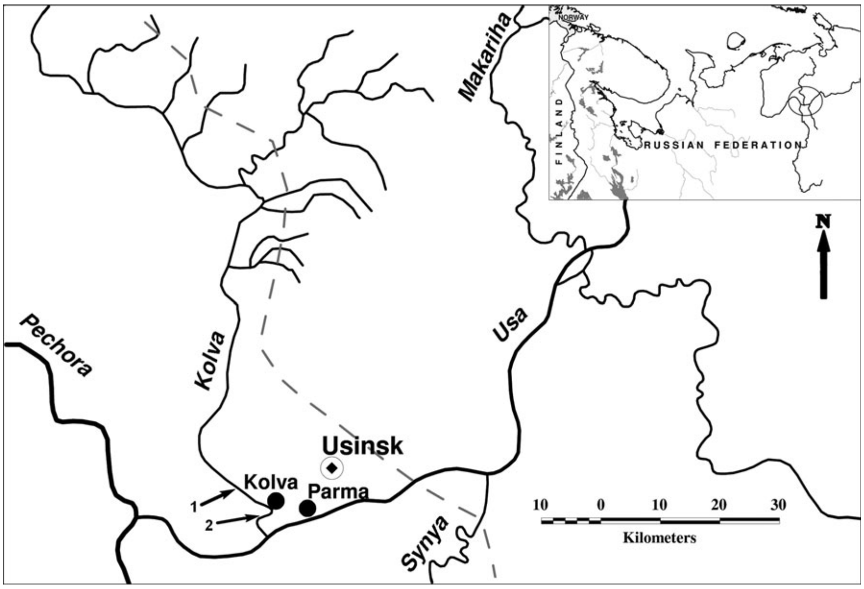

Fig. 1. Study area and location of two sites (1 and 2) for the investigation of the Kolva River, Nenets Autonomous Area

the year 2000 in the Kolva River, the fish community core consisted of grayling, whitefish, vendace, broad whitefish, roach, perch, pike, ide, and burbot. In 2005 and 2007 only nine fish species were found in the test-fishing catches from the Kolva River. Species such as the broad whitefish, burbot (*Lota lota*) and European bullhead (*Cottus gobio*) in earlier catches were no longer found. Thus, the catch composition has changed over the past 60 years.

It should be noted that the composition of fish species, which represent the core fish community in the period from 2000 to 2007, remains stable and includes vendace, whitefish, ide, ruff and perch. Pike, minnow and grayling are still rare. However, analysis of different fish species composition in the catches shows not only changes in fish species diversity, but quantitative changes as well (Fig. 2).

In the studied area of the downstream Kolva River the percentage of vendace in the catches carried out in the 1997–2005 open season decreased from 85 to 0.7% at the first site and from 63.8 to 7.5% at the second site. Nelma was not found in the 2005 catches. The abundance of immature whitefish

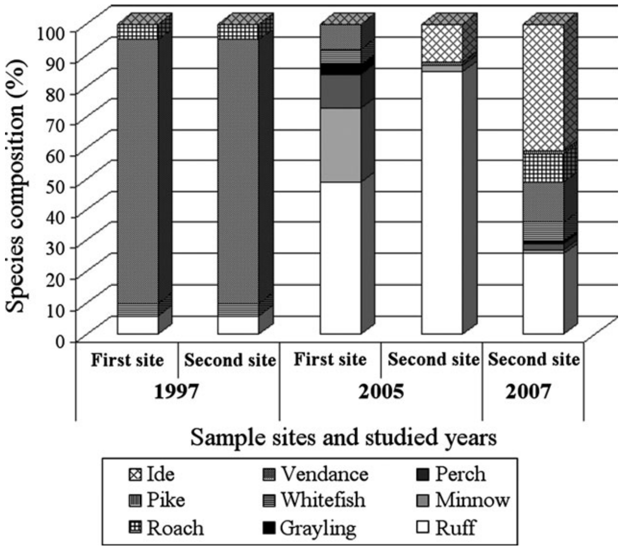

Fig. 2. Structure and species composition of the fish community, Kolva River sites, post-accidental oil spill

decreased from 12.1% in 1997 to 5.0% in 2005 at site 2, and at site 1 there were no young whitefish whatsoever in 2005. At the same time, the opposite tendency was observed with regard to ruff: in both studied areas their numbers increased sharply from 6.3 to 84.7% at site 1 and from 1.7 to 47.5% site 2. Also, ide abundance significantly increased to 11.7% (Fig. 2). In 2005 an increased contribution of minnow and perch percentage was revealed as well. Thus, coregonids (whitefish and vendace) that previously dominated the fish fauna were replaced by perch (ruff, perch) and cyprinids (ide and minnow) in 2005 (Fig. 2).

Analyses of catch composition in 2007 showed that the abundance of different fish species had changed (Fig. 2). In 2007 the vendace abundance increased from 1 to 13%, ide from 12 to 41%, and the proportion of roach increased from 0.1 to 9% in the studied area of the Kolva River in comparison with 2005. In 2007 whitefish made up 6% of the total catch. In 2007 only one specimen of European grayling was found in the catches. The 2007 investigation data also showed relatively low abundance of minnow, perch and pike.

