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CATCH-EFFORT ANALYSIS

USING

A MICROCOMPUTER PROGRAM

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INTRODUCTORY COMMENTS

In the present paper, the author introduces two original programs for the micro-computer which can be used to analize the status of fishing activities and fish stocks as well as their annual changes, using catch and fishing effort data "by statistical areas". With these programs, several important factors of fishing operation and parameters of fish stock are calculated and tabulated (Program No. 600-A). Also, seven graphs and four histograms are generated for quick and easy understanding of situations under study (Program No. 600-B).

Before presenting the programs, a brief explanation of some important parameters, such as the stock density index, the stock size index, the effectiveness of effort, etc. will be given.

With regard to computer operation, the author has had in mind primarily readers with little or no experience in computer handling. The "Remarks" column of each program, therefore, contains detailed operational instructions as well as explanations of steps which the computer must follow. It may be interesting to note that the work done by the computer within thirty minutes, would take about two months of calculations, tabulation, graph drawing etc., if done manually.

With these programs, various pieces of information can be obtained, such as (i) geographical distribution of catch, i.e. "Which is the most exploited area?"; (ii) geographical distribution of fishing effort expended, i.e. "In which areas do fishermen spend most effort?"; (iii) geographical distribution of CPUE (catch per unit effort), i.e. "Which area has the highest density of fish?"; size of fish stock by each area, i.e. "Which area has the largest amount of fish?" In this case, not only the density of fish but also the surface size (in square kilometers) of each area is taken into consideration. Information concerning annual changes in the above-mentioned factors can also be obtained by these programs.

The most important parameters of the fish stock in the fishing area as a whole, such as the effective effort, the density index, the size index and the effectiveness of fishing effort, are also computed. By studying these parameters for successive years, important information relating to fishing activities and fish stocks can be obtained; for instance, whether the size of stock is increasing or decreasing, whether the effective effort against the fish stock is increasing or decreasing etc.

A close study of these parameters is one of the very basic and indispensable tasks in stock assessment for advanced study on fish population using theoretical models.

CONTENTS

1. A BRIEF EXPLANATION ON PARAMETERS

1.1 The concept of CPUE

CATCH is the most important information required for estimating the abundance of fish in a fishing ground. In the past, CATCH was considered an index of abundance of fish. For example, if the catches from Areas A and B were 100 metric tons and 50 metric tons respectively, we considered that the abundance of fish in Area A was twice as large as that of Area B. In this case, if we expended the same amount of fishing "effort" in Areas A and B, the above consideration was correct. However, if in order to obtain twice as large catch in Area A we also doubled our effort in Area A as compared to Area B, then we must suppose that Areas A and B have about equal abundance of fish, since it is quite natural that a greater effort results in proportionally better catch. Consequently, not only CATCH but also EFFORT must be taken into account to estimate the abundance of fish in the sea. The relationship can be expressed as follows:

$$\text{FISH STOCK} \times \text{FISHING EFFORT} = \text{CATCH}$$

This symbolic expression denotes that when a fish stock is exploited by a fishing effort, then, the result obtained is catch. Therefore,

$$\text{CATCH} / \text{FISHING EFFORT} = \text{FISH STOCK}$$

This means CATCH per unit of EFFORT, represents FISH STOCK. In other words, the fish stock (its size or its density) is closely related to the factors of CATCH and EFFORT.

The concept of CPUE (Catch Per Unit Effort) is based on the above reasoning, and it is thought that CPUE represents abundance of fish in the sea.

However, when a fishing area is very large, the geographical distribution of fish is not always homogeneous; some parts will have a lot of fish while other parts may have very little. Therefore, if most of the fishing effort is expended in a rich fishing area, the catch will naturally become larger. On the contrary, if most of the fishing effort is expended in a poor fishing area the catch

will automatically become smaller, in spite of the fact that the same amount of fishing effort is expended in both cases as a whole. Therefore, CPUE cannot always represent the fish stock accurately. In order to avoid this kind of deviation of CPUE as an indicator of size or density of fish stock, an improved method described below can be introduced into our analysis.

1.2 Stock density (ϕ)

In order that the problem may be understood easily, a very simplified model will be used here. The whole fishing area is devided into four sub-areas, which will be called Areas 1, 2, 3 and 4. Suppose that all of these Areas have the same surface size (in square kilometers) and the distribution of fish in each Area is homogeneous. Also suppose that the catchability of fishing gear by unit fishing operation, (unit of effort; "number of days away from port" is used here) is $1/10^5$. (The secondary factors are neglected here for the sake of simplificity of explanation).

Now, a mathematical formula will be introduced here for easy understanding of the calculation procedure.

(1) Total catch (in metric tons) ..... $C = \Sigma Ci$
Where, Ci denotes catch in Area i

(2) Total effort (in days) ..... $X = \Sigma Xi$
Where, Xi denotes fishing effort expended in Area i

(3) (Simple) CPUE ..... $\Sigma Ci/\Sigma Xi$

(4) Stock density index ..... $\phi = \Sigma(Ci/Xi)/4$
Where, 4 is the number of areas

(5) Stock size index ..... $N = \Sigma(Ci/Xi)$

(6) Effectiveness ..... $r = \text{CPUE}/\phi$

(7) Effective effort ..... $\tilde{X} = X \cdot r$

Two cases are provided here in the form of a table (see Table 1). In Case A the fishing effort is expended in rich fishing areas, whereas in Case B it is expended in poor fishing areas. The box on the extreme left shows the fish stock: 100,000 metric tons of fish in Area 1, 200,000 metric tons of fish in Area 2, etc., Area 1 is the poorest and Area 4 is the richest area. When fishing effort is expended in Case A-1, then, catch will be Case A-2 and estimated stocks from the catch data (Case A-2) and effort data

(Case A-1) will be Case A-3. The CPUE of Case A, that is, C (total catch)/X (total effort) in the overall area (Area 1 to Area 4) is 3 metric tons. In Case B, this value is 2 metric tons, or 1 ton less than in Case A. That is to say, there is a difference in CPUE in spite of the original stock being exactly the same. Consequently, according to the formula given above, effectiveness (of fishing effort) in Cases A and B is 1.2 and 0.8 respectively. In the same manner, effective effort will be 120 days and 80 days though the actual number recorded in the log-book is 100 days in both cases.

Table 1. CPUE and Density Index

Case A.

Stock in the sea

Area 1 100,000 (in M/T)	Area 2 200,000 (in M/T)
Area 3 300,000 (in M/T)	Area 4 400,000 (in M/T)

Case B.

Case A-1 Effort expended

Area 1 10 (in days)	Area 2 20 (in days)
Area 3 30 (in days)	Area 4 40 (in days)

Case A-2 Catch obtained

Area 1 10 (in M/T)	Area 2 40 (in M/T)
Area 3 90 (in M/T)	Area 4 160 (in M/T)

Case A-3 Stock estimated

Area 1 1 (in M/T)	Area 2 2 (in M/T)
Area 3 3 (in M/T)	Area 4 4 (in M/T)

Total = 100 (days) Total = 300 (M/T) Total = 10 (M/T)

CPUE = (300 M/T)/(100 days) = 3 (M/T)
DENSITY INDEX = (1 + 2 + 3 + 4)/4 = 2.5 (M/T)
SIZE INDEX = 1 + 2 + 3 + 4 = 10 (M/T)
EFFECTIVENESS = 3/2.5 = 1.2
EFFECTIVE EFFORT = 100 × 1.2 = 120 (days)

Case B-1 Effort expended

Area 1 40 (in days)	Area 2 30 (in days)
Area 3 20 (in days)	Area 4 10 (in days)

Case B-2 Catch obtained

Area 1 40 (in M/T)	Area 2 60 (in M/T)
Area 3 60 (in M/T)	Area 4 40 (in M/T)

Case B-3 Stock estimated

Area 1 1 (in M/T)	Area 2 2 (in M/T)
Area 3 3 (in M/T)	Area 4 4 (in M/T)

Total = 100 (days) Total = 200 (M/T) Total = 10 (M/T)

CPUE = (200 M/T)/(100 days) = 2 (M/T)
DENSITY INDEX = (1 + 2 + 3 + 4)/4 = 2.5 (M/T)
SIZE INDEX = 1 + 2 + 3 + 4 = 10 (M/T)
EFFECTIVENESS = 2/2.5 = 0.8
EFFECTIVE EFFORT = 100 × 0.8 = 80 (days)

The differences in figures between Case A and Case B arise from the difference in the geographical distribution of fishing effort. In other words, in Case A, the fishing effort is concentrated on richer areas, whereas in Case B, effort is expended in poorer areas as mentioned previously. In Case A, the actual fishing effort against the fish stock is more than that of the effort recorded in the log-book. Regarding the exploitation of fish stock, in Case A is stronger than in Case B as a overall area.

However, from the viewpoint of estimation of fish stock, the value of stock density or stock size index shows the same value of 10 and 2.5 respectively in both Case A and Case B. This means that the stock density index is a more stable value for estimating the fish stock even though the geographical distribution of effort (and consequently the catch) changes case by case. It can be said that the density index is a better indicator of stock than CPUE.

1.3 The size of area

As mentioned before, the surface size of the fishing grounds is disregarded in order to simplify the explanation. In many cases, however, the areas differ in size, and this factor of size should be taken into consideration. That is, calculations of density index described above should be weighted by area. In this case, calculation should be made by using the following formula.

(i) Total area ..... $A = \Sigma Ai$
Where, Ai denotes the surface size (in square kilometers) of Area i.

(ii) Stock density index ..... $\phi = \{\Sigma(CiAi/Xi)\} / \Sigma Ai \ (= N/\Sigma Ai)$

(iii) Stock size index ..... $N = \Sigma(CiAi/Xi)$

Theoretically speaking, CPUE means a unit of production, not density. The density must have a dimension such as area or volume. Therefore, when we take into consideration the area (in square kilometers), CPUE described above becomes density. In the previous explanation, we neglected the surface size of the area in order to simplify the explanation. However, in the actual fact, we keep the size of each area in mind, because in Cases A and B, all areas are the same size (= 1), therefore, we can obtain density by simply deviding by the number of areas (÷ 4).

Mathematically, CPUE is a simple average of CPUE in the whole area, while the density index is a weighted average of CPUE in each Area.

In terms of mathematical statistics, a stock in the sea is "POPULATION", while A-3 and B-3 are "SAMPLES of POPULATION" estimated by A-1, A-2 and B-1, B-2 respectively.

1.4 Other parameters

We have so far mentioned some other parameters, namely, the stock size index (N), effective effort $(\tilde{X})$ and effectiveness (r). Their meaning and mathematical formulae have already been explained above. However, a further clarification of effectiveness (r) should be made at this point.

