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BIOLOGICAL DIVERSITY OF SULA RIVER (UKRAINE) UNDER DIFFERENT HYDROLOGICAL CONDITIONS

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ABSTRACT

Hydrobiological research of the main components of the biota of the lower reaches of the Sula River was conducted. The river flows into the Kremenchutsk Reservoir. Zoobenthos, zooperiphyton, vascular water plants, and ichthyofauna in lotic and lentic microbiotopes were studied. Species and communities of protected status were stated. It was shown, that a significant share (about 30%) consists of rheophilic species. 28 species of fish were registered in the studied area, of which eight are invasive species and 10 are under protection. The biotopic distribution of different fish species, and the intensity of the downstream migration of juvenile fishes in spatial, temporal, and species aspects were estimated. It was identified, that about 12 million young fish migrate from the researched part of the Sula River to the Kremenchuk reservoir during the season.

RÉSUMÉ: Diversité biologique de la rivière Sula (Ukraine) dans différentes conditions hydrologiques.

Des études hydrobiologiques des principales composantes du biote du cours inférieur de la rivière Sula, où la rivière se jette dans le réservoir de Krementchouk, ont été menées. La végétation aquatique supérieure, les groupes zoobenthos et périphyton, les plantes vasculaires aquatiques et les roches, l'ichtyofaune, des microbiotopes lotiques et lentiques ont été étudiés. Les espèces et les groupes d'hydrobiontes à statut protecteur ont été déterminés. Il est montré qu'une partie importante (environ 30%) est constituée d'espèces rhéophiles. La composition des espèces et la structure des groupes végétaux, ainsi que les groupes de zoobenthos, d'épiphyton et d'épilithon ont été déterminées. 28 espèces de poissons ont été recensées dans la zone étudiée, dont huit invasives et 10 sous protection. La distribution des biotopes de diverses espèces de poissons a été déterminée, l'intensité de la migration descendante des jeunes poissons a été calculée dans les aspects spatiaux, temporels et spécifiques. Il a été établi qu'au cours de la saison, environ 12 millions de spécimens de jeunes poissons migrent de la rivière Sula dans le réservoir de Kremenchutsk, au niveau de la zone d'étude.

REZUMAT: Diversitatea biologică a râului Sula (Ucraina) în diverse condiții hidrologice.

Au fost efectuate cercetări hidrobiologice ale principalelor componente ale biotei din cursurile inferioare ale râului Sula. Râul se varsă în lacul de acumulare Kremenchutsk. Au fost studiate zoobentosul, zooperifitonul, plantele de apă vasculare și ihtiofauna în microbiotopii lotici și lentici. Au fost precizate speciile și comunitățile cu statut protejat. S-a demonstrat că o pondere semnificativă (aproximativ 30%) este formată din specii reofile. În zona studiată au fost înregistrate 28 de specii de pești, dintre care opt specii invazive și 10 aflate sub protecție. Au fost estimate distribuția biotopică a diferitelor specii de pești și intensitatea migrației în aval a peștilor juvenili din punct de vedere spațial, temporal și a speciei. S-a identificat că aproximativ 12 milioane de pești tineri migrează din partea cercetată a râului Sula către lacul de acumulare Kremenchuk în timpul sezonului.

INTRODUCTION

The vast majority of rivers in Ukraine are regulated by dams at a considerable length. There are very few areas with an unmodified, natural lotic regime, and they are under threat of further regulation or anthropogenic transformation.

Hydrobiological researches of the sections with a natural flow are very important for the investigation of river biota, its biodiversity, which is one of the main characteristics of a "good ecological status". And one of the important factors in the formation of biodiversity is the hydrological regime.

The Sula River in the research area is characterized by an almost natural state, with the clearly expressed riverbed, additional floodplain waterbodies, and well-developed floodplain, although polluted by discharges from the upstream located settlements.

Due to its structure and location, the lower reaches of the Sula River serves as an area of mass spawning and feeding of fishes, which migrate here from the Kremenchuk reservoir.

Recently, work on the engineering and building of hydraulic structures on small rivers has noticeably intensified in Ukraine. This makes it necessary to study the current ecological state of river ecosystems prior to the start of such construction. In particular, there was a project for the building of a hydraulic construction in the lower reaches of the Sula River.

