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ECOLOGICAL AND FISHERY MELIORATION OF LAKES OF THE ARMIZON DISTRICT OF THE TYUMEN REGION

SUMMARY. This article names the main courses of complex melioration of forest-plain areas of the Tyumen region. The introduction of methods of complex melioration of forest-plain fishkill lakes with crucian carp core of ichthyocenosis let the region farm valuable fishes (carp, pike perch, whitefishes, herbivorous fishes, etc.) using multiyear feeding. Previously, in the south of the Tyumen region, including the Armizonsky district, the prevailing technology of fish-farming was breeding one-year-old peleds weighing 70–150 each (by planting eggs) and two-year-old carps weighing 0.6–0.7 kg each (by planting one-year-olds). Total fish rearing for sale was then within the range from 30–40 to 70–80 kg/ha. Lakes of the Armizonsky district are shallow (2–3 m) and liable to fish suffocation, but their feeding potential is high.

KEY WORDS. Ecological and fishery melioration of lakes, technologies of increasing fish production of lakes

Relevance

Russian fishing industry, as a part of agro-industrial complex, is aimed at intense progressive development, which is defined by the Federal Law No. 189-FZ of July 2, 2013 "About the aquaculture (fish farming) and about modification of separate legal acts of the Russian Federation". Specific measures on the development of fish-farms in Russian Federation subjects are specified by "The Fishing Industry Development state programme", approved by Government Resolution No. 315-r of March 7 2013.

The major component of fishery progress at Russian inner water bodies (to which water bodies of the Ob-Irtysh river basin belong) is fish rearing for sale, which includes fish-farm, pond, and industrial technologies. For the administrative municipal districts of the Tyumen region, all kinds of fishery technologies can develop efficiently. Nowadays, the most perspective technology is fish-farming using polyculture along with hydrotechnical reclamation of forest-plain lakes.

Fish rearing for sale in the Tyumen region and neighboring regions appeared in 1950–70s. At those times, fish catch normally comprised 30–50 kg/ha, whereas the maximum annual catch was 100–130 kg/ha [1, 2, 3]. Further improvements of lake fish-farming technologies let local fisheries consider 100–130 kg/ha catches average, and 220–250 kg/ha or more – top catches [4, 5, 6].

The increase of the fish capacity of the Trans-Urals forest-plain lakes is caused by the improved level of understanding of the problem of reclamation of water bodies for fish culture [7, 8, 9], which improves the process of fish farming from one-year to two-year and multi-year production, i.e. large food fish instead of underyearlings. It increases the number of local fisheries and makes them adopt new efficient technologies instead of old ones.

In the Trans-Urals, forest-plain lakes of crucian carp ichthyological type are the most productive in terms of biological and fishing productivity [10, 11, 12]. But most of them are prone to fish suffocation because of their shallowness [13, 14]. This results in partial or total fish-kill, as fish need water-dissolved oxygen.

According to the authors' analysis of plenty perennial data on the Trans-Urals ameliorative lakes fish catches, we can rear fish for sale in much greater quantities, in particular – from 20–50 kg/ha to 100–200–250 kg/ha. The reasonable use of recommended fishery systems, adapted to particular water bodies, gives estimated catches of zonal rates annually [4, 5, 6, 12], which is confirmed by the practice of progressive fish farms in the Chelyabinsk, Kurgan, and Tyumen regions.

Having had actual fish production achievements at the lakes and fish farms of the Trans-Urals, we perform explanatory and promotional works at a big group of lakes in the Armizonsky district of the Tyumen region [2, 7, 11, 13].

Characteristics of fish-farm lakes

According to physiographic classification of the Tyumen region, water bodies of the southern part of the region are characterized by organic (sapropelic) type of deposition of sediments [11, 14, 15], which are naturally renewed every year [11, 12, 15]. Littoral zones of forest-plain lakes commonly have sandy and silty-sandy soils, occasionally loamy. Most bottom sediments consist of dark grey and black sapropels. In intensely overgrown water bodies, the upper layer of silts is covered with a thick layer of plant refuse. The thickness of sapropel deposits differs, and in forest-plain water bodies, it is usually up to 1.5 m.