Effectiveness (r) is a ration of CPUE to the density index. If the geographical distribution of fishing effort is homogenous over the whole area, then $r = 1$. If $r > 1$, the distribution of effort is more or less concentrated in a rich fishing area. In the case of $r < 1$, the distribution of effort is more or less concentrated in a poor fishing area. Therefore, represents the magnitude of deviation of distribution of fishing effort in the Whole area.

2. COMPUTER PROGRAMS NOS. 600-A AND 600-B

2.1 Outline

As described in the Introductory Comments, with the two programs given here and a SHARP PC-1500 micro-computer with 8K RAM module, we can construct two tables, namely, (1) the table of total catch, total effort, effective effort, simple CPUE, stock density index, stock size index and effectiveness, by successive years in the whole area, and (2) the table of total catch, total effort, average CPUE and average CPUE × area (in square kilometers), by Area for the successive years (Program No. 600-A). We can also generate seven graphs of curves, that is, annual changes of (1) total catch, (2) total effort, (3) effective effort, (4) CPUE, (5) stock density index, (6) stock size index and (7) effectiveness in whole area. Next, we can obtain four histograms, namely, (1) total catch, (2) total effort, (3) average CPUE and average CPUE × area (in square kilometers) in each Area during the period under analysis (Program No. 600-B). Program B is CHAINed with Program A, therefore, once the CATCH and EFFORT data by area and by successive years are typed into the computer, both the tables and graphs are obtained without repeating the troublesome key-in work. CLOAD of Program No. 600-A (4740 bytes) and 600-B (4936 Bytes) takes around 6 minutes each. About 360 cm of roll paper for printing is necessary. The operating time of the computer is around 10 to 15 minutes (depending upon the number of areas) except key-in of statistical CATCH and EFFORT data. These programs have been arranged for the analysis of fish stocks in the Gulf of Thailand which is devided into 8 areas in statistics of commercial fishing fleet, and the data for 6 to 10 successive years are available. In the case of the number of areas being more or less than 8, and if the data cover more than 10 years, some minor changes in the program list are necessary.

2.2 Key Operation Procedure (Prog. 600-A : and Prog. 600-B)

STEP	KEYSTROKE	DISPLAY (Screen)
0	ON	>
1	DEF A	** CATCH-EFFORT ANALYSIS ** PEN SELECT (0 - 3) = ?
2	2 ENTER	
3	1976 ENTER	Initial YEAR = ?
4		No. of YEARS (6 - 10) = ?
5	10 ENTER	No. of YEAR Columns = ?
6	6 ENTER	SQUARE KM(1) = ?
7	2500 ENTER	SQUARE KM(2) = ? SQUARE KM(8) = ?

Remarks
Make sure that the prompt character is on the screen; this means that the computer is ready for operation.
Beep. The program title is displayed on the screen for about three seconds. Then, four small boxes for pen number selection are printed out on paper. After that, the computer asks your pen number.
If you select pen number 2, press 2 and the key marked ENTER (N.B.: the ENTER key must be pressed after every step in operation. This instruction will therefore be omitted from now on.)
Beep. The computer asks the initial year of your statistical data. If the initial year is 1976, type 1976.
After step 3, the computer asks the number of years in your data. Input it by keystroke. The number of years should be more than 6 and less than 10.
See pages 26 and 27 (layout of Tables), and decide the number of columns. If you want 6 columns, press 6.
The computer generates 6 YEAR columns on paper. After that, the computer asks km^2 of AREA 1. Input data.
The same procedure is repeated until AREA 8. Then, computer sums up AREA 1 to AREA 8 and the total area (in km^2) is printed out on paper for your reference and further consideration in the next step. Beep.

STEP	KEYSTROKE	DISPLAY (Screen)
8		** TOTAL-NON-EFFORT AREA **
		** BY MANUAL Key-in **
	82300 ENTER	P (1) - AREA (?) = ?
	- (Repeat) -	P (10) - AREA (?) = ?
9		CATCH (1,1) = ?
	42432 ENTER	
10		EFFORT (1,1) = ?
	22704 ENTER	CATCH (2,1) = ?
	- (Repeat) -	EFFORT (10,8) = ?
11	7979 ENTER	
12		PEN SELECT (0 - 3) = ?
	3 ENTER	

(cont'd)

Remarks
Two seconds display on the screen (as your reminder). Beep. Two seconds display on the screen (as your reminder). Beep.
If there is no effort (i.e. no fishing operation), in some AREA, subtract this AREA from the total area (in km^2) which was printed out on paper in step 7, and input the remainder (figure in km^2) for the first year, P (1). The same procedure has to be repeated up to the last year, [i.e. in the present case, the number of years is 10, therefore, you repeat it until P (10)].
After a short interval the computer plays a tune (sound); the input catch and effort data, according to the instructions, are displayed on the screen. For example, (1,1) denotes 1st year of AREA 1; (3,5) denotes 3rd year of AREA 5. Two different sounds (beeps) are inserted "between years" as well as "between AREAS" in order to avoid key-in mistakes. The same procedure is to be repeated up to EFFORT (10,8), that is, EFFORT data of the last (10th) year in AREA 8.
The computer prints the title TOTAL CATCH (C) and TOTAL EFFORT (X 2) on paper, then there is a pause of about 15 to 20 seconds. After that, the computer starts to generate Table 2 and AREA 1 to AREA 4 of Table 3.
Beep. after "AREA 4", four small boxes appear on the paper to check the depth of color of pen. Select a suitable pen number (No. 0 to 3); if your choice is No. 3, press 3. The computer continues to generate AREA 5 to AREA 8 of Table 3.

STEP	KEYSTROKE	DISPLAY (Screen)	
13	1 ENTER	PEN SELECT (0 - 3) = ?	
CHAIN		PROG.-600 B	
14		***** PROG.-600 B ****** M/10 ^ ? = INT (Digits 1-3)	
15		Interval of Y-axis = ?	
	20 ENTER	(Key-in mistake TRY AGAIN)	

(cont'd)

Remarks
(Same as step 12) When you select pen number 1, press 1.
After step 13, Program-600 B is automatically CLOADed, and "PROG-600 B" appears on the left side of the screen. The CLOAD takes about 6 minutes.
Two seconds display of the program number. "TOTAL CATCH IN M/T" (M/T denotes metric tons) and "MAX M = " in CSIZE. 1 (small character size) are printed out. The value of M (maximum) is also printed out in CSIZE 2 on paper. (see p. 20) In order to reduce digits attached to Y-axis in graph (see p. 20), M mentioned above should be divided by 10 ^ ? (10 ^ 1 = 10^1 = 10, 10 ^ 2 = 10^2 = 100, 10 ^ 3 = 10^3 = 1000, etc.). For example, in our case, M is 68661 (see p. 20), M is divided by 1000, then M becomes 68.661 (68661 ÷ 1000 = 68.661),this means digits on scale in Y-axis are reduced from 6 to 2 digits. The latter (divisor) should be less than 3 digits (integer part only). In the present case, type 100 (the divisor). Then, (×1000) is printed out on paper.
Now, M (maximum) is 68. Carefully consider intervals on Y-axis, that is, the number of horizontal dotted lines in the graph.
In the example described here, (see p. 20, graph on the left-hand side), interval = 20 is chosen and typed in consequently, three horizontal dotted lines appear on the graph, at the same time. 20, 40 and 60 are attached to each line on Y-axis. The computer starts making the graph. If your choice of "interval" is too small, the computer cannot generate a graph properly. In this case, "Key-in mistake TRY AGAIN" appears on the screen. The program line number of statements goes back to the first line number in step 15.

STEP	KEYSTROKE	DISPLAY (Screen)	
16	(Detailed explanations of keystrokes and displays are omitted here)		
17	3 ENTER	PEN SELECT (0 - 3) = ?	
18	(Detailed explanations of keystrokes and displays are omitted here)	****** END ******	
		>	

(cont'd)

Remarks
"TOTAL EFFORT IN DAYS" and "MAX M = " in CSIZE 1 are printed. The procedure of step 14 to 16 will be carried out up to "SIZE INDEX IN M/T" and MAX M = ". Then final graphs for "EFFECTIVENESS (r)" and "MAX M = " are printed out. The value of M is sometimes less than 1. In such a case, a different type of numeric figure, for instance "8.553250819E-01" is shown. E denotes exponential. The figure means 0.8553250819, consequently, the scale intervals of Y-axis will be less than 1, say, 0.2. (see P.22)
(see step 1 and 2). After typing in the pen number (in this example, it is 3), attachments to 7 graphs of curve are printed out (see p. 22)
Then, the computer asks you the rate of reduction of numerals (scales) attached to Y-axis for the first histogram of CATCH of each AREA. From this step on, the keystroke procedure is exactly the same as for step 14 to 16 described above. After drawing four histograms, the computer plays a tune (beep sound) and "END" is displayed on the screen for about 2 seconds.
The prompt mark " > " appears on the screen. This shows that the work of this program has been completed.

2.3 Printout

(1) Four small boxes for pen number selection are printed out (ref. 2.2 step 1), (2) YEAR column/columns are printed (ref. 2.2 steps 2 to 5), (3) the total area in square kilometers (in small-sized characters) and its answer (in ordinary sized characters) are come out. Then, Table 2 which is devided into 4 parts and Table 3 which is devided into 8 parts (Area 1 to Area 4) are printed out (ref. 2.2 steps 6 to 11).

Table 2.

TOTAL CATCH (C)	TOTAL EFFORT (X1)	DENSITY INDEX (Phi)	SIZE INDEX (N)
42432	58494	182.3	6684
28392	33915	261.5	11301
34767	33626	207.6	8973
66503	53776	458.9	19828
78464	45521	384.8	20490
43689	23749	668.5	38774
36058	15156	740.6	27150
23610	15869	1758.0	64433
13973	11371	431.5	15816
24882	7979	1716.5	62911
392770	299456	681.0	27636

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YEAR	EFFECT EFFORT (X2)	SIMPLE CPUE (d)	EFFECTIVENESS (r)
1 1976	232683	725.4	3.97
2 1977	108551	837.1	3.20
3 1978	167406	1033.9	4.97
4 1979	144890	1236.6	2.69
5 1980	203866	1723.6	4.47
6 1981	65350	1839.6	2.75
7 1982	48681	2379.1	3.21
8 1983	13429	1487.8	0.84
9 1984	32378	1228.8	2.84
10 1985	14495	3118.4	1.81
SUM/MEAN	1031733	1561.0	3.08

AREA TOTAL(SQ.KM) 36656

Table 3.

