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BIODIVERSITY CHANGES IN THE IRPIN RIVER WETLANDS FOLLOWING DAM DESTRUCTION DURING DEFENSIVE OPERATIONS IN KYIV, UKRAINE

***Mykola Prychepa*[1], *Yuliia Kovalenko*[2]**

[1]ORCID 0000-0002-3114-2402
[2]ORCID 0000-0003-4818-4542
[1,2]Institute of Hydrobiology
National Academy of Science of Ukraine, Kyiv, Ukraine

Key words: Irpin River mouth, floodplain, macrophytes, fish, birds, species richness, biodiversity.

Abstract

The aim of this study is to evaluate changes in macrophyte, fish, and bird assemblages in the lower section of the Irpin River following the dam breach and the subsequent ecosystem transformation caused by large-scale flooding. The destruction of a dam on the Irpin River in 2022 resulted in the flooding of over 2,500 hectares of floodplain, representing one of the first documented environmental consequences of the war in Ukraine. This study provides an assessment of early changes in three biotic components – macrophytes, fish, and birds – within the newly formed waterbody. The findings indicate a shift in the ecosystem toward a lentic regime, accompanied by transformations in species composition and habitat structure. A decline in macrophyte species richness, an increase in ichthyofaunal diversity, and the dominance of hydrophilic bird species were observed. In total, 12 species listed in the *Red Data Book of Ukraine*, 5 species included in the European Red List (as Vulnerable or Near Threatened), and 83 taxa protected under the Berne Convention (1979) were recorded, underscoring the high conservation value of the study area. These results provide a valuable baseline for assessing how wetland ecosystems respond to military impacts and enable meaningful international comparisons of the impacts of armed conflict on wetlands, particularly in the context of conserving transboundary migratory species.

Introduction

River valleys are among the most biodiverse ecosystems due to the wide range of habitats they support (McCabe 2010, Podschun et al. 2018). At the same time, they are particularly vulnerable to anthropogenic pressures, especially during military conflicts, which often unfold in such landscapes (Francis 2011). Armed hostilities can cause significant alterations to river

Address: Mykola Prychepa, Institute of Hydrobiology of the National Academy of Science of Ukraine, e-mail: Prichepa1987@ukr.net

hydrology, floodplain integrity, aquatic communities, and even lead to local extinctions (Golet et al. 2013, Maxwell et al. 2018, Larsen et al. 2019, Zhang et al. 2022). The destruction of hydraulic infrastructure, in particular, can drastically reshape riverine and floodplain landscapes (Shevchuk et al. 2022, Leal Filho et al. 2024), resulting in either large-scale inundation or local desiccation. In either scenario, the species composition of flora and fauna inevitably changes (Bodmer 1990). Flooding often creates favorable conditions for water-loving species, while pushing out those that rely on drier, riverbank habitats.

In February 2022, the destruction of a dam and pumping station at the mouth of the Irpin River led to widespread inundation of floodplain areas. This incident resulted in substantial landscape and hydrological transformations (Starodubtsev et al. 2022, Afanasyev 2023). The transition of the ecosystem from a lotic to a lentic system triggered a reorganization of aquatic and semi-aquatic biotic communities, affecting the composition of macrophytes, ichthyofauna, and avifauna. Evaluating these changes is crucial for understanding how biocenoses respond to newly formed conditions and for forecasting future biodiversity shifts in the Kyiv region.

The aim of this study is to assess the changes in macrophyte, fish, and bird assemblages in the mouth section of the Irpin River following the dam breach and subsequent ecosystem transformation due to large-scale flooding.

Methodology

To investigate the changes in biocenoses of the flooded Irpin River floodplain, eight sampling stations were selected in the river's lower reaches. Four stations (*1–4*) (Figure 1, upper panel) were studied before the full-scale Russian invasion in 2022. During 2022–2023, these areas were submerged, and four new stations (*5–8*) were established (Figure 1, lower panel), allowing for a comparative analysis of biotic composition before and after flooding (Table 1).

Ichthyological and botanical surveys were conducted three times per season (April, July, and October), whereas ornithological surveys were carried out six times per season (April–May, July–August, and September–November).

At each sampling station, geobotanical surveys were conducted using a field guide (Chorna 2001). Special attention was given to identifying macrophyte communities, their species composition, and spatial distribution in the aquatic and shoreline zones. Species names follow the *Plants of the World* classification system (*Plants of the world…* 2025).

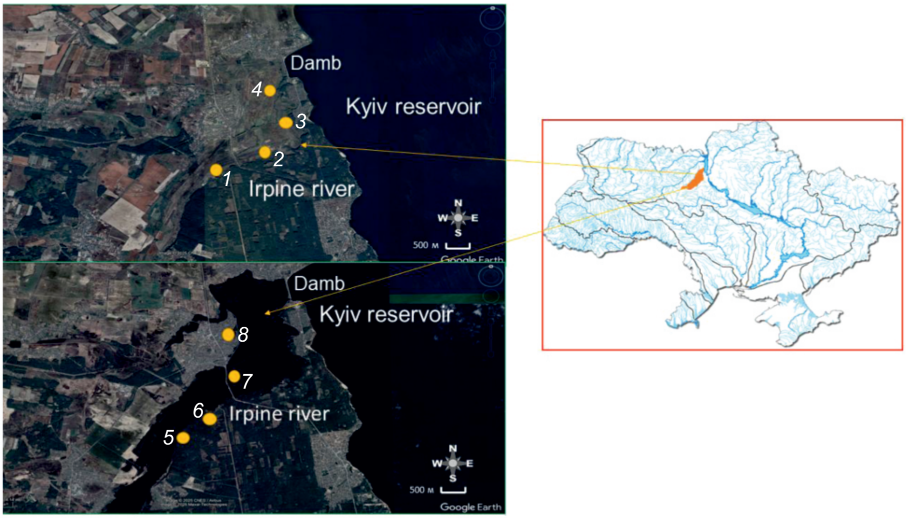


Fig. 1. The study area in the lower Irpin River valley, Ukraine. Upper map – sampling stations *1–4* before flooding. Lower map – sampling stations *5–8* the last after the flooding
Source: own elaboration based on Google Earth

Table 1

Geographic coordinates of sampling stations

Station, No	Year	Latitude	Longitude
1	2021	50.695403	30.312995
2	2021	50.716015	30.347987
3	2021	50.723952	30.354622
4	2021	50.725510	30.361585
5	2023–2024	50.690327	30.311631
6	2023–2024	50.704868	30.329533
7	2023–2024	50.713946	30.338874
8	2023–2024	50.739243	30.341042

Explanations as shown in Figure 1

Ichthyofauna was assessed using standardized test netting methods (Roman 2016) with scoop nets of varying rim diameters (50, 60, and 100 cm) and mesh sizes ranging from 0.3 to 0.5 cm. Each station was surveyed along a 100-meter stretch encompassing all representative biotopes: shorelines, shallow areas, macrophyte beds, and open water. The identification of ichthyofauna was carried out based on the morphological traits described in the catalog of the Zoological Museum of the National Academy of Sciences of Ukraine (Movchan et al. 2003), and cross-verified with the current taxonomic data from Fish Base (Froese and Pauly 2023). In total, 384 fish specimens were collected: 196 individuals in 2021 and 188 individuals in 2023–2024, respectively.

