

# Preliminary data to assess the impact of beaver dams on fish migration and the formation of fish resources in the Middle Ob River flood plain (Tomsk Region)

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**Abstract.** Field research enabled the identification of habitat features and the density of beavers' habitats on a section of the Ob floodplain with an area of about 30 square kilometers. It was established that most beaver families live in lodges and regulate the water level at the sources of floodplain lakes by building dams. The research established that during the under-ice period in these lakes, the oxygen content decreases to below the critical level for the remaining lake-river fish, and dams are an obstacle to their migration to parts of the river system with a favorable oxygen regimen. An experiment was conducted with the descent of water through a dam built by beavers in the source of two floodplain lakes; the number and biomass of migrating fish were counted. On the basis of the obtained data on the species composition, size and weight of the fish, it is proposed that the damage to fish resources caused by the beaver dams in the Ob River floodplain may significantly exceed the commercial value of beavers.

## 1. Introduction

The natural habitat of the beaver (*Castor fiber* L) covers a significant part of Europe and Asia. By the beginning of the 20th century, beavers had practically disappeared from the greater part of the habitat. In the second half of the 20th century, effective measures were taken in Russia to revive the beaver population. As a result of the reintroduction and subsequent dispersal of the population, the beaver has been restored to a significant area of its range [1]. In a number of regions this is facilitated by the low commercial importance of this species. A significant increase in the number of beavers has also been observed in the basin of the middle reaches of Ob River within the boundaries of Tomsk Region, where it has spread practically throughout its territory. According to the Department of Hunting and Fishery of Tomsk Region, their numbers increased from 1,000 at the turn of the millennium to 10,000 by 2015-2016.

The process of reintroducing of the beaver is similar to the process of introducing alien species into formed ecosystems. It is well-known that the introduction of a new species can have a significant impact on the habitat of the native species and displace them [2, 3]. Beavers are one of the few species of mammals that purposefully produce habitat transformations, creating a specific environment. The consequences of the activity of this species of aquatic animals have been well studied in North America, Western Europe and the European part of Russia [4-10]. The identified features of the environment-transforming activity of beavers consist in the appearance of dams and the formation of reservoirs in the upper reaches, in local changes in the hydrological and hydrochemical regimen of watercourses, eutrophication, changes in hydromorphicity of soils, vegetation composition involving



even changes to the dominant complex, amphibians and waterfowl, hydrofauna, etc. It has been established that the activity of the beaver on small watercourses is an important factor causing cardinal changes in the biological organization of watercourses, which involves changes in the species composition and trophic structure of communities of aquatic organism [8-11]. The importance of developing methods for regulating this process was noted [12].

The significance of the environment-transforming activity of beavers on fish migration and the formation of fish communities has been noted [11, 13-15]. However, the available information is still insufficient to assess the intensity and scale of these processes in conditions of different habitats and their comprehensive assessment to determine the correlation of positive and negative impacts. This significantly complicates the ability to predict the consequences of the introduction of this species to eliminate in a timely fashion possible negative effects on fish and other resources.

Studies of the indirect impact of beavers are especially important as their impact is large and little studied. In addition, the results of existing studies do not allow the extrapolation of the obtained data to other regions, since the effects of beaver activity in conditions of different biotopes, morphology and hydrology of rivers and other factors may differ substantially. In particular, this relates to the Ob River floodplain within Tomsk Region, whose environment turned out to be conducive to inhabitation by beavers. There are numerous lakes on the vast Ob River floodplain, whose width reaches 30 km, many of which are connected to the river system by their origins. High productivity and a variety of herbaceous, shrubby and woody vegetation in conditions of decreasing intensity of agricultural use of the floodplain provide beavers with nourishment.

It should be especially noted that the Ob floodplain and floodplain lakes are also extremely important for the spawning and feeding of lacustrine-river fish, which form the basis of commercial fishing. Therefore, in the specific conditions of the Ob River floodplain and its tributaries, significant negative consequences of the construction activity of beavers in the form of certain losses of fish resources are possible.

The purpose of this study is to assess the harm to fish resources caused by the appearance of obstacles in the form of beaver dams, which prevent vital fish migrations along the sources from floodplain lakes with lack of oxygen to parts of the river system with a favorable oxygen regimen.

