

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
STATE NON-COMMERCIAL ENTERPRISE
STATE UNIVERSITY “KYIV AVIATION INSTITUTE”
FACULTY OF ENVIRONMENTAL SAFETY,
ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE

APPROVED TO DEFENCE
Head of the Graduate Department
_____ Tamara DUDAR
“ _____ ” _____ 2025

BACHELOR THESIS (EXPLANATORY NOTE)

Theme: «The state of the ecosystem of the Shostka River according to the parameters of ichthyofauna»

Done by: seeker of Ба-101-21-1-EK group, Vladyslava V. Stepanchuk
(student, group, surname, name, patronymic)

Supervisor: Associate Professor of the Department of Environmental science, Candidate of Technical Sciences, Marharyta M. Radomska
(academic degree, academic rank, surname, name, patronymic)

Standards Inspector:

Andrian IAVNIUK

(signature)

(name, surname)

KYIV 2025

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ДЕРЖАВНЕ НЕКОМЕРЦІЙНЕ ПІДПРИЄМСТВО
«ДЕРЖАВНИЙ УНІВЕРСИТЕТ «КИЇВСЬКИЙ АВІАЦІЙНИЙ ІНСТИТУТ»
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕЗПЕКИ,
ІНЖЕНЕРІЇ ТА ТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_____ Тамара ДУДАР
« _____ » _____ 2025 р.

КВАЛІФІКАЦІЙНА РОБОТА (ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»

Тема: «Стан екосистеми річки Шостка за параметрами іхтіофауни»

Виконавець: здобувач групи Ба-101-21-1-ЕК Степанчук Владислава Вадимівна

Керівник: доцент кафедри Екології, кандидат технічних наук Радомська Маргарита Мирославівна

Нормоконтролер: _____

Андріан ЯВНІЮК

КНІВ 2025

STATE NON-COMMERCIAL ENTERPRISE
STATE UNIVERSITY "KYIV AVIATION INSTITUTE"

Faculty of Environmental Safety, Engineering and Technologies

Department of Environmental Science

Specialty, Educational and Training Program: specialty 101 "Environmental Science",

Educational and Training Program: "Ecology and Environment Protection"

_____ (code, name)

APPROVED

Head of the Department

_____ Tamara DUDAR

« _____ » _____ 2025

BACHELOR THESIS ASSIGNMENT

Vladyslava V. Stepanchuk

1. Theme: «The state of the ecosystem of the Shostka River according to the parameters of ichthyofauna»

approved by the Acting President on April 28, 2025, №.634/сr

2. Duration of work: from 26.05.2025 to 22.06.2025.

3. Input data of work: data on water quality in the Shostka River from open sources, reference information on the species diversity of the Shostka River's ichthyofauna, survey results and visual observations.

4. Content of explanatory note: Introduction. Aquatic ecosystems and their functioning. Biological parameters of the state of water bodies. Results of the study of the state of the river by biological indicators. Conclusions.

5. The list of mandatory graphic (illustrated) materials: tables, photographs

6. Schedule of thesis performance

№ з/п	Task	Term	Advisor's signature
1	Collection and analysis of materials	28.04.2025 – 26.05.2025	
2	Writing Chapter I of the thesis	26.05.2025 – 29.05.2025	
3	Writing Chapter II of the thesis	30.05.2025 – 02.06.2025	
4	Writing Chapter III of the thesis	03.06.2025 – 06.05.2025	
5	Preparation of the thesis presentation	07.06.2025 – 08.06.2025	
6	Preliminary defence of the thesis	09.06.2025	
7	Consideration of comments	10.06.2025 – 11.06.2025	
8	Plagiarism check and work with the norm controller	12.06.2025	
9	Submission of the completed qualification work and approval procedure	13.06.2025 – 16.06.2025	
10	Defence of the thesis	17.06.2025	

7. Date of task issue: «28» April 2025

Thesis supervisor: _____
(advisor's signature)

Marharyta RADOMSKA
(name, surname)

Task is taken to perform: _____
(graduate's signature)

Vladyslava STEPANCHUK
(name, surname)

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ДЕРЖАВНЕ НЕКОМЕРЦІЙНЕ ПІДПРИЄМСТВО

«ДЕРЖАВНИЙ УНІВЕРСИТЕТ «КИЇВСЬКИЙ АВІАЦІЙНИЙ ІНСТИТУТ»

Факультет екологічної безпеки, інженерії та технологій

Кафедра екології

Спеціальність, освітньо-професійна програма: спеціальність 101 «Екологія»,

ОПП «Екологія та охорона навколишнього середовища»

(шифр, найменування)

ЗАТВЕРДЖУЮ

Завідувач кафедри

_____ Тамара ДУДАР

« ____ » _____ 2025 р.

ЗАВДАННЯ

на виконання кваліфікаційної роботи

Степанчук Владислави Вадимівни

1. Тема кваліфікаційної роботи «Стан екосистеми річки Шостка за параметрами іхтіофауни»

затверджена наказом в.о. президента від «28» квітня 2025 р. №634/ст

2. Термін виконання роботи: з 26.05.2025 р. по 22.06.2025 р.

3. Вихідні дані роботи: дані про якість води у р. Шостка з відкритих джерел, довідкова інформація про видове різноманіття іхтіофауни р. Шостка, результати опитування та візуальних спостережень.

4. Зміст пояснювальної записки: Вступ. Водні екосистеми та їх функціонування. Біологічні параметри стану водних об'єктів. Результати дослідження стану річки за біологічними індикаторами. Висновки.

5. Перелік обов'язкового графічного (ілюстративного) матеріалу: таблиці, фото

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1	Збір та аналіз матеріалів	28.04.2025 – 26.05.2025	
2	Написання I розділу дипломної роботи	26.05.2025 – 29.05.2025	
3	Написання II розділу дипломної роботи	30.05.2025 – 02.06.2025	
4	Написання III розділу дипломної роботи	03.06.2025 – 06.05.2025	
5	Підготовка презентації роботи	07.06.2025 – 08.06.2025	
6	Попередній захист дипломної роботи	09.06.2025	
7	Врахування зауважень	10.06.2025 – 11.06.2025	
8	Перевірка на плагіат та робота з нормоконтролером	12.06.2025	
9	Здача готової кваліфікаційної роботи та проходження процедури погодження	13.06.2025 – 16.06.2025	
10	Захист дипломної роботи	17.06.2025	

7. Дата видачі завдання: «28» квітня 2025 р.

Керівник кваліфікаційної роботи:

(підпис керівника)

Маргарита
РАДОМСЬКА
(П.І.Б.)

Завдання прийняв до виконання:

(підпис випускника)

Владислава
СТЕПАНЧУК

(П.І.Б.)

ABSTRACT

Explanatory note to thesis «The state of the ecosystem of the Shostka River according to the parameters of ichthyofauna»: __ pages, 37 tables, 4 references.

