

ISSN : 2321-9602



Indo-American Journal of Agricultural and Veterinary Sciences



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Status of ichthyofauna and analysis of reservoir water quality on a small river under human stress

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Abstract

Large amounts of anthropogenic loading and change of the catchment region have led to the bad quality of the surface waters of the estuary. The ecological and hygienic state of the Basov Kut reservoir's surface waters are reported, as are the findings of accounting for dead fish caused by frosts at the mouth of the Ustye River from 2011-2017, which were monitored during the same time period. It has been determined that the Bas Basin should not be used for leisure activities. Lactose-positive *Escherichia coli*, the *Staphylococcus aureus* index, the Enterococcus microbe index, and *Giardia intestinalis* cysts and eggs are yearly identified in this reservoir, making amateur fisheries a threat to the population as well. *Vibrio cholerae* non O1 (VcnO1) was discovered in 2017. Inconsistencies in hydrochemical markers were most noticeable in 2018: odor, 2 points; color, 3; BOD₅, 6.5-7.5 mgO₂/dm³; COD, 40-50 mgO₂/dm³. The cholera-like vibrio (non O1) was found in samples examined for hygienic, microbiological, and parasitological criteria. Decline in water quality caused by a rise in eutrophication of the reservoir due to the presence of biogenic materials, especially nitrogen and phosphorus compounds. In 2018, the "flowering" of water started in the third decade of June and continued until the fourth decade of October. Because blue-green algae toxins may accumulate in fish tissues and induce toxicity if swallowed, this process is bad for humans as well as aquatic organisms. In addition, a significant fraction of the fish sampled lacked the necessary organoleptic qualities as defined by DSTU 2284: 2010. The largest harm to the populations of fish that inhabit the Estuary during the deaths was suffered in 2012. Scientists and regulatory organizations predicted a loss of 377,4 thousand people due to the collapse of the fishing industry. There have been considerable declines in populations of industrially useful fauna due to annual deaths. In 2017, there was a major depletion of fisheries resources, estimated at over 10,32,000. This raises serious concerns for the viability of recreational fishing in these areas and the continuation of ichthyofaunal reproduction at the Ustya River's mouth.

Key words: the surface waters, anthropogenic loading, transformation, monitoring

1. Introduction

Large amounts of anthropogenic loading and transformation of the catchment region have led to the bad quality of the surface waters of the estuary. The Basov Kut reservoir, built in the early twentieth century and popular for many forms of recreational, recreational, and sport fishing, is one of the features of the Ustya River Basin. The reservoir's water was safe for swimming and eating fish caught in it in the 1980s, but by the turn of the century it had become polluted, as shown by the Ustya River passport. The regulatory agencies have decided to restrict bathing in this reservoir on an annual basis beginning in 2015. Furthermore, field observations place the beginning of the "flowering water" phenomena around June and its conclusion in October. This shift is the consequence of discharges of untreated household and municipal wastewater into the river from communities situated above the reservoir (Zdolbunov town, Kvasiliv township, Novy Dvor village), as well as discharges from big industrial companies (Vol- yn-cement). The ecosystems of the reservoirs near the mouth of the Usti River continue to deteriorate. The

composition of the ichthyofauna in the examined reservoirs has changed significantly as a result of climatic changes, changes in water bodies in reservoirs, and changes in hydrochemical and hydrobiological regimes. Decline and extinction rates for endangered and economically important species have increased dramatically. Iakubchak et al. (2005), Davydov et al. (2007), Grynevych et al. (2018), Prysia-zhniuk et al. (2019), and Fedorovych et al. (2019) all report a considerable decline in the organoleptic, microbiological, and morbidity quality of fishing products. Klymenko and Hrokhovska (2006), Klymenko et al. (2016), Hrokhovska (2017), and Hrokhovska and Konontsev (2018) all conclude that the reservoir's ecological status is precarious and endangers not only the biota of the reservoir but also human health. The research was conducted to assess the state of ichthyofauna under anthropogenic settings and to investigate the water quality of the reservoir on a minor river (middle river according to the Water Framework Directive).

