International Journal of Ecosystems and Ecology Science (IJEES) **Vol. 15 (1):** 133-138 (2025)
https://doi.org/10.31407/ijees https://doi.org/10.31407/ijees15.1

MODELING STOCK DYNAMICS AND PRODUCTION OF BLEAK (*ALBURNUS SCORANZA*) IN LAKE SHKODRA

Valbona Kolaneci[1*], Shkëlqim Sinanaj[2], Marsida Bllaca[1]

[1*]*Agricultural University of Tirana, Faculty of Agriculture and Environment, Department of Aquaculture and Fisheries, Tirana, Albania;*
[2]*University "Ismail Qemali" of Vlora, Faculty of Technical and Natural Sciences, Department of Marine Sciences, Vlora, Albania;*

[*]Corresponding Author Valbona Kolaneci, email: vkolaneci@ubt.edu.al;

Received December 2024; Accepted January 2025; Published February 2025;

DOI: https://doi.org/10.31407/ijees15.115

ABSTRACT

Lake Shkodra's small-scale fisheries play a vital role in supporting the local economy and preserving cultural traditions. According to national fisheries statistics, Albania's inland fisheries production in 2023 reached 4,858 tons, representing 25.12% of the country's total fisheries output, including aquaculture. Over the past 15 years, annual fish production in the Albanian section of the lake has varied from 500 to 900 tons. The composition of fish catches and the relative contribution of specific species to the total yield fluctuate annually, influenced by stock dynamics and the economic priorities of local fishers. The primary fish species targeted by traditional fishery in Lake Shkodra include common carp, Prussian carp, Scoranza bleak, chub, roaches, Albanian rudd, and common nase. Additionally, migratory species such as twaite shad, European eel, mullets, and European flounder are also significant to the fishery. This study aimed to assess the status of the Scoranza bleak (*Alburnus scoranza* Henkel & Kner, 1857) stock in Lake Shkodra and forecast its future production. The findings provide critical insights for developing more effective management measures to ensure the sustainable exploitation and regeneration of the stock. The status of the bleak stock was assessed using length-structured Virtual Population Analysis (VPA), while yield predictions were based on relative yield-per-recruit (Y'/R) models. The population experiences high natural mortality rates for individuals up to 13 cm in length. Additionally, high fishing mortality rates (1.0–1.2 yr^{-1}) are observed in cohorts with a total length of 12.5–16.5 cm. For the current level of E = 0.67 yr^{-1}, the relative yield-per-recruit (Y'/R) was estimated at 0.035. Under three exploitation scenarios (E_{max}, $E_{0.1}$, and $E_{0.5}$) the relative yield-per-recruit was calculated as 0.775, 0.671, and 0.367 respectively. At the current exploitation rate, which exceeds 0.367 $year^{-1}$, the spawning biomass per recruit will continue to decline, potentially compromising the population's ability to recover and sustain itself.

Keywords: Scoranza bleak, Shkodra Lake, VPA.

