On Sweeping Trammel Net (Kogisashiami) Fishery Along Coast of the San'in Districts—II.

Change of Daily Catch by Sweeping Trammel Net in Shimane Prefecture

Takeru KITAHARA*

(Received November 16, 1967)

The preceding paper¹⁾ dealt with the change of the daily catch by sweeping trammel net in Wakasa Bay, and indicated that catch per unit effort (CPUE) of branquillos, *Branchiotegus japonicus japonicus*, decreased considerably with the increase of cumulative fishing effort. The paper showed also that DELURY's model^{2,3)} was successfully applicable to the analysis of the decline in CPUE, and gave the estimations of the amount of the stock and the efficiency of sweeping trammel net.

In Shimane Prefecture, a test operation was carried out in 1964 prior to the premission of this fishery. The fishery has been developed along the coast of Shimane Prefecture since the permission in July of 1965. According to the test operation, CPUE decreases considerably with increasing number of operation over the duration of the test as in Wakasa Bay.¹⁾ Here we will consider only branquillos catch in the following description, which occupied the most of the catch of the fishery. The present paper deals with the trend of CPUE in the test operation and includes also the results of estimating the amount of the stock of the species and the efficiency of the gear. In addition, combining the results in the previous¹⁾ and present papers, we will show a certain relation of the efficiency of the gear to the fishing ground area and the gear size.

Data and Source

Analyses were made with the daily records on the branquillos catch and the number of boat-day in the test operation of sweeping trammel net fishery in Shimane Prefecture. The test operation was carried out in the fishing ground around Oki-noshima Is. over the period of the 3rd of July to the 20th of August in 1964. The daily catch was recorded for each boat in the testing duration. There are the regulations for the test operation as follows: the length and the stretched mesh size of the gear are about 500 m and above 6.0 cm, respectively. The area of fishing ground is about 154 km² and 36 boats are cast into the ground.

* Dept. of Fish., Univ. of Kyoto, Maizuru, Japan. (北原 武, 京都大学農学部)

Analytical Method

Table 1 gives CPUE (in kg/boat-day) and the number of boat-day for time t , t being the time lapse expressed successive three days as unit. This table shows that the intensive fishery is operated concentratively in the limited area during a short

Table 1. Daily variation of CPUE and the number of boat-day from the 3rd of July to the 20th of August, 1964.

Time (3-day)	No. of boat-day	Catch (kg)	CPUE (kg/boat-day)
1	13	895.1	68.8
2	16	999.6	62.5
3	17	1025.0	60.3
4	9	256.9	28.5
5	29	2048.7	70.6
6	12	1918.4	159.9
7	40	4499.8	112.5
8	23	1318.5	57.3
9	47	4151.6	88.3
10	81	4419.9	54.6
11	61	4289.4	70.3
12	28	1530.1	54.6
13	31	1310.8	42.3
14	93	4178.2	44.9
15	93	3527.9	37.9
16	51	1978.7	38.8
17	2	53.0	26.5

period and CPUE decreases gradually with more or less fluctuations as cumulative fishing effort increases. It is found that the trend described above is quite similar to those in Wakasa Bay.¹⁾ Consequently, DELURY's model^{2,3)} can be employed for the analyses of the data in Shimane Prefecture as well as in Wakasa Bay.

Suppose that there is no migration of the species in the time interval of t_0 to t . In fact, some investigators reported that branquillos makes a little migration.^{4,5)} If we assume to be no change in size composition of the stock within the duration of t_0 to t , then DELURY's expression that presents the relation of CPUE in weight, Y/X , to the fishing effort, X , at time t is given as

$$(Y/X)/(Y_0/X_0) = \alpha \exp \sum_{t=t_0}^t X, \quad (1)$$

where Y_0/X_0 refers to Y/X at $t=t_0$ and α is a constant. This equation indicates that the plot of $\log [(Y/X)/(Y_0/X_0)]$ against cumulative effort has a linear relation, and then we can estimate the values of α from the slope and the initial amount of the stock by back extrapolation of the line to $t=0$.

Results and Discussion

In order to verify whether the declines of CPUE are due to the effect of the exploitation or not, Eq. (1) was applied to the records of the test operation. Selecting the value of Y/X for $t=1$ as that of Y_0/X_0 , we plot $\log [(Y/X)/(Y_0/X_0)]$ against cumulative effort on the catch statistics in Fig. 1. From this figure, it is seen that the plots are separated into three parallel parts, decreasing linearly with increasing cumulative effort. We note, however, that there appear the appreciable deviations of the plots for $t=4$ and 8 from linearity to a lower value, which are parenthesized in Fig. 1. These both deviations indicate that the differences between the values obtained from line in Fig. 1 and the actual values of $\log [(Y/X)/(Y_0/X_0)]$ are nearly equal to $\log 0.5$. Since usually one boat-day is approximately two hauls per day, these deviations are supposed to be due to the most part of fleet having one haul at those times for such reasons as bad weather. It is found that the trend of Fig. 1 is extremely similar to those in Wakasa Bay in the previous paper.¹⁾

The linear trend seems to show Eq. (1) at least apparently valid, and hence we may interpret that the decreases in CPUE is due to exploitation, and the jumpings of the plots to higher values indicate the effect of the migration of the species into fishing ground or the expansion of fishing ground. Substantially, however, we can consider this phenomenon as the increase in the abundance of the species in the fishing ground. In Fig. 1, the three lines are approximately parallel to one another, the trend of which shows that the ratio of CPUE to the amount of the stock is nearly constant over the period of the operation.

Since, from the above data, Eq. (1) may be reasonably available for analysing the catch records, let's try to estimate the amount of the stock in the duration of the operation by using Eq. (1). We can obtain $\alpha=6.0 \times 10^{-3}$ (boat-day)⁻¹ from the slopes of lines in Fig. 1. The extrapolation of the line to $t=0$ gives 77.5 kg/boat-day to the value of Y/X at $t=0$. In the theoretical derivation of Eq. (1), Y/X has been assumed to be proportional to the amount of the stock, in which a proportional constant is denoted by α . Using the obtained values of α and Y/X for $t=0$, the initial value, P_0 , of the stock can be calculated, $P_0=77.5/(6.0 \times 10^{-3})=13 \times 10^3$ kg. In addition, since we consider that the deviations from the line to a higher value are due to the increase of the stock in the fishing ground as stated previously, the relative increase of the

Fig. 1. $\log [(Y/X)/(Y_0/X_0)]$ plotted against cumulative effort. Straight lines give $\alpha=6.0 \times 10^{-3}$ boat-day⁻¹.

stock αR , where R denotes the net increase of weight, is able to be estimated from the differences between the actual and calculated values of Y/X . Thus, the values of αR at $t=5, 6, 11, 14, 15$ and 16 can be given 22.7, 95.1, 32.4, 18.8, 12.1 and 10.8 kg/boat-day, respectively, and the sum of them is 192 kg/boat-day, and hence the increases of the stock during the period of the operation can be estimated to be $192/(6.0 \times 10^{-3}) = 32 \times 10^3$ kg. In the above estimations of R 's, the plot for $t=17$ is omitted for the reason that fishing effort is very small, that is, two boat-days. The sum of P_0 and R 's is considered as the amount of the stock in the testing duration, and it is evaluated to be about $13 + 32 = 45$ ton.

We should notice that the obtained values of α are markedly different between in Shimane Prefecture and in Wakasa Bay, for $\alpha = 3.6 \times 10^{-4}$ boat-day $^{-1}$ in Wakasa Bay. On the other hand, there are the differences of the sizes of the gear and the areas of fishing ground for both regions: the length of the gear and the area of fishing ground are about 500 m and 154 km 2 in the former, and 268 m on the average and 687 km 2 in the latter, respectively.

Now, let us consider a relation of α to the gear size and the fishing ground area, though there are other factors affecting it. Since α is assumed to be the ratio of CPUE to the amount of the stock, if the species distributes uniformly in the fishing ground, α is proportional to the area swept by the gear and inversely proportional to the area of fishing ground. According to the results of the preceding papers,^{6,7)} it may be allowed that the area swept by a haul is roughly approximated by πl^2 , l being the length of the gear, though it varies with various factors, i.e. the power of engine, current, etc. Under the assumptions mentioned above, denoting the area of fishing ground by A , α may be presented by

$$\alpha = 2\pi k l^2 / A, \quad (2)$$

where k is a constant. Eq. (2) indicates that the plot of $\log \alpha$ vs. $\log (l^2/A)$ is a linear relation with the slope at 45° .

Fig. 2 gives the plot of $\log \alpha$ for $\log (l^2/A)$ using the above values in both regions, which shows a linear relation with the slope of 45° . Since the slope of the line is quite equal to 45° , it seems that Eq. (2) is valid as least for them. It is likely that Eq. (2) is considerably useful for the regulation of sweeping trammel net fishery.

Next, we will examine the characters of a parameter k in Eq. (2). It is clear that the parameter depends on a relation between the gear and the species encountering the net. In general, the value of k is the range of 0 to 1; if all the species in swept area were caught, k

Fig. 2. $\log \alpha$ plotted as function of $\log (l^2/A)$. Straight line gives $k = 0.56 \text{ haul}^{-1}$.

would be equal to 1, and, on the other hand, if they were not fished at all, $k=0$. From this, it may be suggested that the parameter k is dependent on a variety of factors, such as conditions of operation, mesh size, the ecology and body size of the species, etc. The parameter presents the average of the ratios of catch per haul to the amount of the species inhabiting in a swept area. We can obtain $k=0.56 \text{ haul}^{-1}$ from Fig. 2. According to FUNADA⁴⁾ and some fishermen, the species is inhabitable in the bottom of sandy mud or mud, and so the area operated practically is smaller than A , and, consequently, k is overestimated. It is likely, however, that the estimated value of k does not show a large contradiction, and it is in an agreement with the value obtained by the other method.⁹⁾

The fact that Eq. (2) holds for the data may support this analytical method used in the preceding¹⁾ and present papers to some extent. From the results discussed here, however, we should notice that there remain various problems as to α or k , which will be further studied later.

Finally, the author wishes to express his sincere thank to Prof. Dr. T. KAWAKAMI for his continual guidance throughout this work. His hearty thank are also due to Dr. S. KOJIMA, Shimane Pref. Fish. Exp. Stat., for his help of collecting the catch records concerning the test operation.

References

- 1) T. KITAHARA and K. MATUDA: This Bull., **33**, 1087-1091 (1967).
- 2) D. B. DELURY: *Biometrics*, **3**, 518-535 (1947).
- 3) D. B. DELURY: *J. Fish. Bd. Canada*, **8**, 281-307 (1951).
- 4) H. FUNADA: *Rept. Kyoto Pref. Fish. Exp. Stat.*, **15**, 1-24 (1963).
- 5) K. MATSUBARA and A. OCHIAI: in "Gyoruigaku", part II, 880-882, Koseisha-Koseikaku, Tokyo (1965).
- 6) K. MATUDA: This Bull., **29**, 135-138 (1963).
- 7) K. MATUDA and T. KITAHARA: *ibid.*, **33**, 524-530 (1967).
- 8) K. MATUDA and T. KITAHARA: *ibid.*, **33**, 1096-1098 (1967).