Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(4): 1049 – 1064 (2024)
www.ejabf.journals.ekb.eg

Contribution to the Study of the Age and Growth of *Sander lucioperca* (Percidae, Linnaeus, 1758) in the Hammam Debagh Dam Northeast Algeria

Guettaf Mohamed[1], Rachedi Mounira*[2], Gueroui Yassine[3], Ouartsi Asmaa[1], Mahdid Benaissa[1], Maoui Ammar[3]

[1]Laboratory of Biology, Water and Environment, 8 Mai 1945 University, BP 401, Guelma, 24000, Algeria
[2]Laboratory of biodiversity and ecosystem pollution, Faculty of Natural Sciences and Life, Chadli Bendjedid University, B.P 73, 36000 El-Tarf, Algeria
[2]Laboratory of Ecobiology for marine environments and coastal areas, Faculty of Sciences, Badji Mokhtar University, Annaba, Algeria
[3]Department of Natural Sciences and Life, 8 Mai 1945 University, BP 401, Guelma, 24000, Algeria
***Corresponding Author: rachedi.mounira@yahoo.fr**

ARTICLE INFO

Article History:
Received: May 12, 2024
Accepted: May 19, 2024
Online: Aug. 1, 2024

Keywords:
Sander lucioperca,
Scalimetry,
Growth,
Age,
Hammam Debagh
Reservoir

ABSTRACT

The present study was conducted in the Hammam Debagh reservoir northeastern Algeria from November 2019 to April 2020. To study the age and growth of the Pikeperch (*Sander lucioperca*) population in this reservoir, 126 specimens were sampled, including 77 males and 49 females. The ages, total lengths, and total weights of the samples ranged from 0- 7 years, 15.7- 57.1cm and 92.1 to 1883g, respectively. The age of the fish was determined by the direct method (scalimetry). The lenght-weight relationship was described by the equation $TW = 0.003TL^{3.28}$ for total weight and $EW = 0.002TL^{3.43}$ for eviscerated weight. The ANCOVA test showed no significant difference between the sexes' slopes of the length-weight relations ($F = 3.445$, $P > 0.05$). The von Bertalanffy growth parameters deduced by introducing the average age/length couples were $L\infty = 61.86$cm; $K = 0.30$ year^{-1}, and $t_0 = -0.52$. The equation of the linear growth curve according to the von Bertalanffy model was written as $Lt = 61.86\ (1\text{-}e^{-0.3(t+0.52)})$, and the equation of the weight growth curve was written as $Wt = 2253.96\ (1\text{-}e^{-0.3(t+0.52)})^{3.28}$. The studied species showed a higher rate of masculinity (61.11%) than of femininity (38.89%). The overall sex ratio was in favor of males (SR = 1.57, $\chi^2 = 6.22$; $P < 0.05$), except in March when males dominated (SR = 3: 1 ; $\chi^2 = 6.00$; $P < 0.05$). The monthly variation of the sex ratio was constant throughout the study. The evolution of the sex ration according to the size of the fish showed no significant difference between males and females ($0.806 \leq \chi^2 \leq 2.123$; $P > 0.05$).

INTRODUCTION

From the family Percidae, the species *Sander lucioperca* is native to the European continent. As an exogenous predatory species **(Smith *et al.*, 1998)**, the zander particularly favors calm, slow, and temperate waters **(Larsen & Berg, 2013)**. In lakes, its prefers habitats with depths ranging from 2 to 8 meters (reaching -25 to -30 meters in winter **(Poulet *et al.*, 2005)**. The zander, being less demanding in terms of reproduction, has thrived considerably, even in heavily anthropized environments, where it now represents

a significant fishery resource **(Sokolov & Berdicheskii 1989; Poulet, 2004)**. Its high nutritional value and delicious taste make it the most sought-after freshwater fish in the market compared to other species **(Rahmdel & Falahatkar, 2021)**.

Consequently, as part of developing inland fishing activity to create a biological resource providing high-quality protein at a lower cost for human consumption, five million zanders imported from Hungary were seeded in seven water bodies between 1985 and 1986 for the first time in Algeria **(ANDP, 1991)**. According to information gathered from the fishing and halieutic resources in the direction of Guelma City, the first seeding of zander in the Hammam Debagh Dam took place in 2013. Additionally, aiming to promote the restoration of the fishery heritage of this water structure, a second introduction operation involving several hundred thousand fertilized eggs provided by the EL Ouricia hatchery (Sétif) was carried out in 2016.

However, zander production in the dam has witnessed impressive growth in recent years due to various factors, such as the complete cessation of importing little fish of all species, the overexploitation, food competition and notably, the strong predation of zander fry by larger predators **(Power, 1987; Gröger *et al.*, 2007; Carfagnini *et al.*, 2009; Vinni *et al.*, 2009; Thomas *et al.*, 2020)**.

Based on the aforementioned data, efforts are being made to find concrete solutions to the following issue. Given the current means available, we can acclimate this fish species, preserve it, and enable it to grow and reproduce naturally in environmental conditions vastly different from its original habitat. An assumption has been made that this fish may not adapt well to this new environment. Parameters for growth and performance such as weight, length, growth rate, sex ratio, and size/weight relationship were selected.

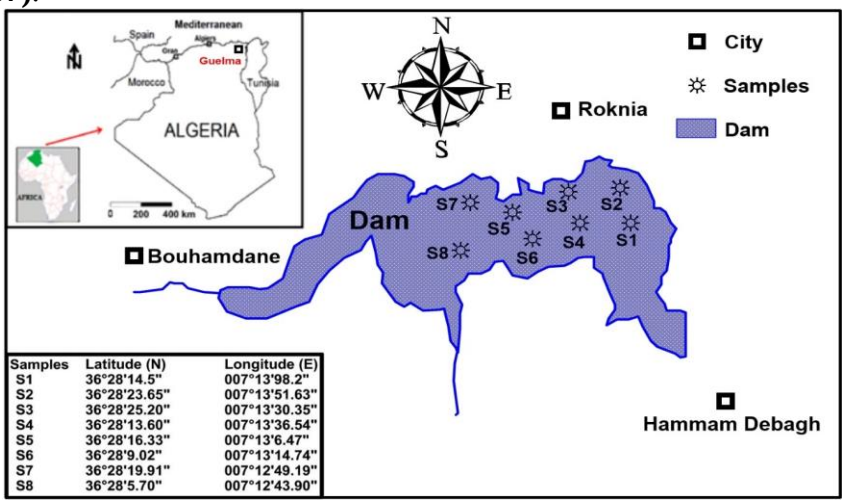
There is very little ecological data on zander in more southern and/or newly colonized regions **(M'hetli *et al.*, 2011; Bouamra *et al.*, 2017)**. However, several studies on the growth of this species have been conducted in Europe and Asia, with some examples being cited **(Argillier *et al.*, 2003; Ložys, 2004; Vinni *et al.*, 2009; Müller *et al.*, 2011; Jůza *et al.*, 2013; Kamilov *et al.*, 2017; Steinberg *et al.*, 2019)**. In this context, the objective of this work was to identify and undertake a study regarding one of the aquaculture potentialities of the region. Age and growth provided information on the productivity of a stock and the rate at which it can be harvested sustainably.

