

## FISH IN WATER BODIES OF THE EMERALD NETWORK OF UKRAINE

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*The paper provides information on the structure of sites of the Emerald Network of Ukraine as special areas of conservation, focused at ensuring the protection of natural fauna, flora and habitats. The development of this network was initiated for the implementation of a set of resolutions of the Berne Convention (1979), and principles of its formation are basically similar to Natura 2000. As of 2019, a total of 271 Emerald sites were designated in Ukraine. According to studies, the water bodies of the network are inhabited by 25 fish species. The data were extracted from up-to-date ichthyological publications on the distribution of fish species in Ukrainian water bodies, catalogues of collections of various zoological museums, regional faunal cadastres, and own research. Analysis of the fish species composition in the sites has shown that the most common and found in more than 60% of the sites are *Cobitis taenia*, *Rhodeus sericeus amarus*, *Misgurnus fossilis*. This can be explained by characteristics of their biology and tolerance to environmental conditions. Endemic species are extremely rare in the Emerald sites and narrowly localized in several river basins. In particular, they are *Zingel zingel*, *Umbra krameri*, *Eudontomyzon danfordi*, *Hucho hucho*, and *Leuciscus souffia* recorded in 5-6 sites of the network. Further research is required that will be focused at the development of an integral network of Emerald sites in Ukraine. For this purpose, ichthyological reserves of general and local significance may be considered as promising areas. The analysis of the species number and distribution in water bodies of Ukraine is quite relative and requires additional special field studies. In addition, a qualitative assessment of the number of fish species in promising areas requires ichthyological research methods to be unified and an effective monitoring system be introduced.*

*Keywords: Natura 2000, Emerald Network, Ukraine, fish, conservation, monitoring.*

**Introduction.** Biological diversity continues to decline worldwide. Habitat destruction, pollution, overexploitation of natural areas and development of artificial landscapes are among the major causes of biodiversity loss. According to the International Union for Conservation of Nature, 15% of mammals, 13% of birds, 37% of freshwater fish and 23% of amphibians in Europe are under threat of extinction. Biodiversity constitutes a natural heritage that needs to be preserved and handed on to future generations, especially in view of its intrinsic value and the ecosystem services that it provides (for example, provision of food, maintenance of air quality, water purification, pollination or recreation) (The Emerald Network in the Republic of Armenia, 2016).

The development of the Pan-European Ecological Network was envisaged as part of the Pan-European Biological and Landscape Diversity Strategy, approved at the 5th Ministerial conference “Environment for Europe” in 1995 (Sofia, Bulgaria) (Boltachov et al., 2011).

In the territory of the European Union countries, a common European ecological network of special areas of conservation called Natura 2000 is

established. Outside of the European Union, the Emerald Network is created, represented by a number of special protection areas, aimed at ensuring the conservation of natural fauna, flora and habitats. The development of this network was initiated for the implementation of a set of resolutions of the Berne Convention (1979), and principles of its formation are basically similar to Natura 2000. Both networks, due to their political weight, geographical distribution, biological and landscape diversity, are the main components of the Pan-European Ecological Network (Pashkevich, Fitsailo, 2012; Solomakha, 2016).

To-date, the Emerald sites have been designated in 6 countries: Belarus, Georgia, Moldova, Norway, Switzerland and Ukraine (List of officially adopted Emerald sites, 2018). In addition, the Standing Committee of the Bern Convention regularly nominates officially as “Candidate Emerald sites” a number of sites proposed by all countries currently working on the establishment of the Emerald Network (7 countries from Eastern Europe and the South Caucasus, 5 countries from the West Balkans, Norway and Morocco) (List of officially nominated candidate Emerald sites, 2018). Several of the

mentioned countries have published their summaries on national Emerald sites and determined their development perspectives (The Emerald Network in the Republic of Armenia, 2016; Gusev, Lisetskii, Ermakova, 2016; Shavgulidze, Artsivadze, Nozadze, 2018).

The Emerald Network of Ukraine is based on approaches and principles of the Pan-European Ecological Network. The recommendation of the Standing Committee (No. 16) (1989) defines the criteria to be met by the Emerald site:

- contributes substantially to the survival of threatened species, endemic species, or any of the species listed in Annexes I and II of the Berne Convention;
- supports significant numbers of species in an area of high species diversity or supports important populations of one or more species;
- contains an important and / or representative sample of endangered habitat types;
- contains an outstanding example of a particular habitat type or a mosaic of different habitat types;
- represents an important area for one or more migratory species.