Avifauna was studied using the point-count transect method across shoreline areas, islands, and open water surfaces (BIBBY et al. 1998, FESENKO and BOKOTEY 2002). Observations were conducted in the morning and evening during dry weather using binoculars and digital cameras. Both resident and migratory species were recorded. Bird species were categorized according to their habitat preferences (e.g., hydrophilic, campophilic, dendrophilic). Abundance was estimated via direct visual counts within a 250–600 m radius at each station. A total of 361 individuals were recorded in 2021 and 818 individuals in 2023–2024, respectively.

The analysis presented focuses exclusively on the flooded territories. To characterize the biotic components, species richness was calculated for macrophytes, fish, and birds, and the Shannon diversity index (SHANNON and WEAVER 1949) was used for fish and birds.

$$H = -\sum_{i} \frac{n_i}{n} \ln \frac{n_i}{n}$$

To evaluate structural differences in biocenoses between the pre- and post-flooding periods, comparative analysis of quantitative indicators and species dominance was performed. Relative abundance (N%) of each fish and bird species was calculated using the formula:

N% = (number of individuals of a given taxon/ total number of all taxa) · 100 (KOSATES 2008).

Graphs, diagrams, and spatial visualizations were created using Microsoft Excel.

All research activities were conducted without removing living organisms from their natural habitats and with minimal disturbance, in accordance with Article 27 of the Law of Ukraine “On the Animal World” (*Zakon Ukrayiny…* 2025).

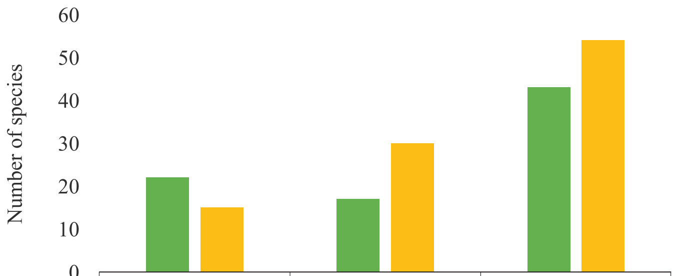
The results presented refer only to areas that were inundated after the dam breach in 2022.

Results

Effects of flooding in the lower reach of the Irpin River on biodiversity

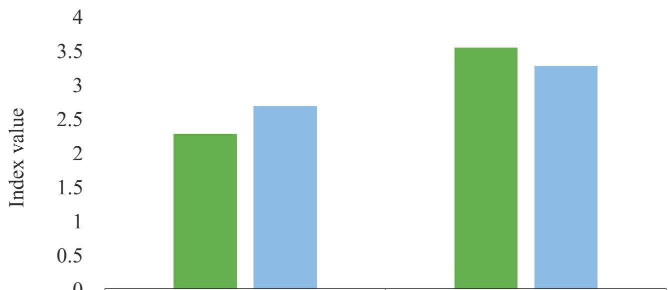
Flooding of a large part of the floodplain in the lower reaches of the Irpin River resulted in marked changes in the species composition of macrophytes, ichthyofauna, and avifauna. An analysis of biodiversity changes following the inundation (Figure 2) revealed considerable shifts in the structure of biotic communities. The number of aquatic plant species decreased by 8, while the number of fish and waterbird species increased by 14 and 11, respectively.

The Shannon diversity index rose by 36.0% for fish and showed a notable 18.0% uptick among waterbirds (Figure 3).



	Macrophytes	Fish	Waterbirds
Before	22	17	43
After	15	30	54

Fig. 2. Changes in species richness of macrophytes, fish, and birds before and after the flooding in the mouth section of the Irpin River
Source: own study



	Fish	Waterbirds
Before	2.27	3.54
After	2.68	3.27

Fig. 3. Changes in the Shannon diversity index (fish and birds) in the studied sections before and after flooding in the lower Irpin River
Source: own study

Macrophytes

The flood event significantly altered the composition of aquatic and riparian vegetation. New shoreline plant associations were formed, including *Typha latifolia*, *Carex riparia*, *Glyceria maxima*, *Phragmites australis*, and *Eleocharis palustris*. Numerous islands emerged within the waterbody, mainly covered by *Phragmites australis* and *Typha angustifolia*. At the same time, overall species richness declined. In 2023–2024, *Ceratophyllum demersum* and *Potamogeton crispus*, typical of lentic environments, became dominant. Locally, *Sparganium erectum*, and *Butomus umbellatus* were also recorded.

A comparative analysis with data from 2021 demonstrated a decline in macrophyte diversity (Table 2).

Table 2

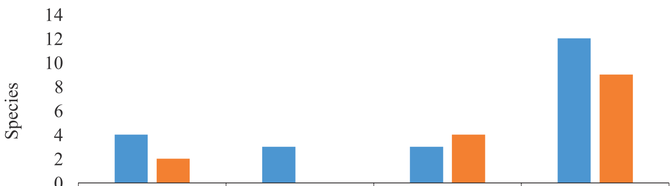
Species composition of macrophytes recorded at sampling stations

No	Species	2021	2023–2024
1	*Lemna minor* L.	+	+
2	*Lemna gibba* L.	–	+
3	*Spirodella polyrhiza* (L.) Schleid	+	+
4	*Nuphar lute*a (L.) Smith	+	–
5	*Nymphaea alba* L.	+	–
6	*Polygonum amphibium* L.	–	+
7	*Stuckenia pectinata* L.	+	–
8	*Potamogeton crispus* L.	+	+
9	*Potamogeton nodosus* Poir	+	–
10	*Elodea canadensis* Mirchx.	+	–
11	*Ceratophyllum demersum* L.	+	+
12	*Hydrocharis morsus-anaae* L.	+	+
13	*Glyceria maxima* (Hartm.)	+	+
14	*Phragmites australis* (Cav.) Trin. ex Steud.	+	+
15	*Schoenoplectus lacustris,* Palla	+	–
16	*Alisma planfago plantago-aquatica* L.	+	–
17	*Sagittaria sagittifolia* L.	+	–
18	*Eleocharis palustris* (L.) R. Br. Roem. & Schult	+	+
19	*Butomus umbellatus* L.	+	+
20	*Typha latifolia* L.	+	+
21	*Typha angustifolia* L.	+	+
22	*Sparganium simplex* erectum Huds.	+	+
23	*Carex acuta* L.	+	+
24	*Carex rostrata* Stokes	+	–
Total number of species		**22**	**15**

The structural composition of macrophyte communities changed significantly, particularly in terms of ecological groups (Figure 4). Floating-leaved plants, once prevalent, were no longer detected after the flood. A decrease in both helophytes and submerged species was also observed.