Concerning chemical classification, the Armizonsky district lakes usually contain hydrocarbonate water, but sometimes – chloride water.

In the lakes of the depth less than 2.5 m, fish-kill occurs almost every winter. In years of high precipitation and the raise of absolute and mean depths, biological life of lake ecosystems does not get destructed.

In this connection, E. Yadrenkina [16] recommends to differentiate the following concepts:

— "fish suffocation" is considered as a case of mass mortality of aquatic organisms at sharp decrease in oxygen in the water;

— "lake liability to fish suffocation" is a property of the defined group of shallow reservoirs to a periodic (cyclic) development of hypoxia, leading to partial or mass death of aquatic organisms;

— "the process of oxygen decrease" reflects the development of hypoxia and the formation of conditions that are not compatible with the viability of aquatic organisms;

— "a lake with a lack of oxygen" is a water body, characterized by periodic development of hypoxia and massive loss of aquatic organisms, with low degree of resistance of dissolved oxygen. These amendments allow to specify the processes and phenomena in a given reservoir.

To view the problem objectively, specialists from two Tyumen universities have been performing a complex assessment of 30 Armizonsky lakes during 2005–2013. They assessed their current ecologic-fishery condition and determined potential bonitet (productivity) of fish capacity, being aware of which, water body users can gradually perform some ameliorative activities, contributing to ecological rehabilitation of the lakes (reducing fish-kills, removing excessive hard vegetation, stabilizing water level regime, etc.).

The main direction of ecologic-fishery reclamation is the increase of fish capacity, which is achieved by systematic planting of enduring young fish into the lakes.

Our recommendations on complex amelioration of some local water bodies are listed in Table 1.

Table 1

The Armizonsky district lakes used for ameliorative fish-farming (2005–2013)

Lake name – area, ha	Depth, m: mean/max	Species	Recommended amelioration activities	Catch bonitet, kg/ha per year
1	2	3	4	5
Zubarevskoe – 201	1.8/2.9	carp, E. cisco, cisco, pike-perch, pike	water aeration, bottom tillage, auxiliary and nursery ponds	170–200
M. Kaynakskoe – 180	1.7/2.3	peled, carp	water aeration, bottom tillage, auxiliary and nursery ponds	150–170
B. Kaynakskoe – 398	1.9/2.6	peled, carp	water aeration, bottom tillage, auxiliary and nursery ponds	140–160
Chyornoye (northern reach) – 3209	1.7/2.7	peled, w. amur, carp	water aeration, bottom tillage, auxiliary and nursery ponds	70–80
B. Kalmakskoye –478	2.1/3.4	peled, pike, w. amur	water aeration, bottom tillage, auxiliary and nursery ponds	150–160

1	2	3	4	5
Vyalkovo – 1320	1.7/2.6	carp, pike-perch, pike, peled, w. amur	water aeration, bottom tillage, auxiliary and nursery ponds	110–150
Ryamovoye – 340	1.7/2.5	carp, pike-perch, pike, w. amur	water aeration, bottom tillage	100–120
Ryzhkovo – 282	1.8/2.6	carp, pike-perch, pike, w. amur	water aeration, bottom tillage	100–120
Sekachevo – 425	1.8/3.0	carp, peled	water aeration, bottom tillage	90–110
Chembarnoye – 60	2.0/2.9	carp, peled	water aeration, bottom tillage	110–120
B. Yegishino – 153	2.0/2.6	carp, cisco, pike-perch. pike	water aeration, bottom tillage, auxiliary and nursery ponds	150–200
M. Yegishino – 46	1.7/2.4	carp, cisco, pike-perch, pike	water aeration, bottom tillage, auxiliary and nursery ponds	150–200
Sivkovo – 137	1.0/1.5	peled	auxiliary pond, water aeration, tillage	90–140
Glubokoye – 129	2.0/2.9	carp, peled	water aeration, bottom tillage	110–130
Zubovik – 38	2.1/2.5	carp, peled	water aeration, bottom tillage	110–130
Lagunovo – 96	2.0/2.8	carp, peled	water aeration, bottom tillage	110–130
Zaboshinskoye – 103	2.6/3.0	carp, peled	water aeration, bottom tillage	110–130
Tatarskoye Vtoroye – 53	2.0/2.7	carp, peled	water aeration, bottom tillage	110–130
Ukhalovo – 45	1.9/2.6	carp, peled	water aeration, bottom tillage	110–130