INTRODUCTION

Cypriniform fishes constitute 48% of the total fish species in Lake Shkodra/Skadar (Dhora, 2004) and are among the most heavily fished species of the lake. Scoranza bleak (*Alburnus scoranza* Henkel & Kner, 1857) is one of the most intensively exploited species in the small-scale fisheries operating along both sides of the lake's border, shared by Albania and Montenegro. Following the 1990s, data on fish catches and catch composition in Lake Shkodra became scarce, incomplete, or unreliable. According to national fisheries statistics, Albania's inland fisheries production in 2023 totaled 4,858 tons, accounting for 25.12% of the country's overall fisheries output, including aquaculture (INSTAT Fisheries, 2023). Over the past 15 years, Lake Shkodra's annual fish production has ranged between 500 and 900 tons. The catch composition and the relative contribution of specific species to the total yield fluctuate annually, influenced by stock dynamics and the economic priorities of local fishers. The main fish species targeted by traditional fishery in Lake Shkodra include common carp (*Cyprinus carpio*), Prussian carp *(Carassius gibelio)*, Scoranza bleak *(Alburnus scoranza)*, chub *(Squalius cephalus*), roaches (*Leucos basac*, *Pachychilon pictum)*, Albanian rudd (*Scardinius knezevici)*, European perch *(Perka fluviatilis)* and common nase (*Chondrostroma nasus*). Additionally, migratory species such as twaite shad (*Alosa falax*), European eel (*Anguilla anguilla*), mullets (*Mugil cephalus, Chelon ramada)* and European flounder (*Platichthys flesus*) are also significant to the fishery. The considerable fluctuations in bleak catches over the past decade are likely attributed to pollution, habitat degradation and flooding within the Drin River Basin and Lake Shkodra. The floods, which increase water levels in nursery areas, may have negatively impacted bleak eggs, larvae, and juveniles. This disruption is evident in reduced catches in subsequent years, reflecting a decline in the abundance of the adult population. Although there have been fluctuations in bleak catches over the years, it remains one of the important fishery targeted species in Lake Shkodra. Scoranza bleak (*Alburnus scoranza*) was most recently assessed for the IUCN Red List of Threatened Species in 2023, where it is categorized as "Near Threatened". The bleak (*Alburnus scoranza*) spawns in the shallow areas near the shore of Lake Shkodra from late April to June (Rakaj, 1995). To preserve the bleak stock in the Lake, the fishery for the species in the Albanian part of the Lake is banned from early April to the end of July, as per the annual regulation issued by the Ministry of Agriculture and Rural Development.

While studies on the morphological and morphometric characteristics of Scoranza bleak (*Alburnus scoranza*) have been conducted (Rakaj, 1995; Dhora, 2004; Kottelat and Freyhof, 2007; Milosević and Mrdak, 2016; Bogutskaya & Ahnelt, 2019), research focusing on its population dynamics and stock assessments in Lake Shkodra remains limited. The studies of Memia (1987), Dervishi et al. (2017) and Marić and Burzanović (2021) provide insights into the bleak population in Lake Shkodra. The studies examined the length-weight relationship and growth parameters of the Scoranza bleak in Lake Shkodra, contributing to the understanding of its population dynamics.

The need to assess the status of fishery resources stems from the "Agriculture, Rural Development, and Fisheries Strategy (2021–2027)", which emphasizes the creation of an efficient data collection system to evaluate the status of fish stocks and ensure their sustainable management. Additionally, several documents and agreements between Albania and Montenegro underscore ongoing efforts for the conservation and sustainable management of fish resources in Lake Shkodra. These include the Strategic Action Plan for Lake Shkodra (2007), the Lake Skadar/Shkodra Integrated Ecosystem Management Project (2008), the Management Plan for Skadar Lake National Park (2016–2020), and the Management Plan for Lake Shkodra Nature Park (2012–2021).

After a prolonged period of overfishing and ineffective fishery management, assessing the bleak stock provides critical data to support fishery managers in developing management plans aimed at ensuring the conservation, regeneration, and sustainable use of the resource. This study aims to evaluate the status of the bleak stock in Lake Shkodra and forecast its future production, providing a basis for sustainable exploitation and the recovery of this vital fishery resource.

MATERIAL AND METHODS

The population dynamics of the bleak (*Alburnus scoranza*) were assessed using length-frequency analysis. Fish samples were obtained from the catches of local small-scale fishery, following the methodology adapted from Sparre and Venema (1998). Sampling was conducted at the primary landing sites: Shiroka, Zogaj, and four locations within the Koplik area, situated along the Albanian stretch of the lakeshore (Figure 1).