AREA 1	
CATCH	EFFORT
15704	22704
9297	10416
9642	8100
19569	13619
24387	17884
18414	14023
8452	6138
8690	9799
6610	7190
12375	2569
133140	112442

AREA 2	
CATCH	EFFORT
12327	17995
8871	12588
11189	11187
20470	19738
36081	45929
20407	5837
2557	4467
1860	35
24	1498
751	3600
114537	122874

AREA 3	
CATCH	EFFORT
14401	17795
4457	7999
4655	5788
7494	6089
8071	7156
4526	2278
22806	6714
8901	3785
0	0
5866	3430
81177	61034

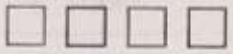
(2500 SQ.KM)	
DENSITY	d x A
691.6	1729
892.5	2231
1190.3	2975
1436.8	3592
1363.6	3409
1313.1	3282
1376.9	3442
886.8	2217
919.3	2298
4817.0	12042
1488.8	3722

(2630 SQ.KM)	
DENSITY	d x A
685.0	1801
704.7	1853
1000.1	2630
1037.0	2727
785.5	2066
3496.1	9194
572.4	1505
53142.8	139765
16.0	42
208.6	548
6164.8	16213

(4000 SQ.KM)	
DENSITY	d x A
809.2	3237
557.1	2228
804.2	3217
1230.7	4922
1127.8	4511
1986.8	7947
3396.7	13587
2351.6	9406
0.0	0
1710.2	6840
1397.4	5589

Four small boxes for pen number selection are printed again, then 8 parts of Area 5 to Area 8 in Table 3 are printed (ref. 2.2 step 12).

Table 3. (Cont'd):



AREA 4	
CATCH	EFFORT
0	0
2050	4314
0	0
1314	1589
0	0
0	0
14912	4891
0	0
2589	477
0	0
20865	11271

AREA 5	
CATCH	EFFORT
232	55
123	123
456	450
12	21
45	45
78	78
450	451
410	400
12	11
13	12
1831	1646

AREA 6	
CATCH	EFFORT
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0

(2110 SQ.KM)	
DENSITY	d x A
0.0	0
475.1	1002
0.0	0
826.9	1744
0.0	0
0.0	0
3048.8	6433
0.0	0
5427.6	11452
0.0	0
977.8	2063

(3120 SQ.KM)	
DENSITY	d x A
4218.1	13160
1000.0	3120
1013.3	3161
571.4	1782
1000.0	3120
1000.0	3120
997.7	3113
1025.0	3198
1090.9	3403
1083.3	3379
1299.9	4055

(3100 SQ.KM)	
DENSITY	d x A
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0

Program 600-A is worked out when the computer has printed out the last part of Table 3. Then, Program 600-B which is automatically CHAINed with Program 600-A is CLOADed. (ref. 2.2 CHAIN, that is, between steps 13 and 14).

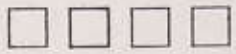
AREA 7	
CATCH	EFFORT
0	0
0	0
0	0
2045	1572
0	0
0	0
0	0
0	0
0	0
3205	1983
5250	3555

AREA 8	
CATCH	EFFORT
0	0
0	0
0	0
0	0
77	74
0	0
333	444
190	101
0	0
0	0
600	619

(2002 SQ.KM)	
DENSITY	d x A
0.0	0
0.0	0
0.0	0
1300.8	2604
0.0	0
0.0	0
0.0	0
0.0	0
0.0	0
1616.2	3235
291.7	584

(1009 SQ.KM)	
DENSITY	d x A
0.0	0
0.0	0
0.0	0
0.0	0
1040.5	1049
0.0	0
250.0	256
1881.1	1898
0.0	0
0.0	0
367.1	370

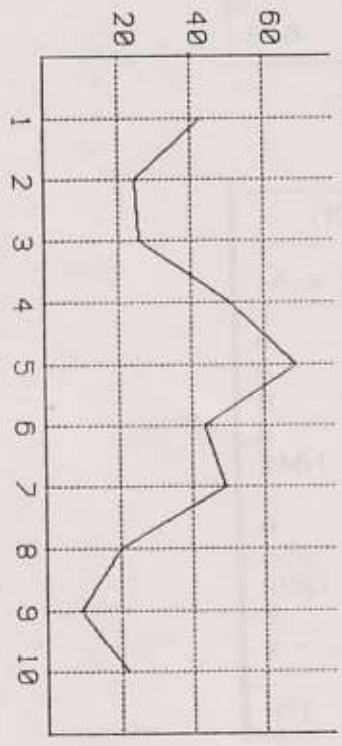
Four small boxes appear again for pen number selection. After suitable pen is selected, the computer generates seven graphs of curve (ref. 2.2 steps 14 to 16).



TOTAL CATCH IN M/T

MAX n = 68661

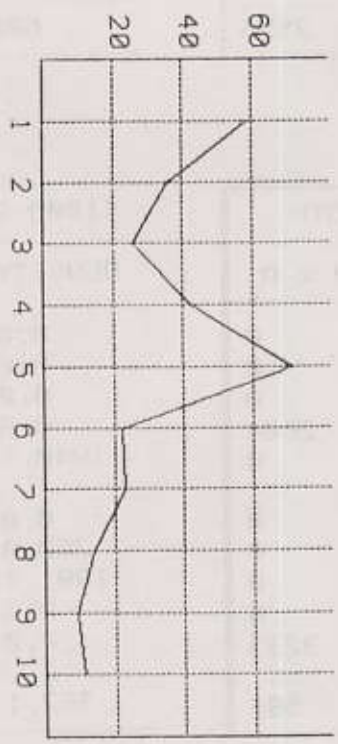
(x1000)



TOTAL EFFORT IN DAYS

MAX n = 71088

(x1000)

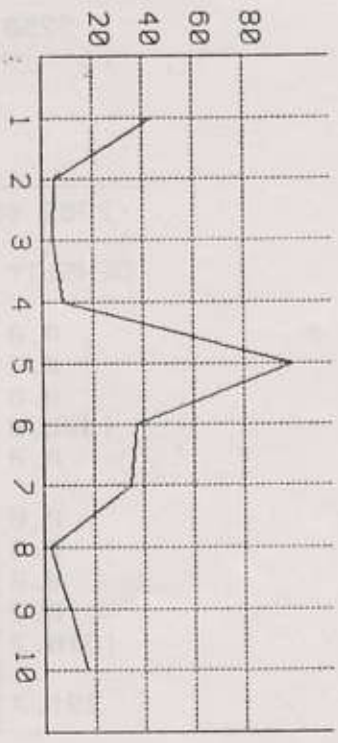


EFFECTIVE EFFORT IN DAYS

MAX n = 223

99025.31

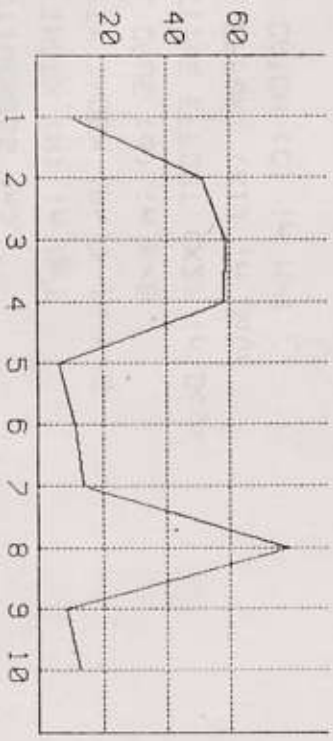
(x1000)



DENSITY INDEX IN K/G

MAX M = 7824.275
055

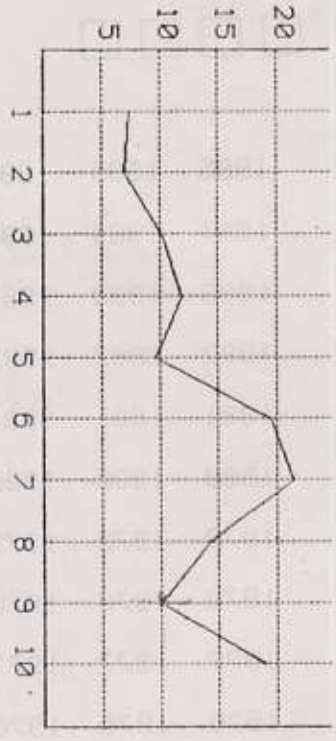
(×100)



SIMPLE CPUE IN K/G

MAX M = 2142.826
228

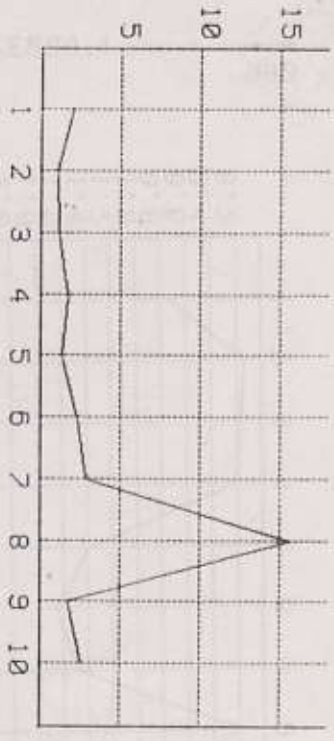
(×100)



SIZE INDEX IN M/T

MAX M = 156485.5
011

(×10000)



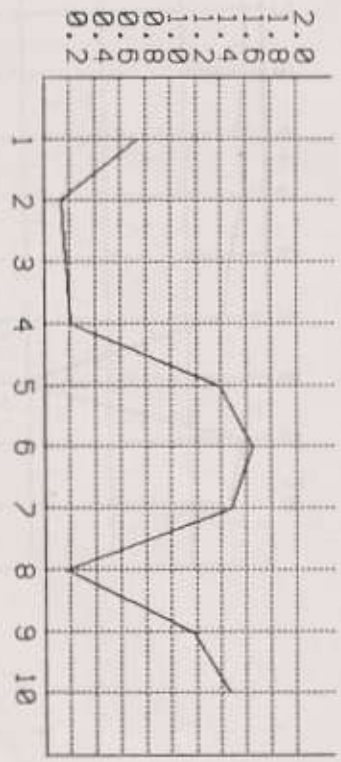
After the computer generates seven graphs, then,**ATTACHMENT** (in small sized characters) and four small boxes are printed out. Select suitable pen, then three columns of year (in this case for example, 1985 to 1976) as well as 7 kind of words [in this case, for example, "EFFECTIVENESS *(r)*" to "TOTAL CATCH *(c)* in M/T"].

Then, four histograms with record of data (in small sized characters) and attachment to histograms are printed out (ref. 2.2 steps 17 to 18).

