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ECONOMIC EFFICIENCY OF INTEGRATING FISHERIES MANAGEMENT AND ENVIRONMENTAL CONSERVATION: INTERNATIONAL EXPERIENCE AND PROSPECTS FOR UKRAINE

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Abstract. The article examines the integration of fisheries management and environmental conservation as an innovative model for the sustainable use of aquatic bioresources in both national and international contexts. The *subject* of the present study is the mechanisms that combine the economic interests of the fisheries sector with ecological objectives, including biodiversity conservation, population recovery, and maintaining the stability of aquatic ecosystems. The relevance of the research is driven by global challenges, including overfishing, poaching, degradation of spawning grounds, climate change, and water pollution. These issues are particularly acute for Ukraine, where the fisheries sector is of both food-related and strategic socio-economic importance, and is characterised by high levels of shadow activity and weak enforcement. The *methodological framework* underpinning this study combines comparative, content, and case-study approaches. The research compares Ukrainian and international models of fisheries management, taking into account the experiences of the European Union, Canada, Japan, and the Baltic States. It also analyses international conventions and directives, such as the Convention on Biological Diversity, the EU Water Framework Directive and the FAO Code of Conduct for Responsible Fisheries, as well as Ukraine's national legislation. System analysis methods are also employed to integrate ecological, economic and social factors into a unified model. Case studies include Ukrainian protected areas such as the Danube Biosphere Reserve, the Lower Dniester National Nature Park and the Ramsar wetlands of the Dniester Delta, as well as international fish stock restoration practices. The study *aims* to identify effective instruments for integrating fisheries management with conservation mechanisms, and to develop recommendations for adapting them to Ukrainian conditions. The article discusses international models such as community-based co-management in Canada, aquaculture and marine protected area development in Japan, fish passage use in the Baltic States, and legal harmonisation of environmental and economic goals within the EU. The main *findings* confirm that a holistic approach ensures the simultaneous achievement of three sets of objectives: ecological (population and biodiversity restoration), economic (increasing the profitability of the fisheries sector and developing aquaculture and recreational fishing tourism) and social (local community involvement and improved governance transparency). Priority areas for Ukraine include aligning legislation with EU environmental directives, developing innovative monitoring technologies (such as eDNA and satellite systems), legalising the shadow sector, and expanding co-management practices involving local communities and fisheries co-operatives. The study concludes that integrating fisheries management with environmental conservation is essential for Ukraine to transition to a sustainable model of aquatic bioresource use. This approach enables both the ecological resilience of water bodies and the economic efficiency of the sector. Adopting the best global practices, from EU environmental directives to Japan's integration of aquaculture and marine

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protected areas, can enhance the competitiveness of Ukraine's fisheries sector and facilitate its integration into the international market.

Keywords: integrated management, fisheries, aquatic bioresources, aquaculture, protected areas, co-management, ecological quotas, poaching, biodiversity, sustainable development.

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1. Introduction

The state of global aquatic biodiversity is one of the most important indicators of ecological security and sustainable development. According to estimates by the Food and Agriculture Organization of the United Nations (FAO) (2022; 1995), over 34% of the world's fish stocks are overexploited, with a further 60% being harvested at the limit of their biological sustainability. This situation highlights a profound crisis in the governance of aquatic resources, pointing to the urgent need to reconsider the approach to their use and protection. Many of the global challenges humanity faces are associated with ecosystem degradation, climate change and water pollution (The Law of Ukraine "On Fauna" of 13.12.2001 No. 2894-III (as amended), 2001). Climate change leads to shifts in hydrological regimes, which directly affect fish spawning, migration and population recovery. Pollution, including the inflow of nutrients and toxic substances, causes habitat loss and a decline in biodiversity and fish productivity in aquatic ecosystems (The Law of Ukraine "On Fauna" of 13.12.2001 No. 2894-III (as amended), 2001).

At the same time, the fisheries sector is experiencing an increasing number of conflicts between economic interests and environmental protection objectives. On the one hand, fisheries provide food security, create jobs, generate export revenue and have socio-cultural significance for many coastal and riverine communities. However, overfishing, destructive fishing practices and the disregard for seasonal and biological restrictions pose serious threats to the stability of aquatic ecosystems. This issue is of particular concern for Ukraine, which has an extensive network of rivers and coastal systems, significant potential for aquaculture and capture fisheries, and is simultaneously facing habitat degradation, a decline in the population of commercially valuable fish species, and widespread poaching (Burhaz, Soborova & Matviienko, 2023).

The search for a balance between the economic benefits of fisheries and ecological safety is pursued through the development of international legal and regulatory instruments in global practice. Among them, the Convention on Biological Diversity (The Convention on Biological Diversity, 1992) has played a central role in defining strategic directions for the conservation and sustainable use of natural resources, including aquatic bioresources. Its provisions emphasise the need to integrate biodiversity conservation into sectoral policies, particularly those relating to fisheries. Another important document for the European Union is the EU Water Framework Directive (The European Commission, 2000), which introduced an ecosystem-based approach to integrated river basin management and established a foundation for aligning economic activities with water protection objectives. Equally significant is the FAO Code of Conduct for Responsible Fisheries (FAO, 1995), which sets out universal principles for states and fisheries stakeholders. These principles cover everything from adhering to biological exploitation standards to safeguarding community rights and minimising environmental impact.