The development of Emerald Network and Natura 2000 seeks to ensure the conservation of rare habitats, plant and animal species. Fish is an important component in the majority of the established natural protected areas in most European countries. The assessment of representativeness of fish species and their status defines further steps in the development of management plans and implementation of special measures for the restoration of rare species populations. Thus, a number of countries summarized the fish data within nature conservation networks and are planning special biotechnical activities (Thiel, Backhausen, 2006; Bănăduc, Oprean et al., 2011; Wolnicki et al., 2011; Curtean-Bănăduc, Cismaș et al., 2015).

The Ukrainian part of the European Emerald Network has been developed since 2009. The leading organization responsible for its establishment is the Ministry of Ecology and Natural Resources of Ukraine, the developer is the charity organization "Intertekotsentr". Based on the results of the surveys, in 2016 the Standing Committee of Bern Convention approved a list of Emerald sites, which includes 271 sites for Ukraine. Since 2016, the non-governmental nature conservation initiative "Emerald – Natura 2000 in Ukraine" and NGO "Ukrainian Nature Conservation Group" have launched the development of a shadow list of the Emerald Network. By now, they have proposed to extend the Ukrainian Emerald Network adding 124 new sites (Polyanska et al., 2017, Vasyliuk et al., 2019a). In addition, a methodical guide on the design and conservation of

Emerald Network sites was developed (Vasyliuk et al., 2019b). Nowadays, at the national level, legal mechanisms for the development and functioning of the Emerald network are considered, and gaps in the Law of Ukraine "On the Emerald Network Sites" are evaluated (Bevz, 2018).

The main purpose of research was to analyze the representativeness of fish in water bodies of the Emerald Network of Ukraine and identify gaps in the current knowledge of rare fish species populations in the country. As part of this goal, the following objectives were foreseen:

- to analyze the current structure of the Ukrainian Emerald sites;
- to evaluate the representativeness of fish in water bodies of the Emerald Network;
- to identify the importance of the Emerald objects for the protection of fish;
- to analyze gaps in current ichthyological studies in the context of the Emerald Network;
- to propose further steps for the development of ichthyological studies as an integral part for the management of the Emerald sites of Ukraine.

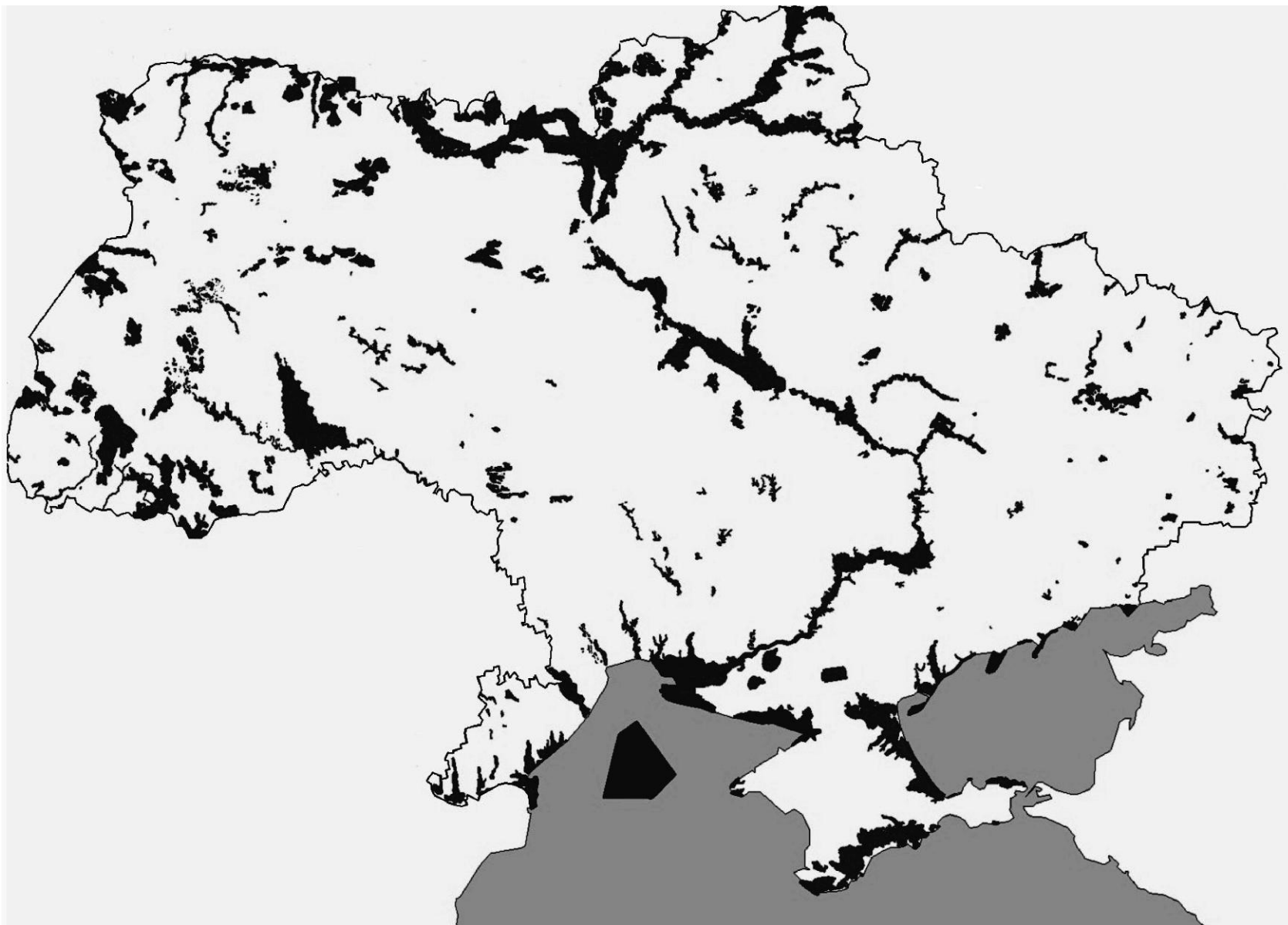
**Materials and methods.** Emerald Network development projects in Ukraine have been implemented since 2009 by the charity organization "Intertekotsentr" within the framework of a joint programme between the European Union and the Council of Europe on the preparation of the Emerald Network of conservation areas. Over the period of 2009-2013 ichthyological research was consolidated in a collective monograph (Boltachov et al. 2011).