Quantitative analysis of macrophyte ecological groups revealed notable shifts in species representation following the flooding. The number of submerged species declined from 4 to 2, and floating-leaved species were no longer recorded after inundation. Free-floating species remained relatively stable (3 to 4 species), while the number of helophyte species decreased slightly from 12 to 9. Despite this reduction in helophyte species richness, their spatial dominance increased considerably, with species such as *Phragmites australis* and *Typha latifolia* expanding across large areas of the shoreline and forming dense monodominant stands.

These changes reflect a simplification of community composition, favoring generalist or tolerant species capable of thriving under lentic, low-flow conditions with high sedimentation. The loss of floating-leaved species suggests a decrease in habitat heterogeneity and light penetration, likely due to increased turbidity and organic matter accumulation.



	Submerged	Floating-leaved	Free-floating	Helophytes
Before	4	3	3	12
After	2	0	4	9

Fig. 4. Comparative changes in the number of macrophyte species across ecological groups in the lower Irpin River before (1) and after (2) floodplain inundation; species – see Table 2
Source: own study

Ichthyofauna

Prior to flooding, the Irpin River supported a typical lowland ichthyofauna characteristic of the Polissia region. In 2021, the fish community was dominated by native species such as *Rutilus rutilus* (roach), *Alburnus alburnus* (bleak), and *Rhodeus sericeus* (bitterling), which together accounted for over 50% of the catches (Table 3). Following the flood, substantial changes were observed in the structure of the ichthyofauna and in the relative abundance of individual species within the ichthyocenosis. Following the dam breach and subsequent inflow from the Kyiv Reservoir, the species composition underwent substantial changes. Newly recorded species included *Neogobius melanostomus* (round goby), *Vimba vimba* (vimba bream), *Ballerus ballerus* (blue bream), and *Aspius aspius* (asp), among others.

The expansion of shallow-water zones promoted the proliferation of species adapted to lentic environments, such as *Abramis brama* (common bream), *Blicca bjoerkna* (silver bream), and especially *Carassius gibelio* (Prussian carp), which became one of the dominant species in 2023–2024, making up 18.6% of the catch.

The altered hydrological regime facilitated the expansion of species with broad ecological tolerance and high reproductive potential. Many of these are

Table 3

Species composition of ichthyofauna at the study sites before and after flooding [%]

No	Species	2021	2023–2024
1	*Leuciscus leuciscus* (Linnaeus, 1758)**	*	*
2	*Squalius cephalus* (Linnaeus, 1758)	3.5	0.5
4	*Rutilus rutilus* (Linnaeus, 1758)	17.9	10.6
5	*Scardinius erythrophthalmus* (Linnaeus, 1758)	4.1	3.2
6	*Alburnoides rossicus* (Berg, 1924)**	–	0.5
7	*Alburnus alburnus* (Linnaeus, 1758)	23.0	15.9
8	*Leucaspius delineatus* (Heckel, 1843)***	4.1	8.0
9	*Blicca bjoerkna* (Linnaeus, 1758)	3.1	8.5
10	*Abramis brama* (Linnaeus, 1758)	–	3.2
11	*Ballerus ballerus* (Linnaeus, 1758)***	–	1.1
12	*Aspius aspius* (Linnaeus, 1758)***	–	*
13	*Vimba vimba* (Linnaeus, 1758)***	–	1.1
14	*Rhodeus amarus* (Bloch, 1782)***	17.9	4.3
15	*Pseudorasbora parva* (Temminck et Schlegel, 1846)	–	0.5
16	*Gobio gobio* (Linnaeus, 1758)	1.0	*
17	*Cyprinus carpio** (Linnaeus, 1758)	–	1.1
18	*Carassius auratus* (Linnaeus, 1758)	1.5	18.6
19	*Cobitis taenia* (Linnaeus, 1758)***	6,1	1.5
20	*Silurus glanis** (Linnaeus, 1758)***	–	1.1
21	*Esox lucius* (Linnaeus, 1758)	2.0	1.1
22	*Lota lota* (Linnaeus, 1758)**	*	*
23	*Pungitius platygaster* (Kessler, 1859)	–	1.1
24	*Sander lucioperca* (Linnaeus, 1758)	–	2.1
25	*Perca fluviatilis* (Linnaeus, 1758)	5.1	2.1
26	*Gymnocephalus cernuus* (Linnaeus, 1758)	–	0.5
27	*Perccottus glenii* (Dybowski, 1877)	2.0	1.1
28	*Neogobius melanostomus* (Pallas, 1814)	–	1.6
29	*Neogobius fluviatilis* (Pallas, 1814)***	7.7	6.4
30	*Babka gymnotrachelus* (Kessler, 1857)	–	1.1
31	*Proterorhinus semilunaris* (Heckel, 1837)	1.0	3.1

Explanation: % – relative abundance; * – species found in anglers' catch; ** – *Red Data Book of Ukraine;* *** – Appendices III of the Berne Convention (1979) non-native or invasive, posing potential risks to native communities. However, several sensitive indigenous species – *Aspius aspius*, *Vimba vimba*, *Sander lucioperca*, and *Gymnocephalus cernuus* – were also detected, suggesting that the newly formed environment may partially support their recovery. Overall, the ichthyofaunal composition reflects the interplay between biological invasions, habitat transformation, and natural recolonization dynamics. The observed increase in species richness – from 17 in 2021 to 30 in 2023–2024 – and the restructuring of trophic guilds indicate the formation of a new, lentic-type fish community, distinct from riverine sections outside the inundation zone.

Avifauna

During 2023–2024, a total of 54 bird species were recorded within the study area, the majority of which belonged to the hydrophilic ecological group. The flooding of the floodplain led to substantial changes in the bird community structure: an increase in the abundance of aquatic and wetland species was observed, including *Phalacrocorax carbo* (great cormorant) with 140–180 breeding pairs, *Larus cachinnans* (yellow-legged gull), *Anas platyrhynchos* (mallard), *Cygnus olor* (mute swan), and dispersed colonies of *Podiceps cristatus* (great crested grebe). Migratory species such as *Haliaeetus albicilla* (white-tailed eagle), *Pandion haliaetus* (osprey), and many others from the families Podicipedidae, Anatidae, Laridae, and Scolopacidae were also observed (Table 4).

Table 4

Abundance of the most common bird species recorded before (2021) and after (2023–2024) floodplain inundation [%]