In this context, the integration of fisheries management and environmental conservation becomes highly relevant. Such an approach is pivotal in ensuring the preservation of biodiversity and the recovery of aquatic populations, thereby creating conditions for the long-term economic stability of the sector. Integration is defined as the combination of diverse management mechanisms, including the establishment of ecologically justified quotas, the development of aquaculture, the creation of protected aquatic areas, and the implementation of advanced biotechnologies for population monitoring (Burhaz, Soborova & Matviienko, 2023).

The study takes a comprehensive approach, combining theoretical, analytical and empirical methods to ensure the scientific novelty and practical relevance of the results obtained. The primary sources include international legal and regulatory documents (FAO, 2022; FAO, 1995; The European Commission, 2008; The Convention on Biological Diversity, 1992), as well as national legislation of Ukraine in the fields of environmental protection and fisheries (The *Law of Ukraine "On Fauna" of 13.12.2001 No. 2894-III (as amended)*, 2001; *The Law of Ukraine "On Fisheries, Industrial Fishing and Protection of Aquatic Biological Resources" of 08.07.2011 No. 3677-VI*, 2011; The *Law of Ukraine "On the Red Book of Ukraine" of 07.02.2002 No. 3055-III (as amended)*, 2002; The *Law of Ukraine "On Nature Reserve Fund of Ukraine" of 16.06.1992 No. 2456-XII*, 1992). In addition, reports of international organisations (FAO, 2022; FAO, 1995); The European Commission, 2000), statistical data, and scholarly publications by Ukrainian and foreign authors were utilised.

Methodologically, the research relies on a comparative analysis of Ukrainian and international models of aquatic bioresource management, a content analysis of legal and regulatory documents, and case study methods applied to protected areas in Ukraine and elsewhere. A systems analysis approach was also employed to integrate economic, ecological and social factors into a unified model. This process facilitated the identification of obstacles to implementing modern practices and the development of recommendations for adapting the most effective international strategies to the Ukrainian context.

2. State of Fisheries Management in Ukraine

The management of fisheries in Ukraine is currently experiencing a protracted period of transformation, the form of which has been shaped by two principal factors. Firstly, there are internal structural problems which have had an effect on the transformation, and secondly, there are external challenges linked to global ecological processes and the country's international commitments. In recent decades, Ukraine has experienced a decline in commercial stocks of key fish species, an increase in poaching activities, a degradation of spawning habitats, and the inadequacy of existing monitoring and management systems. These issues have a direct impact on the economic performance of the fisheries sector and the ecological balance of aquatic ecosystems.

One of the most critical issues is that of overfishing. In a multitude of water bodies, particularly in the Dnipro and Dniester cascades, industrial harvest levels have been observed to exceed the reproductive capacity of fish populations. According to studies specialising in the field, average annual freshwater fish catches in Ukraine have declined by more than 50% over the past 30 years, reflecting not only ecological but also management failures. The discordance between official quotas and actual resource volumes undermines the principle of sustainable use.

Poaching represents yet another acute problem. Illegal fishing in inland waters and in the coastal zone of the Black Sea has become systemic, involving both small-scale users with basic gear and organised groups employing industrial nets and prohibited methods (such as electrofishing and explosives). It is estimated by experts that in certain regions, shadow catches exceed official figures by a considerable margin, thereby significantly complicating the formation of reliable statistics and resulting in substantial losses to the state budget.

A further factor that has a detrimental effect on fish stocks is the degradation of spawning habitats. The construction of hydropower plants and dams, in addition to intensive land reclamation and the development of riparian zones, has resulted in a significant decrease in the natural spawning grounds of the species. This phenomenon is particularly evident in the Dnipro basin, where the construction of a series of reservoirs has had a profound impact on the dynamic river ecosystems that were once characteristic of the system. A comparable situation is observed in the lower Danube region, where a lack of coordination between hydraulic engineering projects and ecological requirements results in impediments to the migration of valuable commercial species, including sturgeons.

Existing management mechanisms only partially address contemporary challenges. For example, the licensing and quota system for industrial fisheries in Ukraine has long been ineffective due to the limited monitoring of actual catch volumes. The underfunding of relevant institutions restricts their ability to conduct regular scientific research and enforce compliance with fishing regulations. Consequently, many regulatory acts remain merely declarative and fail to ensure the genuine protection and restoration of aquatic bioresources.