The required activity included filling of the database on the species distribution in each Emerald site. The data were extracted from up-to-date ichthyological publications on the distribution of fish species in Ukrainian water bodies, catalogues of collections of various zoological museums, regional faunal cadastres, and own research. In some cases an expert assessment of the possibility of occurrence of certain species in small and unexplored water areas was made. In total, standard forms for 221 Emerald sites were filled.

**Results and discussion.** Since 18 November 2016, the Emerald sites for three countries (Switzerland, Belarus, Ukraine) have been officially designated. They have successfully passed a biogeographic assessment of their suitability for the conservation of flora, fauna and habitats approved by the relevant resolution of the Berne Convention.

The current Emerald Network of Ukraine includes 271 sites with a total area over 62 thousand km<sup>2</sup>, covering more than 10 % of the Ukrainian territory (Fig. 1).

It includes protected areas of Ukraine with different status:



*Fig. 1. Sites of the Emerald network in Ukraine*

- 19 nature reserves;
- 7 biosphere reserves;
- 44 national nature parks;
- over 120 sanctuaries (*zakazniks*) of state and local importance;
- 22 regional landscape parks;
- 7 Ramsar sites;
- over 80 territories of high/valuable biodiversity, among them reservoirs of the Dnieper, river valleys, limans of the Azov-Black Sea coast, some woodland and mountain areas, etc.

Emerald sites are represented in 4 biogeographical regions:

- Pannonian (Transcarpathian region);
- Alpine (Carpathian region);
- continental (forest-steppe and steppe zones of Ukraine);
- steppe (steppe zone of Ukraine, including the Crimea and water areas of the Black Sea and Sea of Azov).

The highest number of them is located in the continental and steppe bioregions, the lowest – in the Alpine and Pannonian ones (Table 1). The percentage of Emerald sites differs between bioregions. The highest is in the Alpine bioregion, exceeding 22 % of the bioregion area, and for others it ranges about 10 %.