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2. Materials and methods

Investigations were carried out in certain estuaries of the Usti River and Basov Kut reservoir according to certain methods. Hydrochemical, sanitary – microbiological and parasitological parameters were investigated by specialists of Rivnelaboratory center. In addition, data from the reports

3 .Results and discussion

In 2014, an Association Agreement between Ukraine and the European Union was signed, which obliged Ukraine to introduce European standards in the field of water resources management, water protection and pollution control, in particular to introduce the provisions of the EU Water Framework Directive into the Water Code of Ukraine, in general, the practice of water resources management in Ukraine (Khilchevskyi & Hrebin, 2017).

However, the provisions of the WFD are not designed for the critical ecological status of most of our country's water bodies. Therefore, in order to assess the ecological status of the surface waters of river basins, it is necessary to take into account the sanitary and hygienic indicators, reservoir with the requirements of “Hygienic water quality standards of water bodies for meeting drinking, household and other needs of the population” according to the indicators determined by the Rivne Regional

of the Main State Directorate of Conservation, Use and Reproduction of Aquatic Living Resources and Regulation of Fisheries in Rivne Region were used. The results were processed using Microsoft Excel software.

which will make it possible to comprehensively assess the state of the object and determine the degree of danger to the population.

In 2017, the Ministry of Health of Ukraine initiated the creation of a draft order approving the hygiene standards for water quality of water bodies to meet drinking, household and other needs of the population (in accordance with Article 18 of the Law of Ukraine “On Ensuring Sanitary and Epidemic Well-Being of the Population”). And submitted for state registration to the Ministry of Justice of Ukraine.

According to this project, the Bas Basin belongs to the second category of water use. We conducted an analysis of the conformity of surface water quality of the Basov Kut Laboratory Center. The results of the analysis according to the data of Rivne Oblast Laboratory Center are presented in Table 1.

Table 1

Characteristics of surface waters of the Basov Kut reservoir

Indicators	2013	2017
Scent	Responds	Responds
Hydrogen pH	Responds	Responds
Mineral composition	Responds	Responds
Dissolved oxygen	Responds	Responds
Pathogens	Not Responsive	Not Responsive
LKP	Not Responsive	Not Responsive
Coliphages (in plaque-forming units)	Not Responsive	Not Responsive
Viable helminth eggs	Not Responsive	Not Responsive

logical parameters, cholera – like vibrio (*non O1*) was detected; the LKP titer exceeded the norm by 48 times; *E. coli* – 48 times, samples of helminth eggs and giardia cysts were detected in the samples.

Monitoring results indicate that water quality in the reservoir is rapidly deteriorating and is currently catastrophic. The main causes of this process are the non-compliance with the legislative requirements for the protection of water resources, in particular, the continuing discharge of untreated municipal utilities from households. In addition to the indicators analyzed

In addition, such a rapid deterioration of surface water quality leads to the impoverishment of ichthyofauna. According to the reports of the Rivne Fisheries Patrol, over a 10-year period, the fish, which caused a sharp decrease in the dissolved water content, was observed almost annually on the Ustyia River (within the reservoir water area and in the watercourse section within the Rivne city). oxygen (Table 2). This process was due to the complex action of

Over the years, the reservoir has been found to have an excess of the index of lactose-positive *Escherichia coli*, the index *Staphylococcus aureus*, the index of microorganisms of the genus *Enterococcus*. Cysts of *Lambliia intestinalis* and helminth eggs are detected annually. In 2017, cholera vibrios (*Vibrio cholera non O1*) were detected.

In 2018, the water of this reservoir did not meet the standards for the following indicators: odor – 2 points; color 3; BOD₅ – 6.5–7.5 mgO₂/dm³; COD 40–50 mgO₂/dm³. In samples tested for sanitary – microbiological and parasitological

above, there is a deterioration of the water quality by the content of biogenic elements, in particular, Nitrogen and Phosphorus, which leads to increased eutrophication of the reservoir. In particular, the phenomenon of “flowering” of water on this reservoir in 2018 began in the third decade of June (up to maximum temperatures) and lasted until October. Such a process is harmful not only to aquatic organisms, but also to humans, since blue-green algae toxins are able to accumulate in fish tissues and cause poisoning when consumed by such products (Misejko et al., 2001).

abiotic, biotic and anthropogenic factors – a decrease in saturation due to increase in water temperature and increase of biomass of blue-green algae to the level of “flowering” of water due to anthropogenic eutrophication.