MATERIALS AND METHODS

1. Study area

Between 36° 27' 41.78" N - 007° 14' 12.99" E, and at an altitude of 390m, the Hammam Debagh reservoir is located in the Northeast part of Algeria, 20km west of the city of Guelma. It is implanted more precisely at 3km upstream from the locality of Hammam Debagh (Fig. 1). The source of water supply for the reservoir is of a rain-fed origin transported mainly by the Oued Bouhamdane and its tributaries **(ANRH, 2008)**. The reservoir is intended for irrigation and, in the longer term, for the supply of drinking water to the city of Guelma. The reservoir has a total capacity of 220hm^3 allowing an annual regulation of 55 to 60hm^3 **(Louamri, 2010)**. Moroever, it is 430m wide from east to west; 2300m long from north to south and covers an area of 4.9km^2. The depth varies on average between 65 and 98m near the intake tower and begins to decrease irregularly

as it approaches the edge of the upstream zone where it reaches 2m. The bottom of the reservoir is a thick layer of black silt, very thin in some places, resting on a sandy-clay substrate (red and grey clay). It rises from west to east from elevation 530 to elevation 612 **(Guettaf *et al.*, 2019)**. Furthermore, the water temperature varies between 28 to 8.5°C all year round. In the reservoir, a microclimate was formed with an abundant fauna and flora. The ichthyologic fauna associated with the Pikeperch in the reservoir is very diversified. We noted the presence of the common bream (*Abramis brama*), the bighead carp (*Aristichthys nobilis*), the barbel (*Barbus callensis*), the silver carp (*Hypophthalmichtys molitrix*), the European eel (*Anguilla anguilla*), the bleak (*Alburnus alburnus*), the herbivorous carp (*Ctenopharyngodon idella*), the common carp (*Cyprinus carpio*) and the royal carp (*Cyprinus carpio carpio*) **(Meddour *et al.*, 2005; Bacha & Amara, 2007)**.



Samples	Latitude (N)	Longitude (E)
S1	36°28'14.5"	007°13'98.2"
S2	36°28'23.65"	007°13'51.63"
S3	36°28'25.20"	007°13'30.35"
S4	36°28'13.60"	007°13'36.54"
S5	36°28'16.33"	007°13'6.47"
S6	36°28'9.02"	007°13'14.74"
S7	36°28'19.91"	007°12'49.19"
S8	36°28'5.70"	007°12'43.90"

Fig. 1. Location of the study area (Bouhamdane Dam, Guelma)

2. Sampling procedure

A total of 126 specimens of *S. lucioperca* were collected monthly from different areas of the reservoir from November 2019 to April 2020. The fish were captured with a trammel net of 50m in length and a little more than 1m drop (internal mesh 10cm; external mesh 23cm). Fish samples captured at the reservoir were transported to the laboratory in a cooler with an internal temperature not exceeding 4°C. For each individual, the following parameters were recorded: total length and standard length (TL and SL; to the nearest 0.1cm), total weight (TW; to the nearest 0.01g), eviscerated weight (EW; to the nearest 0.01g). Sex and maturity stage were identified by macroscopic observation of the gonads according to the five-point scale of **West (1990)**. The measurement methods were well adapted to the characteristics of the species studied in order to limit the causes of errors and to provide results as precise as possible with the maximum yield. The determination of the age of the captured fish was realized by scale-reading, six to eight scales per fish were taken from below the left pectoral fin. Scales cleaned and mounted between two glass slides and observed under an optical microscope with constant magnification. The FISAT II software allowed us to establish the length and age frequency distribution for the study of the population structure of *S. lucioperca* in the Hammam Debagh Dam.

2. Age and growth

The FiSAT II program, version 1.2.2 **(Gayanilo *et al.*, 2005)** was used to estimate growth parameters using the equation of **von Bertalanffy (1938)**: $TL = L\infty \times (1 - e^{-K(t-t_0)})$, where *TL* is the total length at age t, $L\infty$ is the asymptotic length, *K* is the growth coefficient and *t0* is the theoretical age at length zero. t_0 was obtained from the study of **Pauly (1980)** with reference to the empirical expression; where, $\mathbf{Log}(-t_0) = -0.3922 - 0.2752 \log L\infty - 1.038\, logK$

3. Length-weight relationship

The length-weight relationship (TL-TW) was calculated according to **Froese (2006)** using the equation of $W = a \times TL^b$, where *W* is the weight of fish in grams; *TL* is total length in centimeters; '*a*' is constant, and '*b*' is slope. The difference in the height-weight relationship between the sexes was tested by ANCOVA test, and the isometric growth hypothesis was addressed by t-test. The growth performance index **(Pauly & Munro, 1984)**, $\varphi' = \log K + 2 \log L\infty$, was calculated to compare the results obtained in this study with results published elsewhere.

Sex ratio

The sex-ratio of the Pikperch was calculated globally, monthly, and by length class intervals of 5cm, then compared using the chi-square test (χ^2).

RESULTS

Length-frequency distribution

As shown in Fig. (2), the size frequency distribution reveals that the size class of 35 – 39cm individuals dominated the catches (33.33%), followed by size groups of 39- 43, 31- 35, and 43- 47cm corresponding to 30.16, 19.84, and 7.94% of the total lengths, respectively. It was noted that individuals from the middle class (between 31 and 47cm) were the most fished and best represented.

