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STRUCTURAL CHARACTERISTIC OF ICHTHYOPLANKTON IN A SMALL RIVER FLOWING WITHIN A BAR PLAIN OF THE DNIPRO RIVER

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Purpose. *Using as an example of a small river, which flows through a bar plain of the Dnipro, to study species composition of the littoral ichthyoplankton, dynamics of its structure during the season and its diversity in different parts of the river.*

Methodology. *The littoral ichthyoplankton was investigated during four seasons of 2011-2014 on the Vita river, a right tributary of the Dnipro affected by the operation of Kaniv HPP. The research covered the main channel, a permanent backwater connected with the channel, as well as temporarily flooded areas of the floodplain and separated from the channel oxbow lakes. Samples were collected with standard sweep nets and Bagenal buoyant nets. Identification of young fish was carried out under binocular microscope MBS-9. Early life stages of larvae were determined according to the system of V. Vasnetsov. Species diversity of ichthyoplankton was assessed by the Shannon index.*

Findings. *The littoral ichthyoplankton during May-July mostly consisted of limnophilic fish larvae belonging to a family Cyprinidae. In the river channel and the backwater at the beginning of the period the larvae of roach (Rutilus rutilus) prevailed, later they were substituted by larvae of more thermophilic species, among which the rudd (Scardinius erythrophthalmus) was the most abundant. In the oxbow lakes and temporarily flooded areas in spring the coastal ichthyoplankton was mainly structured by larvae of Carassius sp. and the rudd, in summer the larvae assemblages of oxbow lakes were quantitatively dominated by the sunbleak (Leucaspius delineatus). In areas covered with vegetation the larvae of invasive Chinese sleeper (Perccottus glenii) were firstly found. Rheophilic species among young fish were absent, which indicates unfavorable conditions for their spawning at present hydrologic regime of the river.*

Originality. *For the first time the coastal communities of early young fish in a small tributary of the Dnipro were investigated, seasonal dynamics of their structure was considered, the main spawning grounds of industrial fish were determined.*

Practical value. *The obtained results point out the important role of small tributaries of the Dnipro in reproduction of many fishes, particularly the industrial ones. They can serve as a basis for identifying the most suitable places for restoration of fish populations, as well as for proper planning of measures aimed at protection, conservation and restoration of ichthyofauna of small rivers and waters associated with them.*

Keywords: *Small rivers, bar plain, hydrologic regime, littoral ichthyoplankton, limnophilic species, invasive species.*

PROBLEM STATEMENT AND ANALYSIS OF LAST ACHIEVEMENTS AND PUBLICATIONS

An important role in the reproduction of ichthyofauna in large rivers belongs to their small tributaries. They serve as spawning and nursery grounds for various fishes.

The most effective in this regard are unregulated tributaries, as they do not contain any barriers for fish spawning migrations [1, 2]. However, very few rivers have been still maintained in their natural state. Particularly, in the Kyiv area, most of the Dnipro tributaries are transformed into cascades of ponds or enclosed in collectors and concrete gutters [3]. Moreover, due to differences in water levels, a number of tributaries which flow into the Dnipro reservoirs is now pumped from the embankment areas and completely lost its function as a place of fish reproduction.

Among many small rivers in Kyiv, the Vita River can be considered as the one which is most preserved in its natural state [4]. Even though the channel on its middle reaches is partially straightened, the river does not have any dam along the whole stretch. The lower reaches of the river flow within a bar plain of the Dnipro [5]. After construction of the reservoirs cascade, this rare type of landscape has been preserved only in some parts of the Pripyat River in the Chernobyl Exclusion Zone and on a small plot: on the left bank from Kiev to Bortnychi, and on the right bank in the Vita River mouth area. The unicity of the bar plain is characterized by a peculiar structure: it has a complicated terrain with relatively high bars, as well as an exceptionally sandy soil composition, which causes the floodplain to be eroded with deep water galls, based on which a network of shallow backwaters is formed [6,7].