EFFECTIVENESS(r)
MIN R = 0.136842
288

MAX R = 1.660371
086

*** ATTACHMENT ***

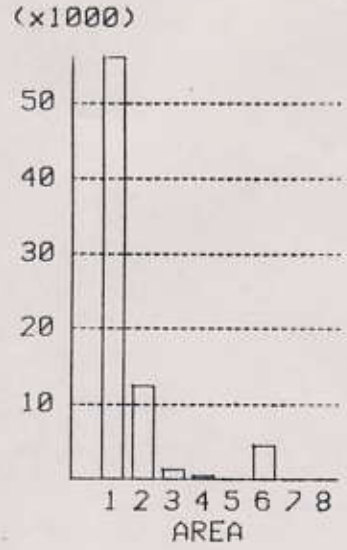


1985	1985	1985
1984	1984	1984
1983	1983	1983
1982	1982	1982
1981	1981	1981
1980	1980	1980
1979	1979	1979
1978	1978	1978
1977	1977	1977
1976	1976	1976

EFFECTIVENESS (r)
SIZE INDEX (N) in M/T
DENSITY INDEX (Phi) in K/G
SIMPL CPUE (d) in K/G
EFFECTIVE EFFORT (X2) in Days
TOTAL EFFORT (X1) in Days
TOTAL CATCH (C) in M/T

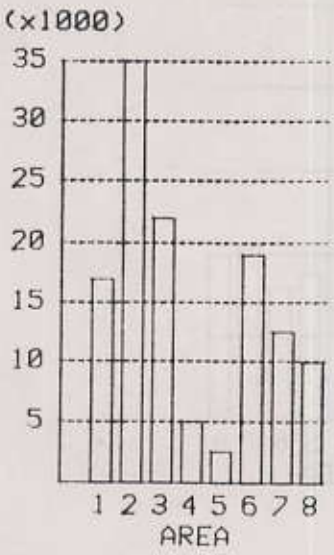
CATCH IN M/T

MAX N(J)= 56234



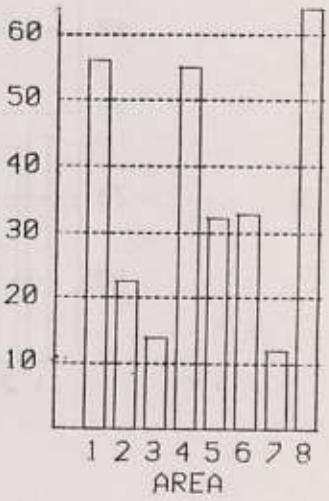
EFFORT IN DAYS

MAX N(J)= 35045



CPUE IN K/G

MAX N(J)= 64.123



** RECORD OF DATA AND PERCENT **

AREA	DATA	PERCENT
1	56234.00	75.00
2	12345.00	16.40
3	1233.00	1.64
4	555.23	0.74
5	0.00	0.00
6	4523.00	6.03
7	0.00	0.00
8	0.00	0.00

** RECORD OF DATA AND PERCENT **

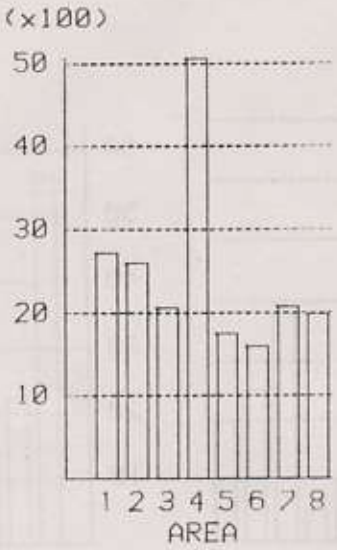
AREA	DATA	PERCENT
1	17023.00	13.00
2	35045.00	28.41
3	22023.00	17.85
4	5007.00	4.12
5	2555.00	2.07
6	18999.00	15.40
7	12500.00	10.20
8	10012.00	8.11

** RECORD OF DATA AND PERCENT **

AREA	DATA	PERCENT
1	56.23	19.44
2	22.50	7.00
3	13.00	4.20
4	55.06	19.03
5	32.23	11.14
6	33.00	11.41
7	12.00	4.10
8	64.12	22.17

f x A IN M/T

MAX N(J)= 5062.818
336



*** ATTACHMENT ***

TOTAL CATCH

TOTAL EFFORT

CPUE

CPUE x A

** RECORD OF DATA AND PERCENT **

AREA	DATA	PERCENT
1	27	13.00
2	26	13.00
3	20	10.40
4	50	25.41
5	17	8.70
6	15	8.11
7	20	10.44
8	10	10.03

2.4 Layout of tables and graphs

A table showing below is a layouted Table 2 using four pieces of Table 2 combined together.

A table showing in the next page is a layouted Table 3 using 8 pieces of Table 3 combined together. In this case, the size of layouted table is too large for put into printing area of one page, so the Table 3 is shrinked half size by photocopy machine. Another example of layout of Table 3 is shown in p. 27.

YEAR	TOTAL CATCH (C)	TOTAL EFFORT (X1)	DENSITY INDEX (Phi)	SIZE INDEX (N)	EFFECT EFFORT (X2)	SIMPLE CPUE (d)	EFFECT IVNESS (r)
1 1976	42432	58494	182.3	6684	232683	725.4	3.97
2 1977	28392	33915	261.5	11301	108551	837.1	3.20
3 1978	34767	33626	207.6	8973	167406	1033.9	4.97
4 1979	66503	53776	458.9	19828	144890	1236.6	2.69
5 1980	78464	45521	384.8	20490	203866	1723.6	4.47
6 1981	43689	23749	668.5	38774	65350	1839.6	2.75
7 1982	36058	15156	740.6	27150	48681	2379.1	3.21
8 1983	23610	15869	1758.0	64433	13429	1487.8	0.84
9 1984	13973	11371	431.5	15816	32378	1228.8	2.84
10 1985	24882	7979	1716.5	62911	14495	3118.4	1.81
SUM/MEAN	392770	299456	681.0	27636	1031733	1561.0	3.08

YEAR	AREA 1 (4520 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	12327	17995	685.0	3096
2 1977	12588	11187	1125.2	5086
3 1978	20470	19738	1037.0	4687
4 1979	36081	30907	1167.4	5276
5 1980	45929	20407	2250.6	10172
6 1981	5837	2557	2282.7	10318
7 1982	4467	1860	2401.6	10855
8 1983	35	24	1458.3	6591
9 1984	1497	751	1993.3	9009
10 1985	105	108	972.2	4394
SUM/MEAN	139336	105534	1537.3	6948

YEAR	AREA 2 (3210 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	14481	17995	809.2	2597
2 1977	4457	7999	557.1	1788
3 1978	4655	5788	804.2	2581
4 1979	7494	6089	1230.7	3950
5 1980	8071	7156	1127.8	3620
6 1981	4526	2278	1986.8	6377
7 1982	22806	6214	3396.7	10903
8 1983	8901	3785	2351.6	7548
9 1984	5866	3430	1710.2	5489
10 1985	12101	5205	2324.8	7462
SUM/MEAN	93278	66239	1629.9	5232

YEAR	AREA 3 (6625 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	0	0	0.0	0
2 1977	2050	4313	475.3	3148
3 1978	0	0	0.0	0
4 1979	1314	1589	826.9	5478
5 1980	0	0	0.0	0
6 1981	14912	4891	3048.8	20198
7 1982	0	0	0.0	0
8 1983	2589	477	5427.6	35958
9 1984	0	0	0.0	0
10 1985	232	55	4218.1	27945
SUM/MEAN	21097	11325	1399.6	9272

YEAR	AREA 4 (2110 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	14481	17995	809.2	3237
2 1977	4457	7999	557.1	2228
3 1978	4655	5788	804.2	3217
4 1979	7494	6089	1230.7	4922
5 1980	8071	7156	1127.8	4511
6 1981	4526	2278	1986.8	7947
7 1982	22806	6214	3396.7	13587
8 1983	8901	3785	2351.6	9406
9 1984	0	0	0.0	0
10 1985	5866	3430	1710.2	6840
SUM/MEAN	81177	61834	1397.4	5589

YEAR	AREA 5 (3120 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	0	0	0.0	0
2 1977	2050	4314	475.1	1482
3 1978	0	0	0.0	0
4 1979	1314	1589	826.9	1744
5 1980	0	0	0.0	0
6 1981	0	0	0.0	0
7 1982	14912	4891	3048.8	6433
8 1983	0	0	0.0	0
9 1984	2589	477	5427.6	11452
10 1985	0	0	0.0	0
SUM/MEAN	20865	11271	972.8	2063

YEAR	AREA 6 (3100 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	232	55	4218.1	13160
2 1977	123	123	1000.0	3120
3 1978	456	450	1013.3	3161
4 1979	12	21	571.4	1782
5 1980	45	45	1000.0	3120
6 1981	78	78	1000.0	3120
7 1982	450	451	997.7	3113
8 1983	410	400	1025.0	3198
9 1984	12	11	1090.9	3403
10 1985	13	12	1083.3	3379
SUM/MEAN	1831	1646	1299.9	4055

YEAR	AREA 7 (2002 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	0	0	0.0	0
2 1977	0	0	0.0	0
3 1978	0	0	0.0	0
4 1979	2045	1572	1300.8	2604
5 1980	0	0	0.0	0
6 1981	0	0	0.0	0
7 1982	0	0	0.0	0
8 1983	0	0	0.0	0
9 1984	0	0	0.0	0
10 1985	3205	1983	1616.2	3235
SUM/MEAN	5250	3555	291.7	584

YEAR	AREA 8 (1089 SQ.KM)			
	CATCH	EFFORT	DENSITY	d x A
1 1976	0	0	0.0	0
2 1977	0	0	0.0	0
3 1978	0	0	0.0	0
4 1979	0	0	0.0	0
5 1980	77	74	1040.5	1049
6 1981	0	0	0.0	0
7 1982	333	444	750.0	756
8 1983	190	181	1081.1	1090
9 1984	0	0	0.0	0
10 1985	0	0	0.0	0
SUM/MEAN	600	619	367.1	370