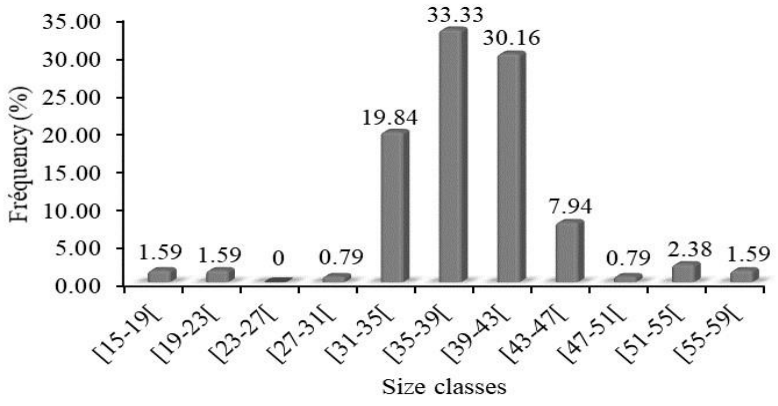


Fig. 2. Length-frequency distribution of *Sander lucioperca* from Hammam Debagh Dam

Age Determination

The scalimetry method enabled us to decompose all the specimens of *S. lucioperca* captured in the Hammam Deagh reservoir into eight age classes (from 0^+ to 7 years) (Fig. 3). The age class of 4 years was dominant for the total population (F = 48.74%), followed

by 3 years (F = 42.02%), while the lowest frequency was recorded for individuals less than one year old, with a value of 0.79%.

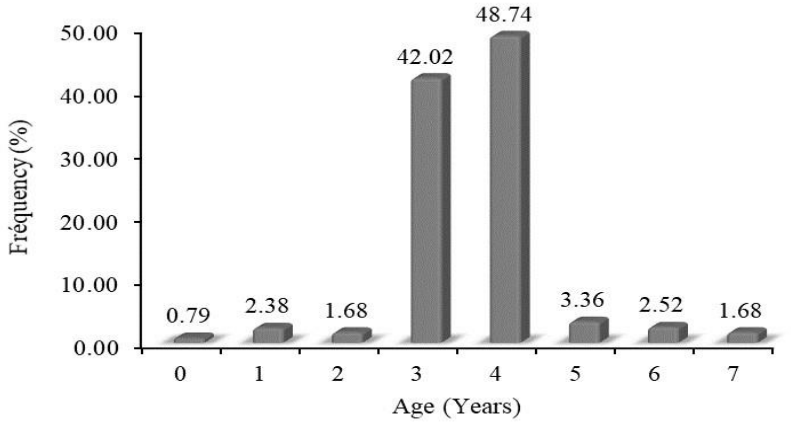


Fig. 3. Age-frequency distribution of *Sander lucioperca* from Hammam Debagh Dam

Linear growth

The parameters of the von Bertalanffy model were L∞ = 61.86cm, k = 0.3, t0 = -0.52. The performance index (φ') calculated was 3.06. These were estimated from the observed age- length pairs. The asymptotic length calculated from the scales (L∞ = 61.86cm) was in perfect agreement with the maximum length observed in the total population (TL = 57.1cm). According to the von Bertalanffy model, the equation of the linear curve is TL = 61.86 $(1-e^{-0.3\ (t+0.52)})$. The theoretical total length observed and the corresponding theoretical annual elevation are shown in Fig. (4).

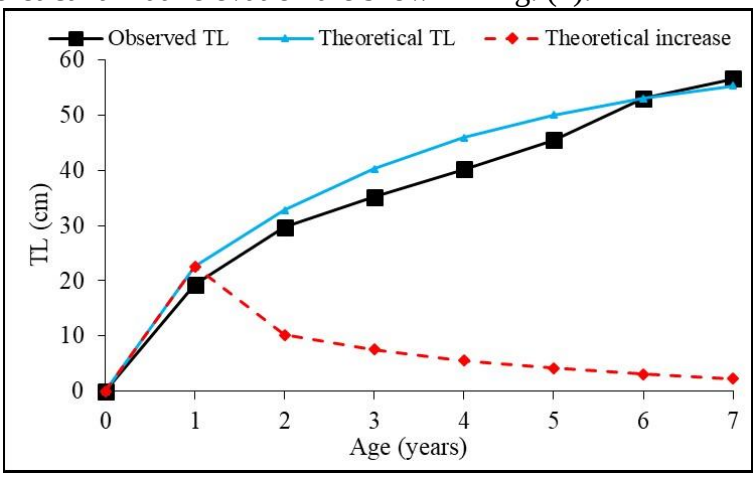


Fig. 4. Linear growth of *Sander lucioperca* from Hammam Debagh Dam

Length-weight relationship

The relationship between total length and total weight was plotted for males, females, and sexes combined (Fig. 5). The study of the length-weight relationship of *S. lucioperca* from Hammam Debagh reservoir shows a significant correlation coefficient ($0.88 \leq r \leq 0.94$; $P < 0.05$). A positive allometry was observed for males and global population between the total weight and the total length of the fish, with a slope equal to 3.25 (*t*-test= 2.03) and 3.28 (*t*-test= 2.42), respectively (Table 1), while the females presented an isometric growth between the total weight and the total length with slope

equal to 3.33 (*t*-test = 1.57). The ANCOVA test showed no significant difference between the sexes' slopes of the length-weight relations (F = 3.445, P> 0.05).

