AgroLife Scientific Journal - Volume 11, Number 2, 2022
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

ASSESSMENT OF WATER QUALITY AND BIOMETRIC ANALYSIS FOR COMMON CARP *Cyprinus carpio* L., 1758: A CASE STUDY FROM BIȚINA POND (ILFOV COUNTY, ROMANIA)

Mala-Maria STAVRESCU-BEDIVAN, Roxana Maria MADJAR, Ionela Alexandra SION, Gina VASILE SCĂEȚEANU

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: ginavasile2000@yahoo.com

Abstract

Weight-length relationships (WLRs), Fulton's K condition factor and the size structure were investigated for common carp Cyprinus carpio (Linne, 1758) collected from Biţina 3 Pond – a freshwater ecosystem used for recreational fishing, located 40 km away from Bucharest.
Negative allometric growth was estimated for common carp as: $TW = 0.0563xTL^{2.7111}$; $TW = 0.2301 \times SL^{2.4175}$ (N = 30, November 2021). The values for condition factor K ranged between 1.44 and 2.67.
*Water samples were collected from 7 sampling points (SP) and were subjected to physico-chemical characterization. Consequently, it was determined the following parameters: pH, electrical conductivity (EC), total hardness (TH), chemical oxygen demand (COD), phosphate phosphorus ($P\text{-}PO_4^{3-}$) and nitrogen pollutant species: nitrate nitrogen ($N\text{-}NO_3^-$), nitrite nitrogen ($N\text{-}NO_2^-$) and ammonium-nitrogen ($N\text{-}NH_4^+$). Total hardness values present very significant correlation with conductivity (r=0.7305***) and distinct significant correlation with pH (r=0.5765**).*
The results indicated that water meets the requirements for optimal development of aquatic organisms.
This paper provides novel information on weight-length relationships, Fulton's K condition factor along with environmental parameters for Cyprinus carpio collected from freshwater ponds designed for sport fishing.

Key words: *Cyprinus carpio, fishing, growth type, pond, water quality.*

INTRODUCTION

Originally native to Asia, *Cyprinus carpio* Linnaeus, 1758 is considered nowadays the most cultivated carp species throughout the world (Khan et al., 2016).
The common carp represent a prized sport species in many European countries where is commonly stocked in fishing ponds (Ruchin, 2019).
In fishery assessment studies, weight-length relationships (WLRs) and condition factor (K) are essential tools to provide the growth type of all fishes and interactions between biotic and abiotic environmental factors (Stavrescu-Bedivan et al., 2016; Stavrescu-Bedivan et al., 2018; Khan et al., 2020).
Relatively few studies have been made concerning the growth characteristics of common carp and its adaptability to environmental conditions in Romania (Gheorghe et al., 2011; Petrea et al., 2017; Nistor et al., 2020; Bădilaș and Păsărin, 2021).
In terms of evaluating the ecosystem health, it was shown before the importance of monitoring the physico-chemical parameters of the water (Mitrănescu et al., 2007; Scăeţeanu et al., 2012) and length frequency distribution within of a fish population (Ranjan et al., 2005; Stavrescu-Bedivan et al., 2016).
The aim of the present survey was to investigate some biometric indices of *Cyprinus carpio* in relation to water quality parameters, in order to determine if common carp individuals find proper life conditions in the Pond Biţina 3 - a freswater resource intensively used for recreational fishing in Ilfov County.

MATERIALS AND METHODS

Study area

The Pond Biţina 3 (Balta Biţina 3) is located in Ialomiţa County (Figure 1), 40 km away from Bucharest and 15 km from Urziceni (44.480831 latitude, 26.114502 longitude GPS coordinates).

Bițina is a freshwater resource sought by anglers (Figure 2) because it is populated mainly with fish for consumption.
A fee is charged for 12 h and ensures obtaining 5 kg of fish for each fisherman (www.baltipescuit.com/).
This ecosystem has a medium size, with a length of about 800 m and the average depth of 3 m (www.pescarinformat.ro/).

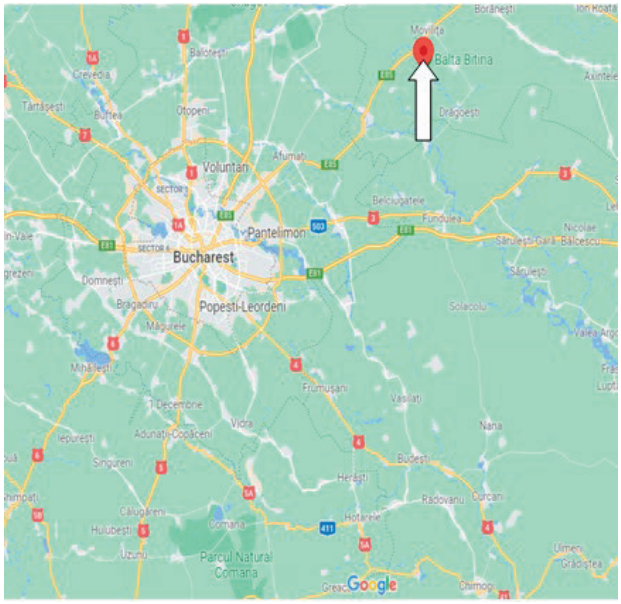

Figure 1. Bițina Pond located in Ialomița County (arrow) (map source: Google Maps)

The grass carps, Gibel carps and common carps are usually found in Bițina 3, the latter being caught in quite large quantities (www.traveleuropa.ro/).
According to administrator of Bițina 3, the fry is raised in fish farming pools from a size of 15-20 g, fed until it reaches a weight of 90-100 g, and then released into the pond; the catches of common carp start at 600 g and could reach 5 kg.
Each year, the fishing season starts on 15 August and ends on 1 December.
The water is flowing and fed from the Dridu dam. The history of Bițina ponds dates back to the time of the communist dictatorship in Romania, being since then a fish farm.