A significant element of the national strategy for the conservation of natural resources is the creation of protected areas, with a particular emphasis on the establishment of ichthyological reserves. The primary objectives of these measures are to protect critical habitats, facilitate spawning and juvenile growth, and contribute to the recovery of fish populations. Ukraine maintains a number of such reserves on the Dnipro, Danube, and Dniester rivers and in delta ecosystems, although their coverage remains insufficient. Furthermore, in numerous instances, the implementation of protective measures is deficient due to inadequate supervision and the pervasive nature of illegal fishing.

Notwithstanding the challenges encountered, there have been some positive developments in the integration of fisheries management with environmental policy. Ukraine is progressively aligning its legislative framework with the requirements of the European Union, where the protection of aquatic bioresources is embedded within the overall water management system. A significant step has been the country's accession to international conventions and programs aimed at protecting sturgeon species, controlling commercial fisheries, and developing aquaculture as an alternative source of fish products (*The Law of Ukraine "On Fisheries, Industrial Fishing and Protection of Aquatic Biological Resources" of 08.07.2011 No. 3677-VI*, 2011; Burhaz, Soborova & Matviienko, 2023).

For greater clarity, Tables 1 and 2 present a systematisation of the key problems and the instruments for addressing them (Burhaz & Matviienko, 2023).

The advancement of fisheries management in Ukraine is contingent upon the implementation of a comprehensive approach that integrates economic,

Table 1
Key problems of fisheries management in Ukraine

Problem	Cause	Consequences for bioresources
Overfishing	Excessive harvest of commercial species beyond reproductive capacity	Decline in abundance and degradation of populations
Poaching	Illegal fishing using prohibited gear and methods	Formation of a shadow market, stock depletion
Insufficient control	Limited funding, low efficiency of monitoring and enforcement	Non-compliance with rules and quotas
Spawning ground degradation	River regulation, pollution, development of riparian zones	Deterioration of natural reproduction conditions
Shadow market	Unregistered circulation of fish products	Reduced state revenues, increased corruption risks

Source: authors' own elaboration based on Burhaz & Matviienko (2023)

Table 2
Role of protected areas

Function	Examples of implementation in Ukraine	Limitations and problems
Conservation of spawning grounds	Ichthyological reserves on the Dnipro and Danube rivers	Insufficient area, fragmentation
Protection of juvenile fish	Conservation zones in river deltas	Violation of protective regime due to illegal fishing
Biodiversity restoration	Inclusion of fisheries sites in the Nature Reserve Fund (NRF)	Low level of integration with local fisheries
Ecological stabilisation	Preservation of wetlands of international importance (Ramsar sites)	Insufficient coordination with fisheries management programs

Source: authors' own elaboration based on The Law of Ukraine "On Fisheries, Industrial Fishing and Protection of Aquatic Biological Resources" of 08.07.2011 No. 3677-VI (2011) and Burhaz, Soborova & Matviienko (2023)

social, and ecological components. This includes the enhancement of monitoring and statistical accounting of catches; the augmentation of anti-poaching control through the utilisation of contemporary technologies (satellite monitoring, electronic reporting systems); the expansion of the network of ichthyological reserves; the development of restocking programmes based on artificial fish breeding; and the assurance of active participation of local communities in management processes.

The present state of fisheries management in Ukraine is thus characterised by a combination of significant challenges and gradual progress towards reform. Despite the limitations that exist, the integration of management mechanisms with environmental activities, the adaptation of European experience, and the development of innovative approaches to control and resource restoration may provide the foundation for the transition to sustainable use of aquatic bioresources in the near future.

3. International Experience and Integration Instruments

The international practice of integrating fisheries management and environmental protection has been demonstrated to encompass a wide range of instruments that combine ecological and socio-economic priorities. In the context of globalisation and increasing anthropogenic pressure on aquatic ecosystems, countries have developed comprehensive governance models that emphasise sustainable use of bioresources, biodiversity conservation, and the maintenance of social stability in coastal communities. A thorough analysis of the experiences of the European Union, Canada, Japan, and the Baltic region is presented, highlighting key directions for integrating economic and environmental objectives. These directions may serve as guidelines for improving Ukraine's model.

In the European Union, a coastal zone management system that is integrated has been established, combining a directive-based ecological approach with fisheries policy instruments. The legal foundations for the conservation of habitats and biodiversity are provided by the Marine Strategy Framework Directive (2008/56/EC) and the Habitats Directive (92/43/EEC), while the core tools for the rational use of bioresources remain quota mechanisms and catch control. The integration of conservation and economic goals in EU policies has promoted aquaculture as an alternative to traditional fishing methods, thereby alleviating the pressure on wild populations (Burhaz, Soborova & Matviienko, 2023).

In Canada, a fundamental aspect of its fisheries management is the decentralised governance model, which entrusts substantial authority to local communities and Indigenous populations. This has resulted in the establishment of a co-management model, whereby communities are not only granted access to resources, but also assume responsibility for their restoration and conservation. The integration of

economic interests and conservation obligations at the local level is reinforced by the combination of traditional knowledge with modern scientific methods, enhancing regulatory effectiveness and the social legitimacy of decisions.