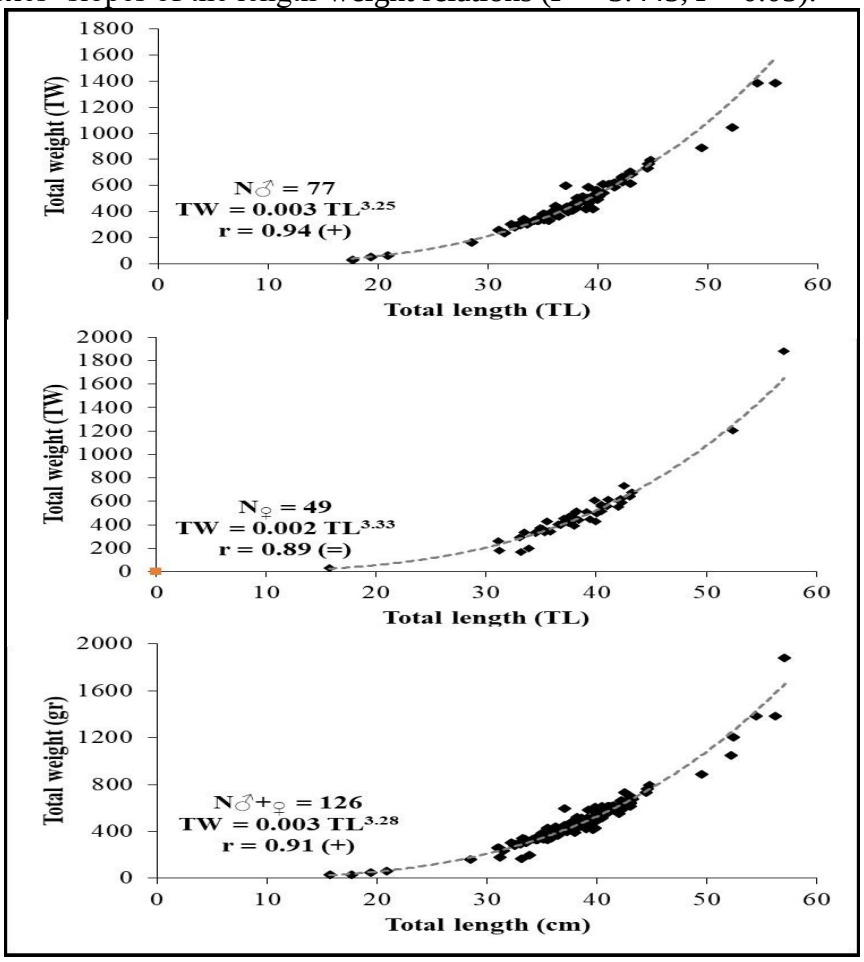


Fig. 5. Length-Weight relationship of *Sander lucioperca* from Hammam Debagh Dam

Table 1. Length-weight relationship of the *S. lucioperca* in Hammam Debagh reservoir (=: Isometric allometry, +: Positive allometry)

Sex	N	r	Mean ± SD	Length-weight relation	t-test & allometry	Linear value(cm) & weight (g) limit
Males	77	0.94	484.1818 ± 22.8577	$TW = 0.003TL^{3.25}$	2.03 (+)	17.7 ≤ TL ≤ 56.2 cm 30 ≤ TW ≤ 1387 g
			444.0779 ± 21.2262	$EW = 0.003TL^{3.30}$	2.49 (+)	26 ≤ EW ≤ 1341 g
Females	49	0.89	483.1448 ± 26.7218	$TW = 0.002TL^{3.33}$	1.57 (=)	15.7 ≤ TL≤ 57.1 cm 29.1 ≤ TW ≤ 1883 g
		0.88	441.3979 ± 25.2536	$EW = 0.002TL^{3.43}$	1.98 (+)	25.5 ≤ EW ≤ 1771g
Total	126	0.91	483.7785 ± 24.4332	$TW = 0.003TL^{3.28}$	2.42 (+)	15.7 ≤ TL ≤ 57.1cm 29.1 ≤ TW ≤ 1883 g
			443.0357 ± 22.8772	$EW = 0.002TL^{3.35}$	2.97 (+)	25.5 ≤ EW ≤ 1771g

Weight growth

Knowing the main parameters of the von Bertalanffy model (L∞, K, to) and the allometry coefficient of the height-weight relationship (b), the absolute weight growth model is written as follows: $TW= 2253.9578\ [1\text{-}e^{-0.3(t-0.56)}]^{3.28}$. The asymptotic weight

(W∞ = 2253.9578 g) was slightly higher than the maximum observed weight (EW = 1771 g). In the total population of this species, the weight increase was equal to 726.99g/ year during the first year, and then the weight gain decreases to 344.28g/ year during the following year, reaching a minimum during the seventh year (93.82g/ year) (Fig. 6).

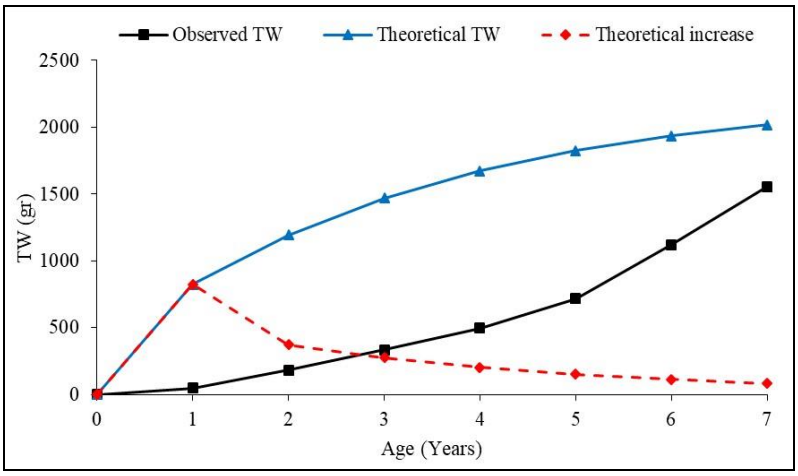


Fig. 6. Weight growth of *Sander lucioperca* from Hammam Debagh Dam

Sex ratio

The study of the overall sex ratio of *S. lucioperca* shows an imbalance in favor of males (61.11%) compared to females (38.89%). The overall sex ratio was SR = 1.57:1 (male:female); and the chi-square-test showed a significant difference compared to the 1:1 ratio (χ^2 = 6.22; P< 0.05) in favor of males. The monthly variation of the sex ratio was constant throughout the study period, except in March when males dominate (SR = 3: 1 ; χ^2 = 6.00 ; P< 0.05) (Fig. 7). The distribution of the sexual situations according to the size was carried out by grouping the specimens in size class of 5cm of interval going from 15.7 to 57.1cm. The evolution of the sex ration according to the size of the fish shows no significant difference between males and females (0.806 ≤ χ^2 ≤ 2.123 ; P> 0.05).