Fish collection and measurements

The specimens of *C. carpio* (N = 30, sex combined) were caught from Bițina 3 Pond in cold fishing season (November 2021) by using a fishing trawl. After sampling, fishes were measured and weighed fresh, directly at the place of their capture (Figure 3).

Figure 2. Recreational fishing in Bițina Pond (November 2021)

Figure 3. Determination of biometric parameters of fish specimens at Bițina Pond (November 2021)

Each *C. carpio* individual was analysed for total length (TL ± 1 mm), standard length (SL ± 1 mm) and weighted (TW ± 1 g). A CAS PB-150 portable bench scale was used. The weight-length relationships were expressed as $TW=aTL^b$ and $TW=aSL^b$ respectively, where intercept (a) describes the rate of change of weight with length and slope (b) gives information about the type of growth (Froese, 2006). The relationships between the weight and the length of fish were determined through linear regression (Log W= Log a + b Log L) (Stavrescu-Bedivan et al., 2016; Stavrescu-Bedivan et al., 2018).
When $b > 3$, a positive allometric pattern of growth is suggested, while $b < 3$ represents a negative allometric or hypoallometric growth type (Karachle and Stergiou, 2012).
The Fulton's condition factor (K) calculated as $K= (TW/TL^3)*100$, was used to assess the overall health or well-being of fish population in their habitat (Nehemia et al., 2012; Khan et al., 2020).

Another studied parameter was size frequency distribution of fish. According to Innal (2012) and Stavrescu-Bedivan et al. (2015), size intervals for total length and total weight distribution of fish samples were established.

Water sampling and analyses

Water samples were collected from different points (Figure 4) of the Bițina 3 pond at about 45 cm below surface layer in labelled sterile recipients that were subsequently stored at 4°C for as short time as possible before analysis to minimize physical and chemical changes. The analyses were carried out within 48 hours of collection. All samples were allowed to stay until they reached room temperature before analysis which were performed in triplicates. The analyses were conducted as previously reported (Stavrescu et al., 2015), by using methods similar to those recommended for drinking water (Mănescu et al., 1994) and briefly listed in Table 1.

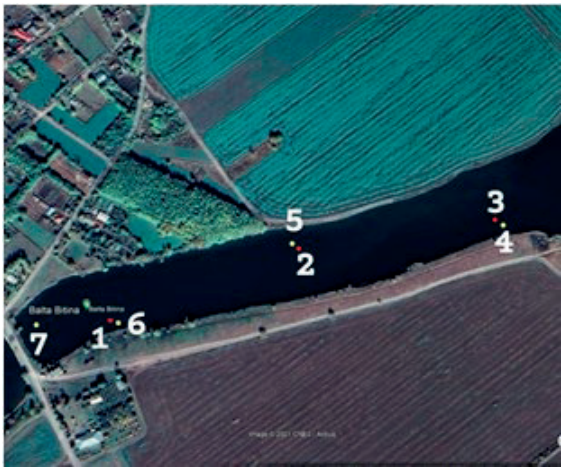

Figure 4. Locations of water sampling points from Bițina Pond (map source: Google Earth)

RESULTS AND DISCUSSIONS

Fish samples and biometric analysis

The biometric data were registered as: TL (min. 29.5 - max. 46.5 cm); SL (min. 24.5 - max. 41.5 cm, with a mean of 34.31 cm); TW (min. 645 - max. 2085 g, with average of 1241.17 g).

WLRs (Figure 5) were expressed as:

Log (TW) = 2.7111 Log (TL) - 1.2491 (r^2 = 0.8647, 95% confidence intervals for the intercept and the slope); TW = 0.0563 x $TL^{2.7111}$; Log (TW) = 2.4175 Log (SL) - 0.6381 (r^2 = 0.8517, 95% confidence intervals for the intercept and the slope); TW = 0.2301 x $SL^{2.4175}$.

Growth type for common carp caught in November 2021 was determined as negative allometric, since b < 3. The values for slope (b) were within the expected range of 2.5-3.5 for all fish analyzed individuals. The negative allometric type of growth suggests that fish increase in length rather than in body thickness.

Fulton's condition factor K has a mean value of 1.98 (min. 1.44- max. 2.67).

For the carp individuals from the CM Lunca irrigation canal, Nistor et al. (2020) postulated a very good and exceptive state of maintenance, in the case of Fulton condition factor ranging from 2.1 and 2.4.

According to FishBase, the common total length for *Cyprinus carpio* is 31 cm.

In Bițina 3 Pond, the value of total length of most *C. carpio* individuals (73.33%) collected in November 2021 ranged between 34.1 and 46 cm, while 16.67% of fishes measured between 28.0 and 34.0 cm. The majority of *C. carpio* (43.33%) registered values of total weight ranging between 645 and 955 grams.

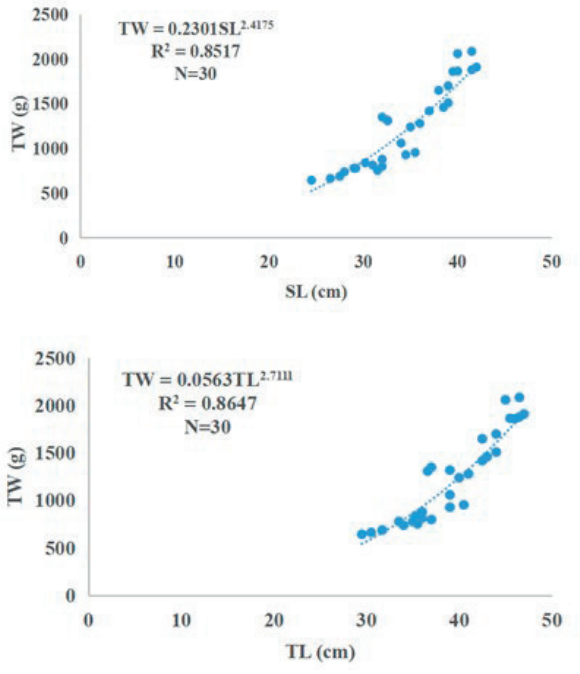

Figure 5. LWRs of the common carp in Bițina Pond (November 2021)

Determining the length of the fish was considered to be more biologically relevant than age (Kalaycı et al., 2007; Rosli and Isa, 2012; Stavrescu-Bedivan et al., 2016).