**Table 1.**  
**Distribution of Emerald sites per bioregions and their total area**

Bioregion	Number of sites	Area, thnd ha
Alpine	23	564.3
Continental	138	3188.6
Steppe	105	2485.6
Pannonian	5	27.8

Analysing the structure of Emerald sites in the context of their suitability as fish habitats we should note that the percentage of water bodies included in the network are quite high. These water areas are represented as follows:

- *In the Dnieper basin* – by all the Dnieper reservoirs, mouth zone, major parts of river channels of the Turia, Stokhid, Prypyat, Desna, some valuable areas of the rivers Sluch, Seim, Ros, Stugna, Udai, Sula, Psel, Vorskla, Orel, etc.
- *In the Dniester basin* – by mountain upstreams of the Dniester river, by Dniestrovskoe Reservoir, some valuable areas of the rivers Stryi, Lomnytsia, Lukva, Zolota Lypa, Strypa, Seret, Zbruch, etc.
- *In the Danube basin* – by the entire river delta, part of the river channel, Danube lakes,

significant parts of the rivers Tisa, Tereblia, Prut, Chorni and Bilyi Cheremosh, Cheremosh, Uzh, etc.

- *In the Western Buh basin* – by some valuable areas of the rivers Western Buh and Rata.
- *In the Southern Buh basin* – by a significant part of the river downstream, water bodies and channels of small rivers in the upper part of the basin, part of the Savranka river channel.
- *In the Siverskyi Donets basin* – by Pechenizke Reservoir, valuable river channels and water bodies of Siverskyi Donets, a significant part of the Oskil river channel.
- *In the basin of rivers of the northern part of the Azov Sea region* – by mouth zones of the rivers Hruzkyi Yelanchik, Berda, Korsak, Lozuvatka, Molochna, Velykyi and Malyi Utliuk.
- *In the basin of rivers of the Crimea* – by some valuable areas of river channels and upstreams of the rivers Chorna, Belbek, Kacha, Alma, Angara.
- *In the basin of rivers of the northern part of the Black Sea region* – by some areas of the rivers Tilihul, Kuchurgan, Kohlynyk, Kyrhyzh Kytai, Kahul, etc.
- *In the water area of the Sea of Azov* – by significant parts of Tahanrozka, Bilosaraiska, Berdianska, Obytichna bays, Molochnyi Liman, part of Utliutskyi Liman, by Central Syvash and Eastern Syvash.
- *In the water area of the Black Sea* – by its significant areas, bights of the southern coast of the Crimea, bays Karkinitaska, Dzharylhachska, Tendrivska, Yahorlytska, limans Dniprovsko-Buzkyi, Berezanskyi, Tilihulskyi, Kuyalnytskyi, Dnistrovskyi, Sasykskyi and Tuzlovskyi. Thereby, the current Emerald Network includes different types of water bodies which are broadly represented within Ukraine and can be potentially important for the fish conservation.

Emerald sites have different importance for the conservation of individual species. According to the Berne Convention requirements the four-level assessment was done (categories A-D) (Table 2).

The analysis of the species number and distribution in water bodies of Ukraine is quite relative and requires additional special field studies. In general, it was carried out in accordance with available literary data, original research and expert opinion. Though certain species or Emerald sites still need further refinement and possible clarification, this analysis provides an opportunity to talk about the suitability and adequacy of the Emerald Network's sites for the conservation of certain species of fish, since these sites, as required by the Berne Convention, provide habitats for about half of the species populations within the bioregion.

