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Study on Primary Fish Species in Lake Ogii: Catch-Related Injuries and Hygiene Practices

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Abstract

Mongolia's rivers and lakes host over 70 fish species, with approximately 30 species harvested for human consumption. The annual fishing season typically spans 180 days, yielding an estimated 600 tons of fish annually. Fishing in Ogii Lake, Arkhangai Province, began in 1938; however, recent years have seen a cessation of regulated fishing, alongside a rise in large-scale illegal fishing, particularly during winter and spawning periods. Climate change has further impacted aquatic ecosystems by altering water regimes, increasing pollution, degrading habitats, and disrupting fish reproductive cycles, resulting in ecological imbalance.

This study collected fish samples over three years at seasonal intervals from two to three subsistence fishing households on Ogii Lake. The species composition identified included Perch (*Perca fluviatilis*), Ide (*Leuciscus idus*), Roach (*Rutilus rutilus*), and Northern Pike (*Esox lucius*). A total of 1,567 fish from these four species were caught using control nets, with sensory and laboratory analyses conducted in 3–5 replicates. The findings highlight the urgent need for standardized protocols in fishing, transport, processing, and storage to promote fishery sustainability and product quality.

Keywords: Standards, gill nets, fish species composition

Introduction

Fishing in Mongolia has a documented history dating back to 1926. During the 1950s, the country reported an average annual fish catch of approximately 630 tons, primarily serving both domestic consumption and international markets [1]. According to a study by Y. Tsend-Ayush and G. Baasanjav (2001), Buir Lake contributed the largest share of the national fish harvest, accounting for 58.6% of the total catch, followed by White Lake (30.1%) and Ogii Lake (11.3%) [2]. Between 1955 and 1989, Ogii Lake was a consistent supplier of fish to the Ulaanbaatar Meat Combine, providing essential raw materials for processing [3]. Historical records indicate that fish harvests from Ogii Lake varied across decades: 31.9 tons between 1955‑1960, 90.4 tons from 1961‑1965, 32.6 tons from 1966‑1970, 24.2 tons from 1971‑1975, and approximately 30 tons between 1976‑1980 [4]. A noticeable decrease in catch volume was recorded after 1981 [2], [5]. Early research by Y. Tsend-Ayush (1968) highlighted seasonal fishing patterns, reporting that nearly 90% of the annual fish harvest occurred during the months of May and June, with the remaining 10% taking place in October. The species composition of the catch was dominated by Roach (*Rutilus rutilus*, 52.9%), followed by Perch (*Perca fluviatilis*, 22.9%) and Northern Pike (*Esox lucius*, 22.4%) [2]. However, in recent decades, populations of these key species have shown a steady decline, likely due to overfishing, habitat degradation, and climatic factors [6], [7].

Materials and Methods

This study aimed to evaluate the physical injuries sustained by fish during harvesting and to analyze the relationship between fishing tools, harvest timing, and the extent of damage. Both sensory evaluations and laboratory analyses were employed to assess the quality and hygienic status of fish harvested from Ogii Lake. Field experiments were carried out in 12 sessions over a total duration of 203 days during the years 2018, 2019, and 2022. The fishing activities followed guidelines outlined in MNS 5974:2009, which specifies the standard for gill net mesh size. Two control groups were established using gill nets with a 50×50 mm mesh. Fish were caught at 30 sampling points across various depths within the lake. To investigate the effect of fishing duration on fish quality and injury, the first control group had nets inspected every two hours, while the second group's nets were checked at 24 to 36-hour intervals. A total of 1,567 fish specimens were subjected to comparative analysis of physical injuries and hygienic quality. Assessments were performed following the MNS 5170:2002 standard, which covers methods for sensory and microbiological evaluation of raw fish and fish products. These combined assessments provided insights into how gear usage and retrieval timing affect post-catch fish condition and product quality.

Results

Relationship Between Age and Body Weight of Fish

In the fishery of Ogii Lake, Perch (*Perca fluviatilis*) and Roach (*Rutilus rutilus*) emerged as the most frequently caught species throughout the year. The Perch population was stratified into nine age groups, ranging from 1+ to 9+, exhibiting significant variability in size. Individual lengths spanned from 102.58 ± 2.3 mm in younger fish to 492.19 ± 1.6 mm in older specimens, while body weights ranged from 103.78 ± 0.34 g up to 741.07 ± 0.56 g.