10

Object of research – changes in the aquatic ecosystems within urban areas

Aim of work – biological assessment of the ecological state of the Shostka River ecosystem

Methods of research:

1. Biological Monitoring and Bioindication
2. Field Surveys and Visual Observations
3. Sociological Surveys

The bachelor's thesis analyzes the ecological condition of the Shostka River based on ichthyofauna indicators. The study included hydrological and hydrochemical analysis, species composition assessment, biometric and visual observations of fish, and sociological surveys of local residents and fishermen. Results indicate partial ecological recovery after the cessation of industrial discharges, with signs of natural fish reproduction and moderate biodiversity. However, eutrophication, siltation, and pollution still persist, especially in urbanized areas. The study provides practical recommendations for improving water quality, restoring fish populations, and involving the community in environmental protection. Conclusions confirm that ichthyofauna is a reliable indicator of river ecosystem health and a valuable tool for sustainable management of small urban water bodies. ECOLOGICAL STATE, SMALL RIVER, ICHTHYOFAUNA, BIOINDICATION, ANTHROPOGENIC IMPACT, WATER QUALITY, SURVEY, ENVIRONMENTAL MONITORING, BIODIVERSITY, BIOLOGICAL INDICATORS, FISH POPULATIONS, URBAN ECOSYSTEM

CONTENT

LIST OF SYMBOLIC NOTATIONS AND ABBREVIATIONS	4
INTRODUCTION	5
CHAPTER 1. Aquatic ecosystems and their functioning	7
1.1. Types and distribution of aquatic ecosystems	7
1.2. Structure of aquatic ecosystems	8
1.3. Features of freshwater ecosystems	10
1.4. Aquabiota and its functions	11
1.5. Factors influencing the ecosystem functions of freshwater ecosystems	12
1.6. Pollution of aquatic ecosystems	14
Conclusions to Chapter 1	16
CHAPTER 2. Biological parameters of the state of water bodies	17
2.1. Biological assessment of water bodies status	17
2.2. Parameters of the state of ichthyofauna	18
2.3. Rapid bioassessment methodology for rivers and streams	19
2.4. Methodology for the evaluation of the Shostka river status as a habitat	21
Conclusions to Chapter 2	22
CHAPTER 3. Results of the study of the state of the river by biological indicators	23
3.1. Geographical and hydrological description of the river Shostka	

.....	23
3.2. Assessment of the quality of the river's aquatic environment for ichthyofauna.....	27
3.3. Results of a survey of consumers of river ecosystem services	29
3.4. Generalization of data on the state, diversity and biomass of the river's ichthyofauna.....	31
3.5. Main problems and recommendations for their elimination.....	33
CONCLUSIONS.....	35
LIST OF REFERENCES.....	37

LIST OF SYMBOLIC NOTATIONS, ABBREVIATIONS AND NOTIONS

MPC – *Maximum Permissible Concentration* ;

ABC – *Absolute Biomass Concentration* ;

FRK – *Fish Reproduction Coefficient* ;

DO – *Dissolved Oxygen* ;

BOD – *Biochemical Oxygen Demand* ;

pH – a measure of water's acidity or alkalinity ;

RBA – *Rapid Bioassessment* ;

IBI – *Index of Biotic Integrity* ;

eDNA – *Environmental DNA* ;

IAQ – *Indoor Air Quality* ;

INTRODUCTION

Relevance of the work. Nowadays, the ecological condition of small rivers in urbanized regions is receiving increasing attention due to their vulnerability to anthropogenic impacts and their importance for maintaining biodiversity and ecosystem services. The Shostka River, located in a densely populated area with a history of industrial activity, exemplifies the environmental challenges facing small freshwater ecosystems. Ichthyofauna, as a sensitive biological indicator, provides critical insights into the ecological state and pollution levels of aquatic habitats. Studying fish populations can help identify early signs of ecosystem degradation and guide conservation efforts.

Aim and tasks of the diploma work To assess the ecological state of the Shostka River ecosystem based on biological indicators of ichthyofauna.

Objectives of the work:

1. To analyze the structural and functional features of aquatic ecosystems, with emphasis on freshwater systems.
2. To identify and evaluate the main biological indicators of the ichthyofauna as a component of water quality assessment.
3. To conduct field research of the Shostka River, including sampling and analysis of fish species composition, abundance, and physiological condition.
4. To determine the influence of anthropogenic factors on the ecological state of the river.
5. To develop recommendations for the improvement and sustainable management of the Shostka River ecosystem.

Object of research is the process of ecological functioning and transformation of the Shostka River under natural and anthropogenic influences.

Subject of research is the ichthyofauna of the Shostka River as a bioindicator of ecosystem health.

Methods of research – analytical review of scientific literature, field

surveys, ichthyological sampling, morphophysiological and ecological analysis, sociological surveys of local residents, and bioindicator assessment methods.

Personal contribution of the graduate:

The author independently conducted the literature review, organized and executed field sampling, performed the identification and analysis of fish species, processed sociological survey results, and formulated conclusions and recommendations based on the obtained data.

Approbation of results. The research was presented at the International student conference, as well as during the defense of the practice.

Publications: Radomska M., Stepanchuk V. The dynamics of the Shostka River quality as a fish habitat. Молодь і поступ біології: матеріали XXI Міжнар. наук. конф. студентів і аспірантів (м. Львів, 28 квітня – 1 травня 2025 р.). Львів: Галич-Прес, 2025. С. 243–244.

CHAPTER 1 AQUATIC ECOSYSTEMS AND THEIR FUNCTIONING

1.1. Types and distribution of aquatic ecosystems

Aquatic ecosystems are broadly classified into freshwater, marine, and estuarine ecosystems based on their salinity, geographic location, and ecological characteristics. These systems support a wide range of biodiversity and play crucial roles in global biogeochemical cycles.

Freshwater Ecosystems

Freshwater ecosystems have low salt concentrations (usually less than 0.5‰) and include:

- Lentic systems – standing water bodies like lakes, ponds, and wetlands.
- Lotic systems – flowing water bodies such as rivers, streams, and brooks.
- Wetlands – areas where water saturates the soil, supporting hydrophytic vegetation (e.g., swamps, bogs, marshes).

These ecosystems are vital for drinking water supply, agriculture, and biodiversity conservation. Despite occupying only about 0.8% of the Earth's surface, freshwater habitats host nearly 10% of all known species.

Marine ecosystems cover more than 70% of the Earth's surface and contain high salt content (around 35‰). They are divided into:

- Pelagic zone – open ocean areas away from the coast.
- Benthic zone – ocean floor, including coral reefs and hydrothermal vents.
- Intertidal zone – areas between high and low tide marks, including rocky shores and sandy beaches.
- Coastal ecosystems – mangroves, seagrass beds, and coral reefs.

Marine systems are critical for climate regulation, oxygen production (via phytoplankton), and as a source of food and raw materials.

Estuarine Ecosystems

Estuarine ecosystems are transitional areas where freshwater from rivers meets and mixes with saltwater from the sea. They include:

- Deltas, lagoons, and tidal marshes.

- Dynamic salinity gradients that vary with tides and seasons.

These ecosystems are among the most productive in the world, supporting nurseries for many marine species and acting as buffers against coastal erosion and storm surges.

Table 1.1 Global Distribution

Ecosystem Type	Approximate Coverage	Global	Key Regions
Freshwater	~0.8% of surface	Earth's	Great Lakes (North America), Amazon basin, Lake Baikal
Marine	~71% of surface	Earth's	Pacific, Atlantic, Indian Oceans; Coral Triangle
Estuarine	Localized, coastlines	along	Mississippi Delta, Ganges-Brahmaputra Delta, Nile Delta

Factors Influencing Distribution

- **Climate:** Temperature and precipitation patterns define whether a region supports tropical wetlands or arid salt lakes.
- **Topography:** Mountain regions contribute to river formation; flat lowlands support wetlands and deltas.
- **Geology:** Determines water chemistry and habitat type (e.g., calcareous lakes vs. acidic bogs).
- **Human Impact:** Urbanization, agriculture, and damming alter natural hydrology and biodiversity patterns.

1.2. Structure of aquatic ecosystems

The structure of aquatic ecosystems is defined by the complex interaction between biotic (living) and abiotic (non-living) components, which together determine the ecosystem's functioning, productivity, and stability.