No	Species	Share [%]		No	Species	Share [%]	
		2021 year	2023–2024 years			2021 year	2023–2024 years
1	2	3	4	5	6	7	8
1	*Anser anser* (Linnaeus, 1758)***	–	0.5	40	*Phalacrocorax carbo* (Linnaeus, 1758)***	–	17.1
2	*Cygnus olor* (Gmelin, JF, 1789)***	–	2.4	41	*Ixobrychus minutus* (Linnaeus, 1766)***	–	0.7
3	*Spatula querquedula* (Linnaeus, 1758)***	0.8	2.2	42	*Ardea cinerea* (Linnaeus, 1758)***	1.1	2.0
4	*Spatula clypeata* (Linnaeus, 1758)***	0.6	0.5	43	*Ardea alba* (Linnaeus, 1758)***	2.2	4.9
5	*Marecca strepera* (Linnaeus, 1758)** (**)	–	1.0	44	*Ardea purpurea* (Linnaeus, 1766)***	–	0.1

cont. Table 4

1	2	3	4	5	6	7	8
6	*Mareca penelope* (Linnaeus, 1758)***	–	3.1	45	*Pandion haliaetus* (Linnaeus, 1758)** (***)	–	0.1
7	*Anas platyrhynchos* (Linnaeus, 1758)***	4.2	7.3	46	*Circus aeruginosus* (Linnaeus, 1758)	1.1	0.6
8	*Anas acuta* (Linnaeus, 1758)***	–	1.5	47	*Circus cyaneus* (Linnaeus, 1758)** (***)	0.3	–
9	*Anas crecca* (Linnaeus, 1758)***	2.2	3.1	48	*Milvus migrans* (Boddaert, 1783)**(***)	–	0.3
10	*Aythya fuligula* (Linnaeus, 1758)***	–	0.1	49	*Haliaeetus albicilla* (Linnaeus, 1758)** (***)	–	0.4
11	*Melanitta nigra* (Linnaeus, 1758)***	–	0.1	50	*Buteo buteo* (Linnaeus, 1758)***	1.4	–
12	*Bucephala clangula* (Linnaeus, 1758)**(***)	–	4.8	51	*Asio otus* (Linnaeus, 1758)***	0.6	–
13	*Mergellus albellus* (Linnaeus, 1758)** (***)	–	0.2	52	*Alcedo atthis* (Linnaeus, 1758)***	1.9	0.6
14	*Mergus merganser* (Linnaeus, 1758)***	–	1.2	53	*Dendrocopos major* (Linnaeus, 1758)***	1.4	–
15	*Perdix perdix* (Linnaeus, 1768)***	1.7	–	54	*Picus canus* (Gmelin, JF, 1788)***	0.6	–
16	*Phasianus colchicus* (Linnaeus, 1758)***	4.4	–	55	*Falco subbuteo* (Linnaeus, 1758)***	0.5	–
17	*Cuculus canorus* (Linnaeus, 1758)***	1.9	1.1	56	*Falco tinnunculus* (Linnaeus, 1758)***	1.1	–
18	*Columba palumbus* (Linnaeus, 1758)	2.2	0.2	57	*Falco peregrinus* (Tunstall, 1771)** (***)	–	0.1
19	*Crex crex* (Linnaeus, 1758)***	1.7	–	58	*Lanius collurio* (Linnaeus, 1758)***	4.4	0.3
20	*Gallinula chloropus* (Linnaeus, 1758)***	1.1	1.5	59	*Lanius excubitor* (Linnaeus, 1758)* (***)	0.6	–
21	*Fulica atra* (Linnaeus, 1758)***	–	5.5	60	*Panurus biarmicus* (Linnaeus, 1758)***	–	1.2
22	*Tachybaptus ruficollis* (Pallas, 1764)***	–	0.5	61	*Alauda arvensis* (Linnaeus, 1758)***	2.2	–
23	*Podiceps cristatus* (Linnaeus, 1758)***	–	4.4	62	*Acrocephalus schoenobaenus* (Linnaeus, 1758)***	3.3	–
24	*Podiceps nigricollis* (Brehm, CL, 1831)* (***)	–	0.2	63	*Acrocephalus palustris* (Bechstein, 1798)***	2.2	–
25	*Haematopus ostralegus* (Linnaeus, 1758)* (**), (***)	–	0.2	64	*Acrocephalus arundinaceus* (Linnaeus, 1758)***	5.0	3.4
26	*Vanellus vanellus* (Linnaeus, 1758)* (***)	2.2	0.1	65	*Locustella luscinioides* (Savi, 1824)***	1.1	–

cont. Table 4

1	2	3	4	5	6	7	8
27	*Calidris pugnax* (Linnaeus, 1758)*(***)	–	1.0	66	*Curruca communis* (Latham, 1787)***	4.2	–
28	*Gallinago gallinago* (Linnaeus, 1758)*(***)	–	0.5	67	*Sturnus vulgaris* (Linnaeus, 1758)	3.9	–
29	*Actitis hypoleucos* (Linnaeus, 1758)***	–	0.1	68	*Luscinia svecica* (Linnaeus, 1758)***	8.0	4.0
30	*Tringa ochropus* (Linnaeus, 1758)***	0.6	0.7	69	*Saxicola rubetra* (Linnaeus, 1758)***	2.2	–
31	*Tringa nebularia* (Gunnerus, 1767)***	–	0.5	70	*Saxicola rubicola* (Linnaeus, 1766)***	5.0	–
32	*Chroicocephalus ridibundus* (Linnaeus, 1758)***	–	5.7	71	*Motacilla flava* (Linnaeus, 1758)***	4.4	–
33	*Larus cachinnans* (Pallas, 1811)	–	6.6	72	*Motacilla alba* (Linnaeus, 1758)***	3.9	1.7
34	*Sternula albifrons* (Pallas, 1764)** (***)	–	0.2	73	*Anthus pratensis* (Linnaeus, 1758)***	1.7	–
35	*Sterna hirundo* (Linnaeus, 1758)***	–	1.0	74	*Anthus trivialis* (Linnaeus, 1758)***	2.2	0.3
36	*Chlidonias hybrida* (Pallas, 1811)***	–	1.5	75	*Anthus cervinus* (Pallas, 1811)***	2.2	–
37	*Chlidonias niger* (Linnaeus, 1758)***	–	0.7	76	*Linaria cannabina* (Linnaeus, 1758)***	2.2	–
38	*Gavia arctica* (Linnaeus, 1758)***	–	0.3	77	*Emberiza citrinella* (Linnaeus, 1758)***	3.3	–
39	*Ciconia ciconia* (Linnaeus, 1758)***	2.2	0.7	78	*Emberiza schoeniclus* (Linnaeus, 1758)***	–	1.0

Explanation: * – species listed in the *European Red List of Birds as NT* – (Near Threatened) and *VU* – (Vulnerable); ** – species included in the *Red Data Book of Ukraine*; *** – species protected under Appendices II and III of the Berne Convention (1979)

Most hydrophilic species recorded after flooding were new to this territory. The regular presence of *Ardea cinerea* (grey heron) and *Ardea alba* (great egret) at the survey locations suggests possible nesting within newly formed reed-willow islands. Among the typical migratory species registered in the lower section of the Irpin River were *Bucephala clangula* (goldeneye), *Anas penelope* (wigeon), *Mergus merganser* (goosander), *Anas acuta* (pintail), *Mergellus albellus* (smew), *Anas querquedula* (garganey), and *Podiceps nigricollis* (black-necked grebe) (Figure 5).

After the flooding of the area, the proportion of the hydrophilic complex increased by 52.6%, while the proportions of the campophilic and dendrophilic groups decreased by 86.7% and 60.5%, respectively (Figure 6).