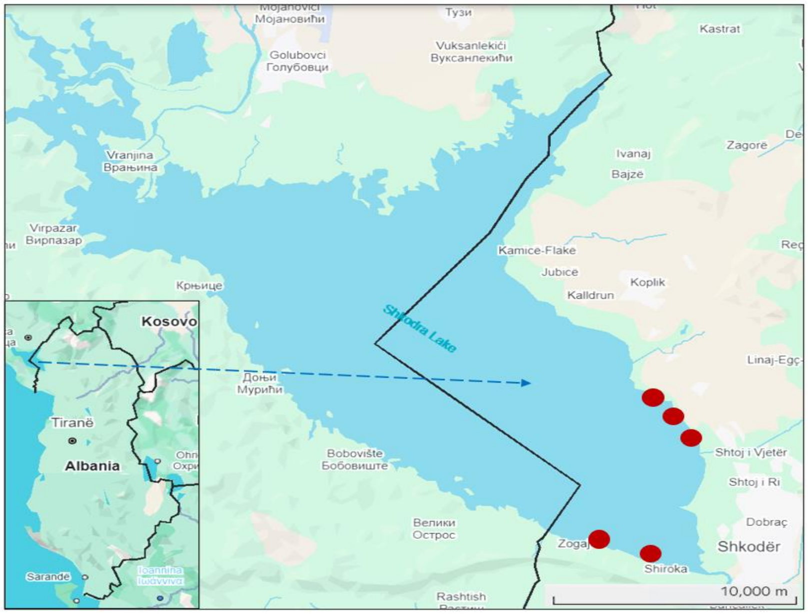

Figure 1. Fishing boat landing sites at Lake Shkodra, where sampling was conducted, are indicated by red dots.

During a year period a total of 420 specimens were collected on a monthly basis. The total length (TL, cm) of sampled fish was measured to the nearest 0.1 cm. The length frequency data were grouped in 1 cm class intervals sequentially arranged to monthly time series.

To perform the Virtual Population Analysis (VPA) of the bleak stock, growth and mortality parameters were estimated using ELEFAN I (Electronic Length Frequency Analysis), as described by Pauly and David (1981) and Pauly and Morgan (1987). These parameters were derived from the time series of length-frequency data. Total mortality rate (Z) for bleak population was estimated by length-converted catch curve (Pauly, 1984; 1990). Natural mortality rate (M) was estimated according to Pauly's empirical formula $\ln M = -0.0152 - 0.279 \cdot \ln L_\infty + 0.6543 * \ln K + 0.463 \cdot \ln T$ (Pauly, 1980) for the average annual temperature of Lake Shkodra of 16.4^{0}C. The fishing mortality rate (F) was estimated using the formula F=Z−M, while the exploitation rate (E) was calculated based on the relationship E=F/Z as described by Gulland (1971).

Length-structured Virtual Population Analysis (VPA) (Jones and van Zalinge, 1981) was applied to evaluate the historical population size and exploitation rates of the bleak stock, as well as to assess the extent to which the population has been impacted by fishing and natural mortality over time. The stock production, expressed as relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R), was predicted using the Beverton and Holt (1966) model, as adapted for application in FiSAT II (2005). The calculations were done using the Knife Edge Method (Gayanilo et al., 2005). The three common thresholds of exploitation rate (E) – E_{MSY}, $E_{0.1}$, and $E_{0.5}$ were used to assess the optimal and sustainable levels of fishing pressure for the bleak stock.

RESULTS AND DISCUSSIONS

The Virtual Population Analysis (VPA) for the Scoranza bleak *(Alburnus scoranza)* in this study reveal insights into the species' population dynamics under current exploitation rate. When compared to findings from other studies on bleak populations in various water bodies, both similarities and marked differences emerge. Es estimated by length-converted catch curve (Figure 2), the total mortality rate (Z) of 3.81 year^{-1} in this study, with a natural mortality (M) of 1.25 year^{-1} and a fishing mortality (F) of 2.56 year^{-1}, suggests a population under substantial fishing pressure.

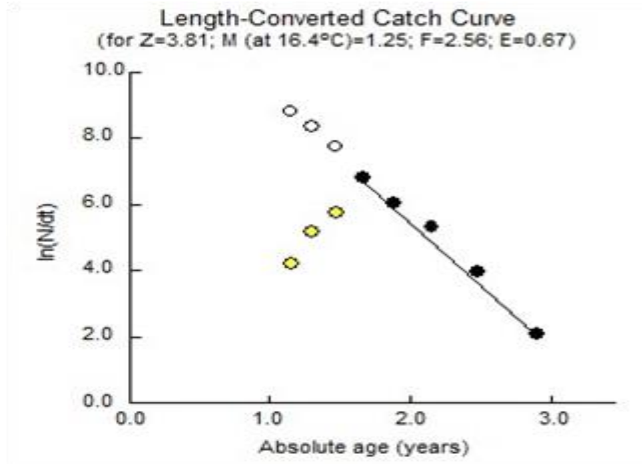

Figure 2. Length converted catch curve for Scoranza bleak population. (The filled points in the graph represent observed values, while the unfilled points are extrapolated values. The yellow points indicate the ages of the bleak that are not vulnerable to fishing gear.)

A comparable study by Memia (1987) in Shkodra Lake reported significantly lower fishing mortality rates for Scoranza bleak during the years 1986–1987 (F = 0.6–1.2 year^{-1}). This increase over time to F = 2.56 year^{-1} in the present study indicates intensified fishing pressure. Similarly, the exploitation rate (E) rose from 0.44–0.50 year^{-1} in 1987 to 0.67 year^{-1} in this study, exceeding the optimal exploitation threshold of E ≈ 0.5 proposed by Gulland (1971) for sustainable fisheries. When comparing natural mortality rates, the rate observed in this study showed a modest increase, rising from 0.8 year^{-1} reported by Memia (1987) to 1.25 year^{-1}. The natural mortality of the reproductive population of Scoranza bleak is influenced by multiple factors. According to Shumka et al. (2000) and Marić & Burzanović (2021), the primary causes include seasonal starvation, environmental stress, and age-related vulnerability due to inefficiencies in energy use and growth. Information on the population dynamics of Scoranza bleak (*Alburnus scoranza*) is scarce in the literature, as this species has a limited distribution, confined to the ecosystems of the Drin River catchment (Kottelat and Freyhof, 2007).

The results of the bleak Virtual Population Analysis (VPA) are presented in Figure 3 and Table 1. In Figure 3, the population dynamics of Scoranza bleak are described in terms of the number of surviving individuals and those exposed to natural and fishing mortality for each length class.

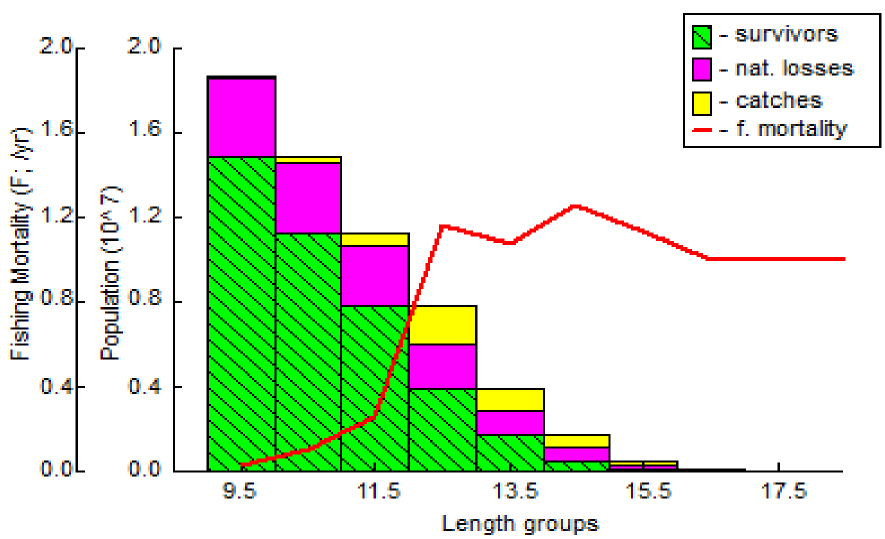

Figure 3. Scoranza bleak Virtual Population Analysis (VPA) structured by length.

Table 1. The number of individuals caught, the number of surviving individuals (N), and the fishing mortality rate for each length class (cm) of the bleak population.

Nr.	Length-class mean	Catches (No. of individuals)	No. of survivors (N)	Fishing mortality (F) rate
1	9.5	100000	18671746	0.034
2	10.5	290000	14842738	0.110
3	11.5	580000	11241292	0.257
4	12.5	1880000	7844800	1.157
5	13.5	1030000	3934282	1.076
6	14.5	600000	17077139	1.259
7	15.5	200000	511203	1.130
8	16.5	40000	90000	1.000

Table 1 presents the data analyzed in Figure 3, showing the number of individuals caught, the number that survived, and the calculated fishing mortality values for each length class. The population dynamics of the Scoranza bleak are influenced by the balance between surviving individuals and those subject to natural and fishing mortality. Fishing mortality rate (F) varies across length classes, with higher rates observed in larger length classes due to increased fishing pressure (Figure 3, Table 1). The highest fishing mortality is observed in the length range of 12.5 to 16.5 cm and remains elevated for individuals in the length class with a mean of 16.5 cm or greater, with a rate of F = 1.0 year^{-1}. The immediate increase of fishing mortality from 0.26 to 1.16 year^{-1} in length class with mean length of 12.5 cm leads to a decrease of the population with 3.4 milion individuals (Table 1).

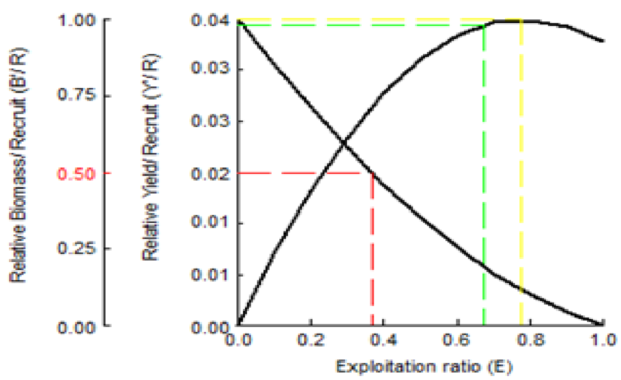

Figure 4. Prediction of the bleak stock production as relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R). The yellow, green, and red dotted lines represent Y'/R and B'/R corresponding to the three exploitation levels: E_{MSY}, $E_{0.1}$, and $E_{0.5}$.

Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) were calculated for three threshold exploitation rates following Sparre and Venema (1998). E_{MSY} = 0.775 year^{-1} represents the exploitation rate that produces the maximum sustainable yield (MSY). The exploitation rate at which the yield per recruit is reduced by 10% from its maximum value (MSY) was determined as $E_{0.1}$ = 0.671 year^{-1}. Finally, the exploitation rate at which the spawning stock biomass per recruit (B'/R) is reduced to 50% of its unexploited level is given by $E_{0.5}$ = 0.367 year^{-1} (Figure 4).

Currently, the exploitation rate for the bleak population is estimated at E = 0.67 year^{-1}, which is below the calculated E_{MSY}. However, given the high fishing mortality observed in certain length classes, it is recommended that the exploitation rate not only remain below E_{MSY} but should be reduced even more than $E_{0.1}$, which corresponds to the level that achieves maximum economic yield (MEY). $E_{0.5}$ = 0.367 year^{-1} suggests that at this level of exploitation, the stock's ability to reproduce is significantly impacted, but still sufficient to allow for long-term sustainability if managed properly. At the current exploitation rate, which exceeds 0.367 year^{-1}, the spawning biomass per recruit will continue to decline, potentially compromising the population's ability to recover and sustain itself.

CONCLUSION

The exploitation of a fish stock at quotas exceeding the stock's sustainable limits harms its regenerative capacity and pushes it toward collapse. Ensuring compliance with existing management measures, conducting continuous monitoring of catches and stock conditions, and adapting management strategies to evolving circumstances would not only help preserve the bleak stock but also support its recovery.

REFERENCES

1. Beverton R J H and Holt S J, (1966). Manual of methods for fish stock assessment. Part 2. Tables of yield functions. FAO PAO Fisheries Technical Paper No. 38 (Rev. 1), 68 p;
2. Bogutskaya N G and Ahneld H, (2019). New data on the western Balkan leuciscids *Alburnoides* and *Alburnus* (Teleostei, Leuciscidae) from the Vjosa River, Albania. ZooKeys 870, 101–115;
3. Dervishi B, Kolaneci V, Kamberi E, (2017). Populations' dynamics of carp (C. carpio) and bleak (A. scoranza) in Shkodra Lake. Albanian Journal Agriculture Science (Special edition),1-5;
4. Dhora Dh, (2004). Assessment of populations and management of the most important fish resources in Lake Shkodra. Scientific Bulletin of the University of Shkodra. Natural Sciences Series (in Albanian), 54, 118 – 125;
5. Gayanilo FC, Sparre P, Pauly D, (2005). FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide (Version 1.2). FAO Fisheries Technical Paper No. 393. FAO, Rome;
6. Gulland JA, (1971). Fish resources of the ocean. *Fishing News Books*, Surrey, London, England. 255p;
7. INSTAT, Fishery statistics, (2023). Institute of Statistics. Republic of Albania. https://www.instat.gov.al/media/13536/fishery-statistics-2023.pdf
8. Jones R and Van Zalinge NP, (1981). Estimations of mortality rate and population size for shrimp in Kuwait waters. Kuwait Bull. Mar. Sci., 2, 273-288;
9. Kottelat M and Freyhof J, (2007). Handbook of European freshwater fishes. Publications Kottelat, Cornol and Freyhof, Berlin, 646 p;
10. Marić D and Burzanović K, (2021). Are there one or two stocks of Scoranza bleak - Alburnus scoranza Bonaparte, 1845 in Lake Skadar (Montenegro). Ecologica Montenegrina, 40, 80-92;
11. Memia Sh, (1987). Study of the population dynamics and exploitation of fishery resources in Lake Shkodra and Lake Fierza (in Albanian). Dissertation. Agriculture University of Tirana, Albania;
12. Milosević D and Mrdak D, (2016). Length-weight relationship of nine fish species from Skadar Lake (Adriatic catchment area of Montenegro). J. Appl. Ichthyol., 32, 1331-1333;
13. Pauly D and David N, (1981). ELEFAN I, a BASIC program for the objective extraction of growth parameters from length-frequencies data. Meeresforsch., 28(4), 205-211;
14. Pauly D and Morgan GR, (1987). Length-based methods in fisheries research. ICLARM Conference. Proceedings 13, 468 p;
15. Pauly D, (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks, ICES Journal of Marine Science, Volume 39, Issue 2, 175–192;
16. Pauly D, (1984). Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part II). ICLARM Fishbyte, 2(1), 17-19;
17. Pauly D, (1990). Length-converted catch curves and seasonal growth of fishes. Fishbyte 8(3), 24-29;
18. Rakaj N, (1995). The Ichthyofauna of Albania (in Albanian). University Book Publishing House. Tirana, Albania, 700 p;
19. Shumka S, Shumka L, Mali S, (2020). On the origin of spring fish mortality cases occurring to Alburnus belvica Karaman, 1924 and Alburnus scoranza Bonaparte, 1845 in Albania. Eurasia J Biosci 14, 2135-2138;
20. Sparre P and Venema SC, (1998). Introduction to Tropical Fish Stock Assessment, Part 1: Manual. FAO Fisheries Technical Paper No. 306/1, Rev. 2, Rome. FAO;