CHARACTERISTICS OF THE POPULATION GROWTH AND MORTALITY OF CARP IN THE DANUBE (Km 170 – Km 196)

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Abstract

The paper presents the results of the investigations made during the 2006 – 2009 period on the carp population from the Danube sector Braila (km 170) - Gropeni (km 196). During the study 367 specimens were caught, with a total biomass of 930, 25 kg.

The purpose of this study was to estimate the growth parameters and the mortality rates for the carp population.

Mathematical relationships: length – weight (L - W) and the growth equation in length von Bertalanffy (VBGF) for the carp population are: $W = 0.0271 * Lt^{2.845}$ *and* $Lt = 87.15 * (1 - e^{-0.260\,(t+0.81)})$.

The estimated values of the mortality rates for this population are high: total mortality (Z) is 0,850 and the natural one (M) reaches the 0,370 value. Exploitation rate (E) calculated for the carp population exceeds the optimal value (0,5) which suggests that the carp population from the studied area is slightly overexploited.

Key words: carp, weight – length relationship, mortality rates

INTRODUCTION

Globally, fishery resources from inland waters are in a continuous declining as a result of the habitat degradation and over-fishing. This tendency, largely due to the intensification of the multiple uses of water (agriculture, electricity, etc.) can not be changed as long as the states do not give sufficient attention to the fishery sector and they will not give until they have sufficient information about fisheries and their values for present and future.

To determine the status of fisheries under exploitation should be made an estimation of the of fish populations stocks, so that fisheries resources to be used in a responsible and sustainable manner [9]. It can be said that the assessment of the fish stocks objective is to manage them so that the catches to come from the production maximum value or otherwise the fishes can not be captured neither too early nor too late. There are two major elements to describe the dynamics of a population: the average increase of the body in mass units and length, and the mortality.

MATERIAL AND METHOD

The scientific fishing was realized in 2006-2009 period in the Danube, Braila (km 170) – Gropeni (km 196) (figure 1).

This area presents a special importance for the fish populations, being a central wetland type, the Danube including between his arms, from north to south the following islands: Calia, Fundu Mare Harapu.

The scientific fishing was realized in Fundu Mare Island, Cravia arm, Calia arm and the Danube arms.

The tools used were specific to the habitat type, as follows: in the pond were used cornel tree baskets (varse in romanian) from fishermen's string (with a=28 mm) and static gillnets with different meshes (a=40 mm ÷50 mm) and on the river's channel, gillnets (with a = 12 mm÷32 mm).

The number of carp exemplars caught was of 367 and the total biomass of 930, 25 kg.

After the catchments, the specimens were biometrical and gravimetrical measured.

It has been measured the total length (Lt ± 1 mm) and weight (W ± 1g) of each specimen.

It had been obtained a series of quantitative and qualitative data on the carp's populations in the area of the Danube.

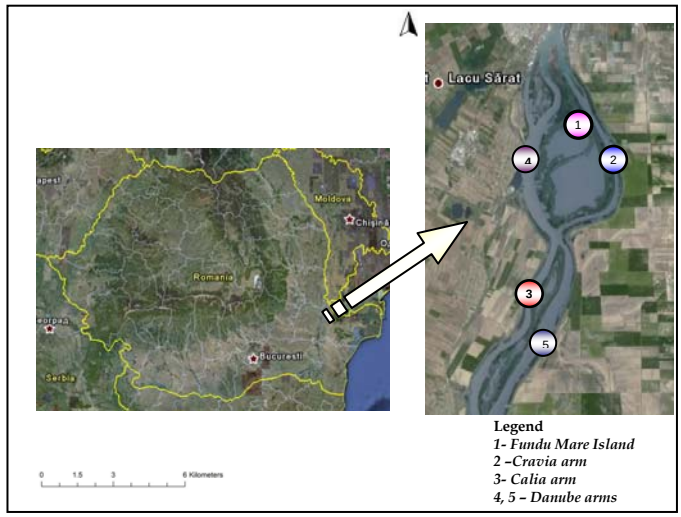

Figure 1 Study area

Data analysis

- Length – weight relationship

The equation which describes the best the changes that occur in the body weight of fish length-weight (L–W) is the relationship: $W = a * L^b$, where:

W – Individual weight (g),
L – Total length (cm),
a and b regression constant.

For the growth and mortality study was used the statistics program FISAT II.

- Determination of growth

The growth parameters were estimated by using the frequency on lengths with ELEFAN model implemented by FISAT II. Program.

The general growth equation in length as a function of age (von Bertalanffy) is:

$$L_t = L_\infty \left(1 - e^{-\left[K(t - t_o)\right]}\right) \quad [10], [7], [11]$$

Where:

L_∞, is the asymptotic length of the fish;

k is curvature parameter which determines how fast the fish approaches the L_∞.

