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The Optimum Level of Exploitation and an Approximate Assessment of Argentine Stocks (*Argentina silus* Ascanius) in the Browns Bank Area[1]

by

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M E M O R A N D U M

In this study the growth parameters of argentine are precisionized by means of applying the Bertalanffy's equation. The optimum fishing intensity is assessed and the estimation is given to the stock in the early part of 1972.

I N T R O D U C T I O N

The specific feature of the stock of argentine is attributed to the fact that overfishing may rapidly undermine the resources.

Because of the slow growth rate and late maturity it will take a long period of time to increase the size and productivity of the stock. Therefore the evaluation of optimum level of exploitation and as well as of the resources is essential for rational fishery.

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The working material is based on length/age and catch data of argentine for 1972 in the Brown's Bank area:

Assuming that argentine fishery at that time was stable, we will use for investigation of optimum fishing intensity the catch model of Beaverton and Holt (1957). We used formulas (tables) of Beaverton and Holt (1966) to avoid complex calculations. As is known, Bertalanffy growth parameters should be available for applying the model of Beverton and Holt. The mathematical method of Hohendarf (1966) was used for calculation of parameters. The optimum age for exploitation was derived from Kutty and Quasim (1968) equation for isometric growth:

$$tq = \frac{\ln (3k+M) - \ln M}{K} + to$$

where:

tq - the optimum age for exploitation

M - instant natural mortality coefficient

K - growth rate coefficient

t_o - hypothetical age when the length of fish equals 0.

The average length of fish at the time of recruiment to the fishery was derived from the following formula:

$$L_t = L/1 - e^{-k(tq - to)/}$$

where L is theoretically feasible length of fish (in Santimeters).

An approximate evaluation of the length of fish was obtained according to Murphy's formula (1965).

$$C_i = N_1 \frac{F}{F + M} (1 - e^{-z})$$

C_i - catch for given year,

N_i - the size of the population in the early part of the year,

F - instant fishing mortality coefficient

Z -total instant mortality coefficient

e - base of natural logarithms.

The natural mortality of argentine in all calculations was taken for constant value, M = 0.23 (Shevchuk, 1974).

Except the above mentioned code letters used in the text and diagrams, we shall also come arcoss the following:

G/R - yield per recruit

W - theoretically feasible maximum weight of fish (in grams)

CM - mortality coefficient, %

E - exploitation rate, derived from the proportion $\frac{F}{F + M}$

Optimum level of exploitation.

The catch equation of Beaverton and Holt (, , 1957) allows to trace how the size of catch changes depending on variations in values for F. And this is the way to determine the optimum level of exploitation.

The application of Beaverton and Holt model is quite admissible as the stock of argentine does not fluctuate sharply in size. For successful application of this model we have to calculate the Bertalanffy growth rate parameters (table 1).

Assessment of argentine growth parameters in Brown's Bank area.

K	L	to
0,88	49.14	- 3.84

Differences in values of above parameters and those which were obtained earlier (Shevchuk, 1973) are large.

Apparently the reason is simple: previously the extreme year-classes were not included into calculations because of their negligibility.

After obtaining additional data the size of these year classes was taken into account.

Table 2 shows that calculated Bertalanffy growth rate data conside with those observed.

Argentine growth rate, calculated and observed (sm)

Age years	Observed	Calculation	Age	Observed	Calculated
1	16.95	17.17	9	32.42	33.21
2	20.43	19.84	10	34.37	34.54
3	22.33	22.28	11	35.92	35.75
4	24.37	24.52	12	37.04	36.86
5	26.44	26.57	13	38.36	37.88
6	28.21	28.45	14	39.05	38.81
7	29.02	30.18	15	39.74	39.67
8	30.83	31.76	-	-	-

This coinsidence of growth parameters is an important condition for successful application of catch equation of Beaverton and Holt. The usage of tables of Beaverton and Holt (1966) made calculations more simple. Additionally it was necessary to find the value of C (lc/L).