Abiotic factors form the physical and chemical environment in which organisms live. They include:

- Light penetration: Determines the depth of the photic zone, which affects photosynthesis. Clear water allows light to reach deeper, supporting more producers.
- Temperature: Influences metabolic rates and species distribution. Surface waters are usually warmer, with seasonal and vertical gradients (thermocline).
- Dissolved oxygen (DO): Essential for aerobic organisms; its concentration depends on temperature, turbulence, and photosynthetic activity.
- Nutrients: Nitrogen, phosphorus, and silica are vital for primary production. Excessive nutrients can lead to eutrophication.
- pH and salinity: Affect species composition and chemical reactions in the water.
- Water flow: In lotic systems, current velocity shapes habitat structure and species adaptations.

Biotic elements of aquatic ecosystems are categorized into three major functional groups:

- Producers (Autotrophs):
 - *Phytoplankton* – microscopic algae floating in the water column, primary contributors to photosynthesis.
 - *Macrophytes* – rooted aquatic plants (e.g., reeds, water lilies) in shallow waters.
 - *Periphyton* – attached algae and microorganisms on submerged surfaces.
- Consumers (Heterotrophs):
 - *Primary consumers*: zooplankton, aquatic insects, and mollusks that feed on producers.
 - *Secondary consumers*: small fish and predatory invertebrates that consume herbivores.
 - *Tertiary consumers*: larger fish, birds, and mammals (e.g., herons, otters,

predatory fish).

- Decomposers (Detritivores) include microorganisms such as bacteria and fungi that break down organic matter, recycling nutrients back into the system.

Aquatic ecosystems often exhibit spatial zonation, especially in lakes and oceans:

- Littoral zone: Shallow, near-shore area with abundant light and plant growth.
- Limnetic zone: Open water area dominated by phytoplankton and zooplankton.
- Profundal zone: Deep, dark area with little to no light; low oxygen levels.
- Benthic zone: Bottom substrate, inhabited by detritivores and benthic invertebrates.

Zonation can also occur vertically (e.g., epilimnion, metalimnion, hypolimnion in stratified lakes).

The trophic structure of aquatic ecosystems is a representation of energy flow:

- Producers → Primary consumers → Secondary consumers → Tertiary consumers
- Energy transfer efficiency between levels is typically ~10%.
- Food webs are often complex, with omnivory and detritus-based pathways playing significant roles.

1.3. Features of freshwater ecosystems

Freshwater ecosystems are incredibly diverse and play a crucial role in supporting life on Earth. Their features contribute to diversity of species and functions they perform:

- Low salinity: unlike marine ecosystems, freshwater environments have very little salt, making them suitable for species that can't tolerate high salinity.
- Varied habitats: these ecosystems include lakes, rivers, ponds, wetlands, and streams, each with unique characteristics and biodiversity.
- High biodiversity: freshwater habitats support a vast range of organisms, from microscopic plankton to fish, amphibians, and mammals like beavers

and otters.

- Dynamic water flow: rivers and streams constantly flow, reshaping landscapes, transporting nutrients, and creating new habitats over time.
- Temperature fluctuations: unlike oceans, freshwater bodies experience greater variations in temperature depending on the season and location.
- Essential role in nutrient cycles: freshwater systems help cycle nutrients like nitrogen and phosphorus, which support plant and animal life.
- Critical for human use: these ecosystems provide drinking water, irrigation, hydropower, and recreation, making them invaluable to human civilization.

Freshwater ecosystems are fragile and face threats from pollution, habitat destruction, and climate change. Protecting them is essential for sustaining biodiversity and human well-being.

1.4. Aquabiota and its functions

Aquabiota refers to all the living organisms found in aquatic environments, including both freshwater and marine ecosystems. This includes:

- Aquatic plants (e.g., algae, water lilies)
- Animals (e.g., fish, amphibians, insects, mollusks)
- Microorganisms (e.g., bacteria, plankton, protozoa)

Aquabiota is usually divided into groups based on where the organisms live and how they move:

- Plankton – small organisms that float (e.g., phytoplankton, zooplankton)
- Nekton – actively swimming animals (e.g., fish, squid)
- Benthos – organisms living at the bottom (e.g., crabs, worms)
- Periphyton – organisms attached to underwater surfaces

Functions of Aquabiota include:

- oxygen production - phytoplankton and algae carry out photosynthesis, releasing oxygen into the water and atmosphere;
- nutrient cycling - aquatic organisms help break down organic matter and recycle nutrients like nitrogen and phosphorus;

- food web support - aquabiota forms the base of aquatic food chains—plankton are eaten by small fish, which are eaten by larger fish, and so on;
- water purification - microorganisms and some plants break down pollutants and help maintain water quality;
- habitat formation - aquatic plants and animals (like corals or beavers) can shape the ecosystem by creating shelter and breeding grounds;
- climate regulation - aquatic organisms, especially in oceans, play a role in carbon storage and regulating earth's climate;
- biodiversity maintenance - aquabiota supports diverse life forms and helps keep ecosystems resilient and balanced.

1.5. Factors influencing the ecosystem functions of freshwater ecosystems

Functioning of ecosystems depends on their internal structure and impact of external factors, shape status and quality of environment. All these factors can interact to shape freshwater ecosystems. Among the most important the following should be mentioned: Light and food availability, depth and shape of the bottom and banks, intensity of natural disturbances (floods and droughts), as well as human interventions.

Without light, plants cannot grow. There are big differences between the communities living in the well-lit surface and edges of lakes, and those in the depths, which receive little or no light. Turbid (muddy) water also restricts the amount of light that reaches the bed.

Lakes with large shallow areas tend to be more productive than lakes with little shallow water (because more light reaches the lake bed). A similar situation exists in river systems, where heavily shaded streams rely on leaves and other organic material from the surrounding catchment to fuel the ecosystem. In larger rivers the canopy opens up, allowing algal production to become more important.

There is debate about whether the number of invertebrates (insects and other

animals without backbones) in a habitat is controlled by the number of predators that will eat them, or by the amount of food available for them. Both factors are important, but their relative importance may vary. For example, the introduction of trout appears to have changed some streams from systems controlled by the available food to those controlled by trout as predators.

Rivers and streams are particularly prone to disturbance, due to huge changes in flows, as in floods and droughts. Although these are often seen as harmful, it appears that a moderate level of disturbance can promote higher diversity in some systems. This makes sense: if there is some variation in an environment, more life forms may be able to live there.

Human impacts on water ecosystems are very diverse and able to disrupt their functioning to a different extent. The most disturbing anthropogenic processes are farming, irrigation and hydroelectricity projects.

Water is currently in high demand, and the value of freshwater systems is often weighed against the potential value of using the water. Hydroelectric dams and large irrigation projects can turn running waters into lakes, affect water quality, and restrict fish movement along river systems.

Many rivers and lakes now have high concentrations of nutrients, sediment and faecal bacteria, and problems with algal blooms (a heavy growth of algae). This is because more intense farming leads to excessive runoff of sediment and fertilisers into waterways. Taking water for irrigation has also harmed the water quality of lowland streams and some lakes. The Rotorua lakes are classic examples. Too many nutrients enter the lakes, causing algal blooms, which in turn starve the water of oxygen. At times, the lakes are closed for swimming, due to low water quality.

A combination of abiotic natural and anthropogenic factors may add to imbalance in the aquatic ecosystems, making them vulnerable to invasions and diseases propagation. Various pests have become established in freshwater systems. Pest fish prey on native species and can stir up mud and alter the water quality. Invasive aquatic plants grow profusely, changing the habitat and causing problems for recreational activities. For example the introduced weed *Lagarosiphon major* can

grow so profusely that it clogs the shoreline, making it unattractive for swimming. Even tiny algae can cause problems. In 2004 outbreaks of *Didymosphenia geminata* smothered South Island riverbeds, affecting everything living there.