This research was carried out to assess the possibility of building sluice-regulator construction in the considered river section, which will significantly change its hydrological regime.

MATERIAL AND METHODS

The whole length of the Sula River is 363 km, and the river basin is 19,600 km^2 (State Water Cadastre, 2012). A 10 km long section of the lower Sula River was studied (10-20 km from the confluence of the river into the Sula Bay of the Kremenchuk Reservoir).

The research was carried out in June-July 2018 in the lower reaches of Sula River (from estuary of the Orzhytsia River to the Gorikhove village), on the riverbed, oxbows, and bays (Figs. 1a, b). The riverbed is considered a lotic biotope, and the oxbow, and bays – as a lentic biotope. The research covered vascular aquatic plant communities, invertebrates (benthos and periphyton), and ichthyofauna.



Figure 1a: View of the Sula River in the research area, sampling hydrobiological materials.



Figure 1b: View of the Sula River in the research area, collected fish fry.

We investigated vascular aquatic plants (VAP), identified the species composition, overgrowing features of the VAP in different parts of the waterbodies and its further mapping of the plant cover (Arsan et al., 2006).

Benthos samples were taken by the Petersens bottom grab (capture area = 0.025 m^2). Zooperiphyton samples from submerged VAP (with weights of 0.5 kg) and stones, epiphyton (on VAP) and epilyton (on stones) were distinguished. The samples of invertebrates were preserved in 4% formaldehyde.

Ichthyological material was collected using the ichthyological net into the coastal aquatic plant thickets and by the fishing rod in the open parts of the river. Fish larvae were collected in the spawning sites. A drift of the commercial fishes' juveniles was studied by setting daily experiments using the drift trap (inlet orifice area – 0.24 m^2, 1.5 m long cone from the mill sieve N 12). The exposure lasted for 30 min, the material was taken every two hours.

Concentration of fish juveniles per volume unit (C_{vol}, ind/m^3) was calculated by the formula:

$$C_{vol.} = Q/Svt$$

where Q – number of fish juveniles in the trap (ind.), S – the inlet orifice area (m^2), v – flow velocity (m/s), t – exposition (s).

Total drift of fish juveniles was calculated by multiplying the found value by the river water yield. Water yield was set according to the water-meter post located upstream (in the town of Lubny).

Totally 32 samples of juveniles and adult fish were processed. The species of young fish and the development stage of larvae were determined by Koblitskaya (1981). Rare species were released into the river alive. In addition, the local fisherman were interviewed, results were considered reliable if the fish name was repeated more than five times.

RESULTS AND DISCUSSION

The formation of aquatic plant communities is mostly determined by the hydrological regime (presence and speed of flow), and the type of biotope. The formation of **vascular aquatic plants** in the researched area took place under the influence of the construction of the Kremenchuk Reservoir in 1961, which caused significant degradation of natural phytophilous complexes, and in some cases their complete disappearance. Subsequently, their gradual restoration took place, and today there is a complete inventory of flora and fauna of this section of the river with justification for the creation of protected areas here.

At the same time, the lower reaches of the Sula River have undergone a relatively small anthropogenic transformation, there are preserved natural floral complexes, typical of such habitats. In modern conditions, the main riverbed is surrounded by a thick strip of floodplain reed and cattail thickets, the width of which in some places reaches 150-500 m, and in some places even more. Dominant was *Phragmitus australis* (Cav.) Trin. Ex. Staud, as well as *Typha angustifolia* L. and *T. latifolia* L. These thickets also included *Glyceria maxima* (Hartm.) Holmb., *Acorus calamus* L, *Alisma plantago-aquatica* L., *Oenanthe aquatica* (L.) Poir., *Iris pseudacorus* L., *Carex riparia* Curt., *Carex acuta* L. and *C. acutiformis* Ehrh., *Equisetum palustre* L., *Mentha aquatica* L. and *Cicuta virosa* L.