- The total mortality determination(Z)

The total mortality (Z) was calculated through the linearized catch curve method based on the frequency of lengths structure [3] using the relationships:

$$\ln\left(\frac{C_i}{\Delta t_i'}\right) = a + b \cdot t_i' \quad \text{, where:}$$

C_i is the number of the specimens caught per length classes

$$\Delta t_i = \left(\frac{1}{K}\right) \cdot \ln\left[\frac{L_\infty - L_{i+1}}{L_\infty - L_i}\right]$$

Δt_i is the age difference between the minimum length and maximum length of the age class.

t_i is the relative age at the middle classes of length;

The value of b coefficient with changed sign gives an estimation of the total mortality (Z).

- The natural mortality determination(M)

To determine the natural mortality had been used Pauly's empirical formula [6]:

$\ln M = -0.0152 - 0.279 \ln L\infty + 0.6543 \ln k + 0.463 \ln T^0C$

Where:

M is natural mortality,

K and L_∞ are the growth parameters from VBGF

T^0C – is the average annual temperature.

The average temperature at Braila in the studied years was considered $T=12^0C$.

- The mortality determination through fishing (F)

The mortality due to the fishing losses is calculated by making the difference between total mortality (Z) and natural mortality (M).

$F = Z - M$

- Determination of exploitation rate (E)

Exploitation rate (E) is the report between the fishing mortality and total mortality: $E = F / Z$

For:

E = 0,0 - 0,5 – easily exploited stock;

E = 0,5 - 1 – heavily exploited stock.

RESULTS AND DISCUSSIONS

The carp specimens sampled during the study period had lengths between 23 cm ÷ 86 cm and weights between 9000 g ÷ 432.67 g (Table 1).

Averages for length and weight are calculated for the entire population with a confidence level of 95%.

It may be specified that as with a 95% confidence these average lengths and masses of the entire carp population are in the intervals specified in the table.

The estimation of the a, b coefficients from the equation $W = a * L^b$ for the carp population are determined from the regression between length and mass. (Figure 2).

Table 1 Minimum values, maximum and average length and weight of the carp population

Year	L_{tmin}-L_{tmax} (cm)	W_{min}-W_{max} (g)
2006	23-49 $\bar{L} = 29.55 - 31.43$	150-1800 $\bar{W} = 432.67 - 555.74$
2008	31-86 $\bar{L} = 57.95 - 61.32$	200-9000 $\bar{W} = 3135.77 - 3606.94$
2009	30-76 $\bar{L} = 55.52 - 60.27$	590-6800 $\bar{W} = 2787.13 - 3495.57$

Lt – total length (cm), W – Individual weight (g).

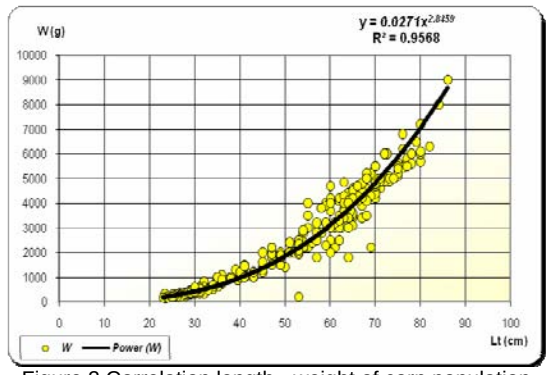

Figure 2 Correlation length - weight of carp population

The relationship between Lt and W for the carp population in the studied sector is: $W = 0.0271 * Lt^{2.845}$ (r=0,978).

The growth character revealed by the "b" coefficient value (2,845) shows us an alometrical growth of the carp population from the studied sector, the increase in

weight is being made faster than in growth and length.

In general, the coefficient b from the length – weight relationship takes values in general between 2 and 4 [12] and is considered a measure of the conditions offered by the environment, being a generalization of the Fulton coefficient [8].

Also, the condition factor (b) is used to offer information about the feeding status of the fishes in its environment being possible to make comparisons with other populations living in different habitats [2].

In order to determine the von Bertalanffy growth equation, it must be estimated the growth parameters values L_∞, k and t_o.

In Table 2 are shown the estimated values of the growth parameters L_∞, k, t_o, obtained through the ELEFAN I method I.

Table 2 The growth parameters values: L_∞, k

$L\infty$	*k*	*to*
87,15	0,260	-0,81

The asymptotical length (L_∞=87, 15 cm) which was determined indicates good growing conditions for the carp population from this sector of the river, comparably to other carp populations from the near regions.

Using these growth parameters we determine the von Bertalanffy growth equation through we can estimate the size of a fish body until it reaches the theoretical maximum length (L_∞).

Mathematical equation that shows the length (Lt) as an age function (t) is as it follows: $Lt = 87.15 * (1 - e^{-0.260(t+0.81)})$

Having the von Bertalanffy growth equation we can trace the growth curve in length (Figure 3).

