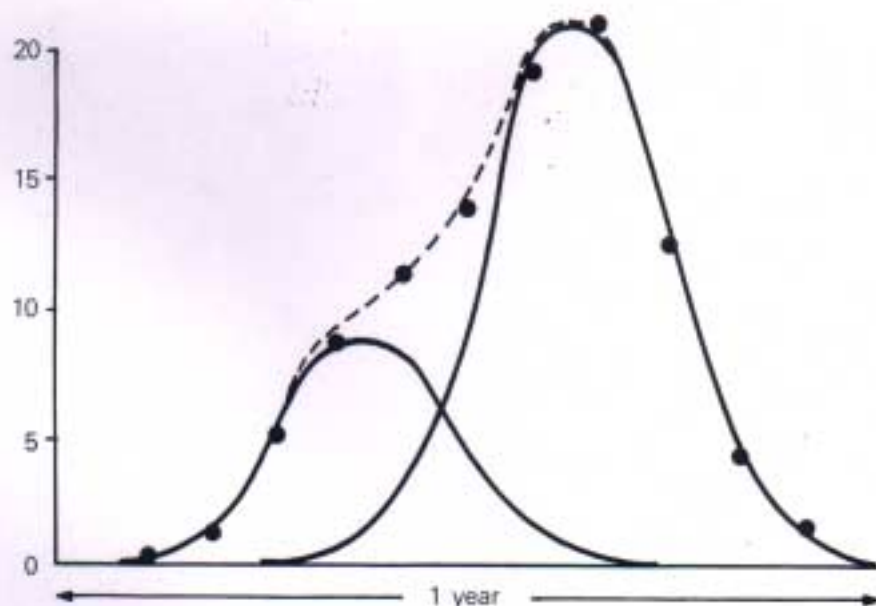


Fishery statistics on the microcomputer : A BASIC version of Hasselblad's NORMSEP Program



BAY OF BENGAL PROGRAMME
Marine Fishery Resources Management

BOBP/MAG/3
RAS/81 /051

FISHERY STATISTICS ON THE MICROCOMPUTER

– A BASIC version of Hasselblad's NORMSEP program

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This paper provides an outline of a mathematical method to analyse overlapping normal distributions. Separations of mixtures of normal distributions is frequently required in fisheries biological analysis, as in the case of length frequency distribution of fishes. Several methods are available for this. The method presented in this paper was originally developed by V Hasselblad and has been cast in its present form by D Pauly and N David. It was originally published as ICLARM contribution No. 193.

The new version, presented in this paper, is written in Microsoft BASIC and can be implemented on a large variety of microcomputers. The specific version presented here can run without modification on an Apple IIe microcomputer (with CP/M-80 operating system). The Program uses up to 12 K of RAM.

This paper grew out of a training course on the use of computers in fishery resources management. The course was organized by the project "Marine Fishery Resources Management in the Bay of Bengal" in cooperation with member-countries Sri Lanka, Bangladesh, Indonesia, Malaysia, Thailand and Maldives. Dr. Daniel Pauly of ICLARM and Mr J Hertel-Wulff of BOBP worked on the version presented in this paper.

The UNDP-funded project "Marine Fisheries Resources Management in the Bay of Bengal" (RAS/81/051) is a component of the Bay of Bengal Programme (BOBP). It has a duration of four years; it commenced in January 1983. Its immediate objective is to improve the practice of fishery resources assessment among participating countries and to stimulate and assist in joint assessment and management activities between countries sharing fish stocks.

This document is a training manual and has not been officially cleared either by the governments concerned or by the FAO.

INTRODUCTION

Like most other biologists, fishery biologists often encounter situations where mixtures of distributions need to be separated into their component distributions.

Such situations arise when, for example, the counts of different-sized ova in a fish gonad have to be separated into batches that will be spawned successively, when length-frequency data have to be separated into age groups or when "pulses" of recruitment are to be quantified (Fig. 1).