Roach were similarly categorized into eight age groups (2+ to 9+), with lengths between 195.58 ± 2.3 mm and 318.31 ± 0.15 mm, and weights from 97 ± 3.1 g to 718.25 ± 0.07 g (Figure 1). These data confirm a clear positive correlation between age and body weight in both species, indicative of healthy growth patterns in the lake's ecosystem.

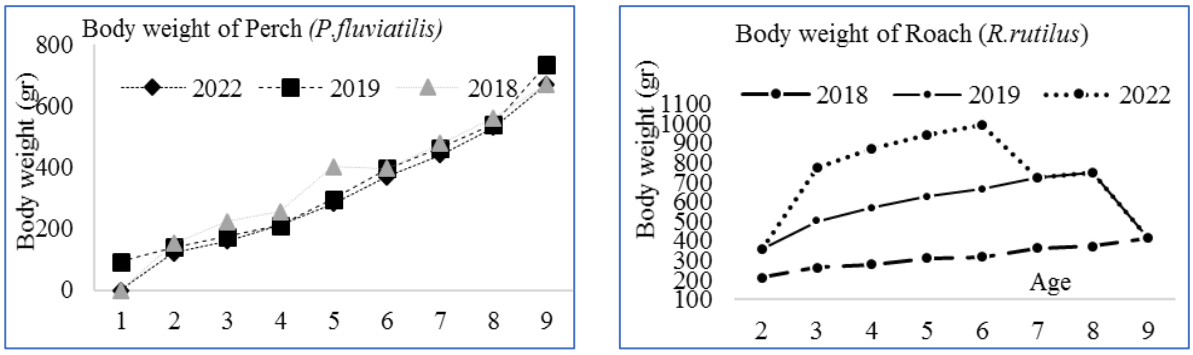


Figure 1. Body size of Perch and Roach fish

Seasonal Distribution and Species Composition

Seasonal sampling, conducted in compliance with MNS 5974:2009 and ISO 1107:2003 standards, revealed the relative abundance and distribution of species caught using control nets (Figure 2). The catch was dominated by Roach, accounting for over half the total catch (58.33%, n = 914), highlighting its prevalence in the lake ecosystem. Ide comprised 18.71% (n = 293), followed by Perch at 13.52% (n = 211), and Pike (*Esox lucius*) at 9.42% (n = 147). The dominance of Roach suggests it is a key species in the lake's food web and fisheries management should consider its ecological importance.

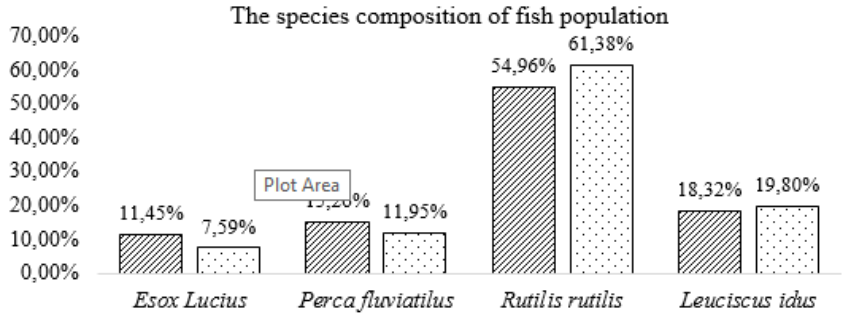


Figure 2. Composition and percentage of fish species caught in control nets. Lined columns represent catches from Gill Net 1; dotted columns represent catches from Gill Net 2.

Sensory Evaluation of Fish Condition and Injury

To complement quantitative catch data, a detailed sensory evaluation was performed on fish collected via gill nets, assessing physical and freshness indicators. Parameters such as scale integrity, fatness, abdominal condition, clarity of eyes and gills, mucus transparency, and fin injuries were systematically recorded. These criteria provide rapid and practical insights into fish quality and handling impacts.

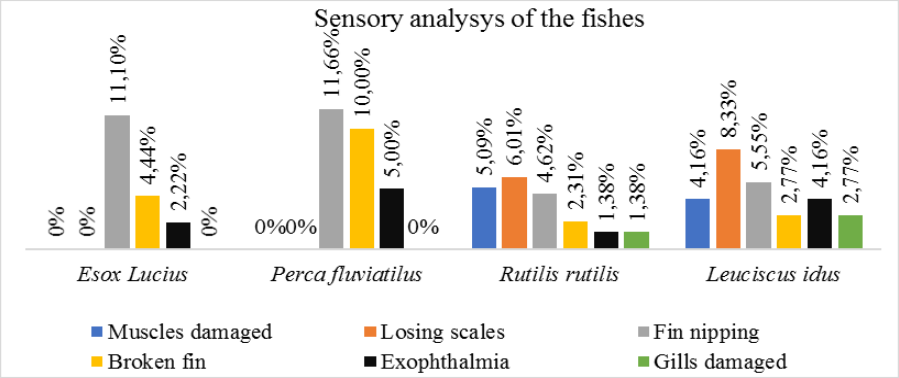


Figure 3. Injuries of fish caught in the first control net, by percentage

First Control Net in Figure 3:

