

# GROWTH AND MORTALITY ESTIMATION PARAMETERS FOR THE PRUSSIAN CARP (*Carassius gibelio*, Bloch, 1782) POPULATION FROM DANUBE RIVER (Km 170 - 196)

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## Abstract

This paper presents the results of the growth and mortality parameters of the Prussian carp population from the Danube (km 170-196). This study was performed on 314 specimens of Prussian carp caught in the period 2006-2009 in the both river and the floodplain ponds. The purpose of this study was to determine the relationships: length – weight (L - W), to estimate the growth parameters (von Bertalanffy)  $L_{\infty}$ ,  $k$ ,  $t$  and the mortality rates (Z, M, F) for the Prussian carp population.

The relationship between length – weight (L - W) in the study period for Prussian carp population is  $W = 0.0298 * L^{2.866}$ .

The assessment of the growth parameters (von Bertalanffy)  $L_{\infty}$ ,  $k$ ,  $t$ , led to values comparable to other populations of Prussian carp in our country which live in similar conditions.

The growth equation that shows the body length (Lt) as a function of the age (t) from the studied population has the form:  $Lt = 39.38 * (1 - e^{-0.630(t+0.140)})$ .

The estimated values of the mortality rates for the studied population are high thus: total mortality (Z) is 2.29 and the natural (M) reaches 0.825.

Exploitation rate,  $E = 0.63$  calculated for the carp population exceeds the optimum value (0.5) suggesting that the population of carp in the studied area is over fished.

**Key words:** Prussian carp, length – weight relationship, growth parameters, mortality rates

## INTRODUCTION

The Prussian carp (*Carassius gibelio*, Bloch, 1782) is a freshwater specie that lives in all categories of water bodies from the plain and up in the hills but not too prosperous in the overgrown vegetation. The Prussian carp became a dominant specie and an important specie in the commercial fishing beginning with 1970 in the Danube river when the changes in the ecosystem have led to the explosion of this species.

The studied river area has a special importance for fish populations because is a central wetland type, the Danube river includes between his arms from north to south next four islands (Calia, Fundu Mare

island and Harapu) from which only one has importance for fishery.

Due to the various hydro-morphological conditions the ichthyodiversity area is very big too.

The Prussian carp is one of the species best adapted to the conditions offered by this sector of the river, bringing a major contribution to fishery productivity of the ecosystem.

Being very abundance specie which has a high intake in the fishery sector, knowledge of the dynamics of this population is particularly important.

## MATERIAL AND METHODS

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

Fish samples were collected from Fundu Mare Island, Cravia arm and Danube river arms.

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The fishing gears used were specific for the habitat type as follows: in the pond were used cornel tree baskets (vârșe in Romanian) and static gill nets with different mesh (with  $a = 28, 40, 50$  mm), and the river channel nets (with  $a = 12 - 32$  mm).

The number of Prussian carp exemplars caught was 314 and the total biomass was ~ 117 kg. The captured exemplars were biometrical and gravimetical measured. It has been measured the total length ( $L_t \pm 1$  mm) and the weight ( $W \pm 1$  g) of each specimen.

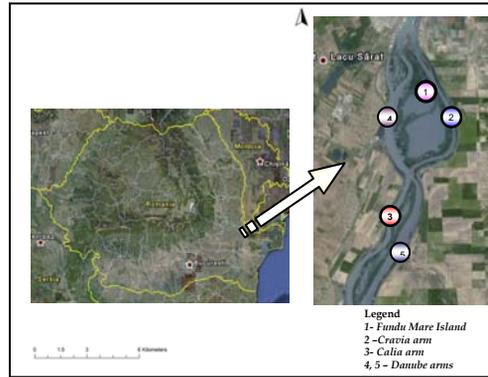


Figure 1 Study area

**Data analysis**

Determining length-weight relationship

The determination of length - weight relationship (L - W) for the Prussian carp population from the studied sector was done using the equation  $W = a * L^b$ , where: W - individual weight (g), L - total length (cm), a and b the regression constants.

Estimating the growth and mortality parameters

- Growth parameters ( $L_{\infty}$ , k,  $t_0$ ) were estimated by using length frequency analysis with the ELEFAN model implemented in FISAT II Program.

Growth equation in length as a function of age (von Bertalanffy) is:

$$L_t = L_{\infty} \left( 1 - e^{-k(t - t_0)} \right) \quad [17], [14], [18]$$

$L_t$  = total length at t age.  $L_{\infty}$  = is asymptotic length of fish; k is curvature parameter which determines how fast the fish approaches the  $t_0$  = theoretical age at which length is 0.