There exist a number of graphical and mathematical techniques which can be used for such separation (see Everitt and Hand, 1981, for a review). Most of them assume that the distributions to be separated from the mixture are normal distributions (Pearson 1984, Harding 1949, Cassie 1954, Tanaka 1962, Hasselblad 1966, Bhattacharya 1967, Yong and Skillman 1971, MacDonald and Pitcher 1978). Of these, only Bhattacharya's method, as adapted in Pauly and Caddy (1984), and the ENORMSEP program of Yong and Skillman, do not require the external input of the expected number of component distributions in the mixture. The NORMSEP program, of which a BASIC version is presented here, also does require such an input. Thus, although NORMSEP is not the most sophisticated tool available to analyse size-frequency distributions, it is useful in situations where the data to be separated do not greatly overlap, or where previous knowledge exists on the number of probable positions of the means of the component distributions (see Mathew 1974).

The version of NORMSEP presented here is a translation of the FORTRAN IV version of NORMSEP in Abrahamson (1971), written by V Hasselblad and modified by P K Tomlinson.

The following changes were made to the original version :

- (i) A routine was added which automatically computes, using the (guessed) means entered, a very large range of possible values for the standard deviation corresponding to each mean, by using a very small (0.01) and a very large (0.50) coefficient of variation ($C.V. = s.d. / \sqrt{\bar{x}}$) to generate the range. This follows Abrahamson's suggestion that "anyone desiring to maintain the rigour of Hasselblad's original procedure only needs to place extremely wide bounds on the standard deviations".
- (ii) A routine was added which internally computes the number and approximate position of the cut-off points.
- (iii) The input routine has been made completely interactive, with prompts provided by the program, along with routines for checking and correcting the data entered from the keyboard.
- (iv) A routine was added along with prompts, to load length frequency data from a disk into memory, and use them as an input to NORMSEP. Such files must have been created by ELEFAN (see David et al 1982). No routine for checking the correctness of file inputs has been included.

The maximum number of iterations, and of component distributions that can be separated, have been set at 125 and 10 respectively; note that the program cannot be used to estimate the parameters (mean, standard deviation) of a single normal distribution. Users should heed Abrahamson's advice, issued in conjunction with the original publication of NORMSEP, that "under any circumstances, Hasselblad (1966) and Cohen (1966) should be reviewed before proceeding."

AN APPLICATION EXAMPLE

Table 1 : Length-frequency data for testing NORMSEP.

Note number and position of modes (underlined)

Lower class limit	Frequency	Lower class limit	Frequency
0	2	10	5
1	23	11	2
2	22	12	3
3	1	13	6
4	37	14	6
5	28	15	15
6	1	16	6
7	6	17	2
8	17	18	2
9	16		—

Table 1 gives a set of frequencies generated (by Everitt and Hand 1981, Table 2.71 from a mixture of components of known characteristics. From the overall appearance of the data, we shall assume that there are four components, with means close to the modes, i.e., 1.5, 4.5, 8.5 and 15.5.

Question : Can our BASIC version of NORMSEP recover the means and standard deviation originally used to generate the data, if these modes are used as initial guesses of the means?