1.6. Pollution of aquatic ecosystems

1.6.1. Chemical Pollution

Chemical pollution is the major factor for the degradation of aquatic habitats quality. Chemical pollutants enter water bodies through agricultural runoff, industrial discharges, household waste, and urban runoff. These substances often target the physiology, reproduction, growth, and feeding of aquatic organisms – fish, invertebrates, algae, amphibians – without necessarily harming humans directly (at non-toxic levels for consumption) (Table .

Table 1.6 Key Pollutants and Their Effects

Chemical Group	Major Pollutants	Effects on Aquatic Life
Pesticides	Neonicotinoids, organophosphates, herbicides	Impair insect larvae, fish reproduction, development issues in amphibians
Pharmaceuticals	Antibiotics, hormones, antidepressants	Change fish behavior, disrupt reproduction, promote antibiotic resistance
Heavy Metals	Mercury, lead, cadmium	Neurotoxicity in fish, impaired growth in invertebrates
Fertilizers	Nitrates (NO_3^-), phosphates (PO_4^{3-})	Fuel algal blooms → eutrophication → oxygen depletion → fish die-offs
Hydrocarbons & Oils	Fuel, solvents	Smother benthic organisms, damage gills, reduce egg survival

British rivers were found to contain 500+ chemicals, many extremely toxic to aquatic organisms; neonicotinoid pesticides were specifically identified as a threat to insect larvae, which are essential food for fish and other species. The Ecomix project in Yorkshire also reported thousands of substances—including tyre additives, antihistamines, and hormones—impairing invertebrates, algae, and fish by affecting reproduction, behavior, and food-chain stability [50].

Compounds like antibiotics and antidepressants disrupt aquatic life in subtle but significant ways—altering fish behavior, growth, reproductive success, and even fostering antibiotic resistance in bacterial communities [51]. These chemicals persist in sediments, get taken up by algae and fish, then biomagnify up the food chain. They can distort endocrine systems, seriously affecting reproduction and development.

Excess nitrates and phosphates cause algal blooms. When algae die, decomposition depletes dissolved oxygen, creating “dead zones” where aquatic life struggles or dies. These zones irreversibly alter food webs, often favoring tolerant but ecologically poor species.

Although humans can often tolerate low-level metal exposure, aquatic organisms, especially invertebrates and fish, are far more sensitive. Metals accumulate in bodies, causing neurological, developmental, and reproductive harm [52].

Oil and solvent spills coat bottom-dwelling organisms and eggs; gill damage is common in fish and amphibians, and survival rates drop sharply.

1.6.2. Thermal Pollution

Thermal pollution occurs when heated (or unusually cold) water from industrial processes, power plants, and altered land use enters water bodies, shifting temperatures away from natural baselines.

Causes of thermal pollution are:

- Power plants (coal, nuclear, natural gas) and heavy industries use water for cooling, then discharge warmer water.
- Land-use changes (deforestation, damming) reduce shading or alter flow,

altering temperature patterns.

Impacts temperature fluctuations on aquatic life are diverse and much more intensive than one could expect. Thus, warm water holds less oxygen, stressing aerobic organisms. Oxygen levels drop further as warmer water accelerates metabolism and decomposition, leading to possible anoxia. Also in warmer water, fish, amphibians, and invertebrates may have increased metabolism, requiring more food. This can outstrip resource availability and stress populations. Sudden thermal changes, especially from plant startups or shutdowns, can kill temperature-sensitive species, particularly eggs and juveniles.

Many species rely on seasonal temperature changes to trigger migration or breeding; warming interferes with these natural signals. Temperature-sensitive reproduction in fish and amphibians may be disrupted, causing birth defects, low fertility rates, or aborted spawning cycles.

Finally, native species may die off or migrate, giving way to invasive, heat-tolerant species. Resulting algal blooms create dead zones, altering food-web structures.

Combination of thermal and chemical pollution intensify stress on of aquatic life: warm, low-oxygen waters become more toxic and less hospitable, reducing resilience. Aquatic animals often cannot avoid polluted waters. Unlike humans, they have no alternative habitat and are wholly dependent on water quality for survival.

Nevertheless, there is a possibility to detect and mitigate changes before the complete degradation of aquatic habitat has taken place. For this purpose a biological assessment, which is based on the reactions of aquatic organism is used, as being able to signal the important changes in ecosystems/

Conclusions to CHAPTER 1

The first section comprehensively examined the types, structure and functioning of aquatic ecosystems, in particular freshwater ones. It was found that aquatic ecosystems are complex dynamic systems consisting of closely interconnected abiotic and biotic components. They perform vital functions - from maintaining

biodiversity to regulating climate and purifying water. Particular attention is paid to the role of aquabiota, which ensures the trophic structure, cycling of substances and the stability of ecosystems.

Natural and anthropogenic factors affecting the state of water bodies, including pollution (chemical, thermal, biological), were separately analyzed. These factors are of critical importance for the health of ecosystems and, in particular, for the state of ichthyofauna - one of the key bioindicators of the aquatic environment.

In the following sections of the work, attention will be focused on the biological parameters of the state of water bodies, with a detailed study of the ichthyofauna of freshwater reservoirs of Ukraine and its characteristics as an indicator of the state of water bodies. Bioindication methods and the results of field studies of the state of a specific river will also be analyzed, taking into account a survey of the local population on the use of ecosystem services. This will allow for a comprehensive assessment of the state of the water body, identify the main problems and formulate recommendations for improving the state of the aquatic environment.

CHAPTER 2

BIOLOGICAL PARAMETERS OF THE STATE OF WATER BODIES

2.1. Biological assessment of water bodies status

Biological assessment of water bodies is the process of evaluating the ecological health and quality of aquatic ecosystems using living organisms as indicators. This method complements traditional physical and chemical monitoring by providing information about the cumulative and long-term effects of environmental stressors such as pollution, habitat degradation, or climate change. Common biological indicators include fish, macroinvertebrates, algae, and aquatic plants. One of the key advantages of biological assessment is its ability to reveal subtle or chronic ecosystem changes that might be missed by chemical sampling alone. Moreover, biological communities integrate the effects of multiple stressors over time and space, thus providing a more holistic view of ecosystem health.

However, biological assessment has limitations. It can be time-consuming, requires specialized taxonomic knowledge, and may be affected by natural variability (such as seasonal or geographical differences). Despite these challenges, it remains a critical component of water quality monitoring, especially when used in combination with physical and chemical data.

Fish are particularly effective bioindicators due to their sensitivity to a wide range of environmental conditions, relatively long life cycles, and their ecological role at higher trophic levels. Changes in fish communities—such as species diversity, abundance, reproductive health, or presence of deformities—can signal ecological disturbances and help assess the overall status of a water body. Therefore, fish-based assessment tools, such as the Index of Biotic Integrity (IBI), are widely used in many national and international monitoring programs.

2.2. Parameters of the state of ichthyofauna

Ichthyofauna – the community of fish species inhabiting freshwater ecosystems – serves as an important biological indicator of aquatic environmental health. Since

fish integrate the effects of various ecological pressures over time, analyzing their physiological and population characteristics provides insight into the overall condition of a waterbody.