Many factors such as sexual maturity age, food, environmental conditions, size of captured specimens, sample size, sampling methods could influence the fish condition and parameters of length-weight relationship in fish (Stavrescu-Bedivan et al., 2016; Famoofo and Abdul, 2020).

Water quality analyses

The results of the analyses and the assignment of quality classes for surface waters according to legislation (Directive 2000/60/EC; Order 161/2006) are presented in Table 2 and Figure 6, respectively.

a) Results concerning pH, EC and TH

For aquatic organisms, **pH** is an important parameter that must be monitored because extreme values are difficult to be neutralized. Some authors (Alatorre-Jacome et al., 2011) consider that an ideal pH for aquacultural system, must be near 7, otherwise life of fish is affected. For example, pH values below 6.50 may reduce fish reproduction (Stone & Thomforde, 2004), meanwhile lethal limits are below 5 and above 10 for most of fish species (Alatorre-Jacome et al., 2011).

In the case of analyzed water samples collected from Biția 3 pond, pH values are between 7.25-7.41, which correspond to range (6.50-8.50) imposed by legislation (Order 161/2006). Moreover, these results are within limits associated with optimal growth of most fish species (Stone & Thomforde, 2004).

Most freshwater lakes and ponds have pH values between 6.00 and 8.00 (LENNTECH) and published data for other fish ponds from Romania reveal pH values (as average): 7.70 (Brănești fish pond) (Stavrescu-Bedivan et al., 2015), 8.33 (Tătaru fish pond) (Scăețeanu Vasile et al., 2019), 7.17 (Comana fish pond) (Stavrescu-Bedivan et al., 2021).

As concerning **EC** parameter, literature (Stone & Thomforde, 2004) indicate that optimal range for aquaculture is 100-2000 μS/cm and increase of this parameter is associated even with addition of fish food (Schenone et al., 2011).

Table 1. Performed analyses, analytical techniques and instrumentation

Analysis	Analytical technique	Instrumentation
pH	Potentiometry	InolabWTW pH-meter
Electrical conductivity (EC)	Conductometry	Hach SensIon7
Total hardness (TH)	Complexonometry	-
Chemical oxygen demand (COD)	Manganometry	-
Phosphate phosphorus ($P\text{-}PO_4^{3-}$)	Spectrophotometry	MetertekSP830 Plus spectrophotometer
Nitrate nitrogen ($N\text{-}NO_3^-$)		
Nitrite nitrogen ($N\text{-}NO_2^-$)		
Ammonium nitrogen ($N\text{-}NH_4^+$)		

Table 2. Results of the chemical analyses for water samples and assigned quality classes

Sampling point	pH	EC (μS/cm)	TH (mg CaO/L)	COD (mg O_2/L)	$P\text{-}PO_4^{3-}$ (mg P/L)	$N\text{-}NO_3^-$ (mg N/L)	$N\text{-}NO_2^-$ (mg N/L)	$N\text{-}NH_4^+$ (mg N/L)
SP1	7.41	851	18.62	6.36	BDL	0.84	BDL	0.55
SP2	7.39	826	18.28	5.88	BDL	0.91	BDL	0.47
SP3	7.34	810	18.28	5.87	BDL	0.83	BDL	0.49
SP4	7.31	809	17.72	5.79	BDL	0.90	BDL	0.54
SP5	7.38	819	17.92	5.79	BDL	0.85	BDL	0.51
SP6	7.25	815	17.72	5.49	BDL	0.82	BDL	0.60
SP7	7.36	801	17.97	5.67	BDL	0.82	BDL	0.54
Average	7.35	818.71	18.07	5.83 [II]	BDL[I]	0.85[I]	BDL[I]	0.53[II]
Range	7.25-7.41	801-851	17.72-18.62	5.49-6.36	-	0.82-0.91	-	0.47-0.60

Values between square brackets represent quality classes for surface water according to Order 161/2006; BDL - below detection limit.

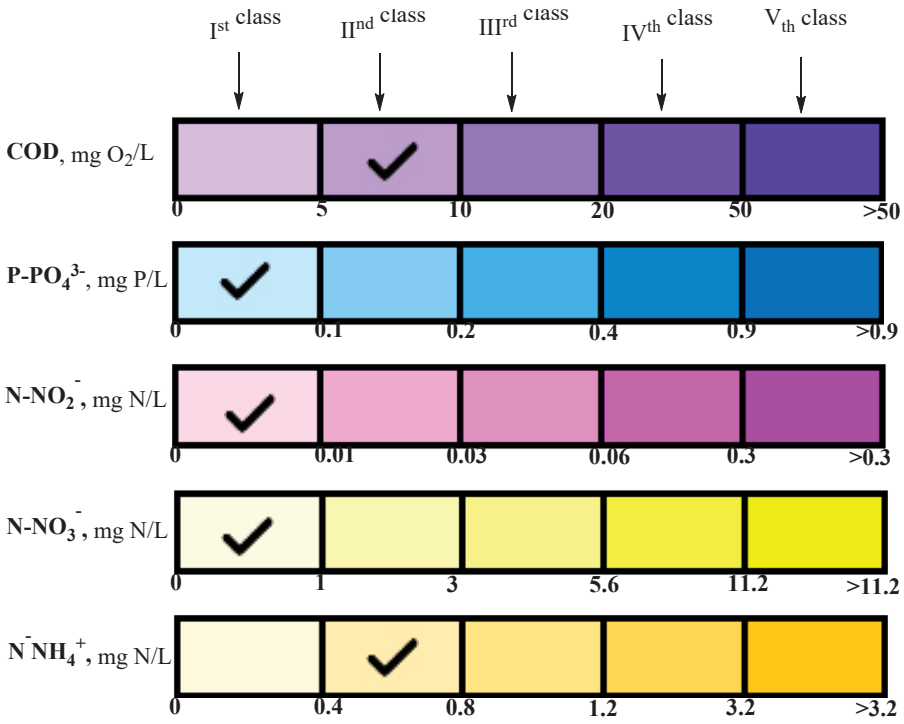

Figure 6. Quality classes for surface water according to legislation and assigned quality classes for water from Biția 3 pond

Analyses indicated for Biția 3 pond EC values between 801-851 µS/cm, higher than those reported for Tătaru fish pond (653-760 µS/cm) (ScăețeanuVasile et al., 2019) and Comana fish pond (645-705 µS/cm) (Stavrescu-Bedivan et al., 2021), but lower than those found for Brănești fish pond (1105-1156 µS/cm) (Stavrescu-Bedivan et al., 2015).