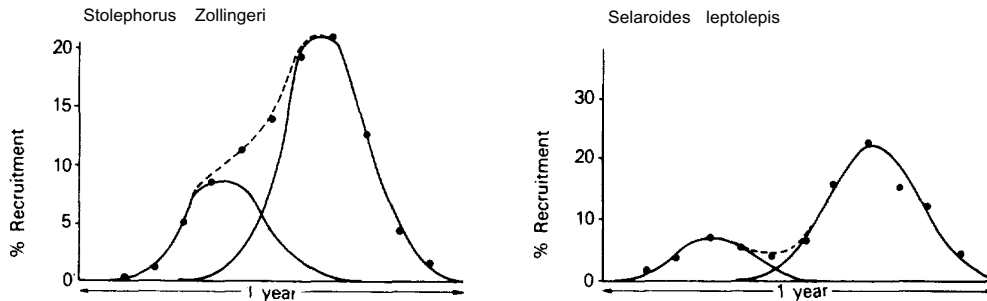


Fig. 1 Recruitment patterns in two stocks of Philippine fishes, derived from length-frequency data projected backwards onto the time axis and used to separate the two pulses of recruitment occurring within a year. The separation of the recruitment patterns into their component distribution was done using NORMSEP; note that the chi-square statistic cannot be used here because recruitment patterns are expressed in % (after Pauly and Navaluna 19841).

The output obtained for a run of our BASIC NORMSEP and the inputs mentioned above are reproduced on page 3. The mean and standard deviations are close to the values used by Everitt and Hand (1981) to generate the data in Table 1.

Component	Mean	Standard deviation
1	2.0	0.5
2	5.0	0.5
3	9.0	1.0
4	15.0	2.0

The only exception is the standard deviation of the 4th component. These results are exactly the same as those obtained by Everitt and Hand (1981). The interpretation of this and other results

obtained by NORMSEP should be undertaken carefully. It is essential, among other things that the user realizes that NORMSEP will always "find" the mean and standard deviation of a distribution if one is assumed to be present, and the preliminary estimate of its mean entered.

RESULTS FOR FILE : TEST

The NORMSEP output, based on data in Table I (see text for interpretation), is given below.

Values after 21 iterations

Group	Mean	St dev	Per cent	Size
1	1.94045	.59151	23.7234	47.4468
2	4.92919	.524968	32.9876	65.9751
3	8.96506	.961204	22.6216	45.2432
4	15.0991	1.59989	20.6674	41.3348

Total *sample* size 200

Actual vs. Predicted Frequencies

Actual	Predicted	Actual	Predicted
2	2.6536	16	15.622
23	22.9724	5	5.78687
22	20.091	2	1.61373
1	4.24912	3	2.8621
37	34.0085	6	6.25408
28	28.1286	6	9.4763
1	2.24172	15	9.83824
6	6.21149	6	6.99787
6	6.21149	2	3.46968
17	16.146	2	1.44271

Degrees of Freedom = 4
 Chi Square Value = 8.18143 Prob = .0851538
 Log of likelihood = 218.802

The "goodness of fit" statistics (the chi-square) may be used to distinguish various alternative interpretations. However, it is essential that this be done after the basic features of the chi-square test have been assimilated (consult a good statistics textbook!).

RUNNING THE PROGRAM

The corresponding prompts of and input to the program are given below.
 Using data from a disk file :

Prompt No.	Prompt	Input
1	ENTER RUN - ID?	TEST
2	DO YOU WANT TO READ FILE FROM DISK (Y/N). THE ALTERNATIVE IS TO ENTER DATA FROM KEYBOARD?	Y
3	ENTER FILE NAME?	B : TEST DATA
4	ENTER NUMBER OF GROUPS YOU WANT TO SPLIT SAMPLE INTO ?	4
5	ENTER ESTIMATE OF MEAN No. 1 ?	1.5
	ENTER ESTIMATE OF MEAN No. 2?	4.5
	ENTER ESTIMATE OF MEAN No. 3?	8.5
	ENTER ESTIMATE OF MEAN No. 4?	15.5
6	PRINT RESULTS (Y/N) ?	Y
7	PRESS (RETURN)	(RETURN)
8	PRESS (RETURN)	(RETURN)
9	CONTINUE WITH NEXT SAMPLE (Y/N)?	Y

Using data input from the keyboard :