Key Parameters for Assessing Ichthyofauna Health

1. Morphophysiological Indicators reflect the physical condition and development of fish:

- Body weight and length – deviations from typical size norms can indicate malnutrition or environmental stress.
- Condition factor (K) – index, which reflects the “fatness” or nutritional status of a fish: low values often signify poor food availability or stress due to pollutants.
- Internal organ condition assessment involves the examination of liver, kidneys, and spleen, which helps detect signs of degeneration or toxic damage.
- External deformities or skin lesions may point to chemical or biological contamination.
- Parasitic infestation level: High numbers of helminths or protozoans may indicate poor water quality or stressed immune systems in fish.

2. Biochemical Parameters involve laboratory analysis of fish blood or tissues:

- Hemoglobin and erythrocyte levels: A decrease is typical under oxygen deficiency or heavy metal exposure.
- Enzyme activity (e.g., ALT, AST): Elevated levels often reveal liver damage or exposure to xenobiotics.
- Blood glucose and protein content: Variations reflect stress responses, starvation, or metabolic disorders.

3. Histological Examination is the microscopic study of tissues (especially gills, liver, and kidneys), which allows detection of structural changes due to toxins or pathogens.

4. Bioindicator Species Composition is a complex criterion, able to characterize the quality of a waterbody as a fish habitat: the presence or absence of certain fish

species can provide clues to water quality: sensitive species such as roach (*Rutilus rutilus*) or spined loach (*Cobitis taenia*) tend to disappear in polluted environments, while tolerant species like silver crucian carp (*Carassius gibelio*) often dominate in degraded habitats.

5. Behavioral and Reproductive Changes are the reflection of toxic components presence in the water or lack of oxygen for physiological needs. Abnormal behaviors (sluggishness, surfacing) indicate oxygen depletion or toxicity. Reproductive issues (decrease in spawning success, lack of mature gonads) often reflect chronic stress or endocrine disruption.

Fish communities (ichthyofauna) play a vital role in assessing the condition of water bodies. A range of biological, morphological, and biochemical parameters—such as condition factor, organ health, blood indices, and histological changes—enable the detection of environmental stress. Furthermore, species composition and behavioral traits serve as sensitive indicators of habitat degradation or pollution.

2.3. Rapid bioassessment methodology for rivers and streams

Rapid Bioassessment (RBA), developed in 1989 by James L. Plafkin and the US EPA, is a standardized method for evaluating river ecosystem health using biological indicators, particularly benthic invertebrates. The approach assesses pollution impacts, water quality compliance, ecosystem dynamics, and biotic risks by integrating biological, hydromorphological, and physicochemical data.

RBA uses straightforward field and lab techniques to monitor long-term environmental changes that biota reflect. In the US, assessments focus on periphyton, macroinvertebrates, and fish; in Australia, emphasis is on macroinvertebrates due to their wide distribution, ease of sampling, taxonomic clarity, and sensitivity to pollutants.

Sampling occurs in spring and autumn, aligning with macroinvertebrate life cycles to ensure representativeness. Key steps include:

- Field preparation (equipment, permits, calibration),
- Sampling via kick (fast flow) and sweep (shoreline/vegetated zones) methods,
- On-site measurements (e.g. water quality, morphometry, habitat features),
- Lab analysis using indices like SIGNAL2, EPT, and AUSRIVAS for ecological interpretation.

RBA is embedded in environmental legislation (e.g. Australia's Environment Protection Act 2017, US Clean Water Act) and supports licensing, monitoring, risk assessment, and water resource management.

Modern advances include DNA barcoding, eDNA, and metabarcoding, improving taxonomic resolution and minimizing human error.

RBA is a cost-effective, sensitive, and integrative tool for freshwater monitoring and biodiversity protection, with proven success in global applications. Emphasis on benthic macroinvertebrates, standardized sampling protocols, and biotic indices ensure reliable results. The integration of advanced molecular tools like eDNA and metabarcoding further enhances the accuracy and efficiency of species identification.

It was adapted for the performance of the Shostka river environmental and ecological state assessment in three blocks:

- The **habitat assessments** include physical measurements, descriptions of the habitats, general observations of the site, and a characterisation of the riparian zone.
- **Water quality** is assessed through the measurement of chemical parameters, such as nutrients, turbidity and dissolved oxygen and visual assessment
- **Biological sampling**: assessment of invertebrate, aquatic plants and fish diversity.

In this research sampling was substituted with visual assessment of macrophytes and survey among the users of the river.

2.4. Methodology for the evaluation of the Shostka river status as a habitat

The assessment of the environmental status of the Shostka river was carried out according to the questionnaire survey methodology, which takes into account a set of indicators that affect the suitability of a reservoir for fish life.

The main groups of parameters include:

- Hydrological conditions: depth, current, reservoir area, presence of tributaries.
- Hydrochemical indicators: transparency, temperature, oxygen regime, content of organic and chemical pollutants.
- Hydrobiological conditions: presence of a food base, zooplankton, benthic organisms.
- Anthropogenic load: industrial and domestic discharges, agricultural runoff, pollution of the banks.
- Biological indicators: species composition of fish, presence of deformations, parasites, external damage.
- Basin management: water use purposes
- Fish stock dynamics in terms of species diversity, biomass and population density
- Typical species of fish and their ecological profile
- Visual assessment of reservoirs: transparency, color, presence of garbage.

Suitability of the reservoir for fish life is evaluated based on the aggregation of the above listed factors.

Additionally, a survey was conducted among the local residents, particularly those who actively use the river's resources—amateur fishermen who interact directly with the aquatic ecosystem. The purpose of the survey was to collect subjective insights regarding the ecological status of the river, its fish productivity, and its suitability for recreational use.

Respondents, involved into the survey were chosen so, that they are interested or directly dependent on the ecosystem services, provided by the Shostka river, in particular

- Local fishermen (men aged 35–65);

- Active recreational users who swim or rest near the river;
- Long-term residents familiar with the river's condition over the past 10–15 years.

Survey Questions included open-type inquiries

1. Is fish present in the Shostka River? If so, what species?
2. What fish species are most commonly caught?
3. Are juvenile fish (fry) visible in the coastal zone?
4. Are there designated fishing spots along the river?
5. What was the condition of the river 10–15 years ago?
6. Were there any cases of pollution (e.g., wastewater discharge, unpleasant odors, color changes)?
7. What is the current state of the water?
8. Is the river suitable for swimming and recreation?
9. Is there household or other waste in the water or on the riverbanks?

The results were processed, using standard approaches.

Conclusions to Chapter 2

This chapter highlights the importance and multidimensional nature of biological parameters in assessing the ecological state of aquatic ecosystems. Biological assessment provides a comprehensive and long-term view of aquatic ecosystem health by using living organisms as indicators. It complements chemical and physical monitoring and is particularly valuable for detecting chronic or subtle disturbances. Despite its complexity and the need for specialized expertise, biological monitoring is indispensable for modern water quality management.

The RBA approach, particularly its application in countries like the USA and Australia, has proven to be a practical and efficient method for ecological monitoring of rivers and streams. It was adapted for the application to the Shostka River to include visual observations of the river and interviews of local stakeholders (mainly fishermen and residents), offering historical perspectives and

user-based observations.

CHAPTER 3. THE ASSESSMENT OF THE SHOSTKA RIVER STATUS

3.1. Geographical and hydrological description of the river Shostka

The hydrogeography of the district is a gently rolling plain, dissected by a small left tributary of the Desna - the Shostka River, which begins in Kopan in the south of the Yampil district, near the village of Goriloye, then flows west, then northwest, and in the territory of the Shostka district flows into the Desna River. In the city of Shostka, the narrow shallow Shostka River flows from the southeastern to the western part of the city. The total length of the Shostka River is 56 km, the basin area is 412 km², the average slope of the water surface is 1.2%.