TH values for Biția 3 pond are between 17.72-18.62 mg CaO/L similar with those reported for Comana fish pond (15.59-17.50 mg CaO/L) (Stavrescu-Bedivan et al., 2021) but lower than those reported for Tătaru fish pond (34.22-47.12 mg CaO/L) (Scăețeanu Vasile et al., 2019). For aquaculture are recommended values between 28-84 mg CaO/L (Stone & Thomforde, 2004) since there are references (Shaw et al., 2004) which state that hard water lakes (67.1-100 mg CaO/L) tend to produce more fish and aquatic plants than soft water lakes (<34 mg CaO/L).

The analysis of the results indicated that conductivity (µS/cm) presents very significant correlation with total hardness (mg CaO/L) with correlation coefficient r=0.7305***. Between pH values and total hardness (mg CaO/L) it has been evidenced distinct significant correlation with r=0.5765** (Figure 7).

b) Results concerning COD

COD is a useful indicator of organic pollution of water, being defined as amount of oxygen that oxidizes organic species of earthly origin or by anthropogenic sources. Usually clean water has COD between 2-4 mg O_2/L. High values of COD indicate high levels of organic compounds and consequently, the high possibility of pathogenic microorganisms' presence (Cohl et al., 2014). For water samples collected from Biția 3 pond the analyses indicated 5.49-6.36 mg O_2/L, levels that correspond to IInd quality class for surface waters (Order161/2006). Based on reported COD values, water from Brănești fish pond (Stavrescu-Bedivan et al., 2015) and Tătaru fish pond (ScăețeanuVasile et al., 2019) was classified as IInd quality class, meanwhile water from Comana pond was associated with IIIrd quality class (Stavrescu-Bedivan et al., 2021).

c) Results concerning phosphate phosphorus

Even if phosphorus is an essential element form plant growth, elevated levels could produce eutrophication, reduces the amount of dissolved oxygen and endanger aquatic organisms (Scăețeanu Vasile et al., 2020).

For instance, it has been reported that body weight of cyprinids decreases with the increase of water phosphorus content (Jeppesen et al., 2000).
For water collected from Biția 3 pond the phosphorus levels were undetectable by spectrophotocolorimetry, therefore, it was assigned Ist quality class. A similar situation was reported for Brănești fish pond (Stavrescu-Bedivan et al., 2015) in contrast with Tătaru fish pond were the levels of phosphorus were so elevated that were associated with Vth quality class (Scăețeanu Vasile et al., 2019).

d) Results concerning nitrogen species

In ponds, nitrogen is found as organic and inorganic forms, the latter comprising nitrate (NO_3^-), nitrite (NO_2^-) and ammonium (NH_4^+) species. Nitrogen accumulation in fish ponds is an important matter because may lead to fish death and may contribute to eutrophication (Chen et al., 2017). Levels of inorganic nitrogen higher than 0.3 mg/L in spring are sufficient to support summer algae bloom (Shaw et al., 2004).
Water samples collected from Biția 3 pond contain low levels of nitrate nitrogen (0.82-0.91 mg N/L), undetectable nitrite nitrogen and ammonium nitrogen at levels (0.47-0.60 mg N/L) which correspond to IInd quality class.
Data regarding nitrogen species levels in water collected from Brănești fish pond, Tătaru fish pond and Comana pond has been previously published and may be accessed for thorough reading and comparisons (Stavrescu-Bedivan et al., 2015; Scăețeanu Vasile et al., 2019; Scăețeanu Vasile et al., 2020; Stavrescu-Bedivan et al., 2021).
According to literature (Camargo et al., 2005), nitrate toxicity to freshwater fishes increases with increasing nitrate levels and exposure times, but a maximum concentration of 2 mg N/L would be protective for most sensitive freshwater species.
As concerning nitrite, high levels may cause hypoxia due to methemoglobin formation in fish blood (Durborow et al., 1997), desirable range for nitrite in ponds being less than 0.1 mg N/L (Austin et al., 2016). Other authors (Camargo & Alonso, 2006) estimated for nitrite nitrogen that range 0.08-0.35 mg N/L is adequate to protect aquatic species during short-term exposures.
Between ammonium ion (NH_4^+) and unionized ammonia (NH_3) occurs an equilibrium driven by pH and temperature (Camargo & Alonso, 2006). There species are products of fish metabolism, their levels being related with protein rich feed input in the pond (Alatorre-Jacome et al., 2011).
Regarding ammonia influence on fish health, literature data sustain that toxicity varies with fish species, salmonids for example being more sensitive than other fish species (Stone et al., 2013), age or other quality parameters (Latha & Lipton, 2007). Goldfish, *Carassius auratus* and Gibel carp *C. gibelio* seem to have a greater resistance to ammonia (Schenone et al., 1982; Nathanailides et al., 2003).
The values of COD at sampling moment correlate with increase of ammonium, nitrate and total mineral nitrogen levels (Figure 8, Figure 9 and Figure 10). The decrease of water quality is related with increase of nutrients' contents, this being highlighted by COD variation.