<i>Prompt No.</i>	<i>Prompt</i>	<i>Input</i>
1	ENTER RUN – ID?	TEST
2	DO YOU WANT TO READ FILE FROM DISK (Y/N). THE ALTERNATIVE IS TO ENTER DATA FROM KEYBOARD?	N
3	ENTER NUMBER OF (LENGTH) CLASSES	19
4	ENTER NUMBER OF GROUPS YOU WANT TO SPLIT SAMPLE INTO ?	4
5	ENTER ESTIMATE OF MEAN No. 1 ?	1.5
	ENTER ESTIMATE OF MEAN No. 2?	4.5
	ENTER ESTIMATE OF MEAN No. 3?	8.5
	ENTER ESTIMATE OF MEAN No. 4?	15.5
6	ENTER LOWER LIMIT OF SMALLEST CLASS?	0
7	ENTER CLASS WIDTH ?	1
8	ENTER FREQUENCY : 1?	2
	ENTER FREQUENCY : 2?	23
	enter frequencies from Table I	
9	ANY CORRECTIONS (Y/N) ?	N
10	REVIEW FREQUENCIES (Y/N) ?	N
11	PRINT RESULTS (Y/N) ?	N
	. continue as 7 above .	

The prompts given by the program are shown above. Error messages for keyboard are not shown.

Data files created or extracted by ELEFAN for analysis by NORMSEP must consist of only one sample (i.e., a set of corresponding midlength and frequencies from only one week, month or year etc. For example, a set of monthly samples collected during a year (12 samples) must therefore be subdivided using ELEFAN into 12 sub-files.

Acknowledgement

We are most thankful to Mr. H. Larssen, Danish Institute for Fisheries and Marine Research, Denmark for his assistance with testing the program and his suggestions towards improving the routines.

REFERENCES

- Abrahamson, N.J. 1971. Computer programs for fish stock assessment. FAO Fish. Tech. Pap. 101, 148p.
- Bhattacharya, C.G. 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics* 23 : 115 – 135.
- Cassie, R. M. 1954. Some uses of probability paper in the analysis of size-frequency distribution. *Aust. J. Mar. Freshw. Res.* 5:513-522.
- Cohen, A.C. 1966. Estimation of parameters for a mixture of normal distribution by V.Hasselblad. *Technometrics* 8(3):445-446.
- David, N., Palomares L. and Pauly D. (1982). ELEFAN 0, a BASIC program for creating and editing files for use with the ELEFAN I, II and III programs. ICLARM. 16. p. (mimeo).
- Everitt, B.S. and D.J. Hand. 1981. *Finite mixture distributions*. Chapman and Hall, London. 143 p.
- Harding, J.F. 1949. The use of probability paper for the graphical analysis of polymodal frequency distribution. *J. Mar. Biol. Assoc. U.K.* 28:141-153.
- Hasselblad, V. 1966. Estimation of parameters for a mixture of normal frequency distributions. *Technometrics*. 8:431-444.

- Lien, D.A. 1981. *The BASIC handbook encyclopedia of the BASIC computer language* (2nd ed.) CompuSoft Publishing, San Diego.
- Macdonald, P.D.M. and T.J. Pitcher. 1978 Age-groups from size-frequency data : a versatile and efficient method of analyzing distribution mixture. *J.Fish. Res. Board Can.* 36:987-1001.
- Mathew, C.P. 1974. An account of some methods of overcoming errors in ageing tropical and sub-tropical fish populations when the hard tissue growth markings are unreliable and the data sparse, p. 158-166. *In* T.B. Bagenal (ed.) *Ageing of fish*. Unwin Brothers, Old Woking. 234p.
- Pauly, D. and J.F. Caddy. 1985. A modification of Bhattacharya's method for the analysis of mixture of normal distributions. *FAO fish. Circ.* No. 781, Rome, 16p (+ Errata Sheet).
- Pauly, D. and N.A. Navaluna. 1984. Monsoon-induced seasonality in the recruitment of Philippine fishes p. 822 – 833. *In* G.D. Sharp and J.Csirke (eds.) *Proceedings of the expert consultation to examine changes in abundance and species composition of neritic fish resources*. San Jose, Costa Rica, 18 – 29 April 1983. F.A.O. Fish Rep. No. 191, Vol 3.
- Pearson, K. 1894. Contribution to the mathematical theory of evolution. *Phil. Trans. Roy. Soc.* London. 185:71-1 10.
- Tanaka, S. 1962. A method of analyzing polymodal frequency distributions and its application to the length distribution of the porgy, *Tauius tumifrons* (T. and S.). *J. fish. Res. Board Can.* 19 : 1143-1159.
- Yong, M.Y. and R.A. Skillman. 1971. A computer program for analysis of polymodal frequency distributions (ENORMSEP), FORTRAN IV, U.S. *fish Bull.* 73(3):681.