Japan has adopted a dual approach, integrating the development of aquaculture with the expansion of marine protected areas. This balance ensures both economic benefits from the industrial cultivation of aquatic organisms and ecological objectives for the conservation of marine ecosystems. The contribution of marine reserves to the recovery of natural fish stocks is well-documented, as is the role of advanced aquaculture technologies in ensuring the stable production of salmonids, molluscs and seaweeds. Another factor that lends support to the integration of fishing co-operatives is their active involvement in the field, which combines business interests with ecological responsibility.

The Baltic states are an example of engineering–ecological integration. In areas with high densities of hydraulic structures that disrupt the migration of fish, fish passes are widely used to restore the ecological connectivity of river ecosystems. This is complemented by artificial restocking programmes aimed at compensating for losses in commercial fish populations. The Baltic model is characterised by its practical focus on technical solutions that offer economic and ecological value, and by the integration of these programmes into the EU's unified policy framework.

It is evident from international experience that the effectiveness of aquatic bioresource management is contingent on the integration of conservation measures with economic mechanisms. It is imperative to prioritise not only the conservation of biodiversity but also the economic viability of coastal regions and the active involvement of local communities in decision-making processes. For Ukraine, the most appropriate course of action would be to adopt the best international practices, ranging from the introduction of co-management mechanisms and aquaculture development to the application of engineering solutions for the restoration of fish resources in river basins that have been heavily impacted by anthropogenic pressures (Tables 3, 4).

Thus, international models demonstrate varying levels of integration, ranging from legal and administrative approaches (EU) to socio-community models (Canada), techno-ecological strategies (Japan) and engineering–restoration solutions (Baltic countries). For Ukraine, the value of these approaches lies in the potential to create a combined model where state regulation is complemented by local community participation and conservation measures are integrated with the development of modern aquaculture and technical restoration programmes.

At the same time, the practical implementation of such a combined model requires the adaptation of foreign experience, as well as the establishment of a holistic system of instruments integrating the ecological, social and economic dimensions of management.

Integrating fisheries management and environmental protection requires applying a set of tools that combine ecological, social and economic approaches. In the face of the current challenges posed by global climate change, the degradation of aquatic ecosystems and the growing demand for fish products, traditional management methods are proving inadequate. Therefore, innovative approaches that balance resource use and conservation are of key importance.

Table 3

Instruments of integrating fisheries management and environmental protection in different countries

Country	Key instruments	Integration effect
European Union	Quotas, directives, subsidies for aquaculture	Reduction of wild stock harvest, development of alternative economic activities
Canada	Community co-management, traditional knowledge	Combination of social responsibility and ecological efficiency
Japan	Marine protected areas, modern aquaculture	Recovery of fish stocks alongside the growth of aquaculture production
Baltic countries	Fish passes, artificial restocking	Mitigation of hydropower impacts and conservation of fish populations

Source: authors' own elaboration based on FAO (1995), The European Commission (2008), and international case studies

Table 4

Comparison of ecological and socio-economic outcomes of international practices

Country	Ecological outcome	Socio-economic outcome
European Union	Biodiversity conservation, catch control	Support for fisheries, stimulation of innovation
Canada	Recovery of local stocks	Development of coastal communities, preservation of cultural heritage
Japan	Expansion of protected areas	Growth of aquaculture product exports
Baltic countries	Restoration of natural fish migration	Stability of commercial fisheries

Source: authors' own elaboration based on FAO (2022) and OECD (2022)

The most promising instruments include protected aquatic areas, ecological fishing quotas, aquaculture development, the application of biotechnologies for resource monitoring and involving local communities in management processes.

Protected aquatic areas are a fundamental element of integrated management, ensuring the preservation of essential ecosystem functions in bodies of water. The effectiveness of marine and riverine protected areas worldwide has been demonstrated by the recovery of commercial fish populations, increased biodiversity and growth in fisheries productivity in adjacent areas. For Ukraine, key directions for action include the establishment of new and the expansion of existing ichthyological reserves, the integration of fishing grounds into the nature reserve fund, as well as the implementation of joint programmes under the Ramsar Convention.

A secondary instrument employed is that of ecological fishing quotas, which take into account the current state of fish populations and their innate reproductive capacity. In contradistinction to purely economic limits, which are oriented towards profit maximisation, ecological quotas are adaptive to seasonal and interannual fluctuations in fish abundance. The introduction of electronic reporting systems for industrial users is of particular importance, as it minimises the scope for manipulation and allows more effective planning of restocking measures.

Aquaculture is regarded as a strategic alternative to fishing in natural water bodies. The development of modern forms of freshwater and marine aquaculture has been demonstrated to reduce pressure on wild populations while ensuring food security and export potential. In Ukraine, this area is undergoing active development with regard to the cultivation of herbivorous species (white and grass carp, bighead carp), trout, and common carp, as well as mariculture. However, the attainment of stable results necessitates investments in innovative technologies, improvements in genetic stock, and enhanced water quality control systems.