Aquatic plants in the riverbed are situated in belts depending on the depth. The first belt is formed by helophytes, the composition of which is almost similar to the composition of the coastal strip. The second belt is formed by plants with floating leaves on the water – *Lemna trisulca* L., *Lemna minor* L., and *Spirodela polyrrhiza* L. At depths of 0.9-1.2 m on muddy-sandy bottom sediments in this zone, there are also *Nuphar lutea* (L.) Smith., *Nymphaea alba* L., *Hydrocharis morsus-ranae* L. At a depth of 1.2-1.5 m on silty soils, thickets of submerged plants are formed, consisting of *Ceratophyllum demersum* L., *Potamogeton perfoliatus* L., *P. crispus* L., *P. lucens* L. and *Myriophyllum spicatum* L. Areas of the riverbed with a depth of more than three m are free of thickets. All bays and oxbows within the research area are completely overgrown. As a rule, there are also three ecological groups of plants: helophytes, plants with floating leaves and submerged. In general, the flora of channel areas is richer than the flora of lentic biotopes, combining both species typical of non-flowing areas and rheophilic plant species, the share of which is about 8%.

The rare part of flora confirmed during the research includes one species of vascular plant – *Salvinia natans* L. – a holarctic plurizonal relict (tertiary) species that occur in fragments throughout the study area, sometimes forming communities. This species is protected by the Berne Convention and listed in the Red Book of Ukraine.

Three identified formations are listed in the Green Book of Ukraine: 1) communities of the *Nuphareta luteae*; 2) communities of the *Nymphaeeta albae*; 3) communities of the *Salvinieta natantis*, all occurred in small areas.

The communities are protected by the Berne Convention and the Habitats Conservation Directive in the researched area:

– Fen-sedge beds;
– Water soldier rafts;
– Frogbit rafts;
– Magnopotamion or Hydrocharition type vegetation of natural eutrophic lakes.

The analysis of our data in comparison with the data of previous studies shows that the plant communities of the researched area of the river are in a relatively stable state, which has developed here for a long time after the creation of the reservoir (Klestov et al., 2016).

In communities of **aquatic invertebrates** were identified 67 LIT (lower identified taxa), in the epiphyton – 33 LIT, in the epilithon – 39 LIT, in the zoobenthos – 34 LIT (Fig. 2). The number of taxonomic groups in the communities was similar – 10-12. The zoobenthos was distinguished by a large number of species of Oligachaeta and Chironomidae, epiphiton – larvae of Insecta and Gastropoda, three species of Spongia were noted only in the epilithon. The diversity number of taxa in the taxonomic groups was quite high: in epiphiton – 2.92, epilithon – 3.06, and zoobenthos – 2.33 LIT. One species (medicinal leech *Hirudo medicinalis* (L.)), which was found in epiphiton, was included in the Red Book of Ukraine (Red Book, 2009).

The applying of cluster analysis (Bray-Curtis Cluster Analysis) confirmed the low similarity of the zoobenthos taxonomic composition with other communities (the similarity was 32%), which stood out in a separate cluster. At the same time, the taxonomic composition of the epiphyton and epilithon were similar (the similarity was 80%).

Is necessary to remark, that in the list of aquatic invertebrates is a number of rheophilic and oxyphilic species, including larvae of Ephemeroptera, Trichoptera, *Simuium* sp., *Rheotanytarsus exiguus* Johannsen (Chironomidae), *Tubifex newaensis* (Michaelsen) (Tubificidae). Gactropods *Theodoxus fluviatilis* L., which prefer stony substrates, are also indicators of rheophilic conditions. The relatively large taxonomic richness of Trichoptera takes our attention – six species were found there: *Hydroptila tineoides* Dalman, *Leptocerus tineiformis* Curtis, *Neureclipsis bimaculata* (L.), *Hydropsyche angustipennis* (Curtis), *Oecetis lacustris* (Pictet), *O. furva* (Rambur).

In general, about 24% of the registered taxa of aquatic invertebrates are characteristic of rheophilic living conditions. Changing the lotic conditions to limnic ones can lead to a reduction in the part of these species or their complete loss from the hydrobiocenoses.

The taxonomic composition of aquatic invertebrates allows us to assess the water quality in the lower Sula River. According to the Trent biotic index (TBI) (Woodiwiss, 1964) (recommended by the EU Water Framework Directive), water in this area can be classified as Class II – "Pure" (TBI = 7).