PROGRAM LISTING

The listing given below (pages 6-13) is the version of BASIC suitable for Apple IIe with CP/M operating system, which is a dialect of Microsoft BASIC. It should therefore be easily converted for use of Microcomputers other than Apple IIe using Microsoft BASIC. The BASIC translation guide by Lien (1981) should help in such conversions, should any problem occur.

Our version of NORMSEP does not require that a printer be connected to the computer (although this will be helpful). About 12K of program memory must be available for the program and the data; these memory requirements can be slightly reduced by deleting all REMs. In case a printer is connected, the interface card must be configured for the CP/M system to enable hard copy.


```

10 REM =====
20 REM
30 REM
40 REM          *****  NORMSEP PROGRAM  *****
50 REM
60 REM
70 REM =====
80 REM THIS IS A BASIC LANGUAGE VERSION OF PROGRAM TCPAI
90 REM (FORMALLY NORMSTEP) WHICH IS AVAILABLE IN THE FORTRAN LANGUAGE.
100 REM
110 REM IT WAS TRANSLATED INTO RADIO SHACICS BASIC II FROM THE ORIGINAL BY
120 REM N. DAVID AND IT'S INPUT ROUTINE MODIFIED AND EXPANDED BY D. PAULY
121 REM (BOTH ICLARM).
130 REM
140 REM THE VERSION FOR APPLE IIe (WITH CP/M-80 OPERATING SYSTEM) WAS PREPARED
150 REM BY 3. HERTEL-WULFF, BOBP.
160 REM
170 REM IT USES THE STEEPEST DESCENT METHOD AS NORMAL
180 REM DISTRIBUTION SEPARATOR.
190 REM
200 REM THIS PROGRAM CONSISTS OF A MAIN ROUTINE AND SEVERAL
210 REM SUBROUTINES:
220 REM     CHISQ
230 REM     NORM
240 REM     TRUNC
250 REM     STRUN
260 REM     VPLOT
270 REM
280 REM APPLE IIe VERSION, FEB. 1986.
290 REM
300 REM =====
310 CLEAR 200
320 DIM Q(120,10),QQ(120),P(20),MU(20),SG(20),F(120),FS(120)YQ(10)
330 DIM NF(120),NS(20),XT$(8),YT$(50),PP(20),MP(20),SP(20),NX(20),NG(120)
340 DIM BU(20),BL(20),AU(20),AL(20),FX(20),XAS(30),XHS(30)
350 HOME:PRINT TAB(25); "NORMSEP":PRINT
360 CO=.39894228#
370 INPUT"ENTER RUN-ID ";M1$
380 PRINI"DO YOU WANT TO READ FILE FROM DISK (Y/N). THE"
390 INPUT"ALTERNATIVE IS TO ENTER DATA FROM KEYBOARD ";S$
400 IF S$ <> "Y" AND S$ <> "N" THEN GOTO 380
410 IF S$="N" THEN GOTO 430