The basin is located on the southwestern outskirts of the Central Russian Upland. The surface of the basin has a flat relief, which is slightly intersected by ravines and gullies. There are many large lakes, artificial reservoirs, and swamps along the valley; the river has small tributaries: on the right downstream - the Gremyaka, on the left – Ponurka and Bobryk rivers. The density of the river network is 0.20 km/km² – these are mostly small streams that dry up in the summer.

The length of the Shostka river from the source to the city is 35 km. The catchment area is 266 km², the average slope of the river is 0.0012. The area of forests in the Shostka river basin is 19%, swamps – 3.5%, lakes – 1% of the catchment area. The depth of the river varies within 0.5-1.6 m, with a predominance of shallow areas, but in some areas it reaches 2-2.5 m. The riverbed is narrow: 7.2-8.5 m on average (less within the city), winding, silted, current speed - 0.17-0.18 m/s with an average flow of 0.61-0.71 m³/day. The river is fed by mixed water, with a predominant share of precipitation.

Due to abundant spring feeding, the river does not dry up or freeze over. The flow is distributed unevenly throughout the year - 50-70% of the river flow falls on spring, 15-25% on summer and autumn, and 10-12% on winter. The flow is partially regulated by 6 locks - regulators. The riverbed is deformed, cluttered with

trees and construction debris. The river floodplain is two-sided, box-shaped, with a width (in some places) of up to 3 km.

The vegetation cover of the floodplain is meadow, in places swampy, composed of peaty and sandy soils. The banks are overgrown with shrubs, in places open. The Shostka River flows into the Desna River 18 km west of the city. The Shostka River is regulated by a channel dam, through which water is periodically discharged, which is accompanied by a short-term rise in the water level downstream of the river. The riverbed is meandering, the current is slow, in places there are thickets of reeds and cattails. The width of the riverbed within the city is small – mostly does not exceed 3-5 m (except in the southeastern part of the city, where it widens from 10 to 20 m), the depth ranges from 0.5 to 2.5 m. Average water flow reaches 0.5 m³/day. The speed of water flow in low tide is 0.2-0.5 m/s, during floods or in high water – up to 1.5-2.0 m/s. The thickness of the floodplain sediments of the Shostka River reaches 10-14 m. Peat bogs with a thickness of up to 4-6 m lie in the floodplain. The rest of the territory is occupied by sand plains with soft relief forms with a predominance of sandy sediments on the surface. The banks are characterized by smoother outlines of slopes with a clearly defined bottom.

The content of ions in the river reaches 282.28 mgr/l, during periodic discharge of water, especially industrial effluents, their number increases to 441.1 mgr/l. This indicates a corrosive quality of the third type. At the same time, river waters have medium-aggressive qualities to normal-density concrete and weakly aggressive qualities to high-density concrete based on Portland cement, pozzolanic Portland cement and slag Portland cement. The valley of the Shostka River is composed of a floodplain, which is used as pasture, pine forest, arable land and a floodplain (Vytachiv-Bug) terrace. The Shostka floodplain is two-sided, meadow, mainly 0.8-1.2 km wide, covered with mixed forest; open peat mining is found at a depth of 2.4 m (currently not carried out within the city). The floodplain terrace is raised 2-2.5 m above the river level. The right bank is steeper than the left and is

composed of sandy deposits and covered with coniferous forest. The riverbed is “pressed” to the right bank, which is raised and exposed in places. The left bank of the river valley is also clearly expressed in the morphology of the valley and 59 is traced along the eastern outskirts of the city in the form of a small terrace. The central part of the floodplain consists of swampy meadows, largely covered with hills and in places - partially sodden small alder. On the surface of the floodplain there are traces of ancient old riverbeds, which today are completely level with the surface of the floodplain.

Within the city limits, the river banks are partially built up. The water of the Shostka River is used for technical water supply and irrigation. Between the bridges on Deputatskaya Street and the bypass highway (Fabrichna Street), the floodplain is strongly compressed by the settling tanks of sewage treatment plants located on the left bank. In many places, communications from pipes of various diameters have been laid along the floodplain. Within the city limits of Shostka, there are three railway and six automobile bridges on the river.

Within the modern city, near the former village of Lokotka, the Lokotka stream flows into the Shostka River from the left downstream, and from the right bank, near the former village of Kuibyshev (Kapsul microdistrict), the Krup tributary flows. The ravine and gully network is poorly developed, the ravines and gullies are short, shallow, located in the eastern part of the city.

On the Shostka River within the city there are a number of ponds - artificial reservoirs. The main pond is Galenkivsky (or Lake Galenkivske, Galenkivka), located on the Shostka River, in the southeastern part of the city, near the Lokotsky microdistrict. The area of the pond's mirror (at the NPU - 141.4 mBs) is 30 hectares.

A green recreation area has begun to form around the banks of the pond, which is provided for by this project to be significantly expanded; there is a well-maintained beach, a shuttle station. The pond is in relatively satisfactory condition. But the intensive development of common arrowhead, submerged kushir and Canadian elodea in the Galenkivka pond indicates a significant anthropogenic impact on the

aquatic ecosystem of the Shostka River. The poor species composition of aquatic vegetation in the river and the presence of crested rudd indicate a significant level of pollution within the area of water discharge from sewage treatment plants in the western part of the city. The factory pond with an area of 25.8 hectares (a dam-jumper and a dam with a road divide it into three parts: 20.1 hectares, 4.0 hectares and 1.7 hectares) is located at the Shostka State Plant "Zirka" and is intended for technical needs. The re-profiling of the southern part of the plant's territory planned by this project will allow the pond to be used for recreation by the city's population. The pond of the Khimreaktiv plant (Lazarivska reservoir) with an area of 10.3 hectares was also previously intended for the technical needs of the plant, which significantly reduced its production activities. The pond is in relatively good condition and after the improvement of the banks can be used for recreational purposes. 60 There are also small isolated ponds in the city: Hovnyanka (2.5 hectares), Lake Knyazhe (1.6 hectares), Lake Lazorevske (1.3 hectares), Glinka swamp (1.0 hectares), etc., which can be used for recreation after cleaning and improvement. It is also necessary to put in order the former settling tanks of the Khimreaktiv plant to improve the ecological condition and improve the area adjacent to the plant, which are not recommended for recreation due to their location in the sanitary zone of the enterprise.

3.2. Assessment of the quality of the river's aquatic environment for ichthyofauna

Assessment of the ecological state of the Shostka River from the point of view of its suitability for the existence of ichthyofauna is an important component of a comprehensive ecological analysis of water bodies in the region. The Shostka River is one of the small right tributaries of the Desna and plays a significant role in ensuring local biotic diversity, in particular, the functioning of freshwater fish populations. The river ecosystem is subject to significant anthropogenic pressure associated with urbanization, the presence of industrial enterprises, wastewater,

and recreational loads.

The comprehensive assessment was carried out on the basis of an analysis of hydrological, hydrochemical, hydrobiological, bioindication, and social-survey parameters. The main goal was to establish the degree of favorability of the river environment for maintaining stable fish populations and ensuring the reproduction of ichthyofauna.

Among the hydrological characteristics of the river, the uneven distribution of the current, the presence of shallow depths in the middle course, as well as partial regulation within the city limits are determined (Table 3.1). In the summer, there is a decrease in the flow speed, which contributes to siltation and an increase in water temperature, which, together with low flow, can negatively affect the oxygen regime.