Ichthyofauna of the lower reaches of the Sula River comprised 28 fish species of the eight fish families: Cyprinidae – 17, Gobiidae – three, Percidae, and Cobitidae – two species each, and families of Siluridae, Esocidae, Gasterosteidae, and Syngnathidae comprised one species each. Juvenile fishes of 15 species were found.

The major part of caught fishes belong to the river type (dace *Leuciscus leuciscus* (Linnaeus, 1758), chub *Squalius cephalus* (Linnaeus, 1758), ide *Idus idus* (Linnaeus, 1758), asp *Aspius aspius* (Linnaeus, 1758), and spiny loach *Cobitis taenia* Linnaeus, 1758); and river-lake type (bleak *Alburnus alburnus* (Linnaeus, 1758), bream *Abramis brama* (Linnaeus, 1758), blue bream *Ballerus ballerus* (Linnaeus, 1758), silver bream *Blicca bjoerkna* (Linnaeus, 1758), Chienese chebachok *Pseudorasbora parva* (Temminck and Schlegel, 1846), silver carp *Hypophthalmichthys molitrix* (Valenciennes, 1844), carp *Cyprinus carpio* Linnaeus, 1758, catfish *Silurus glanis* Linnaeus, 1758, and pike perch *Sander lucioperca* (Linnaeus, 1758)).

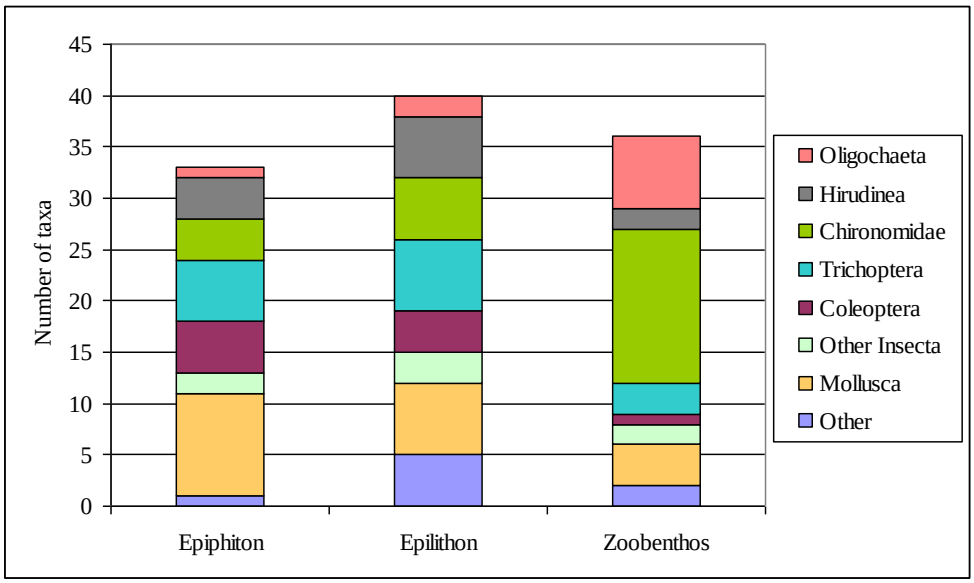


Figure 2: Taxonomic structure of aquatic invertebrate communities in the the lower reaches Sula River, July 2018. The "Other Insecta" included – Ephemeroptera, Simuliidae, Culicidae, Odonata, "Others" – Spongia, Turbellaria sp., Nematoda sp., Crustacea (*Asellus aquaticus* L.).

Fish of river type and river-lake type were respectively 17.9% and 32.1% of the total fish species number, adult specimens were found mainly in the free of plants and flowing sections of the river, of depth up to 4-5 m, with the flow velocity 0.5-0.7 m/s and sand bottom.

The Ponto-Caspian species round goby *Neogobius melanostomus* Pallas, 1814 and monkey goby *Neogobius fluviatilis* (Pallas, 1814) also favored lotic conditions (7.1%) and were found in free coastal areas of the river with overgrown with VAP (up to 35% projective water surface cover in the researched area) with clean sand bottom and stream up to 0.5 m/s.