YEAR	AREA 1 (2500 SQ.KM)				AREA 2 (2630 SQ.KM)				AREA 3	
	CATCH	EFFORT	DENSITY	d x A	CATCH	EFFORT	DENSITY	d x A	CATCH	EFFORT
1 1976	15704	22704	691.6	1729	12327	17995	685.0	1801	14401	17795
2 1977	9297	10416	892.5	2231	8071	12588	704.7	1853	4457	7999
3 1978	9642	8100	1190.3	2975	11189	11187	1000.1	2630	4655	5788
4 1979	19569	13619	1436.8	3592	20470	19738	1037.0	2727	7494	6089
5 1980	24387	17884	1363.6	3409	36081	45929	785.5	2066	8071	7156
6 1981	18414	14023	1313.1	3282	20407	5837	3496.1	9194	4526	2278
7 1982	8452	6138	1376.9	3442	2557	4467	572.4	1505	22886	6214
8 1983	8690	9799	886.8	2217	1860	35	53142.8	139765	8901	3785
9 1984	6610	7198	919.3	2298	24	1498	16.0	42	0	0
10 1985	12375	2569	4817.0	12042	751	3600	208.6	548	5866	3430
SUM/MEAN	133140	112442	1488.8	3722	114537	122874	6164.8	16213	81177	61034

AREA 4

YEAR	AREA 5 (3120 SQ.KM)				AREA 6 (3100 SQ.KM)				AREA 7	
	CATCH	EFFORT	DENSITY	d x A	CATCH	EFFORT	DENSITY	d x A	CATCH	EFFORT
1 1976	232	55	4218.1	13160	0	0	0.0	0	0	0
2 1977	123	123	1000.0	3120	0	0	0.0	0	0	0
3 1978	456	450	1013.3	3161	0	0	0.0	0	0	0
4 1979	12	21	571.4	1782	0	0	0.0	0	2045	1572
5 1980	45	45	1000.0	3120	0	0	0.0	0	0	0
6 1981	78	78	1000.0	3120	0	0	0.0	0	0	0
7 1982	450	451	997.7	3113	0	0	0.0	0	0	0
8 1983	410	400	1025.0	3198	0	0	0.0	0	0	0
9 1984	12	11	1090.9	3403	0	0	0.0	0	0	0
10 1985	13	12	1083.3	3379	0	0	0.0	0	3205	1983
SUM/MEAN	1831	1646	1299.9	4055	0	0	0.0	0	5250	3555

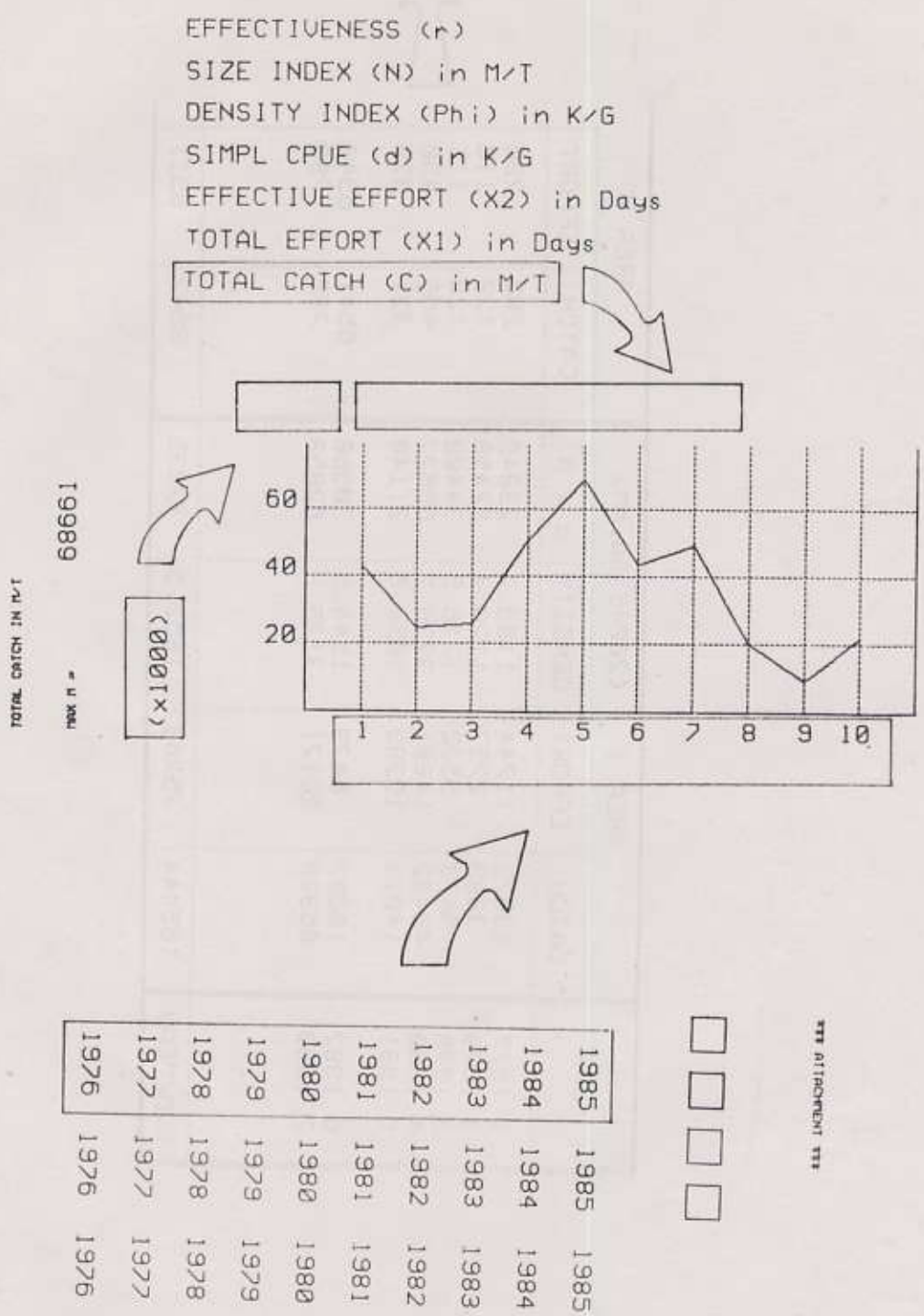
AREA 8

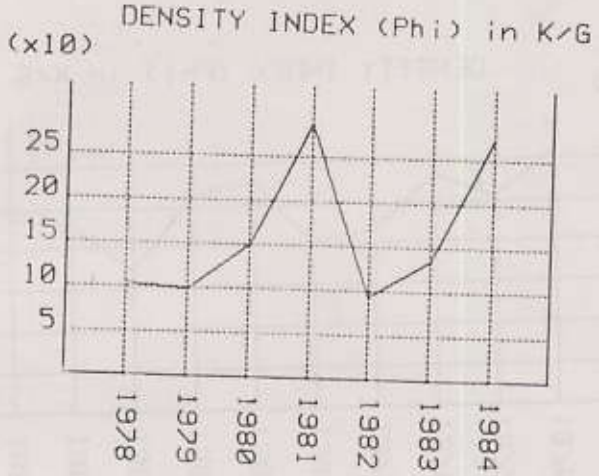
Examples in this and next pages showing Tables 2 and 3 in the case of number of years is less than ten. (These examples is 7 years).

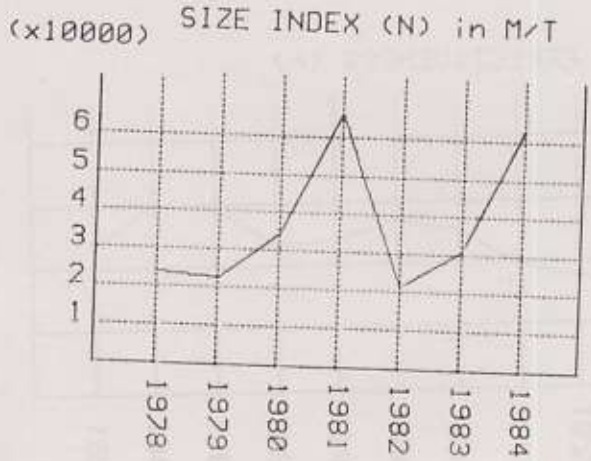
The following pages shows how to layout graphs of curve and histograms and results of layout. It is self-explanatory and needless to explain.

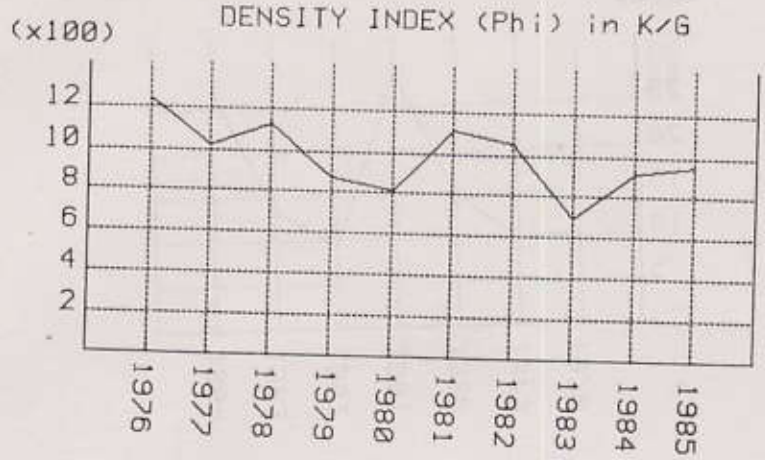
YEAR	TOTAL CATCH (C)	TOTAL EFFORT (X1)	EFFECT EFFORT (X2)	SIMPLE CPUE (d)	DENSITY INDEX (Phi)	SIZE INDEX (N)	EFFECTIVNESS (r)
1 1977	200	200	600	1000.0	333.3	1000	3.00
2 1978	120	110	439	1090.9	272.7	1090	3.99
3 1979	132	123	97	1073.1	1360.3	4081	0.78
4 1980	486	480	242	1012.5	2006.6	4013	0.50
5 1981	366	365	365	1002.7	1000.7	4003	1.00
6 1982	6582	6580	4845	1000.3	1358.3	4075	0.73
7 1983	812	801	188	1013.7	4297.2	4297	0.23
SUM/MEAN	8698	8659	6779	1027.6	1518.5	3222	1.46