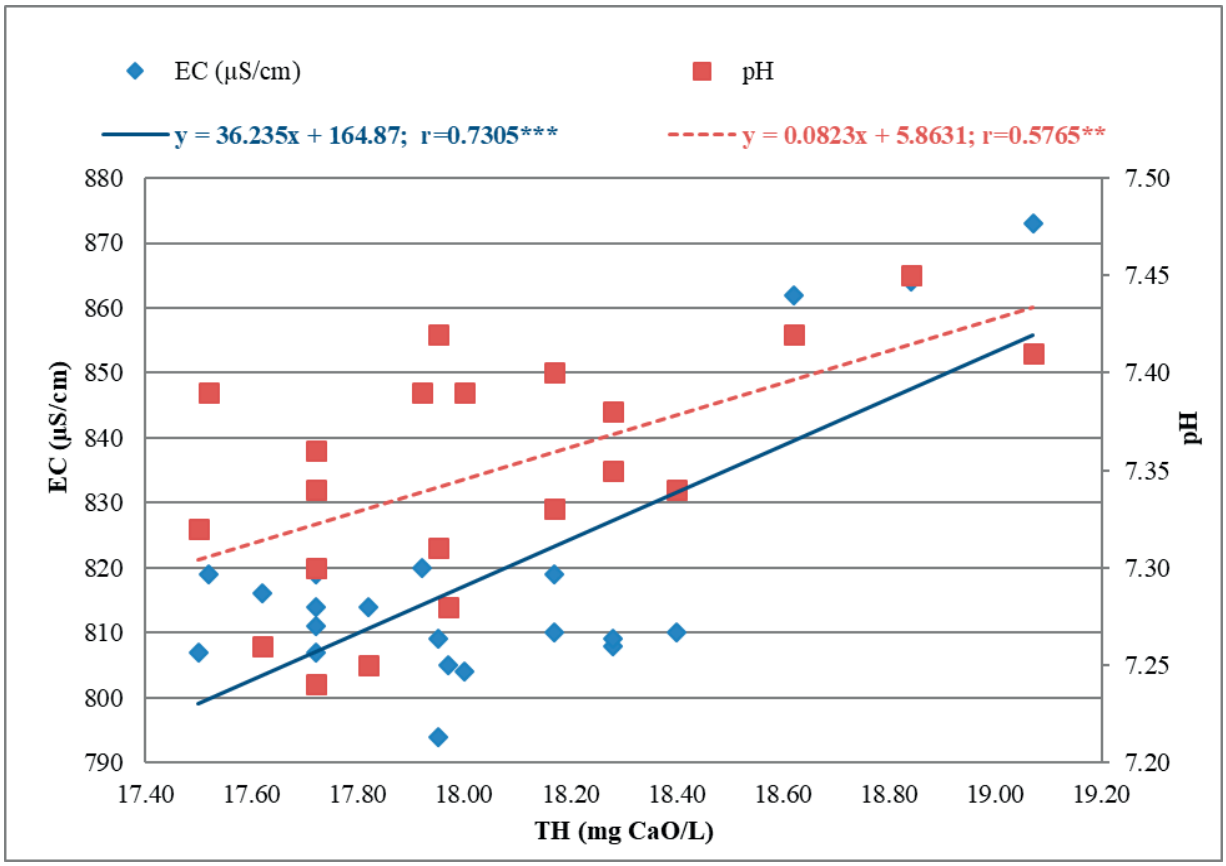

Figure 7. Correlations between conductivity and pH values with total hardness of water samples from Bițina 3 pond

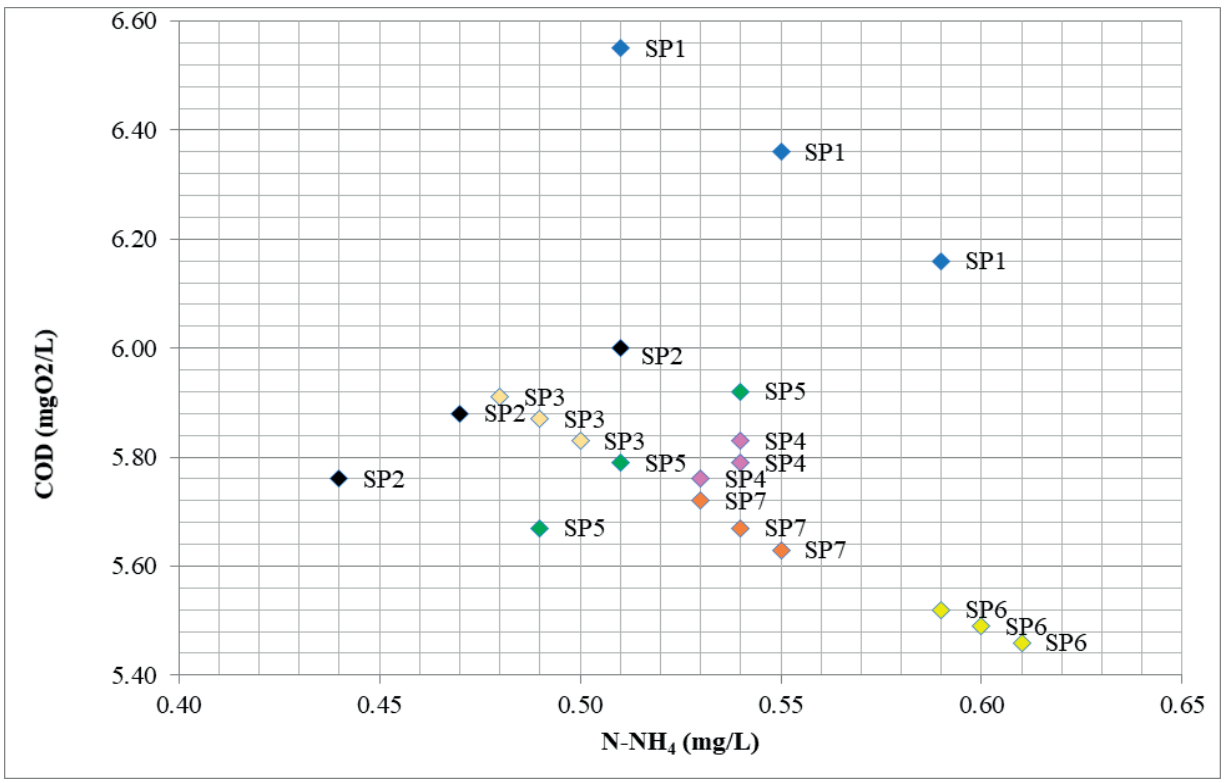

Figure 8. The Cartesian coordinates given by COD and ammonium nitrogen at sampling moment