Comparative analyses of the age structure of different fish species in the 1955, 1995 and 2007 catches showed that a sharp rejuvenation of almost all fish species inhabiting the downstream area of Kolva River occurred (Table 1). Decreases in age groups and maximum age of fish were observed, as well as the increase in the abundance of young fish. This tendency was revealed not only in the dominant fish species such as ide, roach, perch, pike, whitefish and vendace, which have always determined the catch compositions, but also in those species with low numbers, such as broad whitefish and peled. In the mid-20th century catches, the roach middle age was 7+ (in an age series from 2+ to 11+), whereas in the 1995 catches the fish aged 5+ (in an age series from 4+ to 7+) predominated (Table 1). In the 2007 samples the roach middle age decreased to 4+ (in age classes from 2+ to 7+) (Table 1). A similar situation was observed in relation to the age structure of ide, pike, whitefish, and perch, i.e. the main commercial fish species (Table 1).

From our point of view, these revealed changes in fish species composition of the Kolva River can be related to the increase in anthropogenic load since the 1960–70s, associated mainly with the development of oil and gas production and

Table 1
Age structure (%) of various fish species caught in Kolva River, 1955–2007

Fish species	Year of sample	Age structure (%)													
		2	3	4	5	6	7	8	9	10	11	12	13	14	15
Roach	1955	5	24	30	3	0	11	8	5	11	3	–	–	–	–
	1995	0	0	2	81	15	2	0	0	0	0	–	–	–	–
	2007	4	25	42	25	0	4	0	0	0	0	–	–	–	–
Pike	1955	0	0	18	64	6	12	–	–	–	–	–	–	–	–
	1995	33	67	0	0	0	0	–	–	–	–	–	–	–	–
Whitefish	1995	20	48	12	20	–	–	–	–	–	–	–	–	–	–
	2007	67	33	0	0	–	–	–	–	–	–	–	–	–	–
Ide	1955	0	5	6	2	1	13	15	21	15	11	7	2	1	1
	1995	0	6	57	25	6	6	0	0	0	0	0	0	0	0
	2007	0	57	0	43	0	0	0	0	0	0	0	0	0	0

transportation in the region. Chronic oil pollution in the Kolva River has been observed for the past 30 years (State Report, 2007). Thus, in the period 1979–1983 the concentration of total hydrocarbon content in water samples exceeded the maximum permissible level for fishery water bodies (0.05 mg L^{-1}) by more than five-fold (Barenboim et al., 2000). In 1990s the average total hydrocarbon concentrations in the Kolva River exceeded the set standards by two- to eight-fold, and in the most severe cases, an excess of 72-times the maximum permissible level was observed. At present, through the accidental oil spills elimination service organization, the content of oil products in the Kolva River is either just under or at the rate of maximum permissible levels. However one- to five-fold excesses were observed during 2007 (State Report, 2007). According to our investigations (Lukin et al., 2011a) carried out on the territory of the Pechora River Basin, including Kolva River downstream (at the same sampling sites described in the present study), the excess in the permissible level of oil products pollution in the Kolva River of autumn 2008 was reached more than six times. Moreover, our investigation of hydrocarbon products and their derivatives carried out in the same sampling sites (Lukin et al., 2011b) also showed accumulation in fish of such substances as organochlorine compounds, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons in the liver and muscles tissues of Kolva River fish in 1997 as well as in 2008.

Affected by oil pollution for decades, long-term changes in the Kolva River fish community in the catchment area are noteworthy of study. Changes in fish species composition and community structure, as well as a shift in the dominant species in the polluted part of the Kolva River, show high susceptibility of whitefish to oil hydrocarbon exposure. The decrease in abundance of these fish species can be induced by the effect of oil products and their derivatives both directly on fish organisms and indirectly with the reduced success in spawning and ensuing population decrease. Fish species more resistant to these types of pollution have the advantage; in the Kolva River, cyprinids (ide) and perches (perch) are among these. Susceptibility of fish from different families vary; in the studied river area they can be ranked in the order of: coregonids > graylings > pikes > perches > cyprinids. The more resistant perch and cyprinid species gradually occupy the available environmental niches.

Moreover, as of 1955 a significant decrease in age parameters of the studied fish has occurred; however, no changes in commercial fishing pressure have been observed. Observed absence of fish in higher age groups, appearance of large quantities of young individuals, and early sexual maturation were revealed in all studied fish, typical examples of the chronic anthropogenic impact. Previous investigations in pollution zones of the Kola Peninsula showed that early maturation of fish demonstrated energy resource deficiency, affecting the support of the somatic and generative metabolism. Thus, conditions of chronic intoxication leading to additional energy expenditures for vital activity and survival of fish were observed (Lukin et al., 2000, 2006; Moiseenko et al., 2002). This similar phenomenon seems to be typical for the Kolva River.

On the whole it can be concluded that the structural changes revealed in the fish community in the anthropogenic waterbodies, compounded by the ongoing chronic pollution, are of a long-term and probably irreversible nature.

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Author's address: J. N. Sharova, Akvaplan-niva Barents, Kolsky 10, 184000 Murmansk, Russia.
E-mails: jul.sharova@yandex.ru; jsharova@inbox.ru