The Armizonsky district lakes occupy 50,000 ha. They differ in size, but they have similar ecological characteristics [11, 13]. An objective bioindicator of natural ecosystems of the Trans-Urals fish-kill lakes is the gibel carp – Carassius auratus gibelio (Bloch, 1782). Table 2 lists the parameters of standard fish length and weight of gibel carps from seven lakes. Growth indicators of gibel carps of the same age are quite similar for different lakes. At the same time, the Bolshoye Yeghishino Lake shows the biggest growth values. The growth of fishes that are bred there – carp, bream, pike-perch, whitefish, etc. – is the best in comparison with nearby lakes. This has resulted from the positive ecologic-fishery impact of the past 10 years (the deepening of 5 ha portion of the lake to 6–7 m, water aeration during the entire winter, bottom tillage on 50–60% of water area in summer). Thus, a naturally fish-kill lake became a non-fish-kill one.

Table 2

Gibel carp growth indicators from several Armizonsky lakes

Lake – area, ha	Age			
	2+	3+	4+	5+
Standard fish length, mm				
Zubarevskoe — 201	113.50±1.53	141.75±4.25	167.82±4.20	175.00±6.39
M. Kaynakskoe – 180	104.33±7.67	131.06±1.42	147.53±5.76	169.17±3.15
B. Kaynakskoe – 398	108.45±4.51	138.12±1.70	153.40±4.42	167.00±6.53
B. Kalmakskoye -478	140.59±2.55	159.33±3.66	172.85±4.58	199.71±6.89
Vyalkovo — 1320	139.45±2.79	153.13±3.93	173.25±3.19	202.83±1.63
Chyornoye — 3209	108.50±1.50	123.56±3.35	149.91±4.41	169.25±3.39
B. Yegishino — 153	169.71±2.35	192.46±7.23	223±3.45	239.07±7.78
Weight, g				
Zubarevskoye — 201	44.25±3.28	89.81±7.46	160.56±11.89	183.67±10.40
M. Kaynakskoe – 180	52.33±3.84	71.28±1.68	108.50±8.57	159.19±11.55
B. Kaynakskoe – 398	54.01±4.31	74.96±3.13	122.40±10.26	148.00±11.51
B. Kalmakskoye -478	105.67±8.25	131.75±7.58	165.78±4.65	215.77±9.56
Vyalkovo — 1320	89.45±6.05	128.13±9.44	166.09±7.97	249.05±13.88
Chyornoye — 3209	53.25±3.19	75.41±5.56	146.18±6.74	165.68±35.33
B. Yegishino — 153	180.56±3.65	255. 55±14.23	440. 78±10.25	613.11±15.07

Amelioration works content

On the basis of scientific recommendations on directions and methods of complex lake amelioration [1, 7, 9, 13] in the Tyumen region, such works are performed at the following lakes of the Armizonsky district: B. Yegishino, M. Yegishino, B. Kaynakskoe, M. Kaynakskoe, Zubarevskoye, B. Kalmakskoye, Vyalkovo, etc.

For successful breeding and over-wintering of planted fish polyculture (carp, whitefishes, herbivorous fishes, pike-perch, pike), fisheries need to perform the following ameliorative works: the deepening of a small portion of the water area to 6–7 m; the creation of a small (0.1–0.3 ha) but deep pond near the lake; the installment of aeration equipment in wintertime.

Some fisheries prefer building 2–3 nursery ponds to bring fish larva up to yearling, and only then they let them breed in the fattening lake, because verkhovka and amur sleeper have appeared in some lakes.

Such pond should be built on the shore that is the closest to the deepest part of the lake, and there should be an electric work and a drove nearby. The pond should be connected to the lake by one or two canals. The ground from excavation works can be used to build nursery ponds on the shore.

The most efficient way to improve the fish capacity of the local water bodies is bottom sediments tillage. It solves several problems at once: the acceleration of sludge deposits oxidation, which reduces winter oxygen consumption; the removal of excessive hard and soft vegetation, the clearing of seine fishing grounds; the improvement of fish meat taste; and the most important – the increase of phytoplankton

and zooplankton production. In summer and autumn, the fish, especially zooplanktophage species, gain length and weight 1.5 times faster than the fish from non-ameliorative water bodies.