420 GOSUB 4590:IF S$="Y" THEN GOTO 440
430 INPUT "ENTER NUMBER OF (LENGTH) CLASSES";N
440 INPUT"ENTER NUMBER OF GROUPS YOU WANT TO SPLIT SAMPLE INTO";K
450 LC=1:REM NUMBER OF SETS OF CUT-OFF POINTS SET TO 1 SINCE THE CUT-OFF POINTS
  ARE COMPUTED INTERNALLY...
460 FOR I=1 TO K
470 PRINT"ENTER ESTIMATE OF MEAN NO.";I;:INPUT YQ(I)
480 NEXT I
490 FOR I=1 TO K-1
500 IF YQ(I)>YQ(I+1) THEN HOME:PRINT "ERRORS  ENTER MEAN VALUES FROM LOWEST TO
  HIGHEST":GOTO 460
510 NEXT I:IF S$="Y" THEN GOTO 700
520 IF K>10 THEN K=10:REM MAXIMUM DISTRIBUTIONS IS 10
530 INPUT "ENTER LOWER LIMIT OF SMALLEST CLASS";XI
540 INPUT "ENTER CLASS WIDTH";XL
550 FOR I=1 TO N
560 PRINT"ENTER FREQUENCY:";I;:INPUT F(I)
570 NEXT I
580 HOME:PRINT TAB(10);"LOOK FOR ERRORS"
590 FOR I=1 TO N
600 PRINR "FREQUENCY NO.":I;F(I)
610 IF I-14 THEN INPUT "PRESS <RETURN>":P$
620 NEXT I
630 FOR I=1 TO N
640 INPUT "ANY CORRECTIONS (Y/N)";P$
650 IF P$="N" THEN GOTO 680
660 INPUT"ENTER FREQUENCY NO. TO BE CORRECTED";J:PRINT"FREQ NO: ";J;:INPUT F(J)
670 NEXT I

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680 INPUT "REVIEW FREQUENCIES (Y/N) ";P$
690 IF P$="Y" THEN GOT0 580
700 SF=0
710 FOR I=1 TO N
720 SF=SF+F (I)
730 NF(I)=FIX(F(I)+.5)
740 NEXT I
750 REM
760 REM
770 HOME:FRINT TAB (20) ; "NORMSEF RUNNING. WAIT"
780 REM =====
790 FOR LY=1 TO LC
800 REM =====
810 REM GET CUT-OFF POINTS FX'S
820 FOR J=1 TO K-1
830 FX(J)=(YQ(J)+YQ(J+1) )/2
840 NEXT J
850 FX (K)=(N-I)*XL+XI
860 REM
870 REM GET LOWER AND UPPER BOUNDS FOR MEANS, BL AND BU'S
880 BL(I)=YQ(I)-.5+(YQ(2)-YQ(I))
890 FOR J=1 TO K-1
900 BU(J)=YQ(J)+ .5*(YQ(J+1)-YQ(J))
910 BL(J+1)=BU(J)
920 NEXT J
930 BU(K)=(N-I)*XL+XI
940 REM GET LOWER AND UPPER BOUNDS FOR STANDARD DEVIATION, AL & AU "S
950 FOR J=1 TO K
960 AL (J)= . 0I*YQ(J)
970 AU (J)= .5+YQ(J)
980 NEXT J
990 REM
1000 FOR J=1 TO K
1010 NX(J)=FIX(((FX(J)-XI)/XL)+.5)
1020 BL(J)=(BL(J)-XI)/XL
1030 BU(J)=(BU(J)-XI)/XL
1040 AL(J)=AL(J)/XL
1050 AU(J)=AU(J)/XL
1060 NEXT J
1070 REM
1080 NX (K) =N
1090 REM
1100 FOR I=1 TO N
1110 FS(I)=F(I)
1120 NEXT I
1130 NB=I
1140 REM COMPUTE INITIAL ESTIMATES USING HALD'S PROCEDURE
1150 AS=0
1160 REM
1170 FOR J=1 TO K
1180 NE=NX (J)