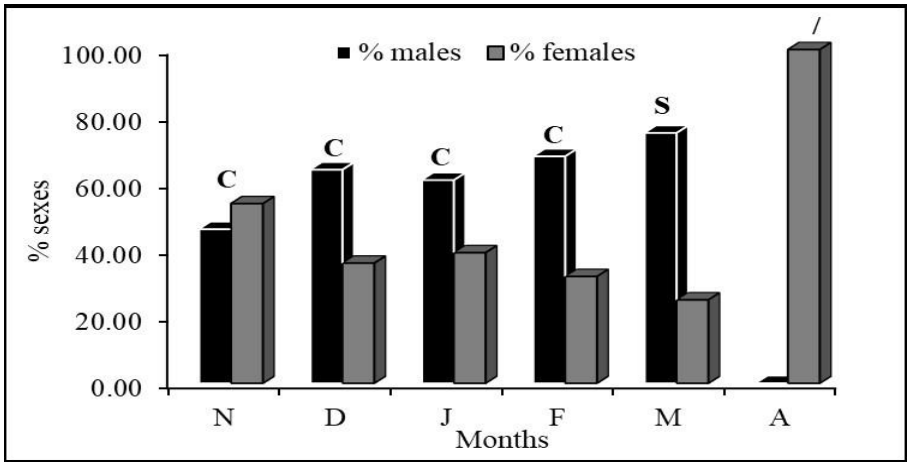


Fig. 7. Monthly variation of the sex ratio of *Sander lucioperca* from Hammam Debagh Dam

DISCUSSION

The determination of age is essential to comprehend the biology of the fish, through which solutions for various problems can be attained concerning fish research and management **(Van Oosten, 1941; Guettaf *et al.*, 2019)**. It is by studying the age of the fish and their mortality that we will know the importance of various age classes of a population. On this knowledge, the basis for predictions about the size of the possible catches and the necessary modifications to the regulations can be assessed. We can hardly study the biology of fish without knowing their age. The definition of particular groupings of the same species or of a single population must take into account this character, we cannot finally observe and interpret the course of the biological phenomena (growth, sexual evolution), without knowing their age **(Bouchereau, 1981)**. The analysis of the percentage of Pikeperch catches by age groups indicates that the juveniles released into the reservoir in 2012 were only 6 months old on average, and that is practically the first recruitment of Pikeperch taken place in 2015, three years after its introduction into the reservoir after the spawners reached sexual maturity **(Lappalainen *et al.*, 2003)**. In addition, the age group, born in 2016 completed 4 years at the date of capture, dominates the population stock. This can be explained by a second recruitment to which an operation of the introduction of hundreds of thousands of fertilized eggs in the reservoir is added, coming from an operation of artificial reproduction of the Pikeperch successful for the first time in the country. On the other hand, the comparison of the results of the relative frequency of the younger groups gives us a value index on an under-exploitation, whereas the scarcity of the older groups in the catches could be an indication of an over-exploitation. Thus, it can be conclude that these variations can occur, also, under the influence of the selectivity of the catching gears and the fishing pressure on certain age classes of the species.

The females caught ranged from 15.7 to 57.1cm in total length, and the males fluctuated from 17.7 to 56.2cm. The total weight of females varied between 29.1 and 1883g, and that of males is between 30 and 1387g. The parameters a and b of the size-weight relationship are very sensitive to the number of monthly samples and the size composition of each sample **(Fréon, 1988)**. Thus, the relationship between length and weight in both sexes combined was highly correlated ($r = 0.91$; $P < 0.05$). From Fig. (5), it can be seen that regardless of the size of the species, the scatterplot is not dispersed, which suggests that the length-weight relationship is governed by the same correlation for all sizes. The value of the allometry coefficient for both sexes combined is $b = 3.28$, derived from the relationship $W = 0.003Lt^{3.28}$. This value was almost identical to values obtained in previous works conducted in different regions for the same species of *S. lucioperca* in three Tunisian regions recording the following values: $b = 3.06$ for the reservoir of Sidi Salem, 3.07 for that of Nebhana, and 3.07 for Lebna **(M'hetli *et al.*, 2011)**. In Algeria, at Hammam Debagh Dam, they found a negative allometry for males and sex combined ($b = 2.852$ and 2.805, respectively) **(Rezaiguia *et al.*, 2023)**. On the other hand, at the Ghrib reservoir, **Bouamra *et al.* (2017)** found a value of $b = 3.23$. In France at the Treignat reservoir, **Argillier *et al.* (2003)** found a value of $b=3.25$. **Milardi *et al.* (2011)** calculated $b=3.37$ in Sahajarvi Lake in southern Finland, and **Pérez Bote and Roso (2012)** found a value of $b=3.16$ in the Alcantara reservoir in southern Spain. This positive allometry indicates that growth in weight was faster than growth in length.

It is thought that some ecological differences such as their presence, stomach fullness, temperature and food may also affect the b value, as stated by **Le Cren (1951)**. The value of b in the length-weight relationship also changes seasonally as a function of the gonadal development of the fish. Thus, the ANCOVA test applied to compare the slope of the height-weight relationship between the two sexes allowed us to find that there was no significant difference between the slopes of the two sexes for the TL-TW relationship (F = 3.445, P = 0.070). Whereas, there was a significant difference between the slopes of the two sexes for the TL-EW relationship (F= 5.329; P = 0.026).

The growth rate of Pikeperch in Hammam Debagh Dam (φ' = 3.06), which seems to be above average, agrees well with other values obtained in different regions as shown in Table (2). Hence we can quote, for example, the results obtained by **Berg (1949)**, **Belyaeva *et al.* (1989)** in Volga River (Russia), **Cernisencu and Staras (1992)** and **Staras *et al.* (1993)** in Danube Delta, Razim Lake (Romania), **Bouamra *et al*. (2017)** in Ghrib reservoir (Algeria), and **Rezaiguia *et al.* (2023)** in Hammam Debagh Dam. The asymptotic length (L∞ = 61.86cm) seems to be very close to the value of the maximum length reached by the species studied L_{max} = 57.1cm. However, it appears significantly low compared to previously published data, where **Bouamra *et al.* (2017)** found 98.5cm at the Ghrib reservoir and 78.0cm at the Cap Djinet reservoir (Algeria), and significantly superior to the value recorded by **Rezaiguia *et al.* (2023)** in Hammam Debagh Dam (L_{max} = 45.3 cm; L∞ = 48.3 cm). In the European regions, **Berg (1949)** found L∞ = 102cm at the Volga River (Russia), **Becer and İkiz (1999)** found L∞ = 112.19 at Lake Eğirdir (Turkey), and **Argillier *et al.* (2003)** found L∞ = 98.60cm at the Castillon reservoir. The geographical variations noted with the results of some authors are probably due to the quality of the sampling, the methods used as well as the fluctuations of the physico-chemical parameters of the environment, the fish density and the trophic capacity **(Djemali, 2005)**.