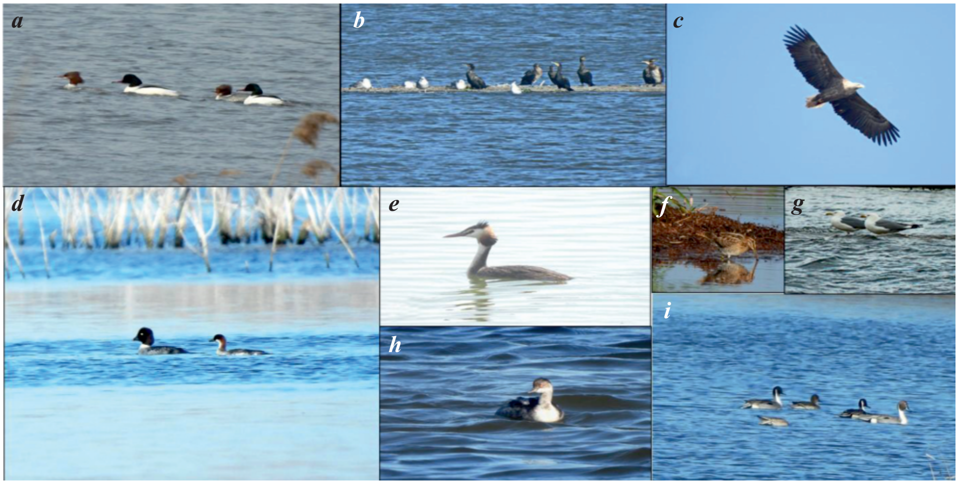
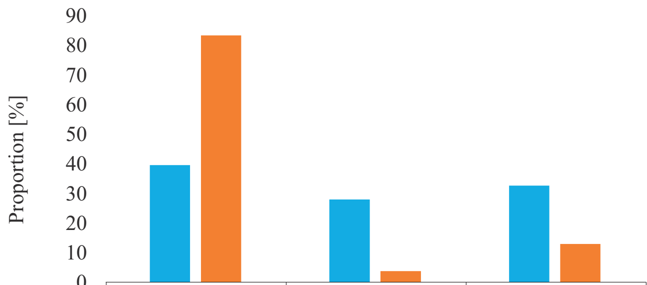


Fig. 5. Selected migratory waterbirds observed after the flooding of the Irpin River floodplain (Demydiv–Kozarovychi): *a – Mergus merganser*; *b – Phalacrocorax carbo*; *c – Haliaeetus albicilla*; *d – Bucephala clangula* and *Mergellus albellus*; *e – Podiceps cristatus*; *f – Gallinago gallinago*; *g – Larus cachinnans*; *h – Podiceps nigricollis*; *i – Anas acuta*
Source: photos by M. Prychepa



	Hydrophiles	Campophiles	Dendrophiles
2021	39.5	27.9	32.6
2023–2024	83.3	3.7	12.9

Fig. 6. Changes in the proportion of bird ecological groups in the lower Irpin River floodplain before and after inundation
Source: own study

In addition, the results indicate that the study area hosts 10 animal species listed in the *Red Data Book of Ukraine* and 5 species included in the European Red List under the categories Vulnerable (VU) and Near Threatened (NT). Furthermore, 75 species recorded in the fauna are protected under Appendices II and III of the Berne Convention (1979).

Discussion

Historical landscape transformation and military impacts

The Irpin River basin has long played a key role both ecologically and strategically. In earlier times, the valley of the Irpin River, together with the Stuhna and Ros rivers, formed a natural water barrier surrounding Kyiv, particularly during spring floods, which transformed the floodplains into impassable wetlands. Historical records indicate that the river was once highly water-rich: the *Descriptions of the Kyiv Province* from 1785 state that in spring, the width of the Irpin reached 200–400 fathoms (426–853 m), with a depth of up to 4 fathoms (8.5 m). These dimensions significantly decreased during summer, reflecting seasonal dynamics of the hydrological regime and the high water capacity of the river in the past. The river's mouth was characterized by multiple channels and swamps, which supported the development of rich biocenoses (Herashchuk and Tarchymnskyi 2023).

Reclamation changes in the 20th century

During the Soviet period, the river landscape underwent major transformations due to the implementation of large-scale land reclamation projects. The Irpin River was converted into a cascade of regulated sections with overflow dams, and the valley was transformed into a drainage–irrigation system, leading to the degradation of natural wetland habitats (Vyshnevskyi et al. 2011). After the creation of the Kyiv Reservoir in the 1960s, it was discovered that the lower reaches of the Irpin lay 3 meters below the reservoir level. To prevent inundation, a protective dam was constructed along the shoreline, along with a pumping station that diverted water from the river into the reservoir (Vyshnevskyi et al. 2011).

Dam breach during the 2022 military conflict

During the Russian invasion in February 2022, a decision was made to destroy part of the dam and the pumping station in order to hinder the advancing troops. This caused uncontrolled flooding of approximately 2,500 hectares of floodplain land, including agricultural areas, forests, and the outskirts of settlements. The villages of Demydiv and Kozarovychi were the most severely affected, along with areas near Hostomel and Moschun. Water from the Kyiv Reservoir inundated the floodplain for more than 20 km upstream, fundamentally altering the hydromorphological characteristics of the river (Starodubtsev et al. 2022).

Hydromorphological changes following flooding

The formerly lotic system acquired lacustrine characteristics, with increased shoreline erosion, changes in sediment composition, and a decline in water quality due to the extensive leaching of organic matter, bank erosion, and altered bottom substrate structure (Afanasyev 2023). Prior to flooding, the Irpin River was characterized by a narrow channel width (15–18 m) and a distinctly perceptible current (Nezbrytska et al. 2024).

Following inundation, the width of the water surface expanded significantly, in some locations – such as near Demydiv – reaching up to two kilometers (Figure 7).

Fig. 7. General view of the Irpin River floodplain landscape before (*a*, *c*, *e*) and after (*b*, *d*, *f*) inundation
Source: photos by Yu. Kovalenko and M. Prychepa

In this context, it is important to note that the current flooding partially replicates the historical natural features of the Irpin Valley landscape, bringing it closer to the hydrological regime described in 18th-century sources.

Similar consequences have been observed in other regions of Ukraine during the war. For instance, the destruction of the Kakhovka Dam in 2023 resulted in the catastrophic inundation of vast areas, causing extensive biodiversity losses, including rare species (VASYLUK et al. 2025). Missile strikes on the dams of the Oskil and Inhul Rivers also led to localized landscape transformations, prompting a reassessment of water ecosystem management strategies under military threats (AFANASYEV 2023).

After the de-occupation of the Kyiv region in April 2022, infrastructure restoration began, including bridge reconstruction and partial pumping of water from flooded areas. However, the drainage process was gradual, and by autumn 2022, a stable water body remained in the widest section of the floodplain between the villages of Huta-Mezhyhirska and Kozarovychi. At present, discussions are ongoing regarding the future of this area: whether to fully restore it to its former state or preserve it as a protected natural site (LADYKA and STARODUBTSEV 2022).

The future direction of restoration will depend on ecological and economic priorities: on one hand, the return of the area to agricultural use; on the other, the conservation of the newly formed ecosystem, which has already begun to function as a natural wetland complex with potentially significant value for biodiversity conservation.