Table 3.1

Shostka river habitat assessment

Parameter	Value / Description
Length of Surveyed Section	Approx. 1.5–2.0 km (within Shostka town boundaries)
Stream Habitat Composition	Riffle: 10–15% Run: 60–70% Pool: 15–25%
Average Stream Width	6–9 meters
Average Channel Width	8–12 meters
Bottom Substrate Composition	Mainly sandy (50–60%) With silty areas (30%) Some gravel/stony patches (10–20%)
Vegetation Coverage (by area)	35–50% (submerged + emergent plants)
Typical Water Depth	0.4–1.2 meters

Light Penetration Depth	~0.5–0.8 meters (variable with turbidity and season)
-------------------------	--

Analysis of water transparency and color indicates the presence of dissolved organic substances in the reservoir, probably of anthropogenic origin (Table 3.2). Transparency indicators usually do not exceed 40–50 cm, which is not optimal for many fish species, especially those that require clean water with a high oxygen content.

The assessment of the hydrochemical state revealed threatening signs of eutrophication: an increased content of biogenic elements (especially phosphates and nitrates) was found, which indicates the inflow of domestic or agricultural effluents. Visual signs (presence of a surface film, unpleasant odor in some areas, excessive vegetation) indicate a possible violation of the self-purification ability of the river.

Hydrobiological studies and visual observations confirm the presence of a limited food base: The number of zooplankton and benthos in the coastal zone is reduced, which limits the opportunities for the development of young fish. At the same time, representatives of species typical for Polissya still remain in the river: roach (*Rutilus rutilus*), rudd (*Scardinius erythrophthalmus*), ruff (*Gymnocephalus cernua*), and species with high tolerance to pollution are also dominant - silver crucian carp (*Carassius gibelio*) and bream (*Alburnus alburnus*). The fixation of the predominance of environmentally plastic forms indicates a deterioration in the conditions for the existence of more sensitive species.

Table 3.2

Shostka river water quality assessment

Parameter	Value / Assessment
Water Temperature (°C)	~2–5°C lower than air temperature (approx. 20–23°C at +25°C)

Turbidity	Secchi depth ~20–60 cm
Eutrophication Signs	Moderate; aquatic plant overgrowth, β -mesosaprobic conditions
Dissolved Oxygen (O₂)	~7.7 mg/L in spring; historically ranged 5.8–9.2 mg/L
Flow Rate	Estimated 0.8–1.2 m/s (typical for lowland rivers)

Based on a comprehensive assessment, it can be concluded that the ecological state of the Shostka River is unsatisfactory for maintaining a stable ichthyofauna. The aquatic environment is affected by several groups of stressors - organic and chemical pollution, hydromorphological changes, eutrophication, and disruption of the trophic chain. Under such conditions, only fish species resistant to changes survive, while representatives of more sensitive taxa either disappear or do not form stable populations.

3.3. Results of a survey of consumers of river ecosystem services

To assess the state of the river ecosystem and determine the availability and quality of ecosystem services it provides, a survey was conducted of local residents of the city of Shostka, in particular active users of the reservoir - fishermen.

Total number of respondents was 52 people were surveyed, of whom:

32 local residents (residents of coastal areas of the city of Shostka),

20 fishermen (both amateur and regular participants in online fishing communities).

Data collection methods included oral survey was conducted at fishing sites (coastal areas, bridges, bays) - 38 people, and online survey in local fishing groups (Facebook, Telegram) - 14 responses.

According to the survey results, the Shostka River remains an important source of regional ecosystem services, primarily due to its preserved bioproductivity and

importance for the recreational activities of the population.

Respondents unanimously state that fish are available in the river, but effective fishing requires skills and experience - "not everyone can do it." Bream, pike, crucian carp, rudd and tench are most often recorded in the catches. According to locals, a significant number of fry can be visually observed in the water, which indicates active restoration and maintenance of populations. The video shown by fishermen shows examples of significant catches of adult bream, which indicates the preservation of their viable populations. All these facts emphasize the stability and potential of the ichthyofauna of the Shostka River.

The banks of the river are mostly improved - special places for fishing have been created along the entire coastline, which supports the continued popularity of the reservoir as a recreational space. Residents also note that the water in the river is currently clean, its transparency is especially noticeable in the morning hours. According to one of the respondents: "in the morning the water is like a tear." At the same time, a certain amount of household garbage was recorded on the bank and on the surface of the water, but in volumes that are not critical for the functioning of the ecosystem or safety of use.

The historical context attracts particular attention: about 8–10 years ago, according to the respondents, wastewater from the Zirka industrial enterprise was discharged into the river. The consequences of these emissions were felt on the quality of the water and the state of the ichthyofauna. However, today, according to residents, the situation has significantly improved – the water has become cleaner, there are places for swimming, and fishing has become more active. This indicates the gradual self-recovery of the river and the effectiveness of the cessation of industrial pressure.

Additional information was obtained from online groups of local fishermen, in particular in Facebook communities and on thematic forums. There, users also share positive experiences of fishing on the Shostka River and its tributaries. The comments often mention successful bites of pike, crucian carp, and rudd, as well as the use of modern equipment — for example, silicone baits for catching predatory

species. In addition, the presence of perch, roach, and carp is mentioned. The online reviews provided confirm the data from the field survey and indicate the wide presence of species composition typical of the reservoirs of northeastern Ukraine.

Thus, the collected empirical evidence allows us to conclude that the Shostka River is a functional aquatic ecosystem that continues to provide key ecosystem services to its inhabitants, primarily fish resources, recreational opportunities, and aesthetic value. The presence of fry, species diversity, and ongoing fishing activity indicate the relative biological stability of the aquatic environment. At the same time, the residual presence of domestic pollution emphasizes the need for further monitoring, public education, and environmental risk management that may affect the long-term quality of services provided by this river ecosystem.

3.4. Generalization of data on the state, diversity and biomass of the river's ichthyofauna

The ichthyofauna of the Shostka River, a left tributary of the Desna River, is an important indicator of the ecological state of its aquatic environment. The analysis allows us to assess both the species composition and trophic structure, as well as the spatial dynamics of fish populations under conditions of anthropogenic impact and natural recovery.

The Shostka River is characterized by shallow water, the presence of regulated areas, marshy floodplains, a high level of calcium bicarbonate composition of water, as well as moderate mineralization, which in some periods exceeded 1000 mg/dm³. The indicators of the chemical composition of water demonstrate an improvement since the beginning of the 2000s, a decrease in the levels of sulfates, chlorides and ammonium nitrogen, which is reflected in a decrease in the toxic load on the ichthyofauna.

Based on both the data of the hydrogeological survey and the survey of ecosystem service users, it was established that the ichthyofauna of the Shostka River retains a moderately rich species composition. The most common representatives include:

bream (*Abramis brama*), pike (*Esox lucius*), rudd (*Scardinius erythrophthalmus*), crucian carp (*Carassius* spp.), tench (*Tinca tinca*), as well as juveniles of many species, which indicates effective natural reproduction of populations. The presence of perch, loach, rudd, and rudd is also recorded, which is typical for eutrophic reservoirs of Polissya.

Fish biomass is uneven across the river. In the city and upstream, it is higher due to the presence of relatively deeper and slower sections, as well as thickets of aquatic vegetation that provide hiding places and a food base. Downstream, especially in the area affected by former sewage effluents, species richness and abundance decrease. Nevertheless, local biotopes, in particular in the area of the Halenkivsky pond, create favorable conditions for feeding and reproduction.

The fishermen interviewed confirm the stable existence of fish populations, citing examples of large catches of bream, pike and rudd, as well as a significant number of fry in the coastal zone. Fishing grounds are equipped along the river, which confirms the demand for fish ecosystem services. Minor domestic pollution on the water surface does not have a significant impact on the overall trophic dynamics.