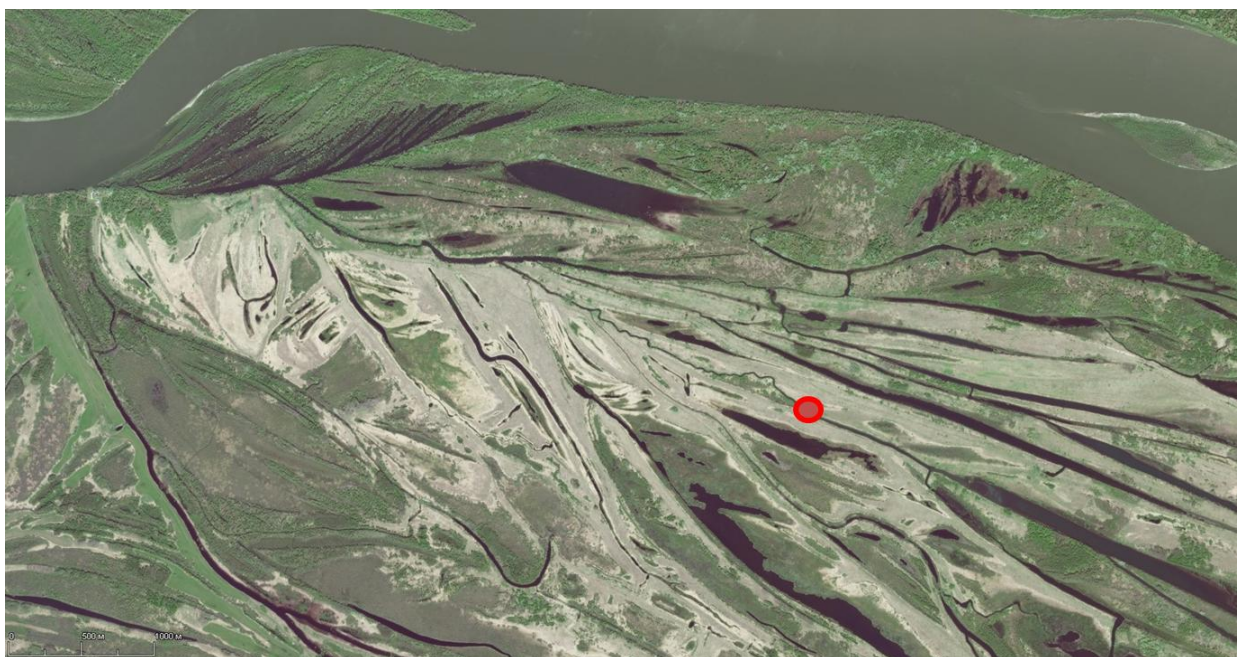
## **2. Materials and methods of the research**

The research was carried out on one of the sections of the Ob River floodplain between Nikolskoe village and the former settlement of Kaibasovo in the Krivosheinsky District of Tomsk Region in July-December 2016. Beavers were first observed in this area in the late 1980s.


The search for beavers' settlements and dams was carried out using all-terrain vehicles and a drone, with subsequent observations and refinements. Materials characterizing the lakes and their sources as a habitat for fish (including the determination of the oxygen content by a thermo-oximeter) were collected. The composition of the fish population of these reservoirs was studied using a set of nets with mesh of 14-55 mm.

The count of the fish population migrating in the Ob River was conducted in a stream flowing from the system of two connecting floodplain lakes (Picture 1) on the flow of water through a beaver dam. Prior to the count, the stream was blocked by an obstruction between both riverbanks made of wooden slats with gaps between them equal to 2.5 cm. A gap of 0.4 m was left between two walls of the lock in the center, through which the fish could slide freely. Periodically this gap was covered by a control fishing device.

The basis of the method for counting the number of migrating fish was a means of estimating the number of fish that passed through a certain length of time through the cross section of the watercourse [16]. The daily catches of each fish species were calculated using the formula  $N = \sum n * T$ , where  $N$  is the total number of fish that migrated per day,  $n$  is the number of fish in catches recorded per day, and  $T$  is the time interval between fish catches.



**Figure 1.** Satellite map of the research area

Key:  - location of the beaver dam

To calculate the commercial return from the migrating juveniles, the coefficients of the commercial return, given in the "Method of assessing the amount of harm ..." [17], were used. In order to catch fish of commercial sizes, the space between the walls of the obstruction were periodically (for 1 hour every 3 hours) overlapped with a muzzle (a wick of rods) with a gap between the rods of 3 cm.

To catch the juveniles below the obstruction, the stream was periodically (for 30 minutes every 3.5 hours) overlapped with a finger net made of 4 mm mesh. The obstruction for catching the juveniles was overlapped by a frame covered with a net with 20 mm mesh in order to prevent the entry of fish species into the finger net. The fish count was conducted from October 19 to November 1, 2016.

### 3. Results of the research

As the number of beavers increases, the hunting quota over the last 10 years increased from a quota of 20 beavers to 300 beavers for the hunting season (according to the Department of Hunting and Fisheries of Tomsk Region). The allocated quotas are used by a maximum of up to 50%.

There are at least 30 exorheic and drainless lakes with an area from 2 to 20 hectares in the surveyed area of the floodplain with a total area of about 30 square kilometers; there are also many lake-like brook bed extensions at the sources of exorheic lakes. Research into the beavers' settlements showed that 5 beaver colonies built their lodges on the steep slopes of lakes in the area of reservoir floodplains that are located on the elevated sections of floodplains. These colonies do not build dams. At least 10 colonies build dams at the sources of floodplain lakes.