The largest extent of work is done at the Zubarevskoye lake.

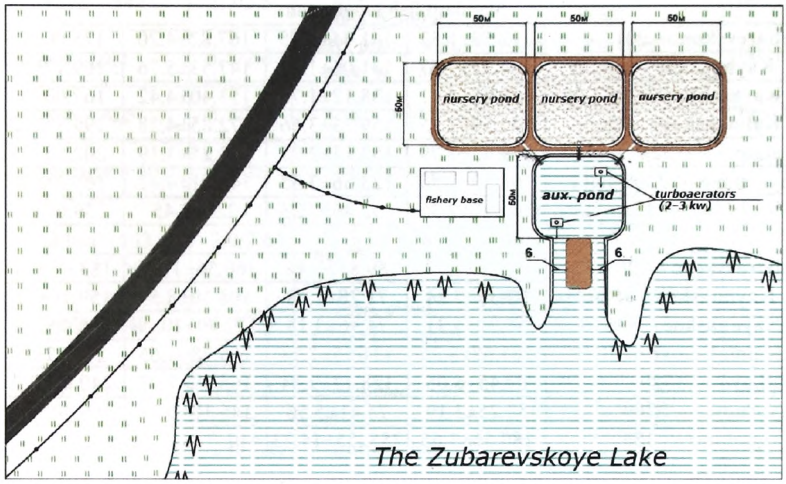

Fig. 1. The scheme of ameliorative fishery base at the Zubarevsjoye lake of the Armizonsky district

According to our perennial observations of the lakes Zubarevskoye, Maloye Kaynakskoye, and Bolshoye Kaynakskoye of the Armizonsky district, and of the water bodies of the Kunashaksky district of the Chelyabinsk region, where tillage practice have long been started, such works should be performed in a slightly windy weather – twice a month in August and September [7]. During this period, fish grow faster (especially peleds and pelchirs), and bottom tillage considerably increases the food capacity of the lake and, as a result, the length and weight of the fish and the fatness of the meat increase. The decrease of newly-created organic matter in bottom sediments reduces the risk of fish-kill. Monthly lake tillage in non-ice seasons significantly reduces the oxidizing activity of sludge deposits, which results in a considerably higher oxygen concentration in water in wintertime than it was in default ecological conditions. The under-ice oxygen consumption for the mineralization of organic matter, produced during the vegetation period, slows down considerably, which gives a possibility to begin using the aeration equipment later: in late Febrary instead of early December [7, 9, 11].

Some of the Armizonsky district lakes, mostly situated in the north-west, occasionally overflow, and in wet years, the water just flows down landscape lowlands to the south (the Kurgan region). For such lakes, we recommend to build low dams to stabilize the water level (with the rise up to 0.7–1.0 m). Such basic reclamation

makes the water body eutrophic (instead of hypereutrophic), which increases its fish capacity and the efficiency of technical and fishery reclamation.

Basic bioecological reclamation is regular planting of young fish in a specified amount for forest-plain zones [4, 6, 11, 12, 15]. Simultaneous breeding of carp, whitefishes, and herbivorous fishes guarantees a 150–200 kg/ha catch of large fish for sale. If necessary, pike-perches and pikes can be inbred, when verkhovka and amur sleeper are present in the ichthyocenosis of a particular water body.

Conclusion

1. Complex reclamations of forest-plain fish-kill lakes allow to breed valuable fish (carp, pike-perch, whitefishes, herbivorous fishes, etc.) using the technology of multi-year breeding. Thus, instead of carp underyearlings of 70–150 g each (from egg planting) and two-year-old carps of 0.6–0.7 kg each (from underyearling planting), fisheries can cultivate large (0.8–2.5 kg each) fish for sale, which is in high demand.

2. The fish, bred on natural self-renewable feeding of the Armizonsky district in forest-plain lakes, is an ecologically safe bioproduct, which is totally safe for human health, no matter how it is cooked. It is caused by the fact that the Armizonsky district lakes are far from modern industrial centers, and they are free of technogenic pollution.

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