The greatest damage to the populations of fish that inhabit the Estuary during the fatalities was caused in 2012. When the estimated loss of fishery resources amounted to 377.4 thousand individuals, according to scientists and con-



tol bodies. In the subsequent period (2013–2016), the annual fatalities led to quite significant losses of populations of

industrially valuable fauna. A significant loss of fishery resources was noted in 2017 – about 10.32 thousand.

Table 2

Results of accounting for dead fish on the Ustya River due to suffocation (according to the data of Rivne Fish Protection Patrol 2011–2017)

№ 3/п	Year	Plot of watercourse	Species composition of dead specimens of fish	Number of fish killed, copies
1	2011	R. Ustya within the city of Rivne	<i>Sander lucioperca</i> , <i>Rutilus rutilus</i> , <i>Carassius gibelio</i> , <i>Leucaspis delineatus</i> + <i>Alburnus alburnus</i>	14220
2	2012	R. Ustya (upper basin of Basov Kut reservoir and within the city of Rivne)	<i>Rutilus rutilus</i> , <i>Scardinius erythrophthalmus</i> , <i>Leucaspis delineatus</i> , <i>Perca fluviatilis</i> , <i>Carassius gibelio</i> , <i>Tinca tinca</i> , <i>Esox lucius</i>	377400
3	2013	R. Ustya (upper basin of Basov Kut reservoir)	<i>Rutilus rutilus</i> , <i>Perca fluviatilis</i>	3034
4	2014	R. Ustya within the city of Rivne	<i>Rutilus rutilus</i> , <i>Esox lucius</i> , <i>Alburnus alburnus</i> , <i>Perca fluviatilis</i> , <i>Leucaspis delineatus</i>	1558
5	2015	R. Ustya (upper basin of Basov Kut reservoir)	<i>Rutilus rutilus</i> , <i>Perca fluviatilis</i> , <i>Sander lucioperca</i>	4656
6	2016	R. Ustya within the city of Rivne	<i>Rutilus rutilus</i> , <i>Perca fluviatilis</i> , <i>Leucaspis delineatus</i> , <i>Blicca bjoerkna</i>	3224
7	2017	R. Ustya within the city of Rivne	<i>Rutilus rutilus</i> , <i>Leucaspis delineatus</i> , <i>Perca fluviatilis</i> , <i>Carassius gibelio</i> , <i>Sander lucioperca</i> , <i>Abramis brama</i> , <i>Blicca bjoerkna</i>	10320

Neglect of the protection of surface waters from pollution leads to danger during rest and depletion of the country's natural resources, in particular, species diversity of ichthyofauna and quality of fishery products. Conservation of

4 .Conclusions

1. During 2013–2017 the basin Kut reservoir was found to have an excess of the index of lactose-positive *Escherichia coli*, the index of *Staphylococcus aureus*, the index of microorganisms of the genus *Enterococcus*. Cysts of *Lambliia intestinalis* and helminth eggs are detected annually. In 2017, cholera vibrios (*Vibrio cholera non O1*) were detected.

2. In 2018, the water of this reservoir did not meet the standards for the following indicators: odor – 2 points; color 3; BOD₅ – 6.5–7.5 mgO₂/dm³; COD 40–50 mgO₂/dm³. In samples tested for sanitary – microbiological and parasitological parameters, cholera – like vibrio (non O1) was detected; the LQP titer was > 240.000 cu/dm³; *E. coli* > 240000, helminth eggs, giardia cysts were detected in the samples.

significant loss of fishery resources was noted in 2017 – about 10.32 thousand.

aquatic ecosystems is an important task for society and, in this context, the positive experience of European Union countries on the restoration of quality and protection of surface waters should be exploited.

3. Water quality in the reservoir is deteriorating very quickly and is currently catastrophic. The deterioration of water quality by the content of biogenic elements, in particular, Nitrogen and Phosphorus, which leads to increased eutrophication of the reservoir. In particular, the phenomenon of “flowering” of water on this reservoir in 2018 began in the third decade of June (up to maximum temperatures) and lasted until October.

4. The greatest damage to the populations of fish found in the Estuary during the fatalities was caused in 2012. When the estimated loss of fishery resources amounted to 377.4 thousand individuals, according to scientists and control bodies. In the subsequent period (2013–2016), the annual fatalities led to quite significant losses of populations of industrially valuable fauna. A

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