Changes in macrophytes composition

Before the flooding, the floodplain sections of the Irpin River were characterized by macrophyte communities typical of lowland rivers. Dominant species included *Potamogeton nodosus* (long-leaved pondweed), *Sagittaria sagittifolia* (arrowhead), *Ceratophyllum demersum* (rigid hornwort), and *Elodea canadensis* (Canadian waterweed). Shoreline areas were covered by dense stands of *Phragmites australis* (common reed) and *Typha latifolia* (broadleaf cattail), forming characteristic riparian ecosystems (SYDORENKO 2011).

The flooding of the floodplain led to significant changes in macrophyte species composition. It is well-documented in the literature that prolonged inundation and strong water level fluctuations exert the most pronounced effects on macrophyte assemblages. Such patterns have been described by researchers studying macrophyte distribution and changes in species richness under floodwater influence and excessive submersion of habitats (STAHR and KAEMINGK 2017, THIEMER et al. 2021). Species richness declined considerably: *Potamogeton nodosus* and *Sagittaria sagittifolia*, which were previously typical channel species, disappeared. In contrast, *Phragmites australis* and *Typha latifolia* significantly expanded and became the dominant species in the newly formed ecosystem. In some locations, their stands covered over 50% of the surface area.

Isolated patches of *Ceratophyllum demersum* and *Potamogeton crispus* (curly pondweed) were also recorded; these species are highly adaptable and capable of surviving in various environments, including lentic biocenoses (LADYKA and STARODUBTSEV 2022). In areas with low or no current, new macrophyte communities formed, primarily consisting of *Lemna minor* (common duckweed) and *Hydrocharis morsus-ranae* (frogbit). On shallow open-water areas, *Persicaria amphibia* (amphibious bistort), a hydrophilic species commonly found in oxbow lakes, floodplain ponds, and reservoirs, developed dense colonies.

In river flood systems, water level fluctuations directly affect the biomass of emergent and floating macrophytes, and indirectly influence submerged vegetation. High concentrations of suspended solids during floods hinder the recovery of plant communities (KANGUR et al. 2003, DEMBOWSKA 2017), as confirmed by observations in the lower Irpin River in 2023 (NEZBRYTSKA et al. 2024).

The absence of floating-leaved species such as *Nymphaea alba* (white water lily) and *Nuphar lutea* (yellow water lily) indicates that suitable environmental conditions for their development are lacking.

The expansion of reed-dominated communities may contribute to the formation of new habitats for waterfowl and aquatic invertebrates. It should be noted that extensive overgrowth of the reservoir by helophytes may eventually lead to gradual waterlogging of the area. At present, however, helophytes are distributed only fragmentarily, forming small islands or narrow coastal strips several meters wide. To adequately assess the condition of aquatic vegetation and its spatial distribution in the reservoir, periodic monitoring is required.

Changes in ichthyofauna

Historical analysis indicates the gradual transformation of the Irpin River ichthyofauna as a result of changes in the hydrological regime and anthropogenic pressures. In the 18th century, the Irpin River maintained a natural connection with the Dnipro, creating migration routes for large sturgeon species, including *Huso huso* (beluga sturgeon), which, according to archaeological evidence, could reach weights exceeding 300 kg (PEREVERZIEV 2021). Already in the first half of the 20th century, researchers noted the disappearance of rheophilic species due to increasing hydrological instability (VELYKOKHATKO 1929, BELING 1937).

The construction of the Kyiv Reservoir and widespread land reclamation in the 1970s marked a new stage of change: invasive and synanthropic species such as *Pungitius platygaster* (southern nine-spined stickleback), *Carassius auratus* (goldfish), and *Pseudorasbora parva* (stone moroko) entered the basin (POLTAVCHUK 1976, MOVCHAN et al. 2003). In the 21st century, additional species were recorded, including *Perccottus glenii* (Chinese sleeper), *Lepomis gibbosus* (pumpkinseed sunfish), and *Babka gymnotrachelus* (racer goby) (KUTSOKON et al. 2012). The spread of non-native species contributed to their dominance in certain ichthyocenoses, particularly in tributaries of the Irpin River (ROMANENKO and MEDOVNIK 2017).

Following the flooding of the floodplain in 2022, these transformation processes intensified sharply. On one hand, there was a further expansion of neolimnetic species, mainly from the Ponto-Caspian complex, such as *Neogobius melanostomus*, *Proterorhinus semilunaris*, and *Babka gymnotrachelus*. These species are also documented in the Danube, Vistula, and other European river systems with modified hydrology (COPP et al. 2005). On the other hand, several ecologically sensitive native species (*Aspius aspius*, *Vimba vimba*, *Sander lucioperca*, *Gymnocephalus cernuus*), which were previously rare or absent, were recorded, suggesting the emergence of conditions favorable to their partial restitution. Additionally, there was a significant increase in the proportion of distant invaders, particularly *Carassius auratus*.

The high proportion of invasive species is a cause for concern due to their well-documented negative impacts on native ichthyofauna, as confirmed in aquatic systems in Spain, Hungary, and the United Kingdom (JIA et al. 2019). However, the preservation of autochthonous genotypes, for example in populations of *Cobitis taenia* (spined loach) (MEZHZHERIN and PAVLENKO 2007), demonstrates the potential for recovery of local biota even under conditions of significant hydrological disturbance. Comparable dynamics were reported in other regulated rivers, where extreme flooding facilitated fish access to newly formed floodplain habitats suitable for feeding and spawning (HOGBERG and PEGG 2016).

Thus, the current ichthyofauna of the Irpin River basin reflects a complex balance between bioinvasions, anthropogenic influences, and natural dynamics – similar to processes observed in many regulated rivers across Europe (HERMOSO et al. 2011). In the area flooded following the dam breach, a distinct ichthyocenosis has formed, characterized by the penetration of new species from the reservoir and an increase in the proportion of limnophilic species. This community significantly differs from that of river sections located outside the flooded zone (PRYCHEPA et al. 2025).

Changes in avifauna

Before the flooding of the floodplain, the avifauna of the study area was characterized by the presence of species associated with both open landscapes and forest or shrub-dominated biotopes. The open areas of the floodplain were predominantly inhabited by campophilic species such as *Alauda arvensis* (Eurasian skylark), *Saxicola rubetra* (whinchat), *Saxicola rubicola* (European stonechat), *Crex crex* (corncrake), and *Curruca communis* (common whitethroat). In riparian shrublands and forested areas, nesting sites of *Asio otus* (long-eared owl), *Falco tinnunculus* (common kestrel), *Perdix perdix* (grey partridge), and representatives of the genus *Phylloscopus* were recorded.

Following the inundation of the area, a significant restructuring of the avifaunal community was observed. The sudden transformation of habitats, particularly the emergence of extensive open water bodies, led to an increase in the proportion of hydrophilic species. The newly formed wetland habitats were rapidly colonized by *Podiceps cristatus* (great crested grebe), *Phalacrocorax carbo* (great cormorant), *Anas platyrhynchos* (mallard), *Ardea cinerea* (grey heron), *Ardea alba* (great egret), and numerous gull and tern species including *Larus cachinnans*, *Chroicocephalus ridibundus*, *Sterna hirundo*, and *Chlidonias hybrida*.