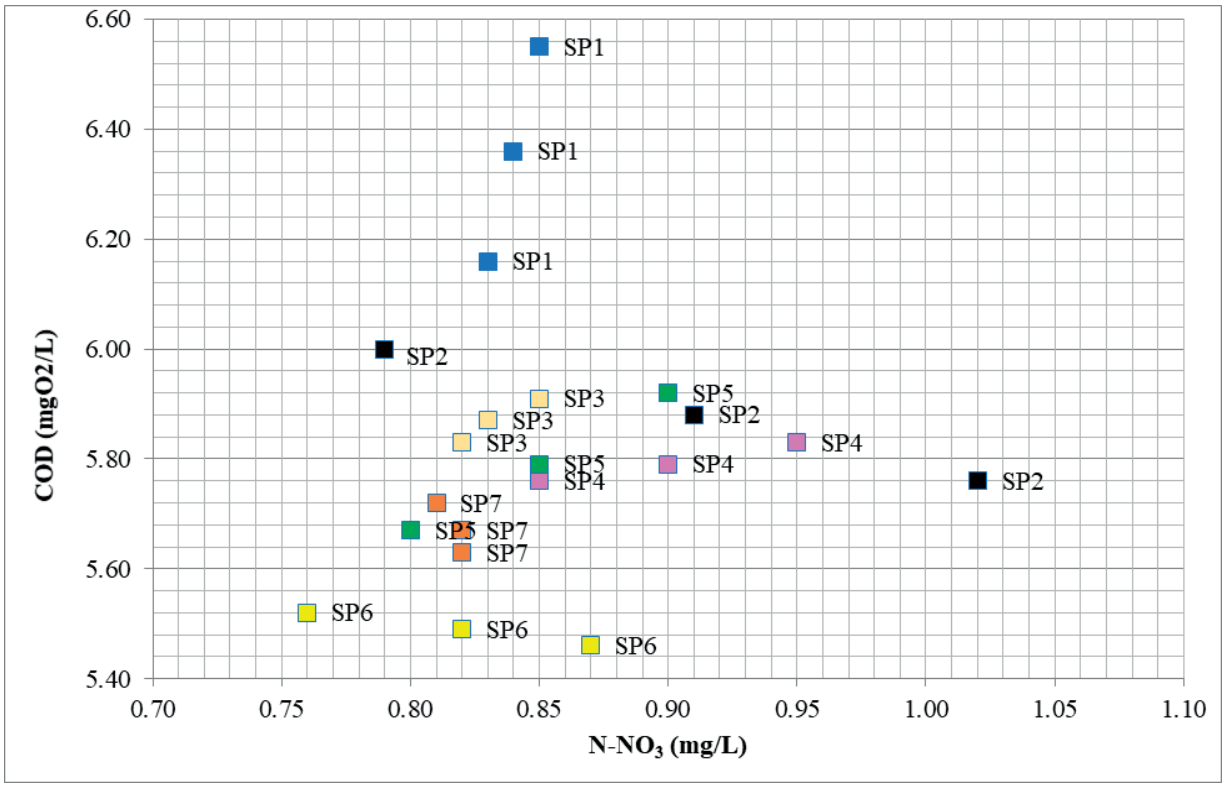

Figure 9. The Cartesian coordinates given by COD and nitrate nitrogen at sampling moment