In the total population of *S. lucioperca* from Hammam Debagh reservoir, the maximum theoretical sizes (55.37cm) are close to those observed (57.1cm). The maximum length observed in the present study is significantly greater than that observed by **Rezaiguia *et al.* (2023)** for zander (45.3cm) in the same area. The annual growth rate is high during the first year (22.61cm) and tends to decrease progressively between the second (10.17cm) and the seventh year when it reaches its lowest values (2.26cm). The absolute weight growth model is written as follows: $Pt= 2253.9578\ [1-e^{-0.3(t-0.56)}]^{3.28}$. The asymptotic weight (P∞ = 2253.95g) is slightly higher than the maximum observed weight (Pe = 1771g). In the total population of this species, the weight increase is equal to 824.002g/ year during the first year, and then the weight gain decreases (370.61g/ year) during the following year, reaching a minimum value during the seventh year (82.69g/ year). It has been reported that the fish growth responds to variability in environmental factors, such as temperature, salinity, oxygen & food availability; it also responds to population density **(Pauly *et al.*, 2010; Brunel *et al.*, 2013; Cheung *et al.*, 2013; Baudron *et al.*, 2014)**. A positive correlation between water temperature and Pikeperch growth has been reported by various authors **(Draulans *et al.*, 1985; Ložys, 2004)**. Concerning latitude, large differences in growth rates of Pikeperch populations in other European water bodies have been reported by **Lehtonen *et al.* (1996)**. Moreover, the growth rate can also be affected by biotic factors. These include the availability of food and the abundance of populations of the same or other species. Food availability is a

limiting factor for anabolic processes **(Brett, 1979; Basilone *et al.*, 2004)**. Some authors **(Sandström & Karås, 2002; Keskinen & Marjomäki, 2003)** demonstrated that Pikeperch are favored in highly eutrophic and turbid systems, as they have visual adaptations that improve their foraging ability in turbid environments. As a result, the available information suggests that population density and food availability associated with higher water temperature hurt growth rates and have a positive effect on asymptotic lengths of the pikeperch in the Hammam Debagh Dam.

Table 2. Comparisons of the pikeperch growth parameters ($L\infty$, k, t_0) and growth performance index of (φ')

Area	n	$L\infty$	K	t_0	φ'	Reference
Hammam Debagh Dam (Algeria)	362	48.3	0.63	-0.22	3.16	(Rezaiguia *et al.*, 2023)
Ghrib reservoir (Algeria)	100	98.5	0.25	- 0.31	3.31	(Bouamra *et al*., 2017)
Cap Djenet reservoir (Algeria)	73	78.0	0.27	- 0.49	-	
Treignat reservoir (France, September)	28	74.40	0.07	–	2.62[a]	(Argillier *et al*., 2003)
Castillon reservoir (France, May)	31	98.60	0.03	-	2.46[a]	(Argillier *et al*., 2003)
Lake Sahajarvi (Finland)	201	65.28	0.11	-0.12	2.67[a]	(Milardi *et al*., 2011)
Volga River, near Tetyushi (Russia)	-	102.00	0.108	- 0.42	3.05	(Berg, 1949)
Volga River (Russia)	-	79.00	0.19	- 1.39	3.07	(Belyaeva *et al*., 1989)
Danube Delta, Razim Lake (Romania)	-	89.80	0.15	–	3.08	(Staras *et al*., 1993)
Danube Delta, Sinoe Lake (Romania)	-	91.10	0.14	-	3.07	(Cernisencu & Staras, 1992)
Eğirdir Lake (Turkey) (female)	328	112.19	0.07	- 1.70	2.95[a]	(Becer & Ikiz, 1999)
Eğirdir Lake (Turkey) (male)	344	94.86	0.09	- 1.31	2.91[a]	(Becer & Ikiz, 1999)
Eğirdir Lake (Turkey)	705	95.4	0.084	- 1.563	0.99	(Balik *et al.*, 2004)
Caspian Sea (Iran)	-	55.05	0.15	- 2.59	2.66[a]	(Abdolmalaki & Psuty, 2007)
Faldeberger Haussee Lake(Germany)	497	81.8	0.24	- 0.01	3.21	(Wysujack *et al.*, 2002)
Alcantara reservoir (Spain)	285	97.15	0.15	-0.91	2.67	(Pérez-Bote & Roso, 2012)
Guelma (Northeast Algeria)	**126**	**61.86**	**0.3**	**- 0.52**	**3.06**	**This study**

[a] values calculated from published data.

Contrary to the results of the data published by **M'hetli *et al.* (2011)** in Tunisia where the overall sex ratio for 576 specimens was 47/53 (males/ females), or the study conducted by **Pérez Bote and Roso (2012)** at the Alcántara reservoir in southern Spain, which showed that the number of females was greater than the number of males, the sex ratio of the Pikeperch in Hammam Debagh reservoir (61.11 males, 38.89 females) is almost similar to that reported by **Kamilov *et al.* (2017)** at Tudakul reservoir in Usbekistan, where the number of males is higher than the number of females (45.49 males, 45.50 females). The sex ratio observed was balanced between the two sexes until February and then shifted to female dominance during March, which coincides with the

spawning period (March-July). For the study of sex ratio as a function of size, we find that males are dominant in all size classes up to 55cm total length. In the larger size classes above 55cm (between 55 and 60cm), the balance between males and females is restored. According to the χ^2, the difference between the percentages of the two sexes is insignificant at the 5% threshold for the different months, except for the month of March that recorded a significant difference. Indeed, the χ^2 calculated for this month ($\chi^2 = 06.00$) is well above the theoretical χ^2 ($\chi^2 = 3.84$).

CONCLUSION

In general, the present study allowed to conclude that this species is adapted to the Hammam Debagh Dam, however the biological and ecological data of the latter would be insufficient for the sampling period. Hence, the need for trolling is a must for at least an entire annual cycle to properly determine the growth rate, the mortality rate, the feeding ethology, the precise period of spawning and the lethal values of the different parameters, notably physicochemical, acting on the growth and reproduction of this species. In the same way, the scientific approach must be directed toward the estimation of the biogenic capacities and toward the estimation of the biomass by improving the estimator; that is to say the technique and the fishing gears. Concerning the aquatic environment, strict control of the pollution must be carried out in order to avoid the destruction of the site. In addition, the work must be oriented toward the reasons for the relative planktonic poverty of the site by proposing an experimental protocol: fortnightly haul (phytoplankton and zooplankton) and at different depths. Additionally, for the dosage of different chemical constituents of the reservoir water, heavy metals, and mineral salts, it is necessary to have an estimate on the average quantities of these elements in the water. This species has high nutritional value appreciated by consumers and is a noble species, which has adapted well to environmental conditions of the stydy area, and it is therefore encouraging for aquaculture.