It is worth noting that similar patterns of avifaunal change were observed after the creation of the Kyiv Reservoir, where the flooding of floodplain areas also led to a substantial increase in hydrophilic species, including some not previously characteristic of the Dnipro valley (Melnychuk 1967, Melnychuk and Holovach 1984, Melnychuk et al. 1989).

The growing numbers of wetland and aquatic birds suggest that the new ecosystem is beginning to stabilize. The high proportion of piscivorous species suggests favorable foraging conditions. However, the scarcity of well-developed macrophyte stands may remain a limiting factor for certain species associated with shallow or vegetated zones.

Moreover, this section of the Irpin Valley plays not only a local ecological role but is also part of a broader regional ecological corridor. As early as the beginning of the 20th century Sharleman (1914) described the Irpin Valley as an important migratory route for birds, particularly raptors, which move across the region in a broad front. He noted that a significant portion of these species diverge along the Desna, Dnipro, and Irpin rivers, including through the Demydiv floodplain (Figure 8).

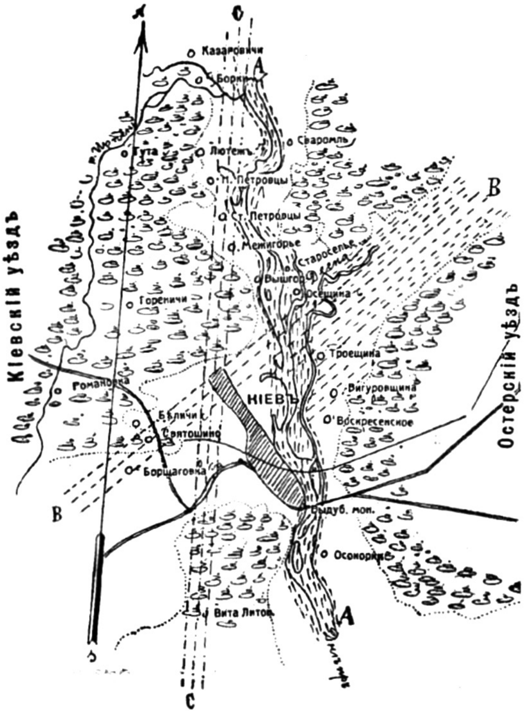


Fig. 8. Archival map of bird migration corridors in the Dnipro Valley,
compiled by M.V. Sharleman
Source: SHARLEMAN (1914)

The current changes in landscape structure may, on the one hand, hinder the movement of species sensitive to habitat fragmentation, while on the other hand, they may create new foraging sites for migratory wetland birds and contribute to the conservation of the gene pool of rare and vulnerable species.

Interrelations between indicators

The flooding of the Irpin River floodplain had a significant impact on its biocenoses, which was reflected in changes in the Shannon diversity index, species richness, and habitat distribution of birds. The observed increase in ichthyofaunal diversity (Figure 1) is likely linked to the influx of new species from the Kyiv Reservoir, which expanded the trophic capacity of the ecosystem. At the same time, the overall abundance of hydrophilic bird species increased, suggesting possible functional changes within the ecosystem.

The decline in macrophyte species richness (see Figure 2) may be attributed to changes in the hydrological regime, including the expansion of the water surface, increased trophic status, and the accumulation of organic silt. These factors reduced water transparency and likely inhibited photosynthesis in some species. As a result, the structure of riparian communities changed, weakening the food base for certain bird groups and aquatic invertebrates. However, the formation of macrophyte islands (primarily composed of *Phragmites australis* and *Typha angustifolia*) locally diversified habitat conditions, providing suitable nesting grounds for waterfowl.

In contrast, the species composition of fish and hydrophilic birds exhibited a clear trend toward increasing diversity, which may indicate ecosystem stabilization. The shift toward a lentic waterbody favored the spread of limnophilic fish, including introduced and eurythermal species, as well as the establishment of large colonies of aquatic birds. These included *Phalacrocorax carbo* (great cormorant), *Larus cachinnans* (yellow-legged gull), *Podiceps cristatus* (great crested grebe), and *Cygnus olor* (mute swan). The formation of new trophic chains attracted bird species that had not previously bred or been observed in the area. Examples include *Podiceps nigricollis* (black-necked grebe), *Mergellus albellus* (smew), *Mergus merganser* (goosander), and *Bucephala clangula* (goldeneye), which now use the territory as a stopover site during migration. Evidence of the interdependence between two components of the wetland ecosystem in the lower Irpin River the abundance of piscivorous birds and the abundance of the most common fish species is provided by a statistically significant positive correlation ($r = 0.851$, $p < 0.05$).

The transformation of biotopes (Figure 4) resulted in a marked dominance of hydrophilic birds, whose share increased from 40% to 83.3%. At the same time, campophilic species nearly disappeared, likely due to the loss of meadow habitats that previously served as breeding grounds. Notably, *Crex crex* (corncrake) and *Alauda arvensis* (Eurasian skylark) are no longer recorded. A slight increase in the proportion of dendrophilic species was also observed, which may be associated with the emergence of a mosaic of macrophyte-covered islands and partially submerged trees that provide shelter and feeding opportunities. These structures proved favorable for nesting by *Ardea alba* (great egret) and for regular sightings of raptors such as *Haliaeetus albicilla* (white-tailed eagle). The consistent presence of both adult and juvenile individuals suggests the possibility of nesting in nearby forested areas.

Overall, the results demonstrate a high degree of interdependence between hydrological, trophic, and biotic parameters of the new ecosystem. As illustrated (Figure 9), the flooding acted as a trigger for the transformation of the

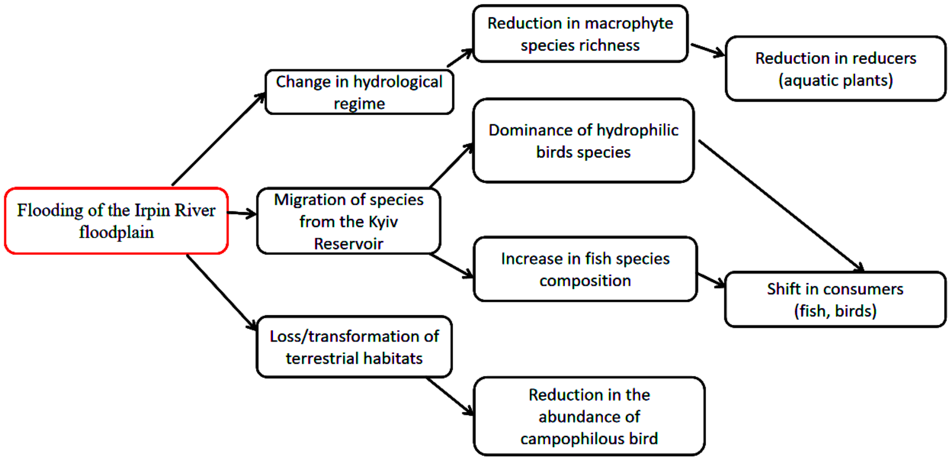


Fig. 9. Scheme of ecological changes in the flooded valley of the Irpin River
Source: own study

hydrological regime, which affected the structure of macrophyte communities. These, in turn, influenced the composition of the ichthyofauna, which subsequently shaped the species structure and abundance of the avifauna.