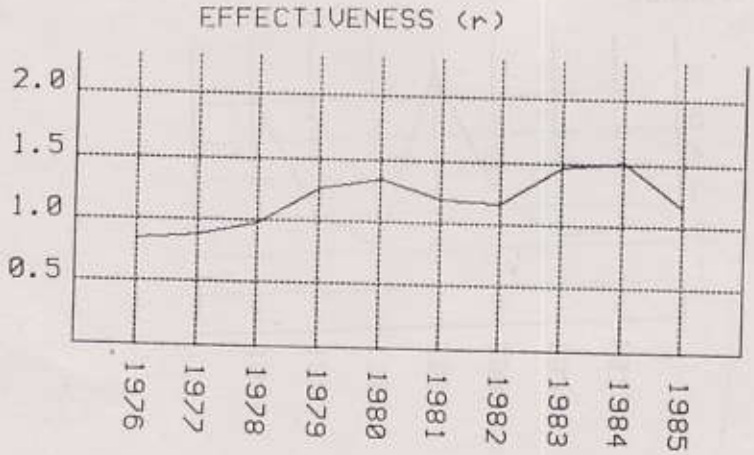
YEAR	AREA 1 (20045 SQ.KM)				AREA 2	
	CATCH	EFFORT	DENSITY	d x A	CATCH	EFFORT
1 1977	13973	11744	1189.7	23849	200	200
2 1978	3089	2757	1120.4	22458	120	110
3 1979	9479	5522	1716.5	34409	120	111
4 1980	48492	14801	3276.2	65672	456	450
5 1981	14015	13289	1054.6	21140	321	320
6 1982	10007	6479	1544.5	30960	6541	6540
7 1983	66389	21171	3135.8	62858	789	780
SUM/MEAN	165444	75763	1862.5	37335	8547	8511

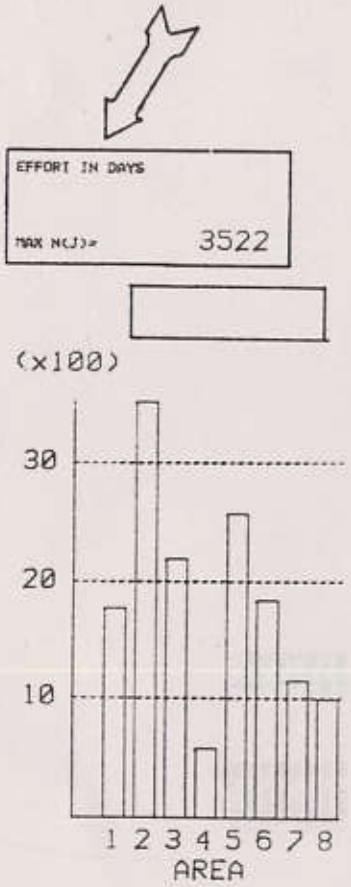

EFFECTIVENESS (r)
SIZE INDEX (N) in M/T
DENSITY INDEX (Phi) in K/G
SIMPL CPUE (d) in K/G
EFFECTIVE EFFORT (X2) in Days
TOTAL EFFORT (X1) in Days
TOTAL CATCH (C) in M/T
TOTAL CATCH IN M/T
MAX R =
68661
(x1000)
60
40
20
1 2 3 4 5 6 7 8 9 10
1985
1984
1983
1982
1981
1980
1979
1978
1977
1976
1985
1984
1983
1982
1981
1980
1979
1978
1977
1976
*** ATTACHMENT ***


DENSITY INDEX (Phi) in K/G
(x10)
25
20
15
10
5
1978
1979
1980
1981
1982
1983
1984


(x10000) SIZE INDEX (N) in M/T
6
5
4
3
2
1
1978
1979
1980
1981
1982
1983
1984


(x100)
DENSITY INDEX (Phi) in K/G
12
10
8
6
4
2
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985


EFFECTIVENESS (r)
2.0
1.5
1.0
0.5
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985



*** ATTACHMENT ***

TOTAL CATCH

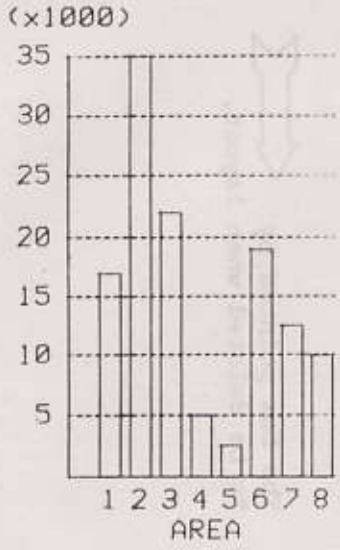
TOTAL EFFORT

CPUE

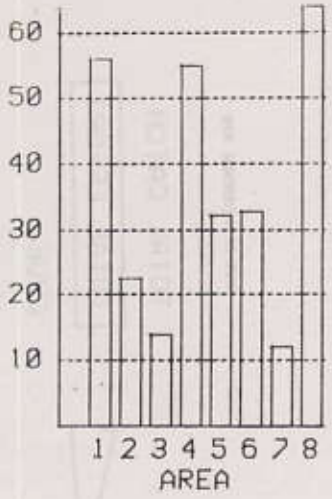
CPUE x A

The box pointed by ⇐ is to be deleted when layout.

TOTAL CATCH



CPUE



** RECORD OF DATA AND PERCENT **

AREA	DATA	PERCENT
1	17023.00	13.00
2	35045.00	28.41
3	22023.00	17.85
4	5007.00	4.12
5	2555.00	2.07
6	18999.00	15.40
7	12500.00	10.20
8	10012.00	8.11

2.5 Program Listing

```
 5:REM **********
   * PROG.-600A *
   *CATCH-EFFORT*
   * ANALYSIS-A *
   **************
10:"A":CLEAR :
   WAIT 100:BEEP
   3,60:PRINT "**
   CATCH-EFFORT A
   NALYSIS**":
   BEEP 3:TEST
11:INPUT "PEN SEL
   ECT(0-3)=?";O:
   COLOR O
15:BEEP 5:INPUT "
   Initial YEAR=?
   ";A
16:BEEP 3:INPUT "
   No.of YEARs(6-
   10)=?";B
17:BEEP 3:INPUT "
   No.of YEAR col
   umns=?";E
18:FOR M=0TO E-1:
   LF 2:C=A-1:
   LPRINT "    YE
   AR":LF 2
19:FOR I=0TO B-1:
   Q=Q+1:C=C+1:
   USING "###":
   LPRINT TAB 1;Q
   :LF -1:USING :
   LPRINT TAB 4;C
20:IF I=4LF 1
21:NEXT I:LF 1:Q=
   0
22:IF I<=8LF (10-
   B)
23:LPRINT "  SUM/
   MEAN":GOSUB 10
   00
25:NEXT M
29:REM **********
30:BEEP 10:WAIT 0
   :Z=B:H=Z-1
40:DIM A(Z,7),B(Z
   ,7),C(Z,7),D(Z
   ,7),K(7),P(Z),
   Q(Z)
60:FOR J=0TO 7:
   CLS :K$="":CLS
   :K$="SQUARE KM
   ("+STR$ (J+1)+
   ")=":PRINT K$;
61:INPUT K(J):
   PRINT K(J):
   BEEP 2,80
62:NEXT J:LF -1
63:FOR J=0TO 7:G=
   G+K(J):NEXT J:
   BEEP 3:CSIZE 1
   :LPRINT TAB 2;
   "AREA TOTAL(SQ
   .KM)":LF -1:
   CSIZE 2:LPRINT
   TAB 9;G:LF 2
64:WAIT 100:PRINT
   "**P=TOTAL-NON
   .EFFORT AREA**
   ":BEEP 3:WAIT
65:WAIT 70:PRINT
   "  ** By MANUA
   L Key-in **":
   BEEP 2,130:
   WAIT
67:FOR I=0TO H:
   BEEP 2,130:
   WAIT 0
77:P$="":CLS :P$=
   "P("+STR$ (I+1
   )+")-AREA(?)="
   :PRINT P$;
78:INPUT P(I):
   PRINT P(I):
   BEEP 3:NEXT I
79:FOR A=100TO 1
   STEP -5:BEEP 1
   ,A:NEXT A:A=0
80:FOR J=0TO 7:
   FOR I=0TO H
82:A$="":CLS
85:A$="CATCH ("+
   STR$ (I+1)+","
   +STR$ (J+1)+")
   "
86:PRINT A$;
87:INPUT A(I,J)
88:PRINT A(I,J)
94:B$="":CLS
```

```
CATCH-EFFORT ANA
LYSIS (Part 1)

SHARP PC-1500
LANGUAGE USED:
 EXPANDED BASIC

PROGRAM No.600A
CASSETTE= 05-A
TAPE COUNTER
      002-080

08 MARCH 1983
S.SHINDO(SEAFDEC)
```

```
95:B$="EFFORT ("+
   STR$ (I+1)+","
   +STR$ (J+1)+")
   "
97:PRINT B$;
98:INPUT B(I,J)
99:PRINT B(I,J):
   BEEP 3
100:NEXT I:BEEP 6,
   40
101:NEXT J:BEEP 5,
   60:LF 2:GOTO 3
   30
102:REM *********
103:FOR J=0TO 7
104:IF J=4LF -3:
   TEST
105:IF J=4INPUT "P
   EN SELECT(1-3)
   =?";O:COLOR O
107:FOR I=0TO H
108:LPRINT "
       AREA":LF -
   1:USING "##":
   LPRINT TAB 14;
   J+1:USING :LF
   1
110:LPRINT "   CAT
   CH   EFFORT":
   LF 1
113:FOR I=0TO H
119:USING "#######
   #"
```

```
120:A(Z,J)=A(Z,J)+
    A(I,J):B(Z,J)=
    B(Z,J)+B(I,J)
130:LPRINT TAB 1;A
    (I,J):LF -1:
    LPRINT TAB 9;B
    (I,J)
132:IF I=4LF 1
140:NEXT I
141:IF I<=8LF (10-
    B)
142:LF 1:LPRINT
    TAB 1;A(Z,J):
    LF -1:LPRINT
    TAB 9;B(Z,J)
150:GOSUB 1050
160:REM *********
170:X$="  (":Y$=
    STR$ (K(J)):Z$
    =" SQ.KM)"
180:W$=X$+Y$+Z$
190:LPRINT W$:LF 1
200:LPRINT "  DENS
    ITY  d x A":LF
    1
210:FOR I=0TO H
211:IF B(I,J)=0LET
    B(I,J)=9E20
212:NEXT I
220:FOR I=0TO H
230:C(I,J)=A(I,J)/
    B(I,J)*1000
240:C(Z,J)=C(Z,J)+
    C(I,J):NEXT I
242:FOR I=0TO H
243:IF B(I,J)=9E20
    LET B(I,J)=0:
    NEXT I
244:FOR I=0TO H
245:D(I,J)=C(I,J)*
    K(J)/1000
250:D(Z,J)=D(Z,J)+
    D(I,J):NEXT I
260:FOR I=0TO H:
    USING "#######.
    #":LPRINT TAB
    1;C(I,J):LF -1
    :USING "#######
    ##":LPRINT TAB
    9;D(I,J)
261:IF I=4LF 1
262:NEXT I:LF 1
263:IF I<=8LF (10-
    B)
264:USING "######.
    #":LPRINT TAB
    1;C(Z,J)/Z
265:LF -1:USING "#
    ########":
    LPRINT TAB 9;D
    (Z,J)/Z
266:AA=1:GOSUB 105
    0
267:NEXT J:BEEP 10
268:LF -3:TEST :
    INPUT "PEN SEL
    ECT(1-3)=?";O:
    COLOR O
269:CHAIN "PROG.-6
    00B"
270:REM **********
    *   CHAIN    *
    * PROG.-600B *
    * == END ==  *
    **************
280:END
330:REM *********
335:DIM AA(Z),BB(Z
    ),CC(Z),DD(Z),
    EE(Z),FF(Z),GG
    (Z):WAIT 0
340:LPRINT "   TOT
    AL   TOTAL"
345:LPRINT "   CAT
    CH   EFFORT"
347:LPRINT "    (C
    )     (X1)":LF
    1
350:FOR I=0TO H:
    FOR J=0TO 7
360:AA(I)=AA(I)+A(
    I,J)
361:BB(I)=BB(I)+B(
    I,J):NEXT J:
    NEXT I
362:FOR I=0TO H
363:IF BB(I)=0LET
    BB(I)=9E20
364:CC(I)=CC(I)+(A
    A(I)/BB(I))*10
    00
366:IF BB(I)=9E20
    LET BB(I)=0
370:GOSUB 1100
372:EE(I)=EE(I)+(D
    D(I)/P(I))*100
    0
373:IF EE(I)=0LET
    EE(I)=9E20
374:GG(I)=GG(I)+(C
    C(I)/EE(I))
375:IF EE(I)=9E20
    LET EE(I)=0
376:FF(I)=FF(I)+BB
    (I)*GG(I)
380:NEXT I
390:FOR I=0TO H
392:A1=A1+AA(I):B1
    =B1+BB(I):C1=C
    1+CC(I):D1=D1+
    DD(I)
393:E1=E1+EE(I):F1
    =F1+FF(I):G1=G
    1+GG(I)
394:NEXT I
395:FOR I=0TO H
396:IF I=5LF 1
400:USING "#######
    #":LPRINT TAB
    1;AA(I):LF -1:
    LPRINT TAB 9;B
    B(I)
405:NEXT I:LF 1
407:IF I<=8LF (10-
    B)
410:LPRINT TAB 1;A
    1:LF -1:LPRINT
    TAB 9;B1
417:BB=1:GOSUB 105
    0
419:REM ********
420:LPRINT "   EFF
    ECT  SIMPLE":
    LPRINT "   EFF
    ORT   CPUE"
422:LPRINT "    (X
    2)     (d)":LF
    1
425:FOR I=0TO H
426:IF I=5LF 1
430:USING "#######
    #":LPRINT TAB
```

```
    1;FF(I):LF -1:
    USING "######.
    #":LPRINT TAB
    9;CC(I):NEXT I
435:IF I<=8LF (10-
    B)
440:LF 1:USING "##
    ######":LPRINT
    TAB 1;F1:LF -1
    :USING "######
    .#":LPRINT TAB
    9;C1/B
450:BB=1:GOSUB 105
    0
451:REM *********
455:LPRINT "  DENS
    ITY   SIZE":
    LPRINT "   IND
    EX    INDEX"
456:LPRINT "   (Ph
    i)      (N)":LF
    1
460:FOR I=0TO H
465:IF I=5LF 1
470:USING "######.
    #":LPRINT TAB
    1;EE(I):LF -1:
    USING "#######
    #":LPRINT TAB
    9;DD(I)
477:NEXT I:LF 1
478:IF I<=8LF (10-
    B)
480:USING "######.
    #":LPRINT TAB
    1;E1/B:LF -1:
    USING "#######
    #":LPRINT TAB
    9;D1/B
485:BB=1:GOSUB 105
    0
489:REM *********
490:LPRINT "  EFFE
    CT":LPRINT "
    IUNESS":LPRINT
    "    (r)":LF 1
491:FOR I=0TO H
492:IF I=5LF 1
495:USING "###.##"
    :LPRINT TAB 1;
    GG(I)
496:NEXT I:LF 1
497:IF I<=8LF (10-
    B)
499:LPRINT TAB 1;G
    1/B:USING
500:GOSUB 1090
510:GOTO 102
999:REM *********

1000:GRAPH :LINE
     (7,7)-(7,365
     ),0,0:LINE (
     7,365)-(147,
     365),0,0
1010:LINE (132,32
     7)-(147,327)
     ,2,0:LINE (1
     47,290)-(10,
     290),2,0
1020:LINE (10,365
     )-(10,7),0,0
     :LINE (10,42
     )-(147,42),2
     ,0
1030:LINE (7,7)-(
     147,7),0,0:
     LINE (132,7)
     -(132,365),0
     ,0
1035:LINE (129,36
     5)-(129,7),0
     ,0
1040:GLCURSOR (0,
     0):TEXT :LF
     4:RETURN
1049:REM ********
1050:GRAPH
1051:IF BB=1LINE
     (5,365)-(230
     ,365),0,0:
     GOTO 1057
1053:LINE (5,365)
     -(230,365),0
     ,0:LINE (230
     ,327)-(5,327
     ),2,0
1054:IF AA=1LINE
     (5,290)-(220
     ,290),2,0:
     LINE (213,36
     5)-(213,7),0
     ,0
1055:IF AA=1LINE
     (216,7)-(216
     ,365),0,0:
     GOTO 1070
1057:IF BB=1LINE
     (5,290)-(220
     ,290),2,0:
     LINE (213,36
     5)-(213,7),0
     ,0
1058:IF BB=1LINE
     (113,365)-(1
     13,7),0,0:
     LINE (5,42)-
     (230,42),2,0
     :GOTO 1080
1060:LINE (5,290)
     -(220,290),2
     ,0:LINE (213
     ,327)-(213,7
     ),2,0
1070:LINE (113,32
     7)-(113,7),2
     ,0:LINE (5,4
     2)-(230,42),
     2,0
1080:LINE (230,7)
     -(5,7),0,0:
     GLCURSOR (0,
     0):TEXT :LF
     5:AA=0:BB=0:
     RETURN
1089:REM ********
1090:GRAPH :LINE
     (5,365)-(116
     ,365),0,0:
     LINE (5,290)
     -(113,290),2
     ,0
1092:LINE (116,36
     5)-(116,7),0
     ,0:LINE (113
     ,7)-(113,365
     ),0,0
1094:LINE (113,36
     5)-(113,7),0
     ,0:LINE (5,4
     2)-(113,42),
     2,0
```

```
1096:LINE (116,7)
     -(5,7),0,0:
     TEXT :LF 5:
     RETURN
1099:REM ********
1100:FOR J=0TO 7
1105:IF B(I,J)=0
     LET B(I,J)=9
     E20
1110:DD(I)=DD(I)+
     A(I,J)/B(I,J
     )*K(J)
1130:IF B(I,J)=9E
     20LET B(I,J)
     =0
1135:NEXT J
1140:RETURN
1150:REM ########
     # STATUS 1 #
     #   4/40   #
     ############
1160:END
```

```
5:REM **********
  * PROG.-600B *
  *CATCH-EFFORT*
  * ANALYSIS-B *
  **************
6:TEXT :WAIT 100
  :PRINT "******
   PROG.-600B **
  ***":BEEP 3:
  WAIT
8:DIM M(7),N(7),
  X(15),U(15),BR
  (7),VV(7)
9:L=B
10:FOR I=0TO H:M(
  I)=AA(I):NEXT
  I
12:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "TOTAL CATCH I
  N M/T":CSIZE 2
  :GOSUB 135
14:FOR I=0TO H:M(
  I)=0:NEXT I
16:FOR I=0TO H:M(
  I)=BB(I):NEXT
  I
18:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "TOTAL EFFORT
  IN DAYS":CSIZE
  2:GOSUB 135
20:FOR I=0TO H:M(
  I)=0:NEXT I
22:FOR I=0TO H:M(
  I)=FF(I):NEXT
  I
23:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "EFFECTIVE EFF
  ORT IN DAYS":
  CSIZE 2:GOSUB
  135
24:FOR I=0TO H:M(
  I)=0:NEXT I
26:FOR I=0TO H:M(
  I)=CC(I):NEXT
  I
27:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "SIMPLE CPUE I
  N K/G":CSIZE 2
  :GOSUB 135
28:FOR I=0TO H:M(
  I)=0:NEXT I
30:FOR I=0TO H:M(
  I)=EE(I):NEXT
  I
32:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "DENSITY INDEX
   IN K/G":CSIZE
  2:GOSUB 135
34:FOR I=0TO H:M(
  I)=0:NEXT I
36:FOR I=0TO H:M(
  I)=DD(I):NEXT
  I
37:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "SIZE INDEX IN
   M/T":CSIZE 2:
  GOSUB 135
38:FOR I=0TO H:M(
  I)=0:NEXT I
39:FOR I=0TO H:M(
  I)=GG(I):NEXT
  I
40:BEEP 5,50,300:
  CSIZE 1:LPRINT
  "EFFECTIVENESS
  (r)":CSIZE 1:Q
  1=1:GOSUB 135
41:FOR I=0TO H:M(
  I)=0:NEXT I
42:GOTO 1500
```

```
CATCH-EFFORT ANA
LYSIS (Part 2)

SHARP PC-1500
LANGUAGE USED:
 EXPANDED BASIC

PROGRAM No.600B
CASSETTE= 05-A
TAPE COUNTER
       083-181

21 MARCH 1983
S.SHINDO(SEAFDEC)
```

```
43:REM *********
44:FOR J=0TO 7:N(
   J)=A(Z,J):NEXT
   J
45:BEEP 5,50,300:
   CSIZE 1:LPRINT
   "CATCH IN M/T"
   :CSIZE 2:LF 2:
   GOSUB 3000
46:FOR J=0TO 7:N(
   J)=0:NEXT J
47:FOR J=0TO 7:N(
   J)=B(Z,J):NEXT
   J
48:BEEP 5,50,300:
   CSIZE 1:LPRINT
   "EFFORT IN DAY
   S":CSIZE 2:LF
   2:GOSUB 3000
49:FOR J=0TO 7:N(
   J)=0:NEXT J
50:FOR J=0TO 7:N(
   J)=C(Z,J):NEXT
   J
51:BEEP 5,50,300:
   CSIZE 1:LPRINT
   "CPUE IN K/G":
   CSIZE 2:LF 2:
   GOSUB 3000
52:FOR J=0TO 7:N(
   J)=0:NEXT J
53:FOR J=0TO 7:N(
   J)=D(Z,J):NEXT
   J
54:BEEP 5,50,300:
   CSIZE 1:LPRINT
   "d x A IN M/T"
   :CSIZE 2:LF 2:
   GOSUB 3000
55:FOR J=0TO 7:N(
   J)=0:NEXT J
57:FOR J=0TO 7:N(
   J)=D(Z,J):NEXT
   J
58:GOSUB 4180
60:BEEP 5:WAIT 15
   0:PRINT "*****
   * END ******"
61:FOR Q=60TO 40
   STEP -2:BEEP 2
   ,Q,300:NEXT Q
65:REM **********
       *  END   *
       **********
 67:END
134:REM *********
135:M=0
136:IF Q1<>1THEN 1
   63
137:IF Q1=1GOTO 13
   8
138:M=10:FOR I=0TO
   H:IF M>=M(I)
   LET M=M(I)
139:NEXT I
140:CSIZE 1:LF 1:
   LPRINT "MIN M
   =":LF -1:CSIZE
   2:LPRINT TAB 9
   ;M:M=0
163:FOR I=0TO H
164:IF M<=M(I)LET
   M=M(I)
165:NEXT I
167:LF 1:CSIZE 1:
   LF 1:LPRINT "M
   AX M =":LF -1:
   CSIZE 2:LPRINT
   TAB 9;M:CSIZE
   2:LF 4
170:IF Q1=1INPUT "
   *Special M for
    (r)* M=?";M
171:IF M<99LET R=1
   :GOTO 190
172:INPUT "M/10^?=
   INT(Dig.1-3):?
   =";R:BEEP 5,5,
   300
174:FOR I=0TO H
175:M(I)=M(I)/R:
   NEXT I
182:L$=" (x":M$=
   STR$ R:N$=")":
   O$=L$+M$+N$
183:LPRINT O$:LF 4
190:INPUT "Interva
   l of Y-axis=?"
   ;E
1110:REM ********
1113:GRAPH :
     GLCURSOR (0,
     0):SORGN :
     TEXT
1115:GRAPH :
     GLCURSOR (25
     ,0):SORGN
1120:ROTATE 1
1125:G=INT (M/R/E
   )
1127:IF G>15WAIT
   150:PRINT "K
   eyin mistake
   , TRY AGAIN"
   :WAIT :TEXT
   :GOTO 172
1140:W=0:FOR W=1
   TO G
1150:X(W-1)=33/M*
   W*E*5*R
1152:IF Q1<>1GOTO
   1160
1153:IF Q1=1GOTO
   1155
1155:GLCURSOR (X(
   W-1),54):
   USING "##.#"
   :LPRINT E*W:
   USING :GOTO
   1170
1160:IF E*W>=100
   GLCURSOR (X(
   W-1),54):
   USING "####"
   :LPRINT E*W:
   USING :GOTO
   1170
1161:IF E*W<99
   GLCURSOR (X(
   W-1),40):
   USING "###":
   LPRINT E*W:
   USING :GOTO
   1170
1165:LPRINT E*W
1170:NEXT W
1180:LINE (0,0)-(
   190,0),0,0
1185:Y=0
1190:FOR W=0TO I
1200:LINE (0,Y)-(
   0,(Y-40)),0,
   0
1210:LINE (0,(Y-4
   0))-(215,(Y-
   40)),1,0
1220:GOSUB 2500
1230:IF W<>0LINE
   (U,Y)-(L,(Y-
   40)),0,0
```

```
     (U,Y)-(L,(Y-
     40)),0,0
1240:IF W>8
     GLCURSOR (-2
     0,(Y-15)):
     GOTO 1260
1250:GLCURSOR (-2
     0,(Y-25))
1260:LPRINT W+1
1270:Y=Y-40:U=L
1280:NEXT W
1283:TEXT :GRAPH
     :GLCURSOR (2
     5,0):SORGN
1285:LINE (0,10)-
     (0,-30),0,0:
     LINE (0,-30)
     -(190,-30),0
     ,0:X=0:Y=10
1287:GOSUB 2500
1290:TEXT :LF 5
1300:RETURN
1449:REM ********
1500:TEST :INPUT
     "PEN SELECT(
     0-3)=?";0:
     COLOR 0
1510:FOR Y=0TO 2
1515:FOR I=0TO H
1520:LPRINT C;" "
     ;C;" ";C:LF
     1
1530:C=C-1:NEXT I
     :LF 2:C=C+H+
     1
1540:NEXT Y
1550:REM ********
1560:DIM S$(6)*30
1570:S$(0)="TOTAL
      CATCH (C) i
     n M/T"
1572:S$(1)="TOTAL
      EFFORT (X1)
      in Days"
1573:S$(2)="EFFEC
     TIVE EFFORT
     (X2) in Days
     "
1574:S$(3)="SIMPL
      CPUE (d) in
      K/G"
1576:S$(4)="DENSI
     TY INDEX (Ph
     ) in K/G"
1577:S$(5)="SIZE
     INDEX (N) in
      M/T"
1579:S$(6)="EFFEC
     TIVENESS (r)
     "
1580:GRAPH :
     ROTATE 1:
     GLCURSOR (0,
     0):SORGN
1590:X=5:Y=0
1600:FOR S=0TO 6
1610:IF S=0
     GLCURSOR (X,
     Y):LPRINT S$
     (0)
1611:IF S=1
     GLCURSOR (X,
     Y):LPRINT S$
     (1)
1612:IF S=2
     GLCURSOR (X,
     Y):LPRINT S$
     (2)
1613:IF S=3
     GLCURSOR (X,
     Y):LPRINT S$
     (3)
1614:IF S=4
     GLCURSOR (X,
     Y):LPRINT S$
     (4)
1615:IF S=5
     GLCURSOR (X,
     Y):LPRINT S$
     (5)
1616:IF S=6
     GLCURSOR (X,
     Y):LPRINT S$
     (6)
1617:X=X+30
1618:NEXT S:TEXT
     :LF 12
1619:GOTO 44
2499:REM ********
2500:FOR N=1TO G
2520:LINE (X(N-1)
     ,Y)-(X(N-1),
     Y-40),1,0
2530:NEXT N
2540:L=33/M*M(W)*
     5*R
2550:RETURN
3000:REM ********
3010:FOR J=0TO 7
3020:IF N<=N(J)
     LET N=N(J)
3025:NEXT J:BEEP
     5
3030:CSIZE 1:
     LPRINT "MAX
     N(J)=":LF -1
     :CSIZE 2:
     LPRINT TAB 9
     ;N:LF 3:BEEP
     5,50,300
3035:IF N<99LET R
     =1:GOTO 3050
3040:INPUT "M/10^
     ?=INT(DIG.1-
     3):?=";R:
     BEEP 5,50,30
     0
3050:FOR J=0TO 7:
     N(J)=N(J)/R:
     NEXT J
3059:L$="(x":M$=
     STR$ R:N$=")
     ":O$=L$+M$+N
     $:BEEP 5
3060:LPRINT O$:
     INPUT "Inter
     val of Y-axi
     s=?";E
3070:REM ********
3080:GRAPH :
     GLCURSOR (0,
     0):SORGN
3090:T=INT (N/R/E
     )
4000:IF T>15WAIT
     150:PRINT "K
     eyin mistake
     . TRY AGAIN"
     :WAIT :TEXT
     :LF 1:GOTO 3
     040
```

```
4010:FOR W=1TO T
4020:U(W-1)=55/N*
     W*E*5*R
4030:IF E*W>=100
     GLCURSOR (-1
     5,U(W-1)-280
     ):USING "###
     #":LPRINT E*
     W:NEXT W:
     USING :GOTO
     4047
4035:IF E*T>=1000
     WAIT 150:
     PRINT "* Inp
     ut Mistake,T
     RY AGAIN *":
     WAIT :GOTO 3
     060
4040:GLCURSOR (-5
     ,U(W-1)-280)
4045:USING "###":
     LPRINT E*W:
     NEXT W:USING
4047:GLCURSOR (0,
     -275)
4060:FOR W=1TO T
4061:U(W-1)=55/N*
     W*E*5*R
4064:LINE (40,U(W
     -1)-275)-(24
     0,U(W-1)-275
     ),2,0
4065:NEXT W
4070:LINE (40,0)-
     (40,-275),0,
     0:SORGN :
     LINE (0,0)-(
     200,0),0,0
4080:FOR J=0TO 7:
     BR(J)=275/N*
     N(J)*R
4085:NEXT J
4088:X=0
4090:FOR J=0TO 7:
     X=X+20
4100:LINE (X,BR(J
     ))-(X+14,0),
     0,0,B
4110:NEXT J
4120:GLCURSOR (0,
     0):SORGN :A=
     0:X=10
4125:FOR J=0TO 7
4130:GLCURSOR (X,
     -20):A=A+1
4140:LPRINT A;X=X
     +20:NEXT J
4150:TEXT :LF 1:
     LPRINT "
          AREA"
4151:TEXT :LF 3:
     BEEP 3,50,30
     0:CSIZE 1:
     LPRINT "** R
     ECORD OF DAT
     A AND PERCEN
     T **":LF 2
4152:FOR J=0TO 7:
     WW=WW+BR(J):
     NEXT J
4153:IF WW=0LET W
     W=9E20
4154:FOR J=0TO 7:
     UU(J)=BR(J)/
     WW*100:NEXT
     J
4155:LPRINT "   A
     REA":LF -1:
     LPRINT TAB 1
     6;"DATA":LF
     -1:LPRINT
     TAB 28;"PERC
     ENT":LF 1
4157:FOR J=0TO 7:
     USING "#####
     ###.##":
     LPRINT TAB 1
     1;N(J)*R;
     USING :LF -1
4158:LPRINT TAB 4
     ;J+1;USING "
     ###.##":LF -
     1:LPRINT TAB
     28;UU(J);
     USING
4159:WW=0
4160:NEXT J
4165:N=0:TEXT
4170:CSIZE 2:LF 3
4178:RETURN
4180:REM ********
4183:TEXT
4185:CSIZE 1:
     LPRINT "***
     ATTACHMENT *
     **":CSIZE 2:
     LF 2
4190:DIM R$(3)
4200:R$(0)="TOTAL
      CATCH ":R$(
     1)="TOTAL EF
     FORT":R$(2)=
     "CPUE":R$(3)
     ="CPUE x A"
4210:FOR R=0TO 3
4212:IF R=0LPRINT
     R$(0):LF 1
4214:IF R=1LPRINT
     R$(1):LF 1
4216:IF R=2LPRINT
     R$(2):LF 1
4218:IF R=3LPRINT
     R$(3):LF 1
4220:NEXT R:LF 4
4230:RETURN
4250:REM #########
     # STATUS 1 #
     #   4936   #
     ############
4260:END
```