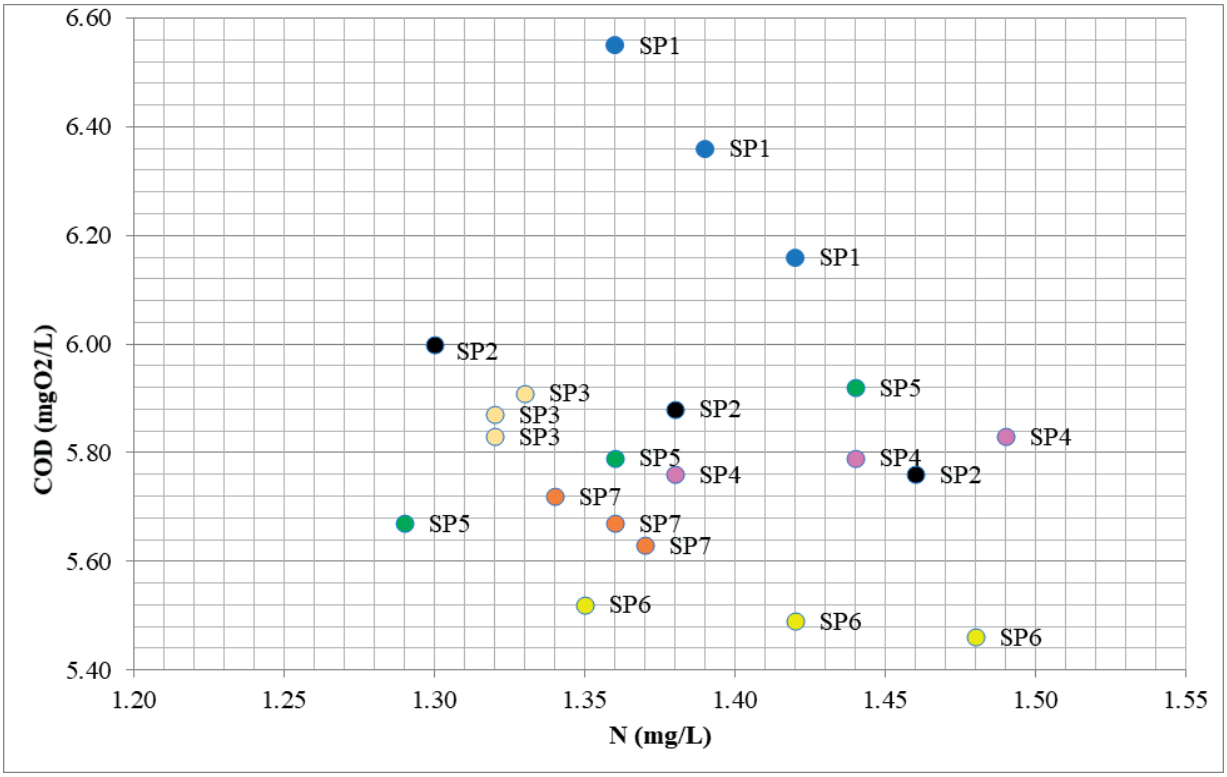

Figure 10. The Cartesian coordinates given by COD and total mineral nitrogen at sampling moment

CONCLUSIONS

This work provided information on length, weight, size frequency distribution, condition factor and parameters of weight-length relationship recorded in *Cyprinus carpio* caugth in one fishing season in the Biţina 3 Pond from Ilfov County, Romania. With values greater than 1, K factor revealed the well-being of sampled common carps in the ecosystem.

On the basis of phosphate phosphorus, nitrate and nitrite nitrogen levels provided by chemical analyses, the water from this pond corresponds to Ist quality class. The determined values for COD and ammonium nitrogen allow association of water with IInd quality class.
Similar studies are important for gathering the biological information concerning the fish well-being and their adaptation to the environment.

ACKNOWLEDGEMENTS

The authors are thankful to Ion Popescu Venus and Tarnavetchi Alexandru administrators for their assistance in providing the fishes and water samples from Bițina 3 Pond.

REFERENCES

Alatorre-Jacome, O., Garcia-Trejo, F., Rico-Garcia, E., Soto-Zarazua, G. M. (2011). Aquaculture water quality for small-scale producers. In: Sladonja B. (Eds.), Aquaculture and the Environment - A Shared Destiny, InTech, www.intechopen.com.

Austin, B. J., Sinha, A., Stone, N., Green, W. R., Daniels, M., Haggard, B. E. (2016). How to collect your water sample and interpret the results for the fish pond analytical package. *Arkansas Water Resources Center*, Fayetteville, AR, FS-2016-02, 1-11.

Bădilaș I. N., Păsărin B. (2021). Researches on the growth rate of carp brood (*Cyprinus carpio*, Linne, 1758) variety without scales Moldova-Podu Ilioaie grown up in the N-E part of Romania. Scientific Papers-Animal Science Series: *Lucrări Ştiinţifice - Seria Zootehnie*, 75: 277-281.

Camargo, J. A. & Alonso, A. (2006). Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: a global assessment. *Environment International*, 32, 831-849.

Camargo, J. A., Alonso, A., Salamanca, A. (2005). Nitrate toxicity to aquatic animals: a review with new data for freshwater intervertebrates. *Chemosphere*, 58, 1255-1267.

Chen, R., Deng M., He, X., Hou, J. (2017). Enhancing nitrate removal from freshwater ponf by regulating carbon/nitrogen ratio. Frontiers in Microbiology, 8, 1712, doi.10.3389/fmicb.2017.01712.

Cohl, M., Lazăr, L., Balasanian, I. (2014). Study on the quality of water supply sources for Iași City, Romania. *Environmental Engineering and Management Journal*, 13(9), 2301-2310.

Durborow, R. M., Crosby, D. M., Brunson, M. V. (1997). Nitrite in fish ponds. *SRAC Publication,* No. 462.

Famoofo, O. O., Abdul, W. O. (2020). Biometry, condition factors and length-weight relationships of sixteen fish species in Iwopin fresh-water ecotype of Lekki Lagoon, Ogun State, Southwest Nigeria. Heliyon. 6(1): e02957.

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22 (4): 241-253.

Gheorghe, D. C., Răzlog, G. P., Cristea, V., Enache, I. (2011). The growth characteristics of common carp (*Cyprinus carpio*) in the northern part of the Small Island of Brăila Natural Park. *AACL Bioflux*, 4(2): 154-158.

Innal, D. (2012). Age and growth properties of *Carassius gibelio* (Cyprinidae) living in Aksu River Estuary (Antalya-Turkey). *Review of Hydrobiology*. 5.2: 97-109.

Jeppesen, E., Jensen, J. P., Søndergaard, M., Lauridsen, T., Landkildehus, F. (2000). Trophic structure, species richness and biodiversity in Danish lakes: changes along a phosphorus gradient. *Freshwater Biology*, 45, 201-218.

Kalaycı, F., Samsun, N., Bilgin, S., Samsun, O. (2007). Length-weight relationship of 10 fish species caught by bottom trawl and midwater trawl from the Middle Black Sea, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences* 7: 33-36.

Karachle, P. K., Stergiou, K. I. (2012). Morphometrics and allometry in fish. In: Wahl C.M., 2012. Morphometrics. New York: Cornell University, 65-68. (Agricultural and biological science). DOI: 10.5772/34529.

Khan, M. N., Shahzad, K., Chatta, A., Sohail, M., Piria, M., Treer, T. (2016). A review of introduction of common carp *Cyprinus carpio* in Pakistan: origin, purpose, impact and management. *Croatian Journal of Fisheries* 74: 71-80.

Khan, M. S., Hayat, S., Ishtiaq, A., Malik, A., Akhtar, M. N., Khan, G. Z., Khan, Z. I., Ali, Q. (2020). Length-Weight relationships of *Cyprinus carpio* from the Indus River at Chashma Lake, District Mianwali, Punjab, Pakistan. *Journal of Wildlife and Biodiversity* 4 (4): 72-80.