Particularly important is the fact that newly formed aquatic bird communities have already established colonies and nesting centers, indicating the potential stability of some of the newly created biotopes. Thus, a cascading effect of changes can be observed within a single landscape, encompassing physical environmental parameters, vegetation, trophic networks, and fauna of higher trophic levels. This indicates a transition of the ecosystem into a new successional state, the further dynamics of which require long-term ecological monitoring.

Species of conservation concern

The presence of a substantial number of rare and protected species highlights the important ecological role of the study area, even after significant anthropogenic alterations. This supports the assumption that the newly formed wetland ecosystem holds potential value for the conservation of regional biodiversity. Particularly noteworthy is the persistence of species listed in the *Red Data Book of Ukraine*, the European Red List, and the appendices of the Berne Convention (1979), emphasizing the need for further protection of this territory.

Thus, the results of this study represent just one example of the ecological transformations caused by warfare – specifically, the flooding of the Irpin

River floodplain, one of the first aquatic ecosystems affected during the full-scale military invasion by Russian forces. These findings demonstrate how military activity alters ichthyofaunal composition, leads to the formation of a new ichthyocenotic core that includes both native and invasive species, and transforms bird communities, including those of transboundary migratory species. The consequences of such processes are also evident in other parts of the Irpin basin (Prychepa et al. 2025), as well as in water bodies located in de-occupied areas of the Kyiv region, where a recovery of piscivorous bird populations has been observed following the decline of invasive fish species and reductions in recreational and anthropogenic pressure (Kovalenko 2024).

Overlaying the actual boundaries of the water surface on the cadastral map revealed that three categories of land were affected by flooding: predominantly private agricultural plots, individual parcels of state or municipal property, and the local reserve "Staropetrivski Nasadzhennya." According to the Land Code of Ukraine (Articles 83, 84, 150), lands classified as water fund and nature conservation areas cannot be privately owned. In this case, however, they remain registered as agricultural land, although they have effectively lost their potential for economic use, which provides grounds for changing their designated purpose (Figure 10).

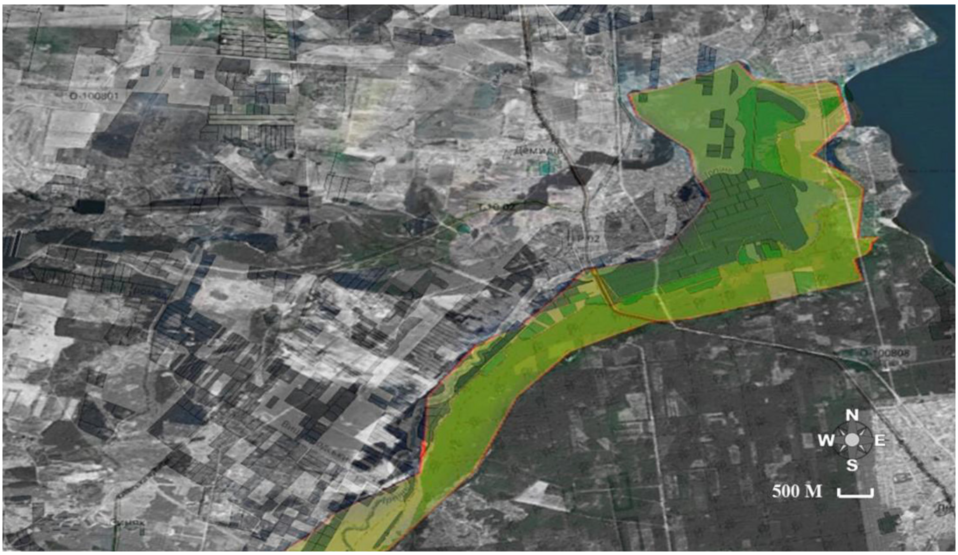


Fig. 10. Map of the boundaries of a proposed landscape reserve
Source: own elaboration based on cadastral map of Ukraine and Google Earth (boundaries of the potential reserve)

Possible solutions include:

1. Voluntary consent of landowners to transfer their plots to the nature reserve fund (with compensation or land exchange).

2. Expropriation of land for public needs, in particular for environmental protection, based on a decision of the regional council or the Cabinet of Ministers of Ukraine.

The ecological value of the territory provides grounds for designating a reserve of national importance. The presence of an existing NRF site the tract *Staropetrivski Nasadzhennya* makes it possible to use it as a foundation for subsequent expansion to encompass the entire wetland complex. In addition, the landscape reserve of local importance *Richka-Heroy-Irpin* is located upstream. Protecting aquatic and riparian floodplain biocenoses would also ensure the conservation of migratory corridors for aquatic and terrestrial animals.

The spatial framework of the proposed reserve should be aligned with the actual water surface and the protective coastal strip, in accordance with the Water Code of Ukraine.

Therefore, the presented data may serve as a basis for future international comparisons of changes occurring in wetland ecosystems during wartime in contrast to other anthropogenic impacts. They can also inform assessments of biodiversity conservation threats and prospects under conditions of armed conflict. This research highlights the need for international cooperation in post-conflict restoration efforts, as seen in initiatives such as LIFE19 IPE/DE/000004 for habitat protection, and sets a precedent for future conservation strategies (Prychepa and Kovalenko 2024).

Conclusions

This study analyzed the initial biological responses of the Irpin River floodplain ecosystem to the hydromorphological transformation caused by the destruction of a dam in 2022. A comparative assessment of biocenoses before and after the flooding revealed several notable changes in the structure of living communities:

1. A decrease in the number of macrophyte species (from 22 to 15), associated with the transition to a lentic system, reduced flow velocity and water transparency, and the accumulation of organic silt.

2. An increase in ichthyofaunal species richness (from 17 to 30 species), primarily due to the influx of fish from the Kyiv Reservoir.

3. A marked predominance of hydrophilic birds within the avifaunal structure – their proportion increased from 40.0% to 83.3%, while campophilic species nearly disappeared.

4. An overall rise in biotic diversity, as indicated by the Shannon index: by 36.0% for fish and 18.0% for aquatic birds.

The findings highlight the emergence of a new ecosystem setup, where some communities have adapted while others have vanished.The high conservation value of the area is underscored by the presence of 12 species listed in the *Red Data Book of Ukraine*, five rare European species, and 83 species protected under the Berne Convention (1979).

These findings highlight the urgent need for long-term ecological monitoring, particularly in light of the transboundary nature of many migratory species. The data obtained may serve as a basis for future international comparative studies of wetland ecosystem transformations caused by armed conflicts, as well as for evaluating biodiversity vulnerability under wartime conditions relative to other anthropogenic pressures.

The presence of rare species and the geographical location, as well as the current status of the studied territory, provide an opportunity to create a general zoological or landscape reserve for the protection and reproduction of rare and vulnerable, typical native species of flora and fauna in the Irpin River valley.

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