Injuries were relatively moderate: Pike showed fin breakage (11.10%), fin injuries (4.44%), and eye injuries (2.22%). Perch displayed similar fin damage (11.66% breakage; 10.00% injury) and eye injuries (5.00%). Roach exhibited muscle dissection (5.09%), scale loss (6.01%), fin breakage (4.62%), and minor gill damage (1.38%). Ide suffered muscle damage (4.16%), scale loss (8.33%), and fin injuries (5.55%).

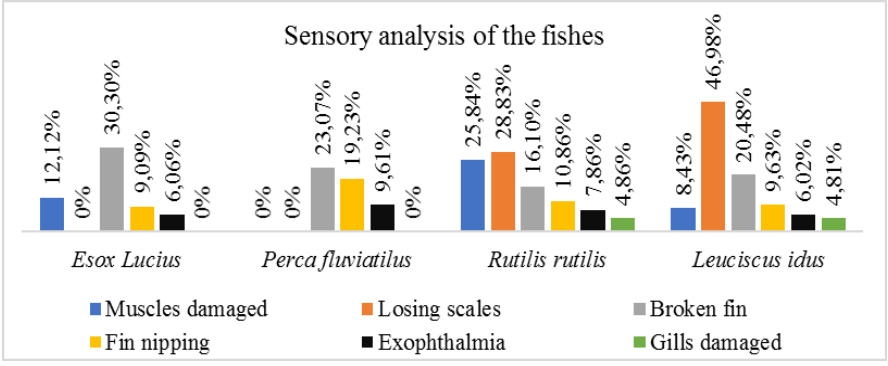


Figure 4. Injuries of fish caught in the second control net, by percentage

Second Control Net in Figure 4: Injury rates were notably higher, likely due to longer net exposure or handling differences. Pike suffered substantial fin ruptures (30.30%) and muscle dismemberment (12.12%). Perch fin ruptures and fractures totaled over 40%, with eye injuries at nearly 10%. Roach injuries escalated to muscle disintegration (25.84%) and extensive scale loss (28.83%), while Ide displayed almost 47% scale loss and significant fin damage (20.48% breakage). These findings highlight increased mechanical stress or predation risk during later netting periods. In Fig. 5 visually document these injuries, underscoring the impact of fishing methods on fish condition.

A. Removing fish from the gill net B. Fin rupture injury C. Scale injury

Figure 5. Visually documentation of fish injuries

Laboratory Analyses Confirming Sensory Assessments

Laboratory tests on 40 fish samples further validated sensory observations. Peroxidase activity, pH levels, reductase test times, and bacterioscopic examinations provided objective measures of freshness and microbial contamination.

Table 1

Comparative Results of Sensory and Laboratory Tests for Perch *(P. fluviatilis)* and Pike *(E. lucius)*

Name of the fish	Sensory test indicators	Laboratory Tests			
		Peroxidase (Colour change time, min)	Bacterioscope (number of rods and cocci)	Reductase (Decolorization time, min)	p H
Perch fish	Fresh	1-2 min	10-17 (abdominal scales)	300	6.7
	Less fresh	3-4 min	30-40 (dorsal fin)	110	6.9
	Spoiled	Color not changed	90-100 (anus)	40	7.21
Common Pike	Fresh	1-2 min	15-20 (abdominal scales)	420	6.8
	Less fresh	3-4 min	30-50 (back row)	113	6.98
	Spoiled	Color not changed	100-130 (anus)	37	7.2

Fresh specimens showed rapid peroxidase color change (1‑2 minutes), moderate bacterial presence (10‑20 rods/cocci), reductase decolorization within 300‑420 seconds, and pH values around 6.7‑6.8. Less fresh and spoiled fish displayed delayed or absent peroxidase reactions, increased bacterial counts, longer reductase times, and higher pH values (up to 7.21), consistent with spoilage processes. The sensory parameters for Pike *(E. lucius)* and Perch *(P. fluviatilis)* closely aligned with the laboratory test results. For instance, Pike *(E. lucius),* which was identified as fresh based on sensory evaluation, showed the presence of 15-20 bacilli in the abdominal meat during bacterioscopic examination, with a pH value of 6.8. The reductase test confirmed that it was indeed fresh.