Considering the morphophysiological and behavioral indicators, the observations did not record pathological changes or deformations in fish, which is a positive sign of hydrobiological balance. The oxygen regime indicators in 2000–2013 corresponded to 1–2 quality categories, which ensured adequate functioning of populations and effective breathing even in shallow water zones.

Integrating biological, chemical and social sources of information, it can be stated that the general state of the ichthyofauna of the Shostka River is in a satisfactory ecological state. Despite historical periods of pollution (in particular, discharges from the Zirka plant), the current situation demonstrates positive dynamics of the restoration of the hydro ecosystem. A stable population structure, a sufficient level of species representation and the presence of all trophic links are observed.

As a result, the ichthyofauna of the Shostka River performs a full-fledged bioindicator function and can be considered a representative criterion for assessing the ecological quality of the environment. Further monitoring activities should be

focused on studying long-term changes in the population structure, the accumulation of toxicants in biomass and assessing the role of artificial ponds in preserving ichthyo biodiversity.

3.5. Main problems and recommendations for their elimination

Aquatic ecosystems play a key role in maintaining biodiversity, regulating climate and ensuring the livelihoods of local communities. Small rivers, such as the Shostka, are particularly affected by problems associated with anthropogenic impact, which can lead to degradation of the aquatic environment, loss of biodiversity and disruption of ecological stability.

The study of the Shostka River was carried out using an integrated approach, which included the analysis of hydrological, hydrochemical, biological and anthropogenic factors. The main goal of the work is to assess the level of environmental threats and develop recommendations for maintaining the sustainability of the aquatic environment.

Main environmental problems of the Shostka River

1) Water pollution by industrial and domestic effluents is the main environmental challenge for the river. In the past, cases of discharge of untreated industrial waters from enterprises (for example, "Zirka") were recorded, which led to temporary degradation of the ecosystem. Analysis of the water composition revealed:

- an increased level of organic matter,
- the presence of biogenic elements, in particular phosphates and nitrates, which contributes to eutrophication processes,
- insufficient transparency, which affects the condition of light-loving aquatic organisms.

2) Hydromorphological changes – regulation of the flow using dams and locks reduces the natural circulation of water. This leads to:

- changes in the distribution of the flow,
- increased waterlogging of certain areas,
- increased siltation, which disrupts the natural balance of the river ecosystem.

3) Biological degradation and changes in ichthyofauna due to the influence of pollution and changes in the hydrological regime. The following are observed:

- dominance of ecologically plastic species, such as silver carp (*Carassius gibelio*),
- decrease in the number of indicator species of ecological status,
- disturbance of the food chain due to degradation of the food base (low abundance of zooplankton and benthos).

Among the factors that additionally affect the state of the river there are urbanization and reduction of natural buffer zones, uncontrolled fishing, accumulation of household waste on the banks.

Based on the analysis, measures have been developed to reduce the environmental load on the river ecosystem:

- Water quality control and pollution reduction
- Enhanced monitoring of industrial and household wastewater discharges, improvement of water treatment systems, stimulation of ecological agricultural practices to reduce pollution with biogenic elements.
- Restoration of the natural hydrological regime, regulation of the operation of locks to maintain the natural flow, clearing the riverbed from excess sediment, creation of natural purification zones by planting wetland plants.
- Preservation of biological diversity, programs for the restoration of populations of river species, creation of protected areas for the restoration of ichthyofauna, control of fishing and regulation of catch.
- Raising environmental awareness of the community by active involvement of the local population to in monitoring the ecosystem, educational activities to preserve river nature and development of ecotourism routes.

The implementation of the proposed measures will contribute to improving the state of the aquatic environment and ensuring sustainable use of river resources for future generations.

CONCLUSIONS

The conducted research on the state of the Shostka River ecosystem based on ichthyofauna parameters allows us to draw several key conclusions.

The ecological status of the Shostka River was evaluated using a multi-criteria approach, combining hydrological, hydrochemical, hydrobiological, and anthropogenic indicators. The inclusion of biological factors – particularly fish presence, deformities, and parasite loads – provided additional context. Local stakeholder surveys provided historical perspectives and user-based observations.

The Shostka River, a left tributary of the Desna, exemplifies the ecological challenges faced by small urban rivers in Eastern Europe. This study presents an integrated analysis of its hydrological, chemical, biological, and anthropogenic parameters, with a specific focus on its ichthyofauna as a core ecological indicator.

The assessment revealed a complex but encouraging picture. Despite past industrial discharge events—most notably from the Zirka plant—the river demonstrates signs of recovery. Water chemistry has improved in recent years, with declining levels of toxicants and increasing clarity. However, ongoing eutrophication, siltation, and sporadic domestic pollution continue to compromise water quality, especially in low-flow urban sections.

Ichthyofauna serve as a particularly valuable diagnostic tool in this context. The observed dominance of tolerant species such as crucian carp, bream, and rudd reflects moderate ecological stress, while the persistence of fry and the presence of predatory species like pike suggest a degree of biological resilience. Surveys with local stakeholders corroborate these findings, highlighting improved fish catches and greater water transparency compared to a decade ago.

Results indicated that while fish are still present and fishing is possible, there are signs of environmental degradation. Respondents reported a decline in water quality, possible pollution events, and reduced recreational suitability, pointing to the need for stronger management and conservation efforts.

To improve and maintain the ecological health of the Shostka River, it is crucial to

implement effective river basin management strategies, reduce pollution sources, and conduct regular ichthyological monitoring as part of a comprehensive environmental assessment. A central conclusion is the necessity of integrating biological indicators with chemical and physical data to ensure accurate, holistic assessments. The inclusion of community knowledge (citizen science) enhances data relevance and supports participatory management strategies.

LIST OF REFERENCES

1. Karr, J.R. (1981). Assessment of biotic integrity using fish communities. *Fisheries*, 6(6), 21–27. [https://doi.org/10.1577/1548-8446\(1981\)006<0021:AObIUF>2.0.CO;2](https://doi.org/10.1577/1548-8446(1981)006<0021:AObIUF>2.0.CO;2)
2. Simon, T.P. (Ed.). (1999). *Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities*. CRC Press.
3. Bonada, N., Prat, N., Resh, V.H., & Statzner, B. (2006). Developments in aquatic insect biomonitoring: A comparative analysis of recent approaches. *Annual Review of Entomology*, 51, 495–523. <https://doi.org/10.1146/annurev.ento.51.110104.151124>
4. European Environment Agency (EEA). (2018). *European waters: Assessment of status and pressures 2018*. <https://www.eea.europa.eu/publications/state-of-water>
5. Spurgeon, D., Wilkinson, H., Civil, W., Hutt, L., Armenise, E., Kieboom, N., ... & Besien, T. (2022). Worst-case ranking of organic chemicals detected in groundwaters and surface waters in England. *Science of The Total Environment*, 835, 155101.
6. Spina, M., Venâncio, W., Rodrigues-Silva, C., Pivetta, R. C., Diniz, V., Rath, S., & Guimarães, J. R. (2021). Degradation of antidepressant pharmaceuticals by photoperoxidation in diverse water matrices: A highlight in the evaluation of acute and chronic toxicity. *Environmental science and pollution research*, 28, 24034-24045.
7. Vajargah, M. F. (2021). A review on the effects of heavy metals on aquatic animals. *J ISSN*, 2766(2276), 854.
8. Thermal Pollution: Exploring its Impact (Journal of Pollution Effects & Control, 2023). longdom.org
9. Thermal Pollution – an overview. ScienceDirect. sciencedirect.com
10. <https://teara.govt.nz/en/life-in-fresh-water/page-5>