In coastal biotopes, areas covered by VAP, up to 1.5 m deep with sandy and silty bottom, with the flow velocity of 0.2-0.5 m/s there were mainly fish species representatives of lake type (pearl roach *Scardinius erythrophthalmus* (Linnaeus, 1758), amur bitterlink *Rhodeus amarus* (Bloch, 1782)) lake-river type (roaches *Rutilus rutilus* (Linnaeus, 1758), crucian carp *Carassius carassius* (Linnaeus, 1758) and gibel carp *C. gibelio* (Linnaeus, 1758), tench *Tinca tinca* (Linnaeus, 1758), loach *Misgurnus fossilis* (Linnaeus, 1758), pike *Esox lucius* Linnaeus, 1758 and perch *Perca fluviatilis* Linnaeus, 1758). This type of species was 7.1 and 25.0% of the total number of species. Such Ponto-Caspian species, as western tubenose goby *Proterorhinus semilunaris* (Heckel, 1837), three-spined stickleback *Gasterosteus aculeatus* Linnaeus, 1758 and pipefish *Syngnathus nigrolineatus* Eichwald, 1831) preferred lentic conditions (10.7%) and were found in the same habitats as lake and lake-river species.

15 young fish species were registered in the samples. Nine species of fish were observed in the samples in June (Tab. 1).

Table 1: The ratio of young fish species from the lower stream of the Sula River in different biotopes, %.

Species	June		July	
	lotic biotope	lentic biotope	lotic biotope	lentic biotope
Rutilus rutilus (L.)	10.9	41.2	6.2	2.5
Scardinius erythrophtalmus (L.)	1.0	1.2	12.5	25.0
Alburnus alburnus (L.)	79.2	27.1	54.3	23.7
Leucaspius delineatus (Heckel)	–	–	–	2.5
Blicca bjoerkna (L.)	–	18.8	4.9	20.1
Ballerus ballerus (L.)	1.0	–	–	–
Abramis brama (L.)	2.1	2.4	–	0.5
Rhodeus amarus (Bloch)	3.7	4.7	22.2	21.2
Cobitis taenia L.	–	4.7	–	1.8
Esox luceus L.	–	–	–	0.9
Pungitius platygaster (Kessler)	–	–	–	0.9
Perca fluviatilis (L.)	2.1	–	–	–
Proterorhinus semilunaris (Heckel)	–	–	–	0.9

Seven young fish species were registered in the samples in the clean areas, among which the larvae of *A. alburnus* were predominant – 79.2%, on average 95 fish/m^2 (lim 5-210). The youth of the species differed in the widest range of development stagiest: from C1 to E (Tab. 2). Part of the youth of roach *R. rutilus* was much smaller and was 10.9%, which was 47 fish/m^2 (lim 0-60). Larvae of bream *A. brama*, blue bream *B. ballerus*, pearl roach *S. erythrophtalmus*, roach *R. amarus* and perch *P. fluviatilis* were represented by the separate fish, their part was from 1.0 to 3.7%, and quantity – 5-23 fish/m^2. Late larvae of bream, roach, and pearl roach were in stages of development E, F, G. Youth of the bitterlink was represented as early larvae (stage D_1) and late larvae (stages D_2, E). Perch youth was 0+ age.

The stocks of young fish in the thickets of submerged aquatic plants at the beginning of the summer were identical to the clear water for the number of species, but differed slightly in species composition. The largest part of the young fish in the samples was roach – 41.2%, on average 55 fish/m^2 (lim 42-71). Late larvae and fry of bleak were – 27.1% and 35 fish/m^2 (lim 10-67), bleak *B. bjoerkna* 18.8% and 13 fish/m^2 (lim 6-20). Frys of bream, roach, bitterlink, and spiny loach *C. taenia* were found in much smaller quantities – from 1.2 to 4.7% of the composition of young fish in the thickets of VAP.

In the flooded areas of meadow vegetation were found crucian carp *C. gibelio* – 78.6%, carp fry *C. carpio* was – 21.1%, as single fish were found loon *M. fossilis* – 0.3%.