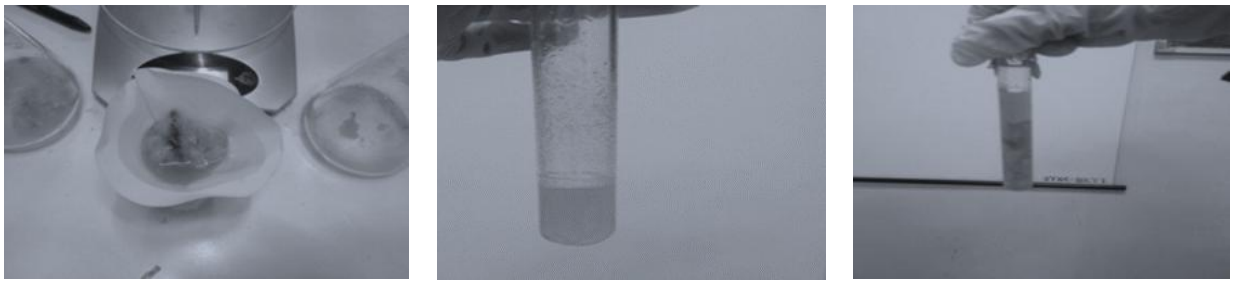
Table 2.
Comparative Results of Sensory and Laboratory Tests for Roach *(R. rutilus)* and Ide *(L. Idus)*

Name of the fish	Sensory test indicators	Laboratory Tests			
		Peroxidase (Colour change time, min)	Bacterioscope (number of rods and cocci)	Reductase (Decolorization time, min)	p H
Ide (L. Idus)	Fresh	1-2 min	10-17 (abdominal scales)	Not discolored	6.5
	Less fresh	3-4 min	35-40 (dorsal fin)	175	6.98
	Spoiled	Color not changed	130-160 (anus)	31	7.26
Roach (R. rutilus)	Fresh	1-2 min	18-20 (abdominal scales)	650	6.6
	Less fresh	3-4 min	38-50 (back row)	138	7.0
	Spoiled	Color not changed	120-130 (anus)	28	7.34

Results followed similar trends, with fresh fish exhibiting strong enzymatic activity, low bacterial loads, and optimal pH (~6.5‑6.6). Spoiled samples showed no peroxidase reaction, bacterial loads exceeding 130 rods/cocci, and elevated pH (up to 7.34), confirming sensory evaluation results.

These analyses not only corroborate the sensory findings but also demonstrate the reliability of combined approaches in assessing fish quality.

The sensory analysis results for Ide (*Leuciscus idus*) and Roach (*Rutilus rutilus*) were further validated by laboratory testing. For instance, in the meat near the excretory pore of Ide, which was classified as aged based on sensory evaluation, approximately 130‑160 bacilli were detected. The pH was measured at 7.26, and no color change occurred during the peroxidase reaction−both indicators consistent with spoilage. These laboratory findings confirmed the sensory assessments for both Ide and Roach.



A. Preparation of fish meat samples

B. Indicator of old fish treated with peroxidase reaction

C. Results of the reductase test of old fish

Figure 6. Laboratory Procedures and Indicators Used to Assess Fish Freshness and Spoilage

In Mongolia, research focused on determining the quality and hygiene parameters of fish and fish products-especially regarding injuries and hygiene during fishing−is extremely limited. This study represents one of the first efforts in this area. Despite the production and sale of approximately 400-450 tons of fish annually in the country, a lack of technology for proper storage, transportation, and processing has led to the selling of fish products at lower prices in the market.

Discussion

The global consumption of seafood, particularly wild-caught freshwater fish, has been steadily increasing in recent decades. This trend underscores the critical need to monitor, conserve, and sustainably manage fish populations in lakes and rivers, especially in ecologically sensitive and economically important areas such as Ogii Lake. While many studies in Mongolia have addressed aspects of fish taxonomy, distribution, and general biology, very few have investigated the quality and hygiene of fish products or assessed the implications of fishing practices on food safety.

This study contributes to filling that gap by providing a comprehensive assessment of both biological and post-harvest quality indicators.