- Total mortality (Z) was calculated using the linearised catch curve method based on length frequency structure [6] using the relationships:

$$\ln \left( \frac{C_i}{\Delta t_i} \right) = a + b \cdot t_i'$$

Where:  $C_i$  is the number of specimens caught per length classes;  $\Delta t_i$  is the age difference between the minimum length and maximum length of the age class;  $t_i'$  is the middle age classes relative to length;

The descending part of the stock value which is in complete exploitation provided the total mortality (Z).

- The natural mortality (M) was determined using the empirical formula of Pauly's [12]:

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

Where: M is the natural mortality, k and  $L_{\infty}$  are growth parameters from VBGF;  $T^{0C}$  – is the annual average temperature.

The average temperature at Braila I judged  $T=12^{0C}$ .

- The mortality due to the fishing looses is calculated making the difference between the total mortality (Z) and the natural mortality (M)  $F = Z - M$

- The exploitation rate (E) suggests how the exploitation of a specie in a fishery, is

calculated as the ratio of fishing mortality and total mortality  $E = F / Z$ .

If E has values up to 0.5 - the stock is easily exploited, if the values are in the range 0.5 to 1 - heavily exploited stocks.

## RESULTS AND DISCUSSIONS

The lengths and the minimum, maximum, average values of weight of the Prussian carp exemplars in study period, are shown in the table 1.

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

Year	Lt ±CI	SD	Wt ±CI	SD
	(Min – Max)		(Min – Max)	
2006	24.1±0.48 (15-31)	2.73	281.22±16.1 (96 – 572)	91.48
2008	27.5±0.69 (13-35)	4.4	423.15±25.63 (50-900)	163.37
2009	28.35±0.86 (23-35)	2.61	458.53±38.54 (300-800)	116.34

Lt – average total length (cm); W- average weight (g); CI – confidence interval with 95%; SD – Standard deviation;

### The relationship length – weight

The regression curve shows a positive relationship between the total length (Lt) and weight (Wt) ( $r = 0.95$ ).

The equation of W - L found for the Prussian carp from the studied sector is  $W = 0.0298 * Lt^{2.866}$ .

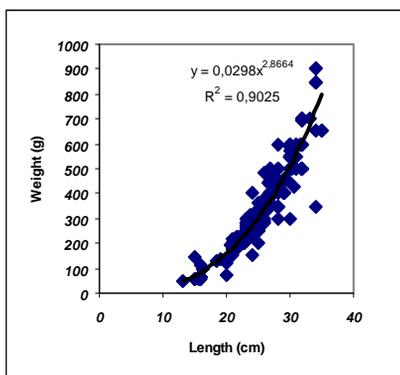


Figure 2 Length – weight relationship of *Carassius gibelio*

The b coefficient value (2866) shows us an allometrical growth of the Prussian carp population

The growth character revealed by the “b” coefficient value (2.845) shows us an allometrical growth of the carp population meaning that the weight increase is made faster than the growth in length.

In general, the coefficient b from length – weight relationship takes over the values in range 2-4 [21] and it is considered a measure of the conditions offered by the environment being a generalization of the Fulton coefficient [16].

Also, the condition factor value (b) is used to offer information about the feeding status of the fish in its environment and to make comparisons with other populations living in different habitats [4].

### Estimating the growth parameters

This study uses the von Bertalanffy growth equation with the ELEFAN model implemented in FISAT II Program.

The growth model of the fishes based on von Bertalanffy growth equation uses the length frequency data. This mathematical model has been discussed and extensively used as a model of fish growth [13], [14], [15], [5], [10] and [19].

To determine the von Bertalanffy growth equations were estimated the growth parameters  $L_{\infty}$ , k, and  $t_0$ . The values of these the parameters are presented the table 2.

Table 2 The values of growth parameters  $L_{\infty}$ , k and  $t_0$  the population of Prussian carp

$L_{\infty}$	k	$t_0$
39.38	0.630	-0.140

The asymptotic length value of the Prussian carp population from the studied

Danube sector ( $L_{\infty}=39.38$  cm) is comparable with the asymptotic length of Prussian carp in other parts of our country, for example in Danube Delta at: Somova, - 40 cm, Isacova 45.7 cm, Baclanesti, - 46.8 cm, Puiu-Roșu, 47.8 cm [22].

The  $k$  parameter value (0.630) is relatively high which indicates that this specie is rapidly approaching the maximum age, so it has a reduced longevity.

With the growth parameters obtained, it can be calculated the fish length at any age of the fish according to the von Bertalanffy growth equation.

The mathematical equation that shows the length ( $L_t$ ) as a function of age ( $t$ ) is as follows  $L_t=39.38*(1-e^{-0.630(t+0.140)})$ .