**Table 2.**  
**Species composition and representativeness of fish in Emerald sites of Ukraine**

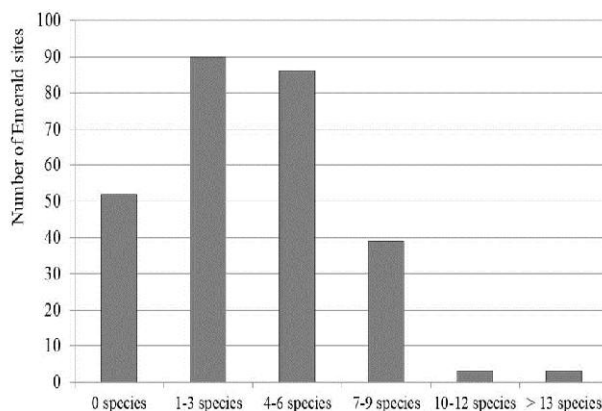
Species	Importance of the area for the population conservation*				Total
	A	B	C	D	
<i>Rhodeus sericeus amarus</i>	7	22	145	9	183
<i>Cobitis taenia</i>	5	9	137	4	155
<i>Misgurnus fossilis</i>	1	10	116	2	129
<i>Aspius aspius</i>	10	16	59	4	89
<i>Gobio albipinnatus</i>	-	28	23	-	51
<i>Eudontomyzon mariae</i>	-	2	43	4	49
<i>Pelecus cultratus</i>	-	-	41	2	43
<i>Sabanejewia aurata</i>	-	29	12	-	41
<i>Alosa pontica</i>	1	21	13	-	35
<i>Alosa tanaica</i>	-	13	10	-	23
<i>Chalcalburnus chalcoides</i>	-	5	14	2	21
<i>Cottus gobio</i>	5	6	8	-	19
<i>Alosa maeotica</i>	-	16	2	-	18
<i>Gobio kessleri</i>	-	5	11	2	18
<i>Phoxinus phoxinus</i>	-	5	10	3	18
<i>Gymnocephalus baloni</i>	-	3	14	-	17
<i>Barbus meridionalis</i>	2	4	9	-	15
<i>Zingel streber</i>	-	9	4	-	13
<i>Zingel zingel</i>	-	6	7	-	13
<i>Hucho hucho</i>	6	3	1	-	10
<i>Eudontomyzon danfordi</i>	-	-	7	2	9
<i>Umbra krameri</i>	1	5	2	1	9
<i>Gobio uranoscopus</i>	5	3	-	-	8
<i>Gymnocephalus schraetzer</i>	3	3	2	-	8
<i>Leuciscus souffia</i>	3	2	2	-	7

Note: \*Importance of the site for the population conservation: A – highest; B – high; C – significant; D – insignificant.

In total, water bodies of the network support 25 fish species, the most common of which are the spined loach (*Cobitis taenia*), European bitterling (*Rhodeus sericeus amarus*), and weatherfish (*Misgurnus fossilis*) owing to their biology and tolerance to environmental conditions. They are recorded in almost 50 % of the sites (Table 2). Endemic species, narrowly localized in some river basins, are extremely rare. Primarily, they are *Zingel zingel*, *Umbra krameri*, *Eudontomyzon danfordi*,

*Hucho hucho*, *Leuciscus souffia*. These species are recorded in 5-6 sites of the network.

Discussion. Analyzing the importance of sites for fish, it should be noted that a significant number of them is fairly well represented by the species of Emerald Network. The leader is the Danube Biosphere Reserve, providing shelter for 17 species of fish. Such a high value is associated with the diversity of environmental conditions in the reserve (marine waters, a powerful delta system and inland lakes) and high endemism of fish species. Also, more than 10 fish species are recorded in the Emerald sites, holding large areas of Alpine and Pannonian bioregions (Uzhanskyi and Vyzhnytskyi natural nature parks, Vynohradivska Tysa, Marmoroski and Chyvchyno-Griniavski Mountains, etc.). The combination of different types of habitats (mountainous and plain parts of rivers) in these sites contributed to the formation of a high fish diversity. The 20 % of the sites (n = 52) have no fish species protected by the Berne Convention in their fauna structure (Fig. 2).



**Fig. 2. Representativeness of the number of fish species within Emerald sites**

In addition, further activities are required aimed at forming an integral network of Emerald sites in Ukraine. In this respect, ichthyological sanctuaries of national and local significance, deepwater wintering habitats, and spawning grounds may be considered as promising areas.

The current ichthyological studies, on which the designation of Emerald sites is based, has certain peculiarities and imperfections:

- lack of comparative data on the population abundance in reservoirs. Unfortunately, in Ukraine there are no unified research methods that allow comparing the number of fish species and receiving representative data on their dynamics.
- lack of a monitoring system and expert network observing the population status of fish species under the Berne Convention. To-date, the legislation only provides for the monitoring of

commercial fish species to determine their number and trends of changes in the populations. Other species, including those listed in the Berne Convention, are not subject to permanent and systematic research.

- technical and legislative restrictions on permits for taking fish from the wild. Bureaucratic obstacles in receiving permits for fish catching blocks the possibility to organize a network of monitoring and systematic ichthyological studies.

In general, the current Emerald Network of Ukraine has fairly high potential for the protection of rare species of fish, which was confirmed in the framework of biogeographic workshops. It should be noted that the justification and approval of Emerald sites is only the first and, in our opinion, the simplest step in implementing resolutions of the Berne Convention. The approved network of sites can serve as a basis and, in the long run, Ukraine has the opportunity to change boundaries of the existing sites and add new ones.