In July 11 species were found in the samples of young fish: five of them (roach larvae *R. rutilus*, silver bream *B. bjoerkna*, rudd *S. erythrophthalmus*, bleak *A. alburnus* and bitterling *R. amarus*) took place in the lotic biotope. In the inflows and abandoned river channels among the water vascular plats the abundance of juvenile ribs was larger (Tab. 1), as there were bleak *L. delineatus*, bream *A. brama*, pike *E. luceus*, spiny loach *C. taenia*, Southern nine-spined stickleback *P. platygaster* and blunt-nosed scourge of late *P. semilunaris*.

Table 2: Stages of development of young fish in the lower reaches of the Sula River, summer 2018; stages of development of young fish (Koblitskaya, 1981). C_1, C_2, D_1 – youthful larva; D_2, E, F, G – last stage larva.

Species	June	July
Rutilus rutilus (L.)	E, F, G	G, fry
Scardinius erythrophtalmus (L.)	E	E, G, fry
Alburnus alburnus (L.)	C_2, D_1, D_2, E	D_2, E, F, G
Leucaspius delineatus (Heckel)	–	G
Blicca bjoerkna (L.)	E, F, G	E, G
Ballerus ballerus (L.)	G	–
Abramis brama (L.)	E, F	Fry
Rhodeus amarus (Bloch)	D_1, D_2, E	D_2, G, fry
Cyprinus carpio L.	fry	–
Carassius gibelio (Bloch)	fry	–
Cobitis taenia L.	–	E, fry
Esox luceus L.	–	Fry
Pungitius platygaster (Kessler)	–	Fry
Perca fluviatilis (L.)	fry	–
Proterorhinus semilunaris (Heckel)	–	Fry

In July, 11 fish species were found in the samples of young fish: five of them (roach larvae *R. rutilus*, silver bream *B. bjoerkna*, rudd *S. erythrophthalmus*, bleak *A. alburnus*, and bitterling *R. amarus*) took place in the lotic biotope. In the bays and oxbows among the VAP thickets the abundance of juvenile ribs was larger (Tab. 1), as there were bleak *L. delineatus*, bream *A. brama*, pike *E. luceus*, spiny loach *C. taenia*, Southern nine-spined stickleback *P. platygaster* and blunt-nosed scourge of late *P. semilunaris*. The juveniles of almost all of the above fish species were in the fry stage, except for portion spawning species (Tab. 2).

The main part in the samples of fish youth from the riverbed part of the river consists of the larvae of the bleak *A. alburnus* – 54.2%, on average 73 fish/m^2 (lim 44-103), larvae and fry of such limnophilous species, as blitterlink *R. amarus* and common rud *S. erythrophthalmus* were represented singly – 22.2 and 12.5%, 45 and 16 fish/m^2 respectively. Part of young fish *R. rutilus* and *B. bjoerkna* was non significant – 6.2 and 4.9%. Their quantity did not exceed 25 fish/m^2, and the frequency of occurrence was 32.0%.

From juvenile fish in lentic biotope among the VAP thickets besides the *A. alburnus*, *B. bjoerkna*, *S. erythrophthalmus*, and *R. amarus*, which were mainly in equal parts (20-25% with the quantity 9-21 fish/m^2) and the separate representatives were met of gossip *R. rutilus*, *L. delineatus*, *A. brama*, *E. luceus*, *C. taenia*, *P. platygaster*, and *P. semilunaris*.

One of the key of fish species' abundance support in rivers is downstream migrations of the fish youth. A drift of the fish youth in June was mainly in the nighttime. The biggest intensity of fish youth downstream migration was registered from the first to the fourth hour at nighttime. Taking into consideration the confidence interval, the size of the drift value calculated for the 10 hours in the dark part of the day, including twilight. The flow velocity during the study period was 0.2 m/s. The biggest part of the samples was the larvae of *A. brama* and *B. bjoerkna*, 51.7 and 36.2%. The larvae of *R. rutilus* and *A. alburnus* were less

common and had a much smaller share in drift, namely 6.9 and 5.2%. The youth of all the above species were in the late stages of larvae development (E, F, G). The drift samples were dominated by larvae of *B. bjoerkna* and *A. alburnus*. The number of larvae of *B. bjoerkna* was on average 0.0617 fish/m^3 (lim 0.0116-0.1620). *A. alburnus* youth was 0.0173 fish/m^3. The larvae of *A. brama* drifted in the night and pre-morning hours, their number was highest at 4-5 A.M., averaging 0.0839 specimens/m^3 (lim 0.0752-0.0926) (Tab. 3). Young of *R. rutilus* drifted downstream both day and night, the number of larvae was 0.0231 specimens/m^3 (lim 0.0115-0.0347). In July drift samples were empty. Taking into consideration that according to the water meter post, the water flow in the lower stream of the Sula River within the study period was 30 m^3/s (equivalent to 108,000 m^3/h), we can calculate the total quantity of young fish carried down by flow per day (Tab. 3).

Table 3: Quantitative meanings of fish drift at the night.

Species	Part in drift, %	Concentration of fish larvae in the sample, org/m^3	Drift of young fish at the researched area, org/year	Quantity of fish larvae for 10 hours of night, org.
Abramis brama (L.)	51.7	0.0839	9061	90610
Blicca bjoerkna (L.)	36.2	0.0617	6663	66630
Rutilus rutilus (L.)	6.9	0.0231	2495	24950
Alburnus alburnus (L.)	5.2	0.0173	1868	18680

Thus, during the young fish migration, in the Sula River estuary, about 200 thousand fish (182.2 thousand) of young fish are carried out to the Kremenchuk Reservoir per day.

A drift of young fish in the stages of late larval development (E, F, G) occurred at night (from 21 to 6 A.M.) because the larvae of fish were already sufficiently developed to navigate well and are able to actively avoid the rapid flow during the day, but at night they endure on the core of the river. During the day fish larvae which rolled downstream also appeared in the traps but in much smaller quantities. It is known that fish youth downstream rolling begins from the stages B-C_1 (Abramiuk et al., 2018). Taking into account that every stage of larvae development takes 3-5 days depending on water temperature, we can assume that the drift of larvae of each species of fish in early summer continues for at least 24 days and the total period of downstream migration continues from the middle of April to the middle of June (near 60 days). This means, that for the entire period, at least 12 mln different species of fish fry are rolled down.

Mostly all species of young fish that we met during the summer, relating to the current belong to the river-lake type (Movchan, 2011). Only roach, perch, and pike belong to the lake-river type, but redfin and rudd, and bitterling – to the lake type, they prefer lentic conditions.

Despite the fact that in adulthood fish species of river and river-lake types in relation to the current often keep to the river areas with a pronounced current, the method of reproduction most of them are phytophiles, and therefore the young of these fish species develop in thickets of VAP, along with the young limnophilous fish species. In the first half of the summer, almost the same number of fish and species composition were observed for groups of young fish in both the lotic and tape biotopes. However, the distribution by the number of juveniles of separate fish species is noteworthy. Thus, in the channel areas, the quantity of bleak youth was into three times larger than in the backwaters (79.2%). The youth

of blue bream *Balerus balerus* were found mostly in the armbeds. In the lentic conditions, the quantity of youth roach was mostly four times larger (41.2%), and the quantity of the youth of silver bream was 18.8%.

The change in the structure of communities of young fish in the second half of the summer is explained by the increase from the spawning portion-spawning fish species and is quite natural. The ratio of the number of roach in the riverbed and in the bays has changed in the direction of the predominance of roach fry in areas with currents. The general quantity of the fry of bream, silver bream, and roach decrease in the samples is explained by their move to the bigger depth connected with their growth and feeding style change.

One of the most important hydrological factors which have a great influence on taxonomic composition is the speed of the stream. Downstream migration of the fish fry from the spawning places to the mouth of the river is the important mechanism of population quantity support and spreading of fish species and can be realized only in lotic conditions.

Among all fish species represented, eight are alien with varying degrees of naturalization: *H. molitrix*, *C. gibelio*, *P. parva*, *N. melanostomus*, *N. fluviatilis*, *P. semilunaris*, *P. platygaster* and *S. nigrolineatus*. Part of alien species was 32.0% from the general fish species.

According to the results of the poll among the fishermen and fish caught by their own methods in the lower reaches of the Sula River were registered adult representatives of *L. leuciscus*, *C. carassius*, *R. amarus*, *A. aspius*, *S. glanis*, *C. taenia*, *S. nigrolineatus*, *N. fluviatilis*, and *P. semilunaris*, which are listed in the different lists of endangered species.

As was mentioned above the spatial distribution of young fish depends on the presence of VAP, but correlates more with the flow velocity than with the species composition of VAP. Biotopic meanings of VAP associations for the fish fry, therefore, are to provide shelter and create conditions for the development of a forage base consisting of aquatic invertebrates.

The research demonstrates that the lower reaches of Sula River has a well-developed biota with high biodiversity, which mainly depends on the diversity of habitats. It is important to provide the existence of the flow regime in this section of the river, which supports the existence of lotic habitats. Due to this, the river biota is enriched by rheophilic species of aquatic organisms, which in general make up about a third of the researched area. 57% of the river fish species were found and were met in lotic habitats. The smallest part of rheophilic species (8%) is registered among higher aquatic vegetation. The highest percentage of rheophilic species is observed in the riverbed, but they are also found in the lentic habitats of bays and backwaters. At the same time, the basis of taxonomic abundance (about 70%) is species with wide ecological diapasons, which can exist in non-flowing conditions. This ratio coincides with the distribution of biotopes within the area because, in the research area, lotic habitats of the channel also occupy about a third of the water surface.

The river with a developed system of floodplain waterbodies has a high biotope diversity and, a high biodiversity, much of which is provided by the presence of lotic habitats. Changes in hydrological conditions due to dehydration or dam construction have little effect on belt biotopes and effectively eliminate lotic habitats, with corresponding losses of biodiversity. Therefore, for the researched river we should expect a decrease in biodiversity with decreasing flow. This pattern should be true for rivers with well-developed biotope diversity, which largely depends on the size of the river. Thus, for small rivers and streams with low biological and biotope diversity, the opposite picture can be observed: increasing biodiversity during dam construction. However, the general increase in species abundance does not preclude the extinction of rheophilic and migratory species, many of which are vulnerable and protected, so each case requires separate research and decision-making.

CONCLUSIONS

The lower reaches of the Sula River are an example of lotic ecosystem with high biodiversity. The biotic complexes of the lower reaches of Sula River were historically formed under the conditions of a rheophilic river regime and contain a third of the rheophilic and oxyphilic species of hydrobionts, some of which are included in international and state protection lists of various levels.

The floristic complexes of the lower Sula River are typical for such habitats and contain six plant communities with conservation status. The structure of phytocomplexes remains stable for many years. The maximum number of vascular aquatic plants is typical for the riverbed sections of the river, rheophilic species are about 8% of the total number of species.

The fauna of aquatic invertebrates in the studied area contains 67 taxa, 15 of which are characterized by rheophilic biotopes. The composition and structure of zoobenthos, epiphiton, and epilithon indicate the presence of anthropogenic impact and pollution of the river ecosystem.

Research has registered 28 species of fish in the lower reaches of the Sula River, the most common of which were bleak, roach, and white bream, 10 of the species found have conservation status, eight are alien.

Downward migration of young industrial fish species occurs in late spring and early summer in the Sula River, during which the Kremenchuk Reservoir receives about 12 million young fish.

Construction of a dam will cause significant changes in the hydrological regime of the river, fundamentally changing the entire structure of the river and near-river biocenoses. The rise of the water level above the lock will lead to a decrease in flow, eutrophication, the creation of limnic conditions, siltation, and overgrowth with VAP. Flooding of large areas of shallow water will lead to a deterioration of the oxygen regime due to the decomposition of a large mass of organic substances, an increase in water loss through evaporation, and, accordingly, a decrease in the water content of the river below the lock. Water depleted in oxygen and saturated with decomposition products entering the river, as well as Sulyansk Bay, can contribute to fish's mass death from suffocation not only in winter but also in summer. Thus, the building of hydraulic structures is undesirable and will lead to a breach of integrity of the river continuum, restructuring, and impoverishment of the ecological communities of the river biota.

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