Based on this equation has been drawn the increase in length curve of the carp population.

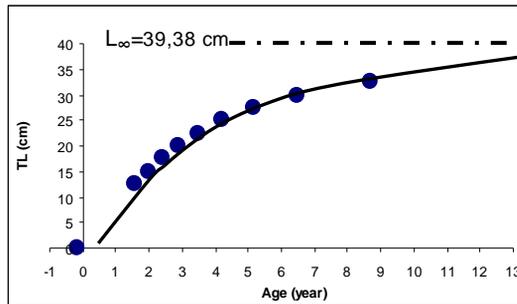


Figure 3 The growth curve in length of Prussian carp population

*Mortality and exploitation rates*

The mortality is a process that determines the population dynamics of the fish stocks [3] being also a necessary component of the fish stock assessment [11].

In the fisheries management knowing the mortality rates is important to determining the optimal level of the fishing effort. Direct measurements of the natural mortality of the fishes from large water basins are impossible to be made [20]. Therefore, it was tried to identify the quantities that can be assumed to be proportional to the natural mortality ( $M$ ) and which are easily to be measured (estimated).

The estimation of the natural mortality ( $M$ ) was performed using the empirical formula for calculation of Pauly (1980).

In the present study, the estimation of the natural mortality was made using Pauly's formula where the average temperature in the study years was considered  $T = 12^{\circ}C$ , and asymptotic length values and the coefficient  $k$  to be already determined.

The total mortality ( $Z$ ) was estimated using the linearized catch curve method based on the length frequency structure [1],

[7], [8], [17], [13], [14], [15], [9], where Bertalanffy's equation is used to convert lengths in age.

The method assumes that mortality is uniform with the age and that the used samples are representative for the age groups considered.

The values of fishing mortality and exploitation rate can be easily estimated knowing the values of natural mortality ( $M$ ) and total mortality ( $Z$ ).

The estimates of the mortality rates for the Prussian carp population investigated are shown in table 3 and figure 4.

Table 3 Mortality rates of Prussian carp population

Specie	Z	M	F	E
<i>Carassius gibelio</i>	2.29	0.826	1.46	0.63

Z – Total mortality;  
 M – natural mortality;  
 F – fishing mortality;  
 E - exploitation rate;

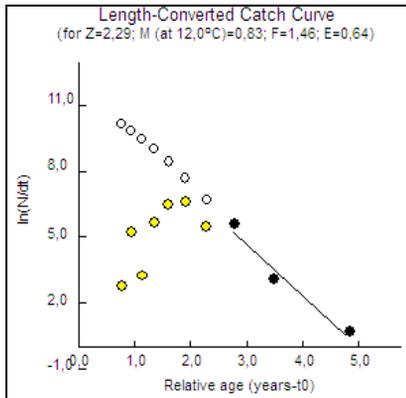


Figure 4 Estimated total mortality (Z) method linearized catch curve

The estimated mortality rates have high values especially the fishing mortality (F) which demonstrates that this specie is overfished.

## CONCLUSIONS

The special conditions of the studied sector make it a favourable place for reproduction, growth and development of many fish species, freshwater and marine.

After the research made on natural populations of the Prussian carp from the Danube (km 170 - km 196) we can conclude:

- The coefficient  $b$  (2866) from relation to length - weight ( $L - W$ ) shows us an allometric increase meaning that the growth rate in length is bigger than the speed of growth in mass. Also, the coefficient  $b$  is considered a measure of the environmental conditions offered, especially feeding conditions. Its value, very close to 3 shows that there is good growth conditions for this specie, especially a sufficient trophic base.

- Also, the asymptotic length ( $L_{\infty} = 39.38$  cm) shows that the carp population of the studied area reaches values close to the population of carp from the Danube Delta, which highlights once more that the natural conditions of this sector are very good for the growth and development of the ichthyofauna.

- $k$  - is considered the growing constant which indicates us the speed with which a fish approaches the asymptotic length (maximum theoretical) and it has been also demonstrated that it is bound to the fish

longevity [2]. Well, the bigger the value of this constant is, the smaller the longevity is.

The estimated value of this constant is high ( $k = 0.630$ ), which demonstrates that the longevity of this specie is quite small (maximum age reported for this species is 10 years - [22]).

- The estimated values of the mortality are high ( $Z = 2.29$ ,  $M = 0.826$ ,  $F = 1.46$ ). The exploitation rate ( $E = 0.63$ ) is higher than 0.5 which demonstrates that the carp population from the studied sector is overexploited, both by legal and illegal fishing. This fact is not a surprise because the abundance of this specie is high and the fishing quotas are also high.

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