All the lakes are shallow (mostly with a depth of 1-2 meters). Sites with depths of up to 1.5 m in summer (after high water) are covered with solid thickets of *Stratiotes aloides* and *Myriophyllum spicatum*. By the end of the summer, they add *Lémna sp.* The mass of higher aquatic vegetation, formed in the summer, cannot decompose by oxidation; it gradually accumulates in lakes and in the under-ice period decomposes under anaerobic conditions. Therefore, in the under-ice period, all the surveyed lakes are subjected to freezing. Even in the deepest of them (Lake Abat), the oxygen content decreased from 6-8 to 1.3 mg / l in early December 2016, i.e. to critical values for lake-river fishes. Moreover, there was a smell of hydrogen sulfide from the water from the ice-hole. In the outflowing brook it was 1.4 mg / l, and at the creek of the Kaibasovsky stream it was twice as much (2.8 mg / l).

due to insignificant enrichment through the formed steam holes. According to our observations, in February at such reservoirs, it is only 0.1-0.2 mg / l, i.e. it decreases to about 0.7-1.5% of normal saturation.

The permanent inhabitants of these reservoirs from among local fish are 2 species of crucian carp: *Carassius gibelio* (Bloch) and *Carassius carassius* (L.), and from introduced species – *Perccottus glenii* Dybowski, which gradually displaces the crucian carp. At the beginning of high water, all species of local lake-river fish rise to spawn and feed in the exorheic lakes from the River Ob. The most numerous of the indigenous species are pike – *Esox lucius* L., ide – *Leuciscus idus* (L.), smoll fru – *Rutilus rutilus* (L.), perch – *Perca fluviatilis* L., for introduced species – bream *Abramis brama* (L.). It is known that the largest individuals from such lakes usually migrate into the river system at the beginning of the ebbing of flood waters, and some mature fish and juveniles (including one-year-olds) can gain weight in these lakes until ice formation [18].

Intensive migration of lake-river fish from the surveyed lakes is observed in the initial period of ice formation, when the oxygen content in the water begins to decrease sharply. Until the appearance of beaver dams on the sources of them at that time, the catching of migrating fish with fishing equipment was carried out until the end of December. The total catch of fish was 1-2 tons. The appearance of beaver dams led to a gradual decrease in catches and to the cessation of such fishing. This information and observations of the gas regimen of lakes in the under-ice period are sufficient grounds for the assumption that the dams built by the beavers are obstacles to the migration of these fish from such floodplain reservoirs, and the remaining fish are doomed to death due to a lack of oxygen (suffocation) in winter.

In the experiment, during the passage of water through a beaver dam from two suffocation lakes and lake-like brook bed extensions of a stream, amounting to approximately 50 hectares in the River Ob, 2196 specimens of fish of commercial size migrated, along with 60460 specimens of juveniles (mainly, one-year-olds) (see Tables 1 and 2.).

The total mass of commercial fish that migrated from these lakes for wintering in the River Ob amounted to 751.2 kg (Table. 1). Almost half of these fish were pike and about 30% were perch. Both these types of fish are important objects of industrial and, in particular, amateur fishing. The intensity of fishing for these species is high. Therefore, the loss of fish resources due to the appearance of beaver dams on sources from such floodplain reservoirs can significantly worsen the situation with commercial fishing.

**Table 1.** Calculation of the mass of fish of commercial size during the period of migration from the surveyed lakes.

[Indicators]	[Species of fish]					[Total amount]
	[Pike]	[Ide]	[Bream]	[Smoll fru]	[Perch]	
[The number of fish]	396	192	108	396	1104	2196
[Average weight, kg]	0.9	0.4	0.35	0.15	0.2	-
[Lump, kg]	356.4	76.8	37.8	59.4	220.8	751.2

It follows from the above calculations that migrating juveniles can provide a commercial return of these fish with a total mass of 230.7 kg (Table 2).

The total value of prevented harm to fish resources in the experiment was approximately 1 ton, i.e. approximately 20 kg from 1 hectare of water area, located above the beaver dam.



**Table 2.** The calculation of commercial return from fry fish, rolled in the stream

[Indicators]	[Species of fish]					[Total amount]
	[Pike]	[Ide]	[Bream]	[Smoll fru]	[Perch]	
[The number of fish]	1220	2620	2404	25804	28412	60460
[Coefficient of trade return, %]	2.2	1.9	0.8	2.3	1.6	-
[The average mass of the caught fish, kg]	0.9	0.4	0.35	0.15	0.2	-
[Trade return, kg]	24.2	19.9	6.7	89.0	90.9	230.7

#### 4. Conclusion

Beavers are not popular targets for commercial hunting in their habitats, which in the flood plain of the River Ob are usually difficult to access. The dams built by them in the floodplain of the middle stream of the River Ob can be obstacles to wintering migrations of lake-river fish from suffocation floodplain lakes to the river system with a favorable oxygen regimen.

Judging by the results of the count of the number and mass of fish that migrated during the passage of water through the beaver dam, the damage to fish resources in the largest lakes with oxygen deficiency in the winter floodplain lakes (with an area of more than 10 hectares) can significantly exceed the commercial value of beavers. Therefore, the habitat of beavers in such areas of the River Ob's floodplain is clearly undesirable. The priority here is the conservation of fish resources.

Significant negative consequences from beaver dams in the form of losses of some fish resources are also possible on the inflowing streams of the River Ob, which fish use for wintering. Measures are required to prevent such undesirable consequences.

The research carried out is preliminary. Additional observations are required at different sites of the floodplain-river system of the Middle Ob.

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