So that to find the value of lc it was necessary to determine the optimum age for exploitation tq. It is equal to 4.64 years. Having received the value of tq and inserting it into Bertalanffy growth equation we received the value of l_c = 25.7 cm.

At this length argentine is recruited to the fishery. The value of C in this case will be $\frac{25.7}{49.1} = 0.52$

Taking various values for fishing mortality coefficient (fig. 1) we find that the size of the yield-per-recruit grows indefinitely with the increase of fishing intensity, reaching the maximum when E = 1 (Beaverton, Holz, 1966).

Let's analyze the character of the curve, showing an increase of G/R and F in percent (table 3) (Rikhter, 1970).

Table 3

Catch growth and fishing intensity rates, %

Values	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Fishing mortality coef.	9.5	18.1	25.9	33.0	39.4	45.1	50.3	55.1	59.3	63.2
Fishing mortality rate	-	47.5	30.0	21.0	16.0	12.4	10.3	8.6	7.0	6.2
Growth rate	-	26.2	11.7	4.5	3.8	3.0	2.3	2.3	1.6	1.1

The above data show that catch growth rate goes up slower than the growth of fishing intensity. Within the range of increase of the value for F from 0 to 0.3 one can observe a marked growth of catches. The continuation of the curve is characterized by sharp decline in catch growth rate. Thus, the assumption is possible, that the optimum level of exploitation is achieved when F = 0.3

The approximate estimate of the stocks.

The separate calculation of F and M based on 1967 and 1972 data allowed to obtain an approximate assessment of the absolute value of the total fishing stock of argentine in the early part of 1972. Having found that the value of L in 1972 was equal to 0.8 and natural mortality coefficient = 0.23; knowing the total catch during the given year, we can calculate the size of the fishing stock according to Murphy's formula.

In round figures the stock was equal to 100000 tons.

At optimum fishing intensity (0.3) the total annual catch will be around 30000 tons.

C O N C L U S I O N

Thus, the optimum level of exploitation of argentine in the Brown's Bank area is 26 %.

The size of the stock in the early part of 1972 was 100000 tons.

The admissible annual catch in 1973 is assessed to be 30000 tons.

R E F E R E N C E

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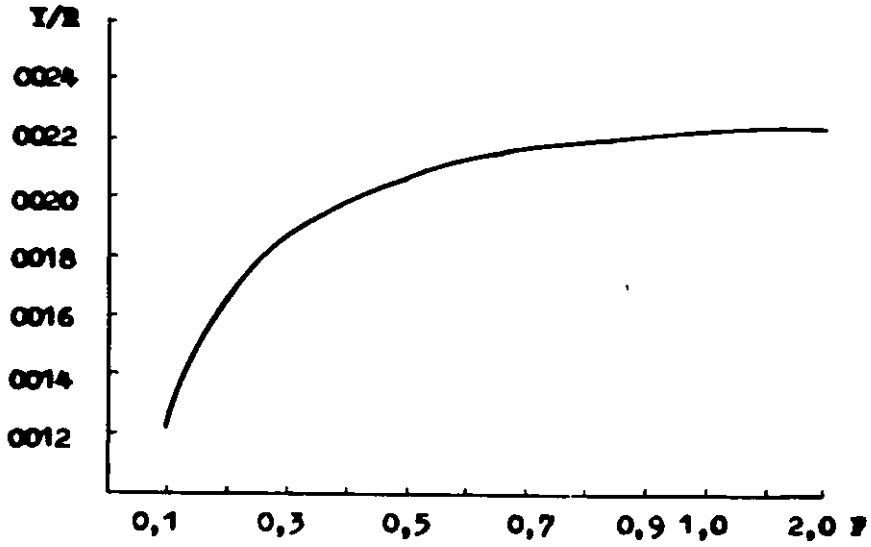

Fig. 1. The correlation between yield-per-recruit (Y/R) and fishing mortality coefficient (F).