REFERENCES

Abdolmalaki, S. and Psuty, I. (2007). The effects of stock enhancement of pikeperch (Sander lucioperca) in Iranian coastal waters of the Caspian Sea. ICES Journal of Marine Science, 64: 973-980.

ANDP. (1991). Agence Nationale pour le Développement de la Pêche.

ANRH. (2008). Agence Nationale des Ressources Hydrauliques – Etude générale des crues du Nord de l'Algérie, Modélisation des débits de crue, Juillet 2008, 73 p.

Argillier, C.; Barral, M. and Irz, P. (2003). Growth and diet of the pikeperch *Sander lucioperca* (L.) in two French reservoirs. Fisheries & Aquatic Life, 11: 99-114.

Bacha, M. and Amara, R. (2007). Les poissons des eaux continentales d'Algérie. Étude de l'ichtyofaune de la Soummam. Cybium, 31: 351-358.

Balik, İ.; Özkök, R.; Çubuk, H. and Uysal, R. (2004). Investigation of some biological characteristics of the silver crucian carp, Carassius gibelio (Bloch 1782) population in Lake Eğirdir. Turkish Journal of Zoology, 28: 19-28.

Basilone, G.; Guisande, C.; Patti, B.; Mazzola, S.; Cuttitta, A.; Bonanno, A. and Kallianiotis, A. (2004). Linking habitat conditions and growth in the European anchovy (*Engraulis encrasicolus*). Fisheries Research, 68: 9-19.

Baudron, A.R.; Needle, C.L.; Rijnsdorp, A.D. and Tara Marshall, C. (2014). Warming temperatures and smaller body sizes: synchronous changes in growth of North Sea fishes. Global change biology, 20: 1023-1031.

Becer, Z.A. and İkiz, R. (1999). Eğirdir Gölü sudak (*Stizostedion lucioperca* L., 1758) populasyonunun büyüme özellikleri. Turkish Journal of Zoology, 23: 215-224.

Belyaeva V, Kazancheev E, Raspopov V 1989. The Caspian Sea: Ichthyofauna and commercial resources. House Nauka, Moscow.

Berg, L.S. (1949). Freshwater fishes of the USSR and adjacent countries. Israel program for scientific translations, Jerusalem, 2: 496.

Bouamra, A.; Belaifa, B.; Chaoui, L.; Kara, M.H. and Arab, A. (2017). Age and growth of Pikeperch *Sander lucioperca* (Percidae) in the Ghrib reservoir (Northwest Algeria). Revue d'Ecologie, Terre et Vie, 72: 83-93.

Bouchereau, J.L. (1981). Contribution a l'etude de la biologie et de la dynamique de la population exploitee de *Sardina pilchardus* (Walbaum 1972) dans la Baie d'Oran (Algerie).

Brett, J. (1979). Environmental factors and growth. Fish physiology, 8: 599-675.

Brunel, T.; Ernande, B.; Mollet, F.M. and Rijnsdorp, A.D. (2013). Estimating age at maturation and energy-based life-history traits from individual growth trajectories with nonlinear mixed-effects models. Oecologia, 172: 631-643.

Carfagnini, A.G.; Rodd, F.H.; Jeffers, K.B. and Bruce A.E. (2009). The effects of habitat complexity on aggression and fecundity in zebrafish (Danio rerio). Environmental Biology of Fishes, 86: 403-409.

Cernisencu, I. and Staras, M. (1992). Valorificarea durabila a resurselor piscicole–pricipiu de baza in practicarea pescutului in Delta Dunarii. Analele Stiintifice ale Institutului-Delta Dunarii.

Cheung, W.W.; Sarmiento, J.L.; Dunne, J.; Frölicher, T.L.; Lam, V.W.; Deng Palomares M.; Watson, R. and Pauly, D. (2013). Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems. Nature Climate Change, 3: 254-258.

Djemali, I. (2005) Evaluation de la biomasse piscicole dans les plans d'eau douce tunisiens: approches analytique et acoustique. Institut National Agronomique de Tunisie/Institut National des Sciences.

Draulans, D.; van Vessem, J. and De Bont, A.F. (1985). Effects of heating on growth and condition of pikeperch (*Lucioperca lucioperca*) in lowland ponds created by sand extraction. Hydrobiologia, 122: 213-217.

Fréon, P. (1988). Réponses et adaptations des stocks de clupéidés d'Afrique de l'ouest à la variabilité du milieu et de l'exploitation: Analyse et réflexion à partir de l'exemple du Sénégal.

Froese, R. (2006). Cube law, condition factor, and weight-length relationships: History, meta-analysis, and recommendations. J. Appl. Ichthyol., 22: 241-253.

Gayanilo, F.; Sparre, P. and Pauly, P. (1996). Fisat: fao-iclarm stock assessment tools. user's manual. Computerized Information Series: Fisheries (FAO).

Gayanilo, F. C.; Pauly, D. and Sparre, P. (2005). FISAT User's Guide. FISAT II. En ligne : http//www.fao.org/fi/statist/fisoft/fisat/downloads.

Gröger, J.P.; Winkler, H. and Rountree R.A. (2007). Population dynamics of pikeperch (*Sander lucioperca*) and its linkage to fishery driven and climatic influences in a southern Baltic lagoon of the Darss-Zingst Bodden Chain. Fisheries Research, 84: 189-201.

Guettaf, M.; Rachedi, M.; Gueroui, Y.; Bousbia, A.; Chelaghmia, M.A. and Maoui A. (2019). Age and growth of common bream, *Abramis brama* (L.), caught at Hammam Debagh Reservoir (Guelma, northeast Algeria). Fisheries & Aquatic Life, 27.

Jůza, T.; Mrkvička, T.; Blabolil, P.; Čech, M.; Peterka, J.; Vašek, M. and Kubečka J. (2013). Occurrence of age-0 year dwarf pikeperch *Sander lucioperca* in late summer–an overlooked phenomenon in reservoirs. Journal of Fish Biology, 83: 1444-1452.

Kamilov, B.; Mirzayev, U. and Mustafayeva, Z. (2017). Age and growth of pikeperch (*Sander lucioperca* (L.)) in Tudakul reservoir, Uzbekistan. International Journal of Fisheries and Aquatic Studies, 5: 361-364.

Keskinen, T. and Marjomäki, T. (2003). Growth of pikeperch in relation to lake characteristics: total phosphorus, water colour, lake area and depth. Journal of Fish Biology, 63: 1274-1282.

Lappalainen, J.; Dörner, H. and Wysujack, K. (2003). Reproduction biology of pikeperch (*Sander lucioperca* (L.))–a review. Ecology of Freshwater Fish, 12: 95-106.

Larsen, L.K. and Berg, S. (2013). NOBANIS–Invasive Alien Species Fact Sheet *Stizostedion lucioperca*.

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, 201-219.

Lehtonen, H.; Hansson, S. and Winkler, H. (1996). Biology and exploitation of pikeperch, *Stizostedion lucioperca* (L.), in the Baltic Sea area. Annales Zoologici Fennici. JSTOR. pp 525-535.

Louamri, A. (2010). Contribution à l'évaluation des transports solides de l'Oued Bouhamdane à la station de Medjez Ammar II et au barrage de Hammam Debagh. International Network Environmental Management Conflicts, Santa Catarina–Brasil, 1:23-29.

Ložys, L. (2004). The growth of pikeperch (*Sander lucioperca* L.) and perch (*Perca fluviatilis* L.) under different water temperature and salinity conditions in the Curonian Lagoon and Lithuanian coastal waters of the Baltic Sea. Hydrobiologia, 514: 105-113.

M'hetli, M.; Ben Khemis, I.; Hamza, N.; Turki, B. and Turki O. (2011). Allometric growth and reproductive biology traits of pikeperch *Sander lucioperca* at the southern edge of its range. Journal of Fish Biology, 78: 567-579.

Meddour, A.; Rouabah, A.; Meddour-Bouderda, K.; Loucif, N.; Remili, A. and Khatal, Y. (2005). Expérimentations sur la reproduction artificielle de Sander lucioperca, Hypophthalmichthys molitrix et Aristichthys nobilis en Algérie. Sci. Technol., 23: 63-71.

Milardi, M.; Lappalainen, J.; Malinen, T.; Vinni, M. and Ruuhijärvi, J. (2011). Problems in managing a slow-growing pikeperch (*Sander lucioperca* (L.)) population in Southern Finland. Knowledge and Management of Aquatic Ecosystems: 08.

Müller, T.; Bódis, M.; Urbányi, B. and Bercsényi M. (2011). Comparison of Growth in PikePerch (*Sander lucioperca*) and Hybrids of Pikeperch (*S. lucioperca*)× Volga Pikeperch (*S. volgensis*).

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 Fish stocks. J. Cons. Int. Explor. Mer., 39: 175-192.

Pauly, D.; Kinne, O. and Jorgensen B. (2010). Gasping fish and panting squids: oxygen, temperature and the growth of water-breathing animals.

Pauly, D.; Munro, J. (1984). Once more on the comparison of growth in fish and invertebrates. Fishbyte, 2: 1-21.

Pérez Bote, J. 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.

Poulet, N.; Arzel, C.; Messad, S.; Lek, S. and Argillier C. (2005). Diel activity of adult pikeperch *Sander lucioperca* (L.) in a drainage canal in the Mediterranean basin during spring. Hydrobiologia, 543: 79-90.

Power, M. (1987). Predator avoidance by grazing fishes in temperate and tropical streams: importance of stream depth and prey size. Predation: direct and indirect impacts on aquatic communities: 331-351.

Rahmdel, K.J. and Falahatkar B. (2021). Adaptation of pikeperch () to formulated diets: A review. Fisheries & Aquatic Life, 29: 1-12.

Rezaiguia, W.; Oudainia, S.E.; Kaizouri, M.; Allalgua, A.; Khacha, 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(12): 3355-3369.

Ricker, W.E. (1975). Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd. Can. 191: 1-382.

Sandströ , A. and Karås, P. (2002). Effects of eutrophication on young-of-the-year freshwater fish communities in coastal areas of the Baltic. Environmental Biology of Fishes, 63: 89-101.

Smith, P.; Leah, R. and Eaton, J. (1998). A review of the current knowledge on the introduction, ecology and management of zander, *Stizostedion lucioperca*, in the UK. Stocking and Introduction of Fish: 209-224.

Sokolov, L. and Berdicheskii, L. (1989). Acipenseridae. 150-153 p. The freshwater.

Staras, M.; Cernişencu, I. and Năvodaru, I. (1993). Contribuţii la cunoaşterea stării şi exploatării stocului de şalău (*Sitzostedion lucioperca* L) din lacul Razim, Analele Ştiinţifice ale Institutului Delta Dunării, Tulcea. Romania: 255-258.

Steinberg, K.; Zimmermann, J.; Meyer, S. and Schulz, C. (2019). Individual growth rates of pikeperch (*Sander lucioperca*) depending on water exchange rates in recirculating aquaculture systems. Aquaculture International, 27: 1025-1035.

Thomas, M.; Lecocq, T.; Abregal, C.; Nahon, S.; Aubin, J.; Jaeger, C.; Wilfart, A.; Schaeffer, L.; Ledoré, Y. and Puillet, L. (2020). The effects of polyculture on behaviour and production of pikeperch in recirculation systems. Aquaculture Reports, 17:100333.

Van Oosten, J. (1941). The age and growth of fresh-water fishes. A symposium on hydrobiology.

Vinni, M.; Lappalainen, J., Malinen, T. and Lehtonen, H. (2009). Stunted growth of pikeperch *Sander lucioperca* in Lake Sahajärvi, Finland. Journal of Fish Biology, 74: 967-972.

Von Bertalanffy, L. (1938). A quantitative theory of organic growth. Hum. Biol., 10: 181-213.

West, G. (1990). Methods of assessing ovarian development in fishes: a review. Aust. J. Mar. Freshw. Res., 41: 199-222.

Wysujack, K.; Kasprzak, P.; Laude, U. and Mehner T. (2002). Management of a pikeperch stock in a long-term biomanipulated stratified lake: efficient predation vs. low recruitment. Hydrobiologia, 479: 169-180.

Zar, J.H. (1999). Biostatistical analysis. ed. Princeton-Hall, New Jersey.