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RELEVANT ASPECTS OF STUDYING THE BIOLOGY AND PRODUCTIVITY OF FRESHWATER FISH

Modern fish farming is one of the key branches of aquaculture, providing the population with high-quality protein products of animal origin. Effective freshwater fish farming is impossible without a deep understanding of fish biology, the patterns of their growth, development, feeding, and reproduction. The relevance of studying these aspects is determined by the need to increase the productivity of water bodies, optimize rearing technologies, and preserve the biodiversity of aquatic ecosystems [4].

The biology of freshwater fish encompasses a wide range of issues–from morphology and physiology to behavior and adaptations to different habitats. Particular importance is given to the study of growth processes, metabolism, reproduction, and responses to environmental factors [4]. Growth rate and feed conversion efficiency depend on the fish species, water temperature, oxygen concentration, chemical composition of the environment, and feeding level.

The study of biological characteristics allows the formation of species-specific maintenance regimes, determination of optimal feeding parameters, and development of methods to stimulate growth. Growth and development rates are closely related to water quality. Temperature, dissolved oxygen, concentrations of ammonia, nitrites and nitrates, and pH are key parameters determining the physiological state of fish [1]. In particular, oxygen deficiency leads to hypoxia, reduced appetite, and slower metabolism, whereas optimal conditions promote intensive growth and lower mortality rates.

Feed composition also plays a significant role. The balance of proteins, fats, carbohydrates, vitamins, and trace elements affects growth rate, immune system development, and disease resistance. Modern research focuses on replacing traditional feed proteins (fishmeal) with alternative sources – insects, macro- and microalgae, bacterial proteins, etc. [3]. This not only reduces production costs but also makes aquaculture more environmentally sustainable [1].

Selective breeding is one of the main directions for increasing fish productivity. It is based on the study of hereditary variability, selection of productive forms, and creation of high-yield lines [2]. Modern aquaculture increasingly applies methods of hybridization, polyploidy, and genetic marking to control breed purity and assess heterozygosity [3]. This is especially important for preserving natural populations in water bodies affected by anthropogenic pressure [2].

Modern biotechnologies open new possibilities for studying fish biology and productivity. These include the use of probiotics, immunostimulants, enzymes, and bioactive additives that improve digestion, strengthen the immune system, and increase resistance to pathogens [2]. Technologies for controlled reproduction, artificial fertilization, and egg incubation are also actively being developed, ensuring stable offspring production under controlled conditions [4].

Bioengineering methods enable manipulations with gametes, cryopreservation of sperm and eggs, and detailed study of fish embryonic development.

An important aspect of current research is the conservation of native species and the rational use of biological resources. Intensive fish farming can lead to reduced natural diversity; therefore, it is essential to combine productive cultivation with ecological principles [1; 2]. Modern reintroduction programs aim to restore populations of valuable species such as sterlet, tench, and pike, which have become rare in certain regions [3].

A comprehensive approach that integrates biological, ecological, breeding, and technological principles ensures the sustainable development of the industry [4]. Ukraine has significant potential in this area due to its numerous freshwater bodies, research facilities, and scientific institutions working on improving aquaculture technologies (Table 1).

In Ukraine, freshwater fish biodiversity conservation currently relies mainly on artificial breeding and reintroduction, while in the EU and worldwide, the ecosystem-based approach prevails – restoring natural habitats, managing river basins, and controlling anthropogenic impacts.

The most effective programs are those that combine biological knowledge, technological innovation, and ecological management at national and regional levels.

In summary, the study of freshwater fish biology and productivity is one of the priority areas of modern hydrobiology and aquaculture. A deep understanding of physiological, ecological, and genetic mechanisms of fish growth allows the development of effective rearing technologies, improvement of product quality, and promotion of sustainable water resource management. Future research should focus on integrating biotechnological, genetic, and ecological approaches to create more efficient fish resource management systems and ensure food security under conditions of global environmental change.

Table 1

Methods for conserving freshwater fish biodiversity

Method / Approach	Effectiveness assessment	Examples
Artificial breeding and restocking	Medium–high. Provides rapid recovery of numbers but not always genetic diversity.	Ukraine – large-scale restocking of sturgeon in the Danube, carp and silver carp in the Dnipro reservoirs. EU – salmon restoration programs in Poland and Germany. Global – hatchery-based Salmon Recovery Program (USA).
Restoration of spawning habitats and hydrological conditions	High. Promotes natural reproduction and preserves local populations.	Ukraine – WWF projects on Danube floodplain restoration. EU – LIFE Rivers program: riverbed cleaning, flow restoration. Global – River Restoration Program (USA, Japan).
Construction of fish passes / removal of migration barriers	High. Restores natural fish migration and reduces population losses.	Ukraine – reconstruction of Danube locks, studies of fish passes on the Dnipro. EU – FishPass project (Netherlands, France). Global – Columbia River Basin Program (USA, Canada).
Genetic and breeding control in artificial reproduction	High when properly implemented. Ensures genetic diversity preservation.	Ukraine – creation of sturgeon genetic banks in Kherson. EU – use of DNA markers in salmon breeding (Sweden, Finland). Global – genetic monitoring of tuna and salmon populations (NOAA, Japan).
Monitoring of populations and aquatic environment	High. Enables early detection of ecosystem degradation.	Ukraine – State Water Ecosystem Monitoring System; ichthyofauna surveys under the "Clean Dnipro" Program. EU – Water Framework Directive (WFD). Global – Freshwater Biodiversity Observation Network (FWBON).
Reintroduction of native species	High for rare or extinct species; requires long-term control.	Ukraine – reintroduction of sterlet, tench, pike. EU – Eel Recovery Plan. Global – salmon restoration programs in North America and New Zealand.
Use of probiotics, immunostimulants, and biotechnologies in fish farming	Medium–high. Reduces mortality, increases resilience and productivity without harming ecosystems.	Ukraine – studies by NUBiP and the Institute of Fisheries on probiotics in carp culture. EU – "Green Aquaculture" programs in Denmark and the Netherlands. Global – biofloc-integrated aquaculture systems (India, Brazil, Vietnam).
Ecosystem-based approach to water management	Highest. Ensures long-term ecological balance and ecosystem recovery.	Ukraine – gradual implementation of Ramsar Convention principles. EU – "EU Biodiversity Strategy 2030." Global – initiatives by IUCN, GEF, and Ramsar on integrated water resource management.

References

1. Ministry of Environmental Protection and Natural Resources of Ukraine. Concept for the Implementation of State Policy on the Conservation of Sturgeon Fishes (Acipenseridae) in Ukraine for 2021–2030 and the Action Plan. Kyiv, 2021.
2. FAO. The State of World Fisheries and Aquaculture (SOFIA) 2018. Rome: Food and Agriculture Organization of the United Nations, 2018. 224 p.
3. Kovalenko, V. O., & Shumova, V. M. Aquaculture of Natural Water Bodies: A Textbook. Kyiv, 2017. 342 p.
4. Vdovenko, N. M. State Regulation of Aquaculture Development in Ukraine: Monograph. Kyiv: Kondor Publishing House, 2013. 464 p.