1190 XB=NE
1200 A=0
1210 B=0
1220 C=0
1230 FOR I=NB 'TO NE
1240 CI=XB-I+. 5
1250 CF=F'S(I)
1260 A=A+CF
1270 B=B+CF'+C I
1280 C=C+CF+CI+CI
1290 NEXT I
1300 REM
1310 ZZ=A*C/ (2*B*B)
1320 X=ZZ: GOSUB 4350 : Z=TR: REM CALL TRUNC(ZZ)
1330 REM
1340 X=Z:GOSUB 3800 :G=GT: REM CALL GTRUN(Z)
1350 REM
1360 SG (J) =B*G/A
1370 IF SG(J) > AU(J) THEN SG(J)=AU(J)

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```

1380 IF SG(J) < AL(J) THEN SG(J)=AL(J)
1390 AU=-Z*SG(J)
1400 IF AV > BU(J) THEN AV=BU(J)
1410 IF AV < BL(J) THEN AV=BL(J)
1420 IF ZZ >= . 55 THEN GOTO 1490
1430 AV=B/A
1440 IF AV > BU(J) THEN AV=BU(J)
1450 IF AV < BL(J) THEN AV=BL(J)
1460 SG(J) =SQR ((C-B*B/A) /A)
1470 IF SG(J) > AU(J) THEN SG(J) = AU(J)
1480 IF SG(J) <AL(J) THEN SG(J) = AL(J)
1490 REM
1500 X=AV/SG(J) : GOSUB 4080 :PK=NR:REM CALL NORM (AV/SG(J))
1510 REM
1520 F(J)=A/PK
1530 AS=AS+P(J)
1540 FOR KK=1 TO N
1550 II=KK+NE
1560 IF II>N THEN GOTO 1670
1570 UM=(AV+KK)/SG(J)
1580 BM=(AV+KK-1)/SG(J)
1590 X=UM:GOSUB 4080 :KF=NR:REM CALL NORM (ULIM)
1600 X=BM: GOSUB 4080 : KP=KP-NR: REM CALL NORM (BM)
1610 KP=A*KP/PK
1626 REM SUBTRACT ESTIMATED JTH SAMPLE FROM REMAINING ONES
1630 FS(II)=FS(II)-KP
1640 IF FS(II) <0 THEN FS(II)=0
1650 IF KP < . 05 THEN GOTO 1670
1660 NEXT KK
1670 REM CONTINUE
1680 NB=NE+ 1
1690 MU(J)=NX(J)-AV
1700 IF MU(J) > BU(J) THEN MU(J)=BU(J)
1710 IF MU(J) < BL(J) THEN MU(J)=BL(J)
1720 NEXT J
1730 FOR J=1 TO K
1740 P(J)=P(J)/AS
1756 NEXT J
1760 L1=0
1770 REM COMPUTE LIKELIHOOD FUNCTION L1
1780 FOR I=1 TO N
1790 QQ(I)=0
1800 FOR J=1 TO K
1810 G(I,J)=CO*EXP(-(I-MU(J)-. 5)^2/(2!*SG(J)*SG(J)) )/SG(J)
1820 QQ(I)=QQ(I)+G(I,J)*P(J)
1830 NEXT J
1840 L1=L1+F(I)*LOG(QQ(I))/LOG(10)
1850 NEXT I
1866 REM START OF METHOD OF STEEPEST DESCENT
1870 FOR IT=1 TO 125
1880 L3=IT
1890 PS=0
1900 FOR J=1 TO K
1910 XD=0
1920 SX=0
1930 S3=0
1940 FOR I=1 TO N
1950 TE=F(I)*Q(I,J)/QQ(I)
1960 XD=XD+TE,
1970 CI==I-. 5
1980 CF=CI-MU(J)
1990 SX=SX+TE*CI
2000 S3=S3+TE*CF*CF
2010 NEXT I
2020 MP(J)=SX/XD
2030 IF MP(J) < BL(J) THEN MP(J)=BL(J)
2040 IF MP(J) > BU(J) THEN MP(J)=BU(J)
2050 SF(J)=SQR(S3/XD)
2060 IF SP(J) > AU(J) THEN SP(J)=AU(J)
2070 IF SP(J) < AL(J) THEN