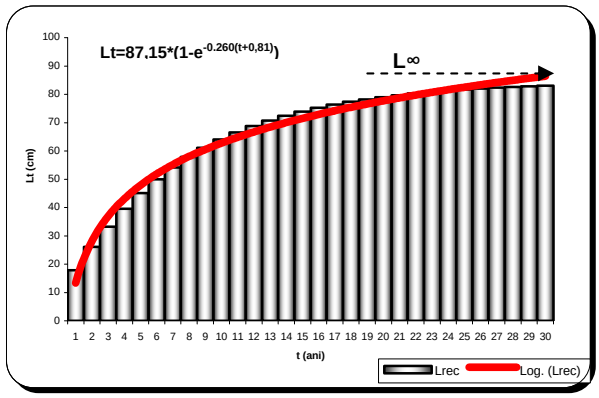

Figure 3 Growth curve in length from the carp population

The mortality and exploitation rates

Mortality is a process that determines the dynamics of the fishes stocks populations [1] being also a necessary component for the fishes stock assessment [4].

In the fisheries management knowing the mortality rates is important for determining the optimal level of the fishing effort. Direct measurements on the natural mortality of the fishes in the big water basins are impossible to make. Therefore, it had been looked to identify the quantities that can be assumed proportional to the natural mortality (M) are which are easily measured (estimated).

The estimation of the natural mortality (M) was performed using the empirical formula for calculation of Pauly (1980). The average temperature in Braila that we considered during the study period was T = 12^0C.

It was found that the value of M is true if the fishing mortality is higher than the natural mortality [5].

The total mortality (Z) was estimated through the linearized curved catch method based on the length frequency structure,

where the Bertalanffy's equation is used to convert lengths in ages.

This method assumes that the recruitment, the fishing mortality (F) and natural mortality (M) are constant and it is actually a graphical representation of the survivor's number over time.

With a dataset of length and frequency on growth parameters it is possible to estimate the total mortality (Z).

This estimation is being made on the catch curve downward and the last groups of length are excluded.

Knowing the estimated values of the natural mortality (M) and total (Z) it can be easily estimated the values of the fishing mortality and the exploitation rate.

The estimative values of the mortality rates and the graphical representation of the total mortality estimation are shown in Table 3 and Figure 4.

Table 3 Mortality rates of carp population

Specia	***Z***	***M***	***F***	***E***	***M/k***
Cyprinus carpio	0,850	0,370	0,48	0,56	1,42

Z – total mortality; ***M –*** natural mortality; ***F –*** fishing mortality; ***E –*** exploitation rate;

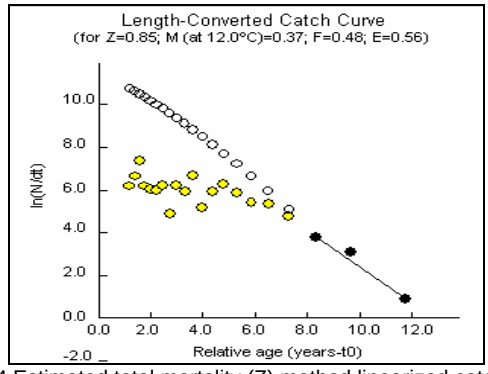

Figure 4 Estimated total mortality (Z) method linearized catch curve

Analyzing the estimated values of the mortality rates we can mention that the carp population is slightly overexploited studied, E = 0.56 (> 0.5) by over fishing or either by poaching.

CONCLUSIONS

The morpho-topographical and hydrological conditions of the sector make it a favorable place for breeding, growth and development of many fish species, freshwater and marine.

After the study made on the growth and mortality of the carp population from the studied Danube sector (km 170 - km 196), we can mention:

- The value of the coefficient „b" (2845) from the length – weight relationship (L - W) indicates us an alometrical increase, the growth speed in length is higher than the growth speed in mass.

Also, the coefficient "b" considered a measure of the environmental conditions provided demonstrate that in the studied sector exist good growth conditions for this specie, especially a sufficient trophic basis for a harmonious growth.

- The estimated asymptotic length (L_∞ = 87, 15 cm) has better values that frame in the limits met in the specialized literature for this specie.
- The value of „k" (0.260) for length indicates a rapid growth of this species in the studied sector.

- For the carp population studied were found the following values of the mortality rates: Z = 0,850, M= 0,370, F=0,480.
- The exploitation rate value (E = 0, 56) exceeds the optimum value (0, 5) for the stock of a population to have a sustainable exploitation, which demonstrates the carp population stock is overexploited through illegally fishing or poaching.

THANKS

Research was conducted in the framework of the projects POSDRU "Efficiency of PhD Students Activity in Doctoral Schools no.61445- EFFICIENT", funded by the European Union and Romanian Government. The authors thank to the management staff of the project for their support.

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