In our opinion, a major problem will be the measures aimed at the legislative regulation of the functioning of the Emerald sites and the development of special measures (management plans) for the conservation of individual species populations or a site as a whole. The lack of normative documents and contradictions in approaches to the use of natural resources in water areas will require many approvals and may lead to conflicts and controversies. This may be particularly acute for the Dnieper River and Dnieper reservoirs, which are, in fact, technical water areas, and the approval of management plans for the species protection will be rather complicated.

It is also necessary to note the specifics of certain species of fish, especially the European bitterling and the spined loach, which have a significant range and high numbers. Adoption of legislative norms regarding the restriction of the use of natural resources in habitats of these species can lead to the blockage of economic activity of most fishery enterprises of Ukraine.

We suggest the following main directions of activities for the development of the Emerald network and conservation of the fish species included in the Berne Convention:

1. *To enable environment for organizing monitoring of fish population statuses in Ukrainian water bodies* through the unification and approval of methods of ichthyological research, formation of an expert network, and simplification of the procedure for obtaining permits for fish catching.
2. *To search new, promising Emerald sites* basing on the development of an effective and professional strategy for the systematic scientific research in water bodies of Ukraine.

3. *To legalize Emerald sites in regulatory provisions and nature conservation laws.* Initially, to provide the mandatory development of management plans for Emerald sites that will include effective measures for the improvement of fish habitats within the particular site.

4. *To take balanced and compromise decisions regarding to the establishment of the procedure for the development of nature resource exploitation practices within Emerald sites.* Primarily, the possibility of an individual approach to the management of Emerald sites and application of different management tools should be provided.

**Conclusions.** As of 2019, a total of 271 Emerald sites were designated in Ukraine. According to studies, water bodies of the network are inhabited by 25 fish species. The most common, due to their biology and tolerance to environmental conditions, are *Cobitis taenia*, *Rhodeus sericeus amarus*, and *Misgurnus fossilis*. Endemic species are extremely rare in the Emerald sites and narrowly localized in several river basins. In particular, they are *Zingel zingel*, *Umbra krameri*, *Eudontomyzon danfordi*, *Hucho hucho*, and *Leuciscus souffia*.

Further research is required and should be focused at the development of an integral network of Emerald sites in Ukraine. For this purpose, ichthyological reserves of general and local importance, deepwater wintering habitats and spawning grounds may be regarded as promising areas.

The development of effective management plans for Emerald sites is possible in case of unified systematic ichthyological studies and definition of expert network.

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## РИБИ ВОДОЙМ СМАРАГДОВОЇ МЕРЕЖІ УКРАЇНИ

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В роботі наведена інформація щодо структури об'єктів Смарагдової мережі України як територій особливого природоохоронного значення, які мають на меті забезпечити збереження природної фауни, флори та оселищ. Розвиток цієї мережі було розпочато з реалізації ряду резолюцій Бернської конвенції (1979 р.), а принципи її формування базуються на в основному Natura 2000. Станом на 2016 рік в Україні відмічається 271 Смарагдовий об'єкт. Згідно досліджень встановлено, що у водних об'єктах мережі мешкає 25 видів риб. Дані були отримані в результаті аналізу сучасних іхтіологічних публікацій про поширення видів риб в українських водоймах, каталогів колекцій різних зоологічних музеїв, регіональних фауністичних кадастрів та власних досліджень авторів. Аналізуючи видовий склад риб територій слід зазначити, що найбільш поширеними є *Cobitis taenia*, *Rhodeus sericeus amarus*, *Misgurnus fossilis*. Це пов'язано з їх біологією і толерантністю до екологічних умов. Слід зазначити, що вони відмічаються більше ніж у 60 % територій. Досить рідкісними видами в об'єктах Смарагдової мережі є ендемічні, які вузько локалізовані в окремих річкових басейнах. Передусім це *Zingel zingel*, *Umbra krameri*, *Eudontomyzon danfordi*, *Hucho hucho*, *Leuciscus souffia*. Вони відмічаються в 5-6 територіях мережі. Зазначається необхідність подальших робіт, які будуть спрямовані на формування цілісної мережі Смарагдових об'єктів в Україні. Перспективними територіями для цього можуть стати іхтіологічні заказники як загального, так і місцевого значення. Окрім того, для якісної системи оцінки чисельності видів риб в межах перспективних територій є необхідність уніфікації іхтіологічних методів досліджень та запровадження дієвої системи моніторингу.

Ключові слова: *Натура 2000, Смарагдова мережа, Україна, риба, охорона, моніторинг*

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