Historical comparisons reveal a shift in the species composition of the fish community. For example, Y. Tsend-Ayush (1974) reported that Perch (*Perca fluviatilis*) made up 22.3% of total catches in Ogii Lake. However, in the current study, Perch accounted for only 13.52%, suggesting a possible population decline. This may be attributed to increased fishing pressure, environmental changes, or interspecies competition. In contrast, Roach (*Rutilus rutilus*) constituted 52.9% of the total catch in the 1960s and 1970s, while our findings show a modest increase to 58.33%, indicating that Roach may be expanding its ecological niche or benefiting from altered habitat conditions.

The duration of gill net exposure plays a key role in determining fish quality and injury rates. Several Mongolian researchers, including D. Ayuurzana, B. Enkhjargal [12], and D. Puntsagnorov [13], have suggested that the optimal gill net fishing duration is 2‑3 hours to preserve freshness. Our field studies conducted in 2018, 2019, and 2022 indicate that a slightly longer exposure time of 2‑5 hours may also be effective in maintaining fish freshness, provided that fish are promptly removed and properly handled. Similar conclusions have been drawn in international research, which emphasizes that the duration and method of capture directly influence post-harvest quality by affecting stress levels, enzyme activity, and microbial growth [14], [15].

Sensory evaluation and laboratory analyses in this study revealed varying degrees of freshness, injury, and spoilage among species, which were strongly influenced by net exposure duration and handling practices. For instance, the occurrence of muscle damage, fin rupture, and scale loss increased significantly in fish from the second control net compared to those from the first. Laboratory parameters such as peroxidase reaction time, pH level, and bacterial load further validated these findings. Similar methodologies are used globally to determine freshness and microbial safety in fish, with indicators like delayed peroxidase reaction and elevated pH (above 7.0) being consistent markers of spoilage [16], [17].

Food safety is a growing concern in developing fish markets, including Mongolia, where cold-chain infrastructure and handling protocols are limited. Studies in other countries have shown that microbial contamination and loss of freshness are common in poorly handled fish products [18], [19]. Our findings suggest that the implementation of basic post-harvest hygiene practices such as immediate net removal, proper washing, and cold storage could substantially improve the quality and safety of fish sold in local markets. This is particularly important considering that Mongolia produces and sells approximately 400‑450 tons of fish annually, yet lacks standardized quality control measures.

Moreover, consumer perception is influenced not only by taste and appearance but also by visible indicators of freshness such as clear eyes, intact scales, and red gills. Previous research from East Asia and Europe shows that consumers tend to avoid purchasing fish that appear damaged or aged, even if the species is desirable or the price is low [20], [21]. Promoting awareness of such quality markers among both vendors and consumers can help build trust in the domestic fish supply and reduce waste due to unsold or rejected products.

This study represents one of the first integrated efforts in Mongolia to assess the intersection of fish biology, post-catch handling, and product hygiene using a multidisciplinary approach. It provides not only a snapshot of current conditions but also practical insights for improving fish quality, reducing post-harvest losses, and ensuring consumer safety. Given the growing reliance on inland fisheries for food security and livelihoods, these findings support the urgent need for investments in sustainable fishing practices, training for fishers, and basic cold-chain technologies. Future research should explore site-specific contamination risks, assess heavy metal and parasite loads, and develop localized guidelines for fish quality monitoring and certification.

Conclusion

This study provides a comprehensive assessment of fish species composition, quality, and handling practices in Ogii Lake. Roach (*Rutilus rutilus*) dominated the catch at 58%, followed by Perch (*Perca fluviatilis*, 13%), Common Pike (*Esox lucius*, 9.5%), and Bull Crucian Carp (*Leuciscus idus*, 9%). Gill nets set according to MNS 5974:2009 and checked every 2–5 hours yielded 32% completely fresh fish and 68% less fresh specimens; however, nets left in the water for 24–36 hours produced 71.5% non-fresh and 28.5% spoiled fish.

Sensory evaluations of 40 representative samples aligned closely with laboratory measures of pH, peroxidase activity, and bacterial load, confirming that net exposure time directly affects product quality. Analysis of injury sources showed that 67% of damage occurred during net removal, 21% during packaging, and 12% during transportation, with prolonged net deployment (>24 hours) identified as the principal driver of market-level injuries. These findings underscore the importance of adhering to optimized net-setting durations, prompt fish handling, and proper post-catch procedures to maintain freshness, reduce spoilage, and enhance the overall quality and market value of freshwater fish products.

Conflict of interest

The authors declare that there is no conflict of interest.

Authors' Contributions

Tumurtogtokh. E served as a consultant and reviewer for both field and laboratory research methodologies, as well as for the design and writing of the research findings.

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