```

```

2080 PP (J) =XD*P (J)
2090 PS=PS+PP (J)
2100 NEXT J
2110 FOR J=1 TO K
2120     PP(J)=PP(J)/PS
2130 NEXT J
2140 LL=0
2150 FOR I=1 TO N
2160     QQ(I)=0
2170     FOR J=1 TO K
2180         Q(I,J)=CO*EXP(-(I-MP(J)-.5)^2/(2!*SG(J)*SG(J)))/SG(J)
2190         QQ(I) =00(1>+Q(I,J) *PP (3)
2200     NEXT J
2210 LL=LL+F(I>*LOG(QQ(I) ) /LOG(10)
2220 NEXT I
2230 REM TEST FOR IMPROVED LIKELIHOOD FUNCTION LL
2240 IF LL<=L1 THEN GOTO 2320
2250 FOR 3=1 TO K
2260     P(J)=PP(3)
2270     MU(J)=MP(J)
2280     SG(J)=SP(J)
2290 NEXT J
2300 L1=LL
2310 NEXT IT
2320 REM
2330 L3=L3-1
2340 FOR I=1 TO N
2350     QQ(I)=0
2360     FOR J=1 TO K
2370         X=(I-MU(J) )/SG(J) :GOSUB 4080 :Q(I ,J)NR
2380         X=(I-MU(J)-1! )/SG(J):GOSUB 4080 :Q(I,J)=Q(I,J)-NR
2390     QQ(I)=QQ( I)+Q(I ,J)*P(J)
2400 NEXT J
2410 FS(I)=QQ(I)*SF
2420 NEXT I
2430 X=-MU(1)/SG(1) :GOSUB 4080 :QQ(1)=QQ(1)+NR*P(1)
2440 X=(MU(K)-N)/SG(K):GOSUB 4080 :QQ(N)=QQ(N)+NR*P(K)
2450 FS(1)=QQ(1)*SF
2460 FS(N)=QQ(N)*SF
2470 NN=MU(1)+1!
2480 PR=0
2490 REM COLLAPSE CHI-SQUARE TABLE
2500 FOR 1=1 TO NN
2510     II=1
2520     PR=PR+FS(I>
2530 IF PR-5! 0 THEN GOTO 2540 ELSE GOTO 6010 2550
2540 NEXT I
2550 NL=II
2560 NN=N-MU (K) +1
2570 PS=0
2580 FOR I=1 TO NN
2590     NC=N-I+1
2600     PS=PS+FS(NC)
2610     IF PS-5!<0 THEN GOTO 2620 ELSE GOTO 2630
2620 NEXT I
2630 NT=NC
2640 AF=0
2650 FOR I=1 TO NL
2660     AF=AF+F(I)
2670 NEXT I
2680 CH= (AF-PR) 2/PR
2690 NH=NT-1
2700 L2=NL+1
2710 FOR I=L2 TO NH
2720     CH=CH+(F(I)-FS(I>)^2/FS(I)
2730 NEXT I
2740 AF= 0
2750 FOR I=NT TO N
2760     AF=AF+F (I)
2770 NEXT I

```

```

2780 CH=CH+ (AF—PS) 2/PS
2790 ND=NT—NL—3*K+1
2800 REM =====
2810 REM
2820 REM          *****   ALARM   *****
2830 REM
2840   FOR I=1 TO 5
2850     BEEP 15,10:BEEP 15,10:BEEP 15,10: FOR J=1 TO 200:NEXT 3
2860   NEXT I
2870 REM
2880 REM =====
2890 HOME: INPUT"PRINT RESULTS (Y/N)";P$
2900 PRINT `RESULTS FOR RUN:";M1$
2910 IF P$="Y" THEN LPRINT" ":LPRINT"RESULTS FOR RUN: ";M1$:LPRINT"-----
-----"
2920 PRINT`VALUES AFTER"; L3;" ITERATIONