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Age Structure and Growth Modeling of *Sander lucioperca* (Linnaeus, 1758) from Lake Oubeira (Northeast Algeria)

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ABSTRACT

The present study provides the first contribution focusing on the growth biology of the pike-perch *Sander lucioperca* in Oubeira Lake (El-Tarf, Northeast Algeria). A total of 374 specimens were sampled, of which 167 were females and 176 were males. The ages, total lengths (TL) and eviscerated weights (EW) of the individuals ranged between 1 and 8 years, from 21.2 to 88.9cm and from 92 to 1771g, respectively. Fish age was determined according to the direct method (scalimetry). The length-weight relationship was expressed by the following equations: $EW = 0.007975TL^{3.02}$ for the entire population, $EW = 0.00538TL^{3.11}$ for female and $EW = 0.0104TL^{2.93}$ for male. The ANCOVA test revealed no significant difference between the slopes of the length-weight relationships ($P > 0.05$). The parameters of the von Bertalanffy model estimated from the age-length data were: $L\infty = 91.39$ cm; $K = 0.41$ an^{-1}; $t_0 = -0.51$. In our case the growth performance was recorded at (φ) 3.28. The asymptotic weight obtained (W_∞ = 1985 g) was slightly higher than the maximum weight observed (1771 g). An isometric growth characterized the studied population (b = 3.02), with a positive allometry for females (b = 3.11) and a negative one for males (b = 2.93). These findings constitute the first comprehensive description of pike-perch growth parameters in Oubeira Lake and provide a baseline for the development of sustainable management and conservation strategies for the species in continental Algerian waters.

INTRODUCTION

Research studies concerning the age and growth of teleosts are essential for understanding the biology of the species and analyzing their population dynamics. The growth marks found on calcified structures, such as scales or otoliths, enable the

estimation of individual age and the development of growth models, thus providing essential tools for the sustainable management of fish stocks (**Laurec & Le Guen, 1981; Campana, 2001**).

The pike-perch (*Sander lucioperca* Linnaeus, 1758) is a carnivorous fish belonging to the Percidae family and is native to Central and Eastern Europe. A valuable economic and halieutic species, it is widely appreciated for its flesh and its market value (**Poulet, 2004**). It has been introduced into several Algerian Waters since the 1980s to diversify the ichthyofauna and develop continental fishing (**Toujani, 1998**). The pike-perch has since adapted to life in a diverse range of dams and lakes, representing currently an important fishery resource.

Studies on pike-perch in North Africa, and particularly in Algeria, remain limited. Some notable contributions include the work of **Bouamra *et al.* (2017)** on Ghrib and Cap Djinet dams, that of **Rezaiguia *et al.* (2023)** on Bouhamdane Dam, and the study of **Guettaf *et al.* (2024)** on Hammam Debagh Dam. On the other hand, in Tunisia, **Toujani (1998)** provided a major reference for the biology and dynamics of the species in the Sidi Salem reservoir. The previous research revealed a high degree of variability in growth parameters depending on the site and ecological conditions, underlining the need for localized studies.

Despite the ecological and halieutic importance of the pike-perch in Algeria, biological and demographic data on its population remain limited in Oubeira Lake (El-Tarf, Northeast Algeria). This lack of information constitutes a limitation to the implementation of suitable management strategies. The purpose of this study is to characterize the size structure of the *Sander lucioperca* population in Oubeira Lake, determine the age of individuals using scalimetry, establish model growth using the von Bertalanffy model, analyze the size-weight relationship and estimate growth performance. It should be emphasized that this approach is being applied for the first time in this area, thus providing essential baseline data for understanding the dynamics of the species and implementing sustainable management strategies for its fish stocks.

MATERIALS AND METHODS

Study area

Oubeira Lake is a freshwater reservoir belonging to the El Kala National Park wetland complex. It is situated 5km southwest of El Kala City. It lies at latitude 36°49′ to 36°52′ North and longitude 8°20′ to 8°25′ East. The lake extends over an area of 2.200 hectares with a maximum depth of 4 metres. It has an endorheic hydrological system and

is fed by four main wadis (small river): Demnet Rihana Wadi (to the North), the Boumerchene Wadi (to the Northeast), Dey L'Grâa Wadi (to the east), and Messida Wadi (to the south) (Fig. 1).

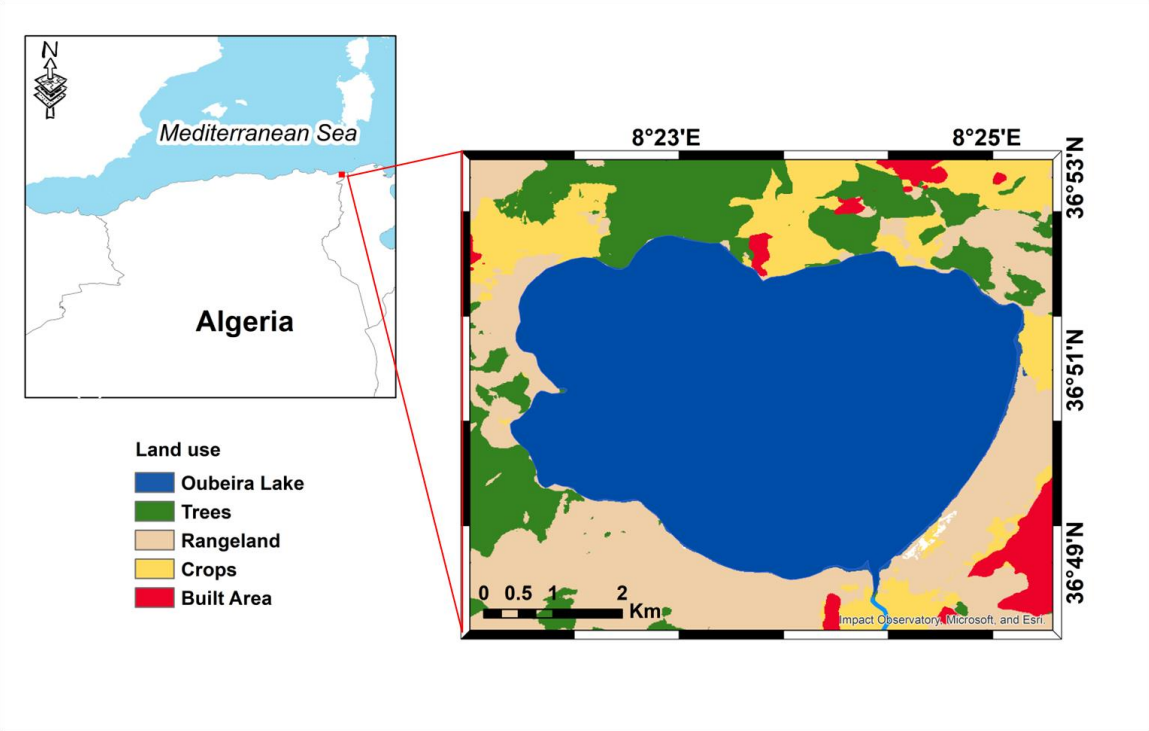

Fig. 1. Localization of Lake Oubeira, land use information retrieved from the Sentinel-2A image with 10m resolution

The lake is home to an ichthyofauna dominated by species belonging to the Anguillidae and Cyprinidae families, as well as a diverse avifauna comprising both sedentary and migratory species. Annual rainfall in the region varies between 700 and 800mm.

Sampling

A total of 374 specimens of *Sander lucioperca* were harvested monthly using a 50-meter-long trammel net between October 2023 and September 2024. For each specimen, total length (TL in cm) and eviscerated weight (EW in g) were measured. The sex and stage of maturity were also determined using macroscopic gonad observations (**Stratoudakis *et al.*, 2004**).

Age estimation

Fish age was determined by removing 6 to 10 scales from the underside of the left pectoral fin for each specimen. After cleaning, the scales were mounted between two glass slides and observed using a constant magnification light microscope. The R

statistical language (version 4.5.0) was used to establish the size-age frequency distribution, providing an analysis of the population structure of *Sander lucioperca* in Oubeira Lake.

Growth parameters

Growth in this study was modelled based on the mathematical equation of **Von Bertalanffy (1938)**:

$$L_t = L_\infty\left[1 - e^{-k(t-t_0)}\right]$$

The FISAT II program (version 1.2.2) was used to estimate the model parameters, namely the asymptotic length (L∞), the growth coefficient (k) and the theoretical age at which the length is zero (to).

For comparative purposes, we used **Pauly and Munro**'s **(1984)** growth performance index (φ), expressed as follows:

$$\varphi = Log_k + 2Log_{L_\infty}$$

Length-weight relationship

Relative growth can be used to verify the existence of a correlation between weight and fish size as well as to model the relationship. According to **Froese (2006)**, the size-weight relationship can be established using the following regression equation:

$$Wt = a.TL^b$$

Where, a is the intercept and b is the slope (growth coefficient). To determine the growth type of the population, the value of b was compared with the theoretical value b_0 = 3, employing a Student t-test, with a significance threshold set at α = 0.05 (**Dagnelie, 1975**). This analysis distinguishes three types of growth: isometric growth if b = 3, increasing allometric growth if b > 3 and decreasing allometric growth if b < 3.

Statistical Analysis

In order to assess differences in the TL between age groups and explore the structuring of the data, variance analysis (ANOVA) was performed to test the effect of the age factor on TL, supplemented by a non-parametric Kruskal-Wallis test to check the robustness of the results in the event that the conditions of normality and homogeneity of variances were not met. In addition, a principal component analysis (PCA) was carried out to identify the main axes of variation, taking into account the sex of the specimens, and to visualize the relationships between the variables, while classification analyses were used

to group the individuals according to their morphometric similarities. Statistical tests and figures were generated using the R statistical language (version 4.5.0).

RESULTS

1. Size frequency distribution

Of the 374 specimens of *Sander lucioperca* caught in Oubeira Lake, the total length ranged from 21.2 to 88.9cm. The frequency distribution depicted in Fig. (2) indicates a distinct predominance of the 27.3 - 34.9cm class, which represents more than half of the total sampled. Classes below 27cm are poorly represented, while classes above 60cm occur marginally, accounting for few individuals. This population structure suggests that intermediate-sized specimens, corresponding to individuals in the active growth phase, dominate the studied population.

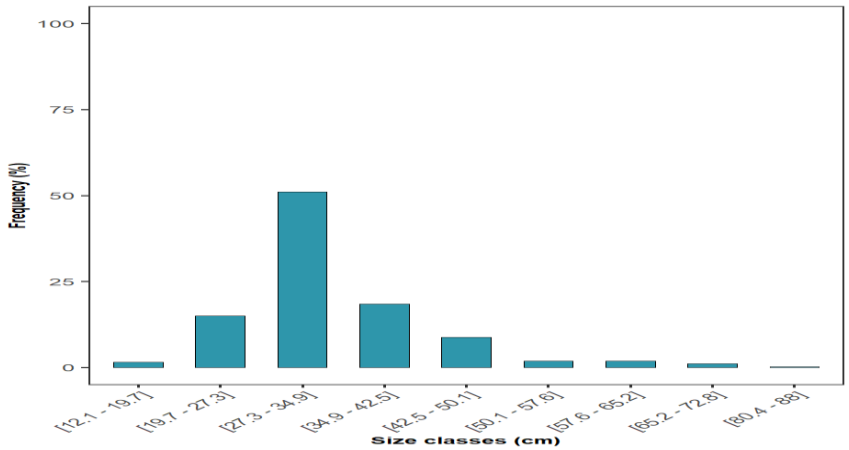

Fig. 2. Population size structure of *Sander lucioperca* in Oubeira Lake

2. Age distribution

Scalimetric analysis revealed the existence of eight age classes, between 1 and 8 years of age (Fig. 3). Individuals aged between 1 and 4 years predominate the population, accounting for the majority of the sampled specimens (with a maximum of 117 individuals recorded for age 2). On the other hand, the oldest age classes (7 and 8 years), although less abundant (6 and 4 individuals, respectively), reach the highest values for length, reflecting the species' considerable growth potential in Oubeira Lake (Fig. 3).

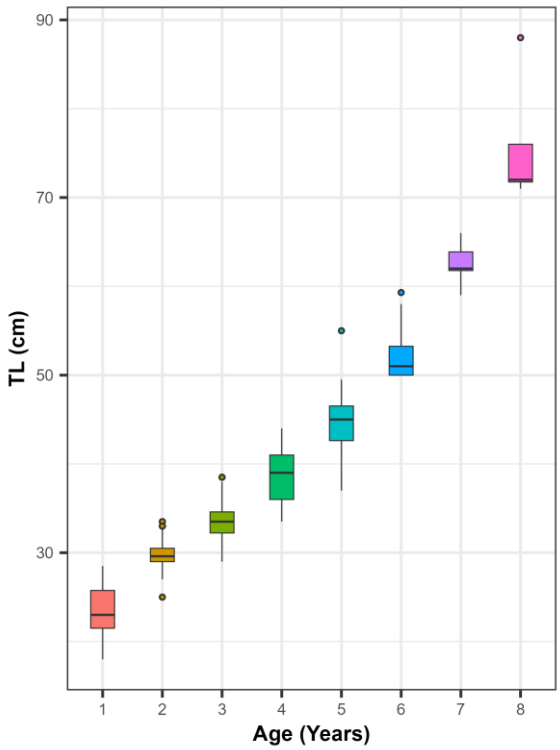

Fig. 3. Age composition of the *Sander lucioperca* population in Oubeira Lake

3. Linear growth

The adjustment of the age-length pairs according to von Bertalanffy's model resulted in the estimation of the following parameters: $L\infty = 91.39$ cm, $k = 0.41$ yr^{-1}, $t_0 = -0.51$ yr and $\varphi = 3.28$. The growth curve obtained (Fig. 4) displays a rapid increase in total length during the first three years, followed by a gradual decrease starting at the age of five. The maximum length observed among older specimens (89 cm) is consistent with the predicted asymptotic value, indicating a good fit between the model and the observed data.

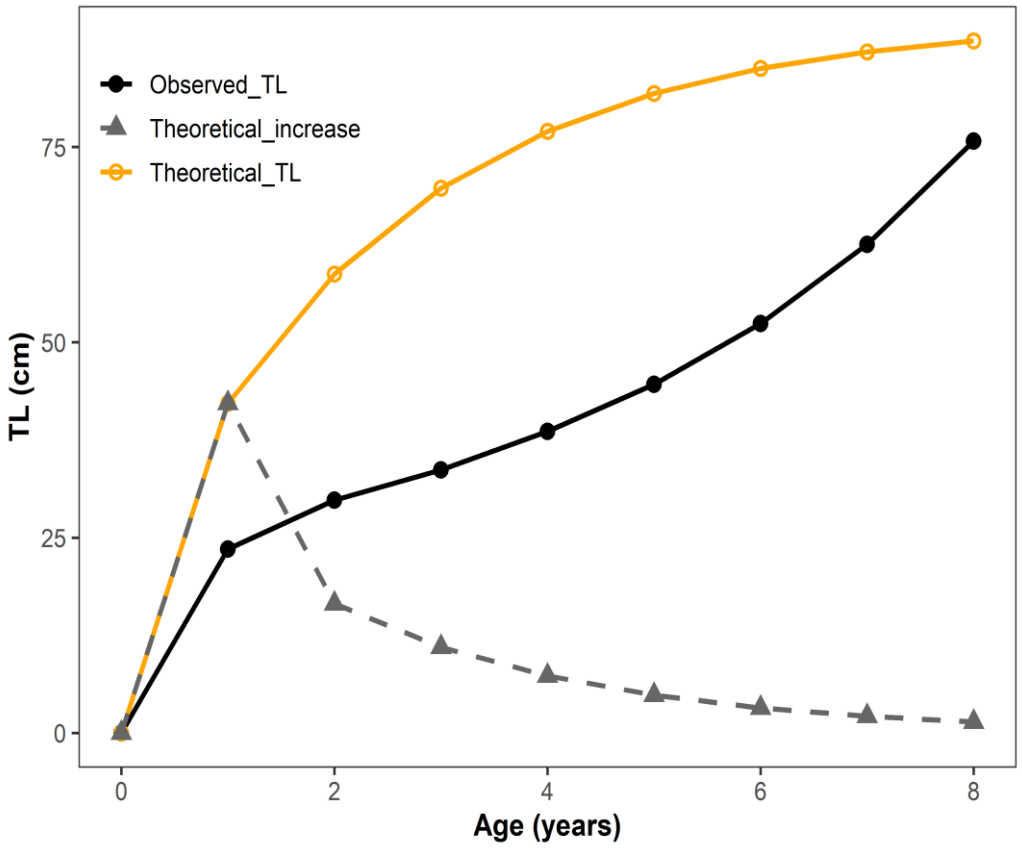

Fig. 4. Observed and theoretical linear growth and theoretical annual increase calculated from scales considering the entire *Sander lucioperca* population of Oubeira Lake.

On the other hand, the analysis of variance (ANOVA) performed on the TL as a function of age showed a highly significant effect of the age factor ($F = 681.2$; $P < 2e\text{-}16$), indicating that the mean height (TL) differed significantly between age classes. The assumption is confirmed by the result of the non-parametric Kruskal-Wallis test ($\chi^2 = 336.14$; $P < 2.2e\text{-}16$).

4. Length-weight relationship

The relationship between total length (TL) and eviscerated weight (EW) was established for the entire population (Fig. 5a), and then considering sex (Fig. 5b, c).

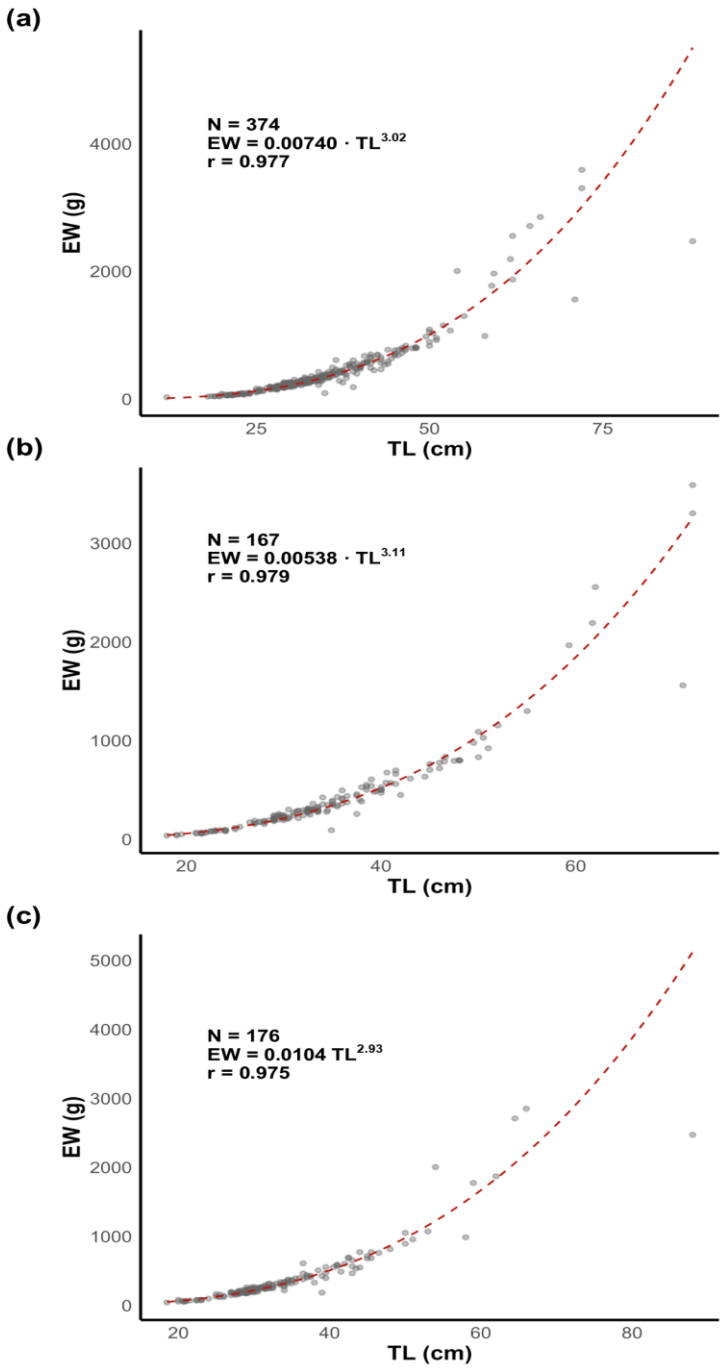

Fig. 5. Length-weight relationship of *Sander lucioperca* from Oubeira Lake. (a) for the whole population, (b) for female, and (c) for male

The coefficients of determination ($r^2 > 0.95$) indicate a strong correlation between length and weight in all cases. Statistical analysis revealed practically isometric growth for the entire population (b = 3.02), a slight positive allometry in females (b = 3.11), and a negative allometry in males (b = 2.93). The t-test applied to the values of b in relation to

the theoretical value (b = 3) confirms that these differences are not significant (*P*> 0.05), pointing to no distinct distinction between the sexes.

5. Weight growth

On the basis of the principal parameters of the von Bertalanffy model (L_∞ = 91.39 cm; k = 0.41 yr^{-1}; t_o = -0.51) and the allometric coefficient of the size-weight relationship (b = 3. 02), the absolute weight growth of *Sander lucioperca* at Oubeira Lake was estimated (Fig. 6). The asymptotic weight calculated (W_∞ = 1985 g) is slightly higher than the maximum weight observed in the sample (EW = 1771 g). The evolution of weight indicates a strong increase during the first year (+ 726.9 g/year), followed by a progressive decrease in annual weight gain, reaching approximately 344.3 g in the second year and a minimum of 93.8 g at the age of 7 years. This pattern reflects rapid growth in the juvenile stage, followed by a marked decline with the ageing process, in line with the classic growth pattern for this species.

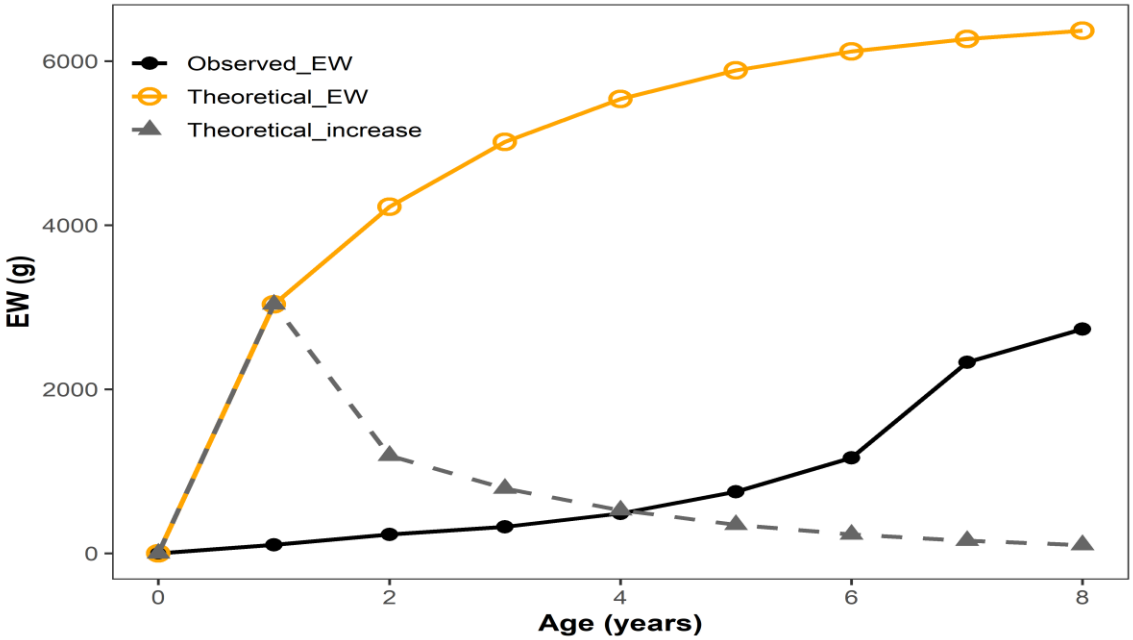

Fig. 6. Observed and theoretical weight growth and theoretical annual increase in the total *Sander lucioperca* population of Oubeira Lake

6. Multivariate analysis of morphometric relationships

Principal component analysis (PCA) illustrated in Fig. (7a) of the TL, EW and age variables shows that the first two axes explain almost all the variability in the data (Dim1 = 92.6% and Dim2 = 6.2%). The first axis (Dim1) is mainly associated with TL and age, reflecting a strong growth gradient where the oldest and tallest individuals are located toward the positive values. The second axis (Dim2), correlated with EW, appears to reflect variation in the weight or physiological condition of the individuals. The similar proximity and orientation of the TL and Age vectors indicate a close relationship between these two variables, while EW contributes a secondary dimension. The projection of

individuals by sex shows a significant overlap between males and females, suggesting little morphometric differentiation between sexes, although some females show higher values of EW, possibly linked to a more advanced stage of maturation.

On the other hand, the classification analysis shown in Fig. (7b) using principal components identified three distinct groups of individuals, confirming a clear structuring according to morphometric variables. The most discriminating variables between clusters were EW ($\eta^2 = 0.85$), followed by age ($\eta^2 = 0.78$) and total length TL ($\eta^2 = 0.77$), indicating that differentiation between groups is mainly related to growth. The first cluster is composed of small, young individuals with low eviscerated weights, reflecting an early stage of development. The second cluster corresponds to older, intermediate-sized individuals with moderate EW, representative of an adult stage. Finally, the third cluster includes the oldest individuals, of large size and with a very high EW, corresponding to stages of full maturity. These results confirm the existence of a clearly identifiable growth and maturation gradient within the studied population and are consistent with the patterns highlighted by the PCA.

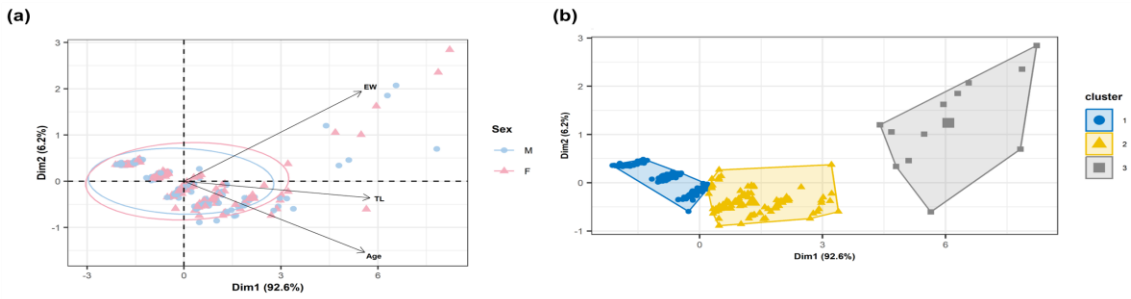

Fig. 7. Results of principal component analysis (PCA) by gender (a) and cluster classification (b).

DISCUSSION

The lack of data on the population dynamics of pike-perch (*Sander lucioperca*) in the continental waters of El-Tarf City, particularly in Oubeira Lake, makes our finding highly relevant, thus providing a key reference base for the development of sustainable management strategies for the species.

In the present study, the maximum age determined for the total population is 8 years. Nevertheless, the total length with a maximum of 88cm associated with the age of 8 years remains higher than those reported in previous studies conducted in other Algerian regions, with maxima ranging from 57.1 to 83 (**Bouamra *et al.*, 2017; Guettaf *et al.*, 2024**). **Rezaiguia *et al.* (2023)** revealed that the longevity determined in

Bouhamdane Dam (Guelma, Algeria) varied between 1 and 3 years, in both sexes, for sizes ranging from 25 to 45.3 cm. In Southern French rivers, **Goubier (1972**) reported a maximum age of 5 years. These disparities in age distribution may be due to the fish's activity, feeding regime and the ecological properties of the habitat (**Alp & Balik, 2000**), but also to the heterogeneity of the methodologies adopted by the various authors and the sampling size of the population.

The observed and theoretical values for the total length and eviscerated weight of fish at different ages are generally close and indicate that linear and weight growth are accurately described by the von Bertalanffy model. Considering the entire population, the asymptotic length determined (L_∞ = 91.39 cm) comes close to that reported by **Khalifa (2015)** in Ghrib Dam (L_∞ = 90.54 cm), while it is higher than the ones found in Bouhamdane Dam, in Hammam Dbagh Dam, and in Cap Djenet hill Dam, with 48.3, 65.47, and 78 cm, respectively (**Bouamra *et al.*, 2017; Rezaiguia *et al.*, 2023; Guettaf *et al.*, 2024)**. On the other hand, a higher asymptotic length was reported in Ghrib Dam with 98.5cm (**Bouamra *et al.*, 2017**). Similarly, different values of L∞ have been observed in various regions: **Pauly (1978**) highlighted a value of 86cm in Germany; **Toujani (1998)** recorded 66cm in Tunisia; **Poulet (2004)** reported 117.9cm in France; and **Pérez-Bote and Roso (2012)** found 97.15cm in Spain. In terms of the growth coefficient (K) and according to the criteria defined by **Branstetter (1987)**, a species is classified as slow-growing when $0.05 \leq K \leq 0.10$ yr^{-1}, intermediate-growing when $0.10 \leq K \leq 0.20$ yr^{-1}, and fast-growing when $0.20 \leq K \leq 0.50$ yr^{-1}. Pike-perch caught in Oubeira Lake can therefore be classified as a fast-growing species, with an estimated growth coefficient of K = 0.41 yr^{-1}. This rate in our study is significantly higher than that recorded in other *Sander lucioperca* populations, such as those in Ghrib Dam (K = 0.25) and Cap Djenet hill reservoir (K = 0.27) (**Bouamra *et al.*, 2017**), Hammam Debagh Dam (K = 0.30) (**Guettaf *et al.*, 2024**). However, it remains lower than that reported in Tunisia (K = 0.53) (**Toujani, 1998**) and for the Bouhamdane Dam (K = 0.63) (**Rezaiguia *et al.*, 2023**). We suggest that geographical variations in pike-perch growth, a phenomenon also observed with the majority of teleosts, result not only from methodological uncertainties related to the reliability of age determination techniques but also from differences in environmental conditions, whether biotic or abiotic (temperature, nutrient availability, intra- and interspecific competition). This assumption is consistent with the conclusions of **İnnal (2012)**, who indicated that growth rate is influenced by variations in water salinity and temperature, as well as by the feeding habits of the fish.

The analysis of the growth performance index (Φ) according to age group allows us to estimate the annual growth rate, calculated here for the entire population, with a value of 3.28. According to **Baijot *et al.* (1994)**, results from population studies are only considered reliable when the growth performance index is between 2.65 and 3.32, which applies to our study. In Algeria, this index has converging values to the one reported in

the present study: 3.06 in Hammam Debagh Dam, 3.16 in Bouhamdane Dam, 3.38 in Ghrib Dam and 3.21 in Cap Djenet reservoir. Similarly, comparable values have been reported in Germany (Φ = 3.09) by **Pauly (1978**) and Tunisia (Φ = 3.06) by **Toujani (1998**). The variations observed in this index could be explained by various factors, including environmental conditions (temperature, geographical location), sample size, or the dimensions of the largest measured individual.

The relative growth of *Sander lucioperca* in Lake Oubeira was isometric for the entire population, with a slope value of 3.02. Similar results have been reported by several authors: **Salo (1988)** for Vanajanselka Lake in Finland (b = 3.05); **Staras (1993)** for Razim Lake in Romania (b = 3.14); **Kangur and Kangur (1996)** for Peipsi Lake in Germany (b = 3.11in 1994 and b = 3.06 in 1995); **Raikova-Petrova and Živkov (1998)** for Batak Dam in Bulgaria (b = 3.08); **Argillier *et al.* (2000, 2003)** for Castillon reservoir in France (b = 3.07 and b = 3.05); **Khalifa (2015**) for Ghrib Dam in Algeria (b = 3.08); **Bouamra *et al.* (2017)** for Cap Djenet reservoir in Algeria (b = 3.05); and **Guettaf *et al.* (2024)** for Hammam Debagh Dam in Algeria (b = 3.28). According to these authors, weight increases proportionally, and even slightly more rapidly, than height. On the other hand, minor allometries were reported by **Bouamra *et al.* (2017)** for Ghrib Dam (Aïn Defla, Algeria) (b = 2.93) and by **Rezaiguia *et al.* (2023)** for Bouhamdane Dam (Guelma, Algeria) (b = 2.85).

Variations in this coefficient are probably attributable to the various types of sampling and to differences in feeding habits during ontogenetic development, particularly between older and younger individuals, as well as to the size of the population studied. In addition, inter-annual changes in the nutritional status of organisms can explain this variation (**Zorica *et al.*, 2006)**. The geographical location associated with environmental conditions and parasitic pathologies are all factors that can affect the value of the coefficient b (**Le Cren, 1951; Bagenal & Tesch, 1978**).

CONCLUSION

This preliminary study, carried out for the first time on the pike-perch *Sander lucioperca* from Oubeira Lake (El-Tarf, Algeria), has expanded our knowledge on this highly commercial species. The results have provided key information on its growth biology, enhancing our understanding of its ecology. These findings provide a solid scientific basis for the implementation of effective management measures and the sustainable conservation of stocks, while providing insight into the ecological interactions involving this species.

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Author contributions

Nabila Bensafia: Conceptualization; Investigation; Methodology; Software; Laboratory Analysis; Writing – original draft; Writing - review & editing;

Rabie Guezi: Investigation; Methodology; Formal Analysis; Laboratory Analysis;

Naouel Ouali: Methodology; Formal Analysis; Software

Khadidja Wissal Abdallah: Formal Analysis; Writing - review & editing;

All authors read and approved the final manuscript.

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Data Availability:

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval

Not applicable.

Competing Interests

The authors declare no competing interest.

REFERENCES

Alp, A. and Balik, S. (2000). Growth conditions and stock analysis of the carp (*Cyprinus carpio*, Linnaeus 1758) population in Gölhisar Lake. *Turkish Journal of Zoology*, *24*, 291–304.

Argillier, C.; Barral, M. and Irz, P. (2003). Croissance et régime alimentaire du sandre *Sander lucioperca* (L.) dans deux retenues artificielles françaises. *Bulletin Français de la Pêche et de la Pisciculture*, *368*, 17–32.

Argillier, C.; Cadic, N.; Schlumberger, O. and Barral, M. (2000). *Retenue de Castillon: étude ichtyologique et diagnose rapide*. Cemagref.

Bagenal, T.B. and Tesch, F.W. (1978). Age and growth. In: *Methods for Assessment of Fish Production in Fresh Waters*. Blackwell Scientific Publications, pp. 101–136.

Baijot, E.; Moreau, J. and Bouda, S. (1994). *Hydrobiological Aspects and Fish in Water Reservoirs in the Sudano-Sahelian Area: The Case of Burkina Faso*. CTA.

Bouamra, A.; Belaifa, B.; Chaoui, L.; Kara, M.H. and Arab, A. (2017). Age and growth of pike perch *Sander lucioperca* (Percidae) in the Ghrib reservoir (Northwest Algeria). *Revue d'Écologie*, *72*, 83–93.

Branstetter, S. (1987). Age, growth and reproductive biology of the silky shark, *Carcharhinus falciformis*, and the scalloped hammerhead, *Sphyrna lewini*, from the northwestern Gulf of Mexico. *Environmental Biology of Fishes*, *19*, 161–173.

Campana, S.E. (2001). Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *Journal of Fish Biology*, *59*, 197–242.

Dagnelie, P. (1975). *Théorie et méthode statistiques: applications agronomiques*. J. Duculot.

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, *22*, 241–253.

Goubier, J. (1972). Acclimatation du Sandre (*Sander lucioperca* L.) dans les eaux françaises. *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie*, *18*(2), 1147-1154.

Guettaf, M.; Rachdi, M.; Gueroui, Y.; Ouartsi, A.; Mahdid, B. and Maoui, A. (2024). Contribution to the Study of the Age and Growth of *Sander lucioperca* (Percidae, Linnaeus, 1758) in the Hammam Debagh Dam Northeast Algeria. *Egyptian Journal of Aquatic Biology & Fisheries*, *28*(5), 1–14.

İnnal, D. (2012). Age and growth properties of *Carassius gibelio* (Cyprinidae) living in Aksu river Estuary (Antalya-Turkey). *Review of Hydrobiology*, *5*, 97–109.

Kangur, A. and Kangur, P. (1996). The condition, length and age distribution of pikeperch, *Stizostedion lucioperca* (L.) in Lake Peipsi. *Hydrobiologia*, *338*, 179–183.

Khalifa, O.F. (2015). *Contribution à l'étude de la dynamique du sandre (Sandre Lucioperca Linnaeus, 1758) dans le barrage de Ghrib*. Khemis Miliana University.

Laurec, A. and Le Guen, J.-C. (1981). *Dynamique des populations marines exploitées. Tome 1. Concepts et modèles*. CNEXO.

Le Cren, E.D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *The Journal of Animal Ecology*, *20*(1), 201–219.

Pauly, D. (1978). A preliminary compilation of fish length growth parameters. *Berichte der Deutschen Wissenschaftlichen Kommission für Meeresforschung*, *26*(1), 1–200.

Pauly, D. and Munro, J.L. (1984). Once more on the comparison of growth in fish and invertebrates. *ICLARM Fishbyte*, *2*(1), 1–21.

Pérez-Bote, J.L. and Roso, R. (2012). Growth and length-weight relationships of *Sander lucioperca* (Linnaeus, 1758) in the Alcántara Reservoir, south-western Spain: comparison with other water bodies in Eurasia. *Journal of Applied Ichthyology*, *28*, 264–268.

Poulet, N. (2004). *Le sandre (Sander lucioperca (L.)): biologie, comportement et dynamique des populations en Camargue (Bouches du Rhône, France)*. Université Paul Sabatier-Toulouse III.

Raikova-Petrova, G. and Živkov, M. (1998). Maturity, spawning and sex ratio of pike perch, *Stizostedion lucioperca* (L.), in two Bulgarian reservoirs as compared to other European habitats. *Journal of Applied Ichthyology*, *14*, 31–35.

Rezaiguia, W.; Oudainia Salah, E.; Kaizouri, M.; Allalgua, A.; Nadjette, N.; Rachedi, M.; Menasria, A. and Kaouachi, N. (2023). Study of the reproduction and growth of *sander lucioperca* from bouhamdane dam, guelma, algeria. *Fresenius Environmental Bulletin*, *32*(7), 3355–3364.

Salo, H. (1988). Zander fishing and catching in the Vanajanselkä in 1985. (Pike-pearch fishery and the potential catch in the Lake Vanajanselkä). *Hämeen kalastuspiirin kalastustoimiston tiedotus*, *4*, 1–55.

Staras, M. and Cernisencu, I.I. (1993). Contributions to the state of knowledge and exploitation of walleye (*Stizostedion lucioperca*) in Lake Razim. *Analele Ştiinţifice ale Institutului de Cercetare-Dezvoltare pentru Delta Dunării*, *2*, 123–130.

Stratoudakis, Y.; Bernal, M. and Uriarte, A. (2004). The DEPM estimation of spawning-stock biomass for sardine and anchovy. *ICES Cooperative Research Reports*, *265*, 1–75.

Toujani, R. (1998). *Le sandre (Stizostedion lucioperca L.) de la retenue de Sidi-Salem (Tunisie): Biologie et dynamique de population*. Université Claude Bernard Lyon I.

Von Bertalanffy, L. (1938). A quantitative theory of organic growth (inquiries on growth laws. II). *Human Biology*, *10*, 181–213.

Zorica, B.; Sinovcic, G.; Pallaoro, A. and Cikes Kec, V. (2006). Reproductive biology and length-weight relationship of painted comber, *Serranus scriba* (Linnaeus,

1758), in the Trogir Bay area (middle-eastern Adriatic). *Journal of Applied Ichthyology*, *22*, 260–263.