The utilisation of biotechnologies engenders novel prospects for ecological monitoring. For instance, environmental DNA (eDNA) analysis facilitates the non-invasive detection of fish species and the assessment of their population sizes, thereby significantly mitigating the impact of anthropogenic activities on these populations. Remote sensing methodologies, encompassing satellite monitoring and automated sensor systems, facilitate the effective monitoring of aquatic conditions, pollution levels and illegal activities. These innovations are becoming pivotal tools for adaptive management under climate change.

It is equally important to involve local communities and fishers' associations in management processes. Experience from around the world shows that co-management enhances the effectiveness of fisheries measures, as those who use the resources become directly interested in conservation. Although examples of such integration remain limited in Ukraine, the development of community initiatives in the coastal areas of the Black and Azov Seas, as well as the Dnipro and Danube basins, illustrates the potential of this approach. Co-management tools increase transparency, reduce poaching and strike a balance between socio-economic interests and conservation priorities (see Tables 5 and 6).

Thus, integrated fisheries management is based on a combination of traditional and innovative approaches. Protected aquatic areas and ecological quotas form the basis of resource conservation; aquaculture reduces pressure on wild populations; biotechnologies provide advanced monitoring; and community involvement enhances the effectiveness of management decisions. Implementing these instruments comprehensively will bring Ukraine closer to achieving a sustainable model for the use of aquatic bioresources, a model that is already in place in many European and global countries.

Table 5
Instruments of integrating fisheries management and environmental protection

Instrument	Essence and role	Advantages	Challenges and limitations
Protected aquatic areas	Establishment of reserves and sanctuaries to conserve spawning grounds and habitats	Biodiversity restoration, increased fisheries productivity	Insufficient coverage, weak enforcement
Ecological quotas	Catch limits based on population status and ecological factors	Conservation of reproductive potential, adaptability	Need for scientific data, risk of manipulation
Aquaculture	Cultivation of fish under controlled conditions as an alternative to commercial fishing	Reduced pressure on wild stocks, food security	High investment costs, ecological risks
Biotechnologies (eDNA, monitoring)	Use of molecular and remote methods for resource assessment	Accuracy, non-invasiveness, timely data collection	Requirement for technological infrastructure, high costs
Community involvement	Co-management through associations and user organisations	Transparency, reduction of poaching, social support	Limited awareness, institutional barriers

Source: authors' own elaboration based on FAO (1995) and Burhaz & Matviienko (2023)

Table 6
Potential for applying integration instruments in Ukraine

Direction	Examples of implementation in Ukraine	Development prospects
Protected aquatic areas	Ichthyological reserves on the Dnipro and Danube	Expansion of the network, establishment of transboundary reserves
Ecological quotas	Quota regulation of commercial fishing in inland waters	Transition to electronic monitoring and reporting systems
Aquaculture	Trout farms in the Carpathians, herbivorous fish in central and southern regions	Introduction of recirculating aquaculture systems, mariculture development
Biotechnologies	Pilot projects on eDNA analysis in the Dniester basin	Large-scale application in state monitoring systems
Community involvement	Fishing co-operatives in the Danube Delta	Development of co-management institutions, integration with tourism

Source: authors' own elaboration based on Burhaz & Matviienko (2023) and The Law of Ukraine "On Fisheries, Industrial Fishing and Protection of Aquatic Biological Resources" of 08.07.2011 No. 3677-VI (2011)

4. Economic Aspects of Integrated Fisheries and Conservation Management

The integration of ecological and economic objectives within the fisheries sector exerts a direct economic effect, manifesting in the revenues of enterprises, the well-being of local communities, and the industry's overall competitiveness (Burhaz et al., 2021). The fundamental dimensions of such integration encompass the restoration of bioresources, the development of aquaculture, the reduction of shadow practices, and the utilisation of tourism and recreational potential.

A significant contributing factor is the conservation of bioresources through the establishment of protected aquatic areas and the introduction of ecological quotas. The experience of EU countries demonstrates that the recovery of populations in protected zones contributes to an increase in commercial catches in adjacent areas by 15–30%, which directly translates into higher revenues for fisheries enterprises. A comparable phenomenon has been documented in Canada, where five years following the establishment of marine reserves, there was an average 20–25% increase in catches, concomitant with a 15–18% rise in the incomes of local communities. The summary of the economic effects of integration is presented in Table 7 (Burhaz et al., 2021).

At the same time, the development of aquaculture is becoming a key strategy for diversifying the fisheries sector. Modern recirculating aquaculture systems (RAS) and mariculture offer the potential for stable production volumes with reduced ecological risk. According to the FAO, the economic return per hectare of modern aquaculture systems is 3–5 times higher than that of traditional pond farming (see Fig. 1).

For Ukraine, where the profitability of aquaculture averages around 1,200 USD per tonne compared to 700 USD per tonne in commercial fisheries, this opens a pathway to higher profitability and export potential. By way of comparison, in Norway the profitability per ton of salmon aquaculture exceeds 3,200 USD, resulting from substantial investments in technology and innovative practices.

A significant challenge for the Ukrainian sector remains poaching and the shadow market (Burhaz & Matviienko, 2023), the scale of which is estimated at 40–60% of official catch volumes. In 2022, the declared catch amounted to 37,000 tons with a value of approximately 2.6 billion UAH, while the real volume, including illegal fishing, reached 57,000–62,000 tons with a value exceeding 4 billion UAH (Figure 2). The budget shortfalls resulting from unpaid taxes amounted to approximately 250–300 million UAH per annum (see Figure 2).

Another promising factor is the development of recreational fishing tourism (Table 8) (Burhaz, Burhaz & Krotov, 2023). Globally, this sector generates multi-billion revenues: in the USA, for instance, the annual figure is in excess of 63 billion USD, whereas in Poland it is in excess of 2 billion USD. In Ukraine, where this segment remains almost undeveloped, the potential annual income could reach 0.3–0.4 billion USD, provided that investments in infrastructure and

Table 7
Economic effects of integrating fisheries management and environmental protection

Direction	Economic outcome	Examples
Protected aquatic areas	Catch stability, increased enterprise revenues	EU, Canada, Scandinavia
Ecological quotas	Market optimisation, reduced volatility risks	Canada, Baltic countries
Aquaculture	Added value, export potential	Norway, Japan
Combating poaching	Legalisation of revenues, growth of tax receipts	Ukraine (pilot projects)
Recreational fishing	Regional development, employment	USA, Poland

Source: authors' own elaboration based on FAO (2022) and Burhaz et al. (2021)

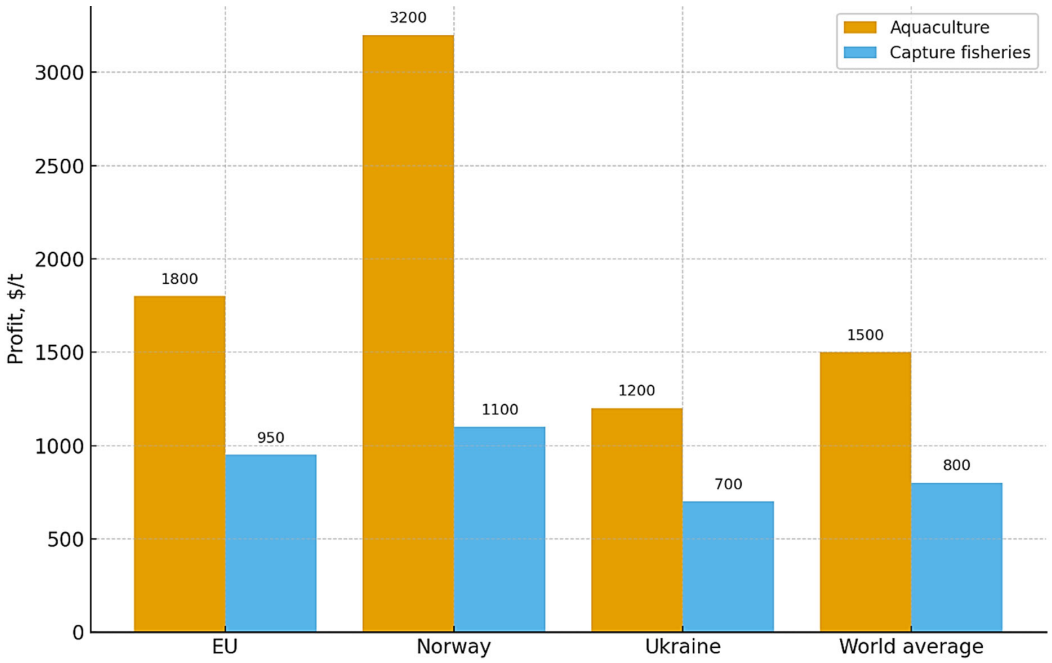

Figure 1. Comparison of profitability between aquaculture and commercial fishing

Source: authors' own elaboration based on FAO (2022) and OECD (2022)

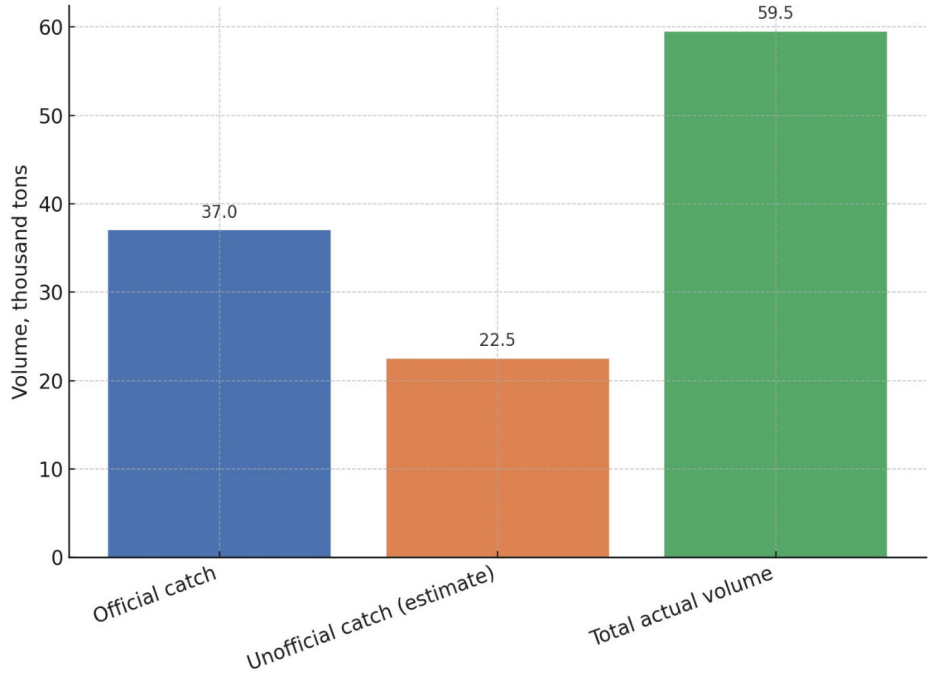

Figure 2. Official and unofficial fish catches in Ukraine (2022)

Source: authors' own elaboration based on Burhaz & Matviienko (2023) and data from the State Fisheries Agency of Ukraine

modern tourist services are made. The multiplier effect is also of significance: every dollar spent by an angler generates approximately another 0.8 billion USD in related sectors, including but not limited to hospitality, transport, food, and services.

Summarised data indicates that fisheries contribute about 0.3% to Ukraine's GDP, compared to 2.5% in Norway, over 1% in Japan and 0.6–0.8% in the Baltic countries. Meanwhile, only 6,000–7,000 people are officially employed in the sector, representing a fraction

Table 8
Revenues from recreational fishing tourism (2021)

Country	Number of angler-tourists (million)	Average income per tourist, USD	Total revenues, billion USD
USA	35	1,800	63
Poland	2.2	950	2.1
Ukraine (est.)	0.5–0.7	600	0.3–0.4

Source: authors' own elaboration based on Burhaz, Burhaz & Krotov (2023) and OECD (2022).

of the number employed in developed fishing nations. This highlights the sector's significant development potential, which could be realised by integrating conservation and economic approaches.

Thus, integrating environmental and economic approaches to fisheries creates conditions conducive to sustainable economic growth, income diversification, and enhanced competitiveness. For Ukraine, this creates opportunities to improve the efficiency of the fisheries sector, attract investment, reduce the shadow economy and strengthen its position in the international market (Burhaz & Matviienko, 2023).

5. Discussion

Discussions on fisheries management in Ukraine reveal a complex balance between the need to conserve biological resources and socio-economic challenges. The analysis confirms that the national model is in a state of transformation, simultaneously exhibiting strengths and weaknesses compared to international practices.

Ukraine has considerable natural potential for developing fisheries, as its inland waters and the Black Sea and Sea of Azov provide a rich resource base. Traditions of commercial fishing have long been established here, and aquaculture has begun to develop more actively in recent decades. Conversely, the Ukrainian model's weaknesses include the ineffectiveness of control, a fragmented legal framework, and the absence of stable co-management mechanisms with local communities. Table 9 presents a comparison of the Ukrainian management model with international practices.

The role of nature reserves in ensuring sustainable fisheries is of pivotal importance. The experience of the European Union and Scandinavian countries demonstrates that the establishment of marine protected areas and ichthyological reserves not only preserves biodiversity but also increases fish productivity in adjacent areas. In Ukraine, there are a number of such areas, but their size and protection regime remain insufficient, thus limiting their impact.

Particular attention should be given to the potential for introducing innovative monitoring methods. The use of eDNA technologies, remote sensing, automated sensors and satellite control allows for the systematic monitoring of aquatic ecosystems and populations, while minimising interference with natural processes. These methods have been shown to be effective in the early detection of invasive species, the assessment of fish populations, and the control of poaching activities, as demonstrated by global practice.

At the same time, significant barriers exist to integrating fisheries management with conservation activities. The main barriers are the imperfect legal framework, lack of funding and weak control (see Table 10).

In this particular context, proposals for Ukraine should be based on the adaptation of the best European practices and the development of partnerships between state institutions, researchers, and local communities. A necessary step is the creation of a unified system for the management of aquatic bioresources that combines economic, ecological, and social aspects.

The discussion thus confirms that the Ukrainian model of fisheries management requires deep

Table 9
Comparison of the Ukrainian management model with international practices

Criterion	Ukraine	International experience (EU, Scandinavia, Canada)
Legal framework	Fragmented, contradictory	Integrated, harmonised, linked to ecological directives
Control and supervision	Limited resources, weak effectiveness	Systematic control, electronic monitoring, satellite tracking
Community involvement	Episodic, voluntary	Institutionalised co-management, fishing associations
Protected areas	Low coverage, weak protection regime	Extensive network of marine and river reserves
Aquaculture	Limited development, technological barriers	High-tech, innovative, market-integrated
Use of innovations (eDNA, IT)	Isolated projects	Widespread implementation in monitoring and forecasting systems

Source: authors' own elaboration based on The European Commission (2000), FAO (2022), and Burhaz & Matviienko (2023)

Table 10
Barriers and opportunities for integrating fisheries management and conservation in Ukraine

Barriers	Opportunities
Imperfect and contradictory legislation	Harmonisation with European law and EU directives
Insufficient funding for monitoring and control	Attraction of international grants, development of public–private partnerships
Weak control and high shadow market in fisheries	Introduction of digital catch tracking tools (electronic quotas, registries)
Lack of systematic community involvement	Establishment of fishing associations, co-management mechanisms
Limited use of innovative technologies	Scaling of eDNA methods, remote monitoring, satellite systems

Source: authors' own elaboration based on Burhaz & Matviienko (2023) and The Law of Ukraine "On Fisheries, Industrial Fishing and Protection of Aquatic Biological Resources" of 08.07.2011 No. 3677-VI (2011).

modernisation with a focus on ecological sustainability and integration with conservation approaches. The utilisation of international experience, the implementation of innovative monitoring methods, and the development of partnerships among all stakeholders can establish the prerequisites for the transition to an effective model of sustainable use of aquatic bioresources.

6. Conclusions

The integration of fisheries management with conservation activities is considered to be one of the most promising pathways towards achieving the sustainable use of aquatic bioresources at both global and national levels. The study confirms that effective coordination between economic and ecological objectives is key to ensuring biodiversity preservation and the restoration of aquatic productivity. Furthermore, it is demonstrated that such coordination can also provide socio-economic benefits for communities and the fisheries sector. Experience from around the world shows that countries that have combined conservation measures with fisheries management in a timely manner have gained significant ecological and economic advantages.

Ukraine has considerable potential for implementing such an integrative model. Firstly, the country's geographical location and climate provide a solid foundation for developing both commercial fisheries and aquaculture, enabling the optimisation of bioresource utilisation. Secondly, the process of European integration provides access to EU practices that can be adapted to Ukrainian circumstances. These include implementing integrated water resource management, introducing ecological catch quotas, using modern monitoring methods and involving local communities in co-management. Thirdly, society and the expert community are increasingly aware of the need to shift from the purely economic exploitation of water bodies to a model that combines profitability with environmental responsibility.

The proposed integration mechanisms provide opportunities for achieving long-term ecological and economic stability. Protected areas and ichthyological reserves ensure the reproduction of natural populations, forming the basis for maintaining ecosystem resilience. Ecological quotas help to control fishing pressure and prevent overexploitation. Aquaculture provides an alternative source of fish products, thereby reducing pressure on natural resources. Modern biotechnologies, such as environmental DNA (eDNA) analysis, satellite monitoring and sensor systems, create opportunities for more accurate and timely management.

It is important to emphasise that the sustainable development of Ukraine's fisheries sector is impossible without a comprehensive state strategy that balances economic interests with ecological requirements. This requires strengthening the role of state institutions and fostering partnerships with communities, businesses and scientists. Only a co-management model of this kind can ensure the effectiveness of integration mechanisms.

Moreover, international co-operation is of critical importance for Ukraine. The transboundary nature of aquatic ecosystems, particularly the basins of the Danube, the Dniester and the Black Sea, makes collaboration with neighbouring countries essential for achieving sustainable outcomes. Joint monitoring programmes, harmonised rules for the use of resources, and coordinated conservation measures will help to prevent conflicts of interest and enhance the effectiveness of management.

In summary, the integration of fisheries management with conservation activities is pivotal to the preservation of biodiversity and the sustainable utilisation of aquatic resources. Ukraine has the potential to successfully combine economic benefits with ecosystem protection through the adaptation of international experience. The proposed mechanisms, ranging from the expansion of protected areas to the utilisation of contemporary biotechnologies, have the potential to ensure long-term ecological and economic stability. In the future, it is anticipated that this will engender conditions conducive not only to the conservation of natural resources but also to the enhancement of the competitiveness of the Ukrainian fisheries sector in the global market.

Despite the extensive scope of this study, several limitations must be acknowledged. The estimation of the shadow fish market in Ukraine remains highly

uncertain due to the absence of transparent statistics and reliable monitoring, which makes it difficult to assess the real scale of illegal catches. Similarly, the evaluation of revenues from recreational fishing tourism is based mainly on projections and international comparisons, and therefore reflects potential rather than verified results. In addition, profitability assessments of aquaculture are limited by fragmented official data and restricted access to financial information at enterprise level. Future research should therefore prioritise the development of transparent monitoring systems for both legal and illegal catches, empirical surveys of recreational fishing and more detailed economic modelling supported by primary statistical information.

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