Since ancient times, the mouth area of the Vita has served as a center for feeding, breeding and settling of fish in the middle Dnipro. In 1921, most of this territory was included into the State Ichthyological Reserve "Koncha Zaspa" [8, 9]. By that time, the Vita was characterized by rich ichthyofauna. E.g., in 1928, D. Beling provided a list of 41 species. This list, in particular, included the representatives of some migratory fish that are not found here nowadays: sturgeon, herring, eel [10]. It had been a long time until the next survey of ichthyofauna was conducted on this area in 1995-1997 [11]. As a result of the work carried out at various parts of the river, 29 species of fish from 13 families were registered in total. Somewhat later, as a result of an inventory of ichthyofauna in the Vita River mouth area in 2006-2007, the list of species found decreased to 21, which was explained by the decline in the number of typical river fishes: chub, asp, razor fish and zobel. The basis of ichthyocomplexes was formed by phytophilic fish: roach, rudd and silver bream [12].

HIGHLIGHT OF THE EARLIER UNRESOLVED PARTS OF THE GENERAL PROBLEM. AIM OF THE STUDY

After creation of the Kaniv reservoir in 1974-1976 [13], the Vita River suffered a backwater effect, which has changed its hydrologic regime: today, when the level of the reservoir is raised, its mouth area may even develop a reverse flow [4]. On the one hand, it creates favorable conditions for spawning of many fish species, especially the representatives of phytophilic ichthyofauna, many of which are valuable for fishing and industry. On the other hand, the conditions of the reproduction of typical river fishes have deteriorated resulting in a significant decrease in their numbers [12].

An indisputable indicator of successful spawning in any river or water body is a presence of early age fish. Since the aggregations of larvae and juveniles of most fishes are mainly located close to the banks, monitoring of such areas when studying the young fish assemblages is of paramount importance [14–17].

Despite the significant role of small inflows of the Dnipro as spawning grounds, very little attention was given to the study of young fish in such rivers, in contrast to the reservoirs, which they flow in. Previous researches were limited by studying the downstream movement of pikeperch *Sander lucioperca* (L.) larvae in the Olshanka River [18] and fragmentary studies of coastal young fish at the peak of flood in the Vita River [11].

The purpose of this study was to investigate the species composition of littoral ichthyoplankton, the dynamics of its structure during the season and its peculiarities and diversity at different parts of the river catchment using the Vita River as an example.

MATERIALS AND METHODS

Coastal ichthyoplankton was investigated from the moment of mass appearance of free-floating larvae in the littoral zone (1st to 2nd decades of May) until most of them transformed to juveniles (2nd to 3rd decades of July) twice a month during the four seasons of 2011-2014. The study was conducted mainly on the river channel and a permanent backwater connected with it, as well as in temporarily flooded areas of the floodplain and oxbow lakes separated from the channel. The flooded section of floodplain located between the channel and the backwater was surveyed in 2013 from June until the first half of July, when the water level dropped and the bank finally drained. The oxbow lakes were studied in 2014.

Samples were collected with sweep nets made of 0.5 mm mill mesh with a metal opening of 0.35 m diameter (circle area of 0.1 m^2), as well as Bagenal buoyant nets [19] modified by Dolinskiy [20] with the circle area of 0.5 m^2. The collected larval fish were preserved in a 4% formaldehyde solution. Water temperature was measured in the water column during each sampling with a mercury thermometer to the nearest 0.1°C.

Identification of ichthyoplankton was carried out under binocular microscope MBS-9 with the help of identification guides [21, 22]. Early life stages of larval fish were determined according to the system of V. Vasnetsov [23]. Fish taxonomy was given according to Yu. V. Movchan [24].

The characteristic of species diversity of the ichthyoplankton was made using the Shannon index. The assessment of species composition similarity in different parts of the river was performed using Sorensen indexes [25, 26].

STUDY RESULTS AND THEIR DISCUSSION

During the period of the research, larvae of 12 fish species belonging to 4 families were found in littoral ichthyoplankton of the Vita River. The most abundant was *Cyprinidae* family, which included 9 species. *Syngnathidae, Odontobutidae* and *Gobiidae* families were represented by one species each (Table 1).

The similarity analysis of ichthyoplankton species composition showed that the most similar were the channel and the backwater, as well as lakes and temporary waters, the Sorensen coefficient for which was 0.90 and 0.75, respectively. Meanwhile, the structure of ichthyoplankton in all studied biotopes fluctuated continuously during the spring-summer period.

Table 1. **Species composition of littoral ichthyoplankton in the Vita River (2011-2014)**

Species	Channel	Backwater	Oxbow lakes	Temporary waters
Cyprinidae				
Rutilus rutilus (L.) – roach	+	+	–	–
Scardinius erythrophthalmus (L.) – rudd	+	+	+	+
Alburnus alburnus (L.) – bleak	+	+	–	–
Leucaspius delineatus (Heckel) – sunbleak	–	–	+	–
Blicca bjoerkna (L.) – silver bream	+	+	+	+
Abramis brama (L.) – bream	+	+	–	–
Rhodeus amarus (Bloch) – bitterling	+	+	–	–
*Carassius sp.**	+	+	+	+
Tinca tinca L. – tench	+	+	–	–
Syngnathidae				
Syngnathus nigrolineatus Eichwald – shore pipefish	+	–	–	–
Odontobutidae				
Perccottus glenii Dybowski – Chinese sleeper	+	+	–	–
Gobiidae				
Proterorhinus semilunaris (Heckel) – western tubenose goby	+	–	–	–
Total:	11	9	5	3

* identified to the genus level

In the coastal zone of the channel and the backwater, first larvae appeared almost simultaneously, mainly in the first decade of May at a water temperature of 15-19°C. The basis of ichthyoplankton at that time consisted of roach larvae, where their relative number reached 98% (Fig. 1). Together with the roach, single larvae of bream, silver bream and rudd were also found. The share of bream larvae was slightly higher in the backwater (3.4%) than in the channel (2.0%). Due to such inequality of larval communities, the beginning of the period was characterized, respectively, by the lowest values of the Shannon index, from 0.13 in the channel to 0.52 in the backwater. The period of roach predominance in ichthyoplankton was rather short and mostly ended at the end of May, since this species is characterized by a short spawning period. With the water warming up to 20-24°C, the roach in ichthyoplankton communities was replaced with the rudd, while the late larvae and juveniles of roach gradually moved away from the shore and settled the deeper areas. In this intermediate period, which accounted for the end of May-early June, the species diversity indices of the littoral ichthyoplankton increased significantly, from 1.18 in the backwater to 1.40 in the river channel. During summer, with further water warming up to 24-25°C, ichthyoplankton in the channel and the backwater was dominated by rudd larvae. Significant share also accounted for such

species as bleak (up to 42% by number), bitterling (up to 36%), silver bream (up to 28%) and *Carassius sp*. (up to 9%). The larvae of tench and the invasive Chinese sleeper occurred in small numbers mainly in vegetated areas of the backwater. The larvae of shore pipefish and western tubenose goby were caught as single individuals in the channel. Despite the predominance of the rudd, due to the presence of other thermophilic species larvae, the Shannon indexes in the summer were practically at the same level as in the transitional spring-summer period, reaching the values of 1.34 in the channel and 1.42 in the backwater.

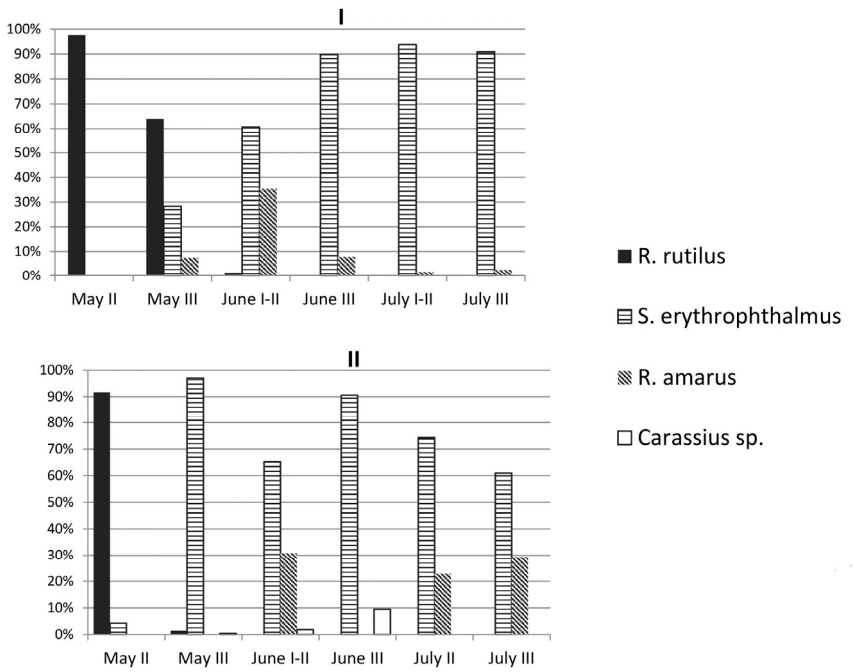

Fig 1. **Dynamics of mass species number ratio in the channel (I) and the backwater (II) ichthyoplankton in 2014**

The temporarily flooded section of the floodplain between the channel and the backwater was characterized by low species richness of ichthyoplankton. In the material collected, the larvae of only three species were detected. Within the flooding period the basis of ichthyoplankton was presented by *Carassius sp*. and the rudd. Silver bream larvae were caught only as single specimens (Fig. 2.I). Despite a fairly good equality of communities, the diversity index due to a small number of species here did not exceed the value of 1.0.

In the investigated oxbow lakes, the first fish larvae emerged near shores in the second decade of May, at a temperature of 15-18°C. The larvae of rudd (84.3% by number) and *Carassius sp*. (15.7%) were detected then. Herewith, the larvae of *Carassius sp*. were caught exclusively inside the water vegetation, while the rudd were mainly found at open areas close to the water plants. In June, the ichthyoplankton was prevailed by the larvae of sunbleak (79.6%), then followed by the rudd (11.1%) and the silver bream (8.3%) (Fig. 2.II). The maximum value of diversity index did not exceed 0.98 due to the low number of species.

The general changes in the ichthyoplankton structure in the channel and the backwater were rather similar and reflected the reproductive periods of species with early and tight (roach) and late and long spawning (rudd, bitterling, bleak, *Carassius sp*.). At the same time, the coastal ichthyoplankton of the backwater, compared with the channel, had a slightly smaller share of roach and a shorter period of its occurrence, while the relative number of rudd and other typical limnophiles such as *Carassius sp*., tench and Chinese sleeper was higher. Such differences are obviously related to different hydrological conditions of the given river sections, since the channel is characterized by the continued overflow, while the backwater is a practically stagnant water body, as a result being more silty and vegetated [7]. Remarkably, the larvae of bream, a commercially valuable species, occurred simultaneously with roach larvae only in May, which indicates rather early and tight spawning of this fish in the Vita River.

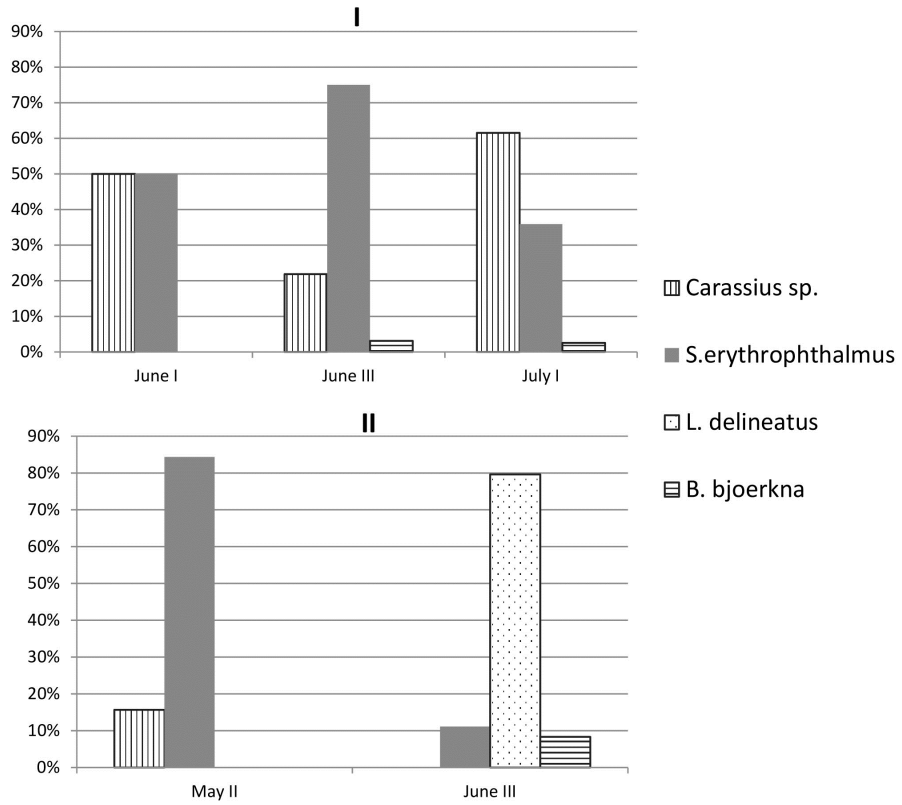

Fig. 2. **Dynamics of ichthyoplankton structure in temporary waters (I) and oxbow lakes (II) of the Vita River**

The obtained results concerning the composition of ichthyoplankton in oxbow lakes and temporary waters indicate that *Carassius sp.* and the rudd prefer shallow places with no current for reproduction. Their spawning in such areas commences somewhat earlier than in the channel and the backwater, which may be explained by faster heating of water to the spawning temperature, as well as by the lack of roach, which massively spawns in the channel and the backwater at the peak of flood. The high number of *Carassius sp*. larvae in such parts of the river emphasizes their key role

in reproduction of this genus. Therefore it is necessary to avoid strong fluctuations in the level of the reservoir during operation of the Kaniv HPP, which can lead to drying the eggs deposited on the flooded banks.

Noteworthy, the larvae of typical river fishes such as chub *Squalius cephalus* (L.), ide *Idus idus* (L.), zobel *Ballerus sapa* (Pallas) and asp *Aspius aspius* L. were not detected at any of the studied sites of the Vita River. A decrease in the number of these species was reported even earlier, however, asp larvae in small numbers were still found [12]. It means that under the current hydrologic regime of the Vita River, connected with its backwater effect by the Kaniv reservoir, the conditions for reproduction of rheophylic fishes are unfavorable.

CONCLUSION AND PERSPECTIVES OF FURTHER DEVELOPMENT

In the littoral ichthyoplankton of the Vita river, 12 fish species, 9 of which belonged to the *Cyprinidae* family, were detected. The littoral ichthyoplankton of the river channel and the backwater during the season changed its structure: in spring, the basis of larvae communities was formed by the roach; in summer, when water temperature increased, the roach was substituted by the rudd. Among secondary species, the commercially valuable ones such as bream, *Carassius sp.* and tench, were also found; their relative number in the backwater section was slightly higher compared to the river channel.

The oxbow lakes and flooded areas of floodplain were characterized by a lower species richness and completely different species ratios. In certain periods, the basis of ichthyoplankton communities of the studied waters was formed by *Carassius sp*. larvae that indicated on their key role in the reproduction of this genus within the Dnipro bar plain.

Due to the specific geological structure of the floodplain, as well as the backwater effect of the Kaniv reservoir, the Vita River serves as a reproduction area mainly for limnophilic fish, while typical river species do not find favorable conditions for spawning here.

An important addition to the data obtained should be the study of ichthyoplankton in open areas of the river, which will provide information about the reproduction of *Percidae* fishes, most of which have pelagic larvae.

We consider it advisable to carry out similar studies on other tributaries of the Dnipro, which will give the possibility to evaluate their role in the reproduction of different fish populations.

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СТРУКТУРНА ХАРАКТЕРИСТИКА ІХТІОПЛАНКТОНУ МАЛОЇ РІЧКИ, ЩО ПРОТІКАЄ В МЕЖАХ КРУПНОГРИВИСТОЇ ЗАПЛАВИ ДНІПРА

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Мета. *На прикладі малої річки, що протікає крупногривистою заплавою Дніпра, дослідити видовий склад прибережного іхтіопланктону, динаміку його структури протягом сезону та її відмінності на різних ділянках річки.*

Методика. *Прибережний іхтіопланктон досліджували протягом чотирьох сезонів 2011–2014 рр. на річці Віта — правій притоці Дніпра, що зазнає підпору внаслідок роботи Канівського гідровузла. Дослідженнями охоплено основне русло, сполучену з ним постійну затоку, а також тимчасово затоплені ділянки заплави та відокремлені від русла заплавні озера. Проби відбирали стандартними мальковими сачками та спливаючими сітками Бедженала. Визначення молоді риб проводили під бінокулярним мікроскопом МБС–9. Періоди і етапи розвитку молоді визначали за системою В. В. Васнєцова. Видове різноманіття іхтіопланктону оцінювали за індексом Шеннона.*

Результати. *Основу прибережного іхтіопланктону протягом травня–липня складали личинки лімнофільних видів риб родини коропових. На початку періоду у руслі та затоці переважали личинки плітки, згодом вони заміщувались личинками більш теплолюбних видів, серед яких основу чисельності складала краснопірка. У заплавних озерах та тимчасово залитих ділянках заплави основу прибережного іхтіопланктону навесні складали личинки карася та краснопірки, влітку у заплавних озерах кількісно переважали личинки вівсянки. У заростих ділянках вперше знайдено личинок інвазивного виду головешки-ротана. Реофільні види риб серед молоді не виявлені, що вказує на відсутність умов для їх нересту при сучасному гідрологічному режимі річки.*

Наукова новизна. *Вперше досліджено прибережні угруповання ранньої молоді риб малої притоки Дніпра, розглянуто сезонну динаміку їх структури, визначено основні місця нересту промислових видів риб.*

Практична значимість. *Одержані результати показують важливу роль малих приток Дніпра у відтворенні багатьох видів риб, зокрема промислово цінних. Вони можуть слугувати основою для визначення найбільш придатних місць для відновлення популяцій риб, а також правильного планування заходів, спрямованих на охорону, збереження та відновлення іхтіофауни малих річок та пов'язаних з ними водойм.*

Ключові слова: *малі річки, крупногривиста заплава, гідрологічний режим, прибережний іхтіопланктон, лімнофільні види, інвазивні види.*

СТРУКТУРНАЯ ХАРАКТЕРИСТИКА ИХТИОПЛАНКТОНА МАЛОЙ РЕКИ, ПРОТЕКАЮЩЕЙ В ПРЕДЕЛАХ КРУПНОГРИВИСТОЙ ПОЙМЫ ДНЕПРА

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Цель. *На примере малой реки, протекающей по крупногривистой пойме Днепра, исследовать видовой состав прибрежного ихтиопланктона, динамику его структуры в течение сезона и ее отличия на разных участках реки.*

Методика. *Прибрежный ихтиопланктон исследовали в течение четырех сезонов 2011–2014 гг. на реке Вита — правом притоке Днепра, испытывающем подпор вследствие работы Каневского гидроузла. Исследованиями охвачено главное русло, соединенный с ним постоянный залив, а также временно затопленные участки поймы и отделенные от русла пойменные озера. Пробы отбирали стандартными мальковыми сачками и всплывающими сетками Бэдженала. Определение молоди рыб проводили под бинокулярным микроскопом МБС-9. Периоды и этапы развития молоди определяли по системе В. В. Васнецова. Видовое разнообразие ихтиопланктона оценивали по индексу Шеннона.*

Результаты. *Основу прибрежного ихтиопланктона в течение мая–июля составляли личинки лимнофильных видов рыб семейства карповых. В начале периода в русле и заливе преобладали личинки плотвы, впоследствии они замещались личинками более теплолюбивых видов, среди которых основу численности составляла красноперка. В*

пойменных озерах и временно залитых участках поймы основу прибрежного ихтиопланктона весной составляли личинки карася и красноперки, летом в пойменных озерах количественно преобладали личинки верховки. В заросших участках впервые найдено личинок инвазивного вида ротана-головешки. Реофильные виды рыб среди молоди не обнаружены, что указывает на отсутствие условий для их нереста при современном гидрологическом режиме реки.

Научная новизна. *Впервые исследованы прибрежные группировки ранней молоди рыб малого притока Днепра, рассмотрена сезонная динамика их структуры, определены основные места нереста промысловых видов рыб.*

Практическая значимость. *Полученные результаты показывают важную роль малых притоков Днепра в воспроизводстве многих видов рыб, в том числе промышленно ценных. Они могут служить основой для определения наиболее подходящих мест для восстановления популяций рыб, а также правильного планирования мероприятий, направленных на охрану, сохранение и восстановление ихтиофауны малых рек и связанных с ними водоемов.*

Ключевые слова: *малые реки, крупногривистая пойма, гидрологический режим, прибрежный ихтиопланктон, лимнофильные виды, инвазивные виды.*