Latha, Y. P. & Lipton, A. P. (2007). Water quality management in gold fish (*Carassius auratus*) rearing tanks using different filter materials. *Indian Hydrobiology*, 10(2), 301-302.

Mănescu, S., Cucu, M., Diaconescu, M. L. (1994). *Chimia sanitară a mediului*. Ed. Medicală Bucureşti.

Nathanailides, C., Perdikaris, C., Gouva, E., Paschos, I., (2003). Gibel carp (*C. auratus gibelio*) growth under increased ammonia concentration. In: Proceedings of the 11thpanhellenic conference of icthyologists, Chania, 178–181 (in Greek with English abstract).

Nehemia, A., Maganira, J. D., Rumisha, C. (2012). Length-Weight relationship and condition factor of tilapia species grown in marine and fresh water ponds. *Agric. Biol. J. N. Am*., 3(3): 117-124.

Nistor, V., Mirea, D., Athanasopoulos, L. P., Tenciu, M., Brânză, D. (2020). Common carp adaptability (*Cyprinus carpio*) to rearing in floating fish cages installed in irrigation canal. *Scientific Papers-Animal Science Series: Lucrări Ştiinţifice - Seria Zootehnie*, 74:139-145.

Petrea, S. M., Mogodan, A., Metaxa, I., Plăcintă, S., Vasile, M. A., Huian, G. (2017). A comparative study on the evaluation of cyprinids growth performance in IMTA systems. *AACL Bioflux* 10(1): 87-102.

Ranjan, J. B., Herwig, W., Subodh, S., Michael, S. (2005). Study of the length frequency distribution of sucker head, *Garra gotyla gotyla* (Gray, 1830) in different rivers and seasons in nepal and its applications. *Kathmandu Univ. J. Sci. Eng. Technol*., 1: 1-14.

Rosli, M. N. A., Isa, M. M. (2012). Length-weight and Length-length Relationship of Longsnouted Catfish, *Plicofollis argyropleuron* (Valenciennes, 1840) in the Northern Part of Peninsular Malaysia. *Trop Life Sci Res*. 2012 Dec; 23(2): 59–65.

Ruchin, A. B. (2019). Rearing carp (*Cyprinus carpio*) in different light: mini-review. *AACL Bioflux* 12(5): 1850-1865.

Scăeţeanu, G., Manole, M. S., Stavrescu-Bedivan, M. M., Penescu, A., Pele, M., 2012. Evaluation of water quality in lakes from Bucharest. *Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering*, I: 113-116.

Scăeţeanu Vasile, G., Madjar, R. M., Silvestro, A., Dulea, C., Stavrescu-Bedivan, M.-M. (2019). Water quality monitoring and assessment of the ecological status of Tătaru fish pond, Călărași County. 19th International Multidisciplinary Scientific GeoConferenceSGEM 2019, *SGEM 2019 Conference Proceedings* 19 (1.4), 309-316.

Scăeţeanu Vasile, G., Madjar, R. M., Stavrescu-Bedivan, M.-M. (2020). A comparative evaluation of surface water quality standards for lakes and fish ponds from Bucharest and vicinity. *Romanian Journal of Ecology & Environmental Chemistry*, 2(2), 30-37.

Schenone, G., Arillo, A., Margiocco, C., Melodia, F., Mensi, P. (1982). Biochemical bases for environmental adaptation in goldfish (*Carassius auratus* L.): resistance to ammonia. *Ecotoxicology and Environmental Safety*, 6(5): 479-488.

Schenone, N. F., Vackova, L., Cirelli, A. F. (2011). Fish-farming water quality and environmental concerns in Argentina: a regional approach. *Aquaculture International*, 19(5), 855-863.

Shaw, B., Mechenich, C., Klessig, L. (2004). Understanding Lake Data (G3582), RP-03.

Stavrescu-Bedivan, M.-M., Scăeţeanu Vasile, G., Madjar, R. M., Matei, P. B., Tobă, G. F. (2015). Comparative study of length-weight relationship, size structure and Fulton's condition factor for Prussian carp from different Romanian aquatic ecosystems. *Agrolife Scientific Journal*, 4(2), 132–139.

Stavrescu-Bedivan, M.-M., Vasile Scăeţeanu, G., Madjar, R. M., Manole, M. S., Staicu, A. C., Aioanei, F. T., Plop, E. F., Tobă, G. L., Nicolae, C. G. (2016). Interactions between fish well-being and water quality: a case study from Morii Lake area, Romania. *Agriculture and Agricultural Science Proceedia* 10: 328-339.

Stavrescu-Bedivan, M.-M., Vasile Scaeteanu, G., Madjar, R. M., Manole, M. S. (2018). Investigation of length-weight relationship and condition factor of *Carassius gibelio* related to water quality in Pantelimon II Lake. *AgroLife Scientific Journal*, 7 (1): 123-130.

Stavrescu-Bedivan, M.-M., Săndulescu, E. M., Croitoru, C. M., Madjar, R. M., Boiu-Sicuia, O.-A., Scăeţeanu Vasile, G. (2021). A preliminary evaluation of water quality related to aquatic organisms in Comana pond. *AgroLife Scientific Journal*, 10(2), 178-188.

Stone, N., Shelton, J., Haggard, B., Thomforde, H. (2013). Interpretation of water analysis reports for fish culture. Southern Regional Aquaculture Center, *SRAC Publication*, 4606.

Stone, N. M. & Thomforde, H. K. (2004). Understanding your fish pond water analysis report, cooperative extension program. University of Arkansas at Pine Bluff, United States Department of Agriculture, 1–4.

***LENNTECH. Available from: https://www.lenntech.com/aquatic/acids-alkalis [06.05.2022].

***http://www.fishbase.org.

***Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

***Order 161/2006 for the approval of the Normative concerning the classification of surface water quality to establish the ecological status of water bodies.

***https://www.baltipescuit.com/balta-bitina.

***https://www.pescarinformat.ro/balta-bitina-pescuit-la-bitina-pamanteni/.

***https://www.traveleuropa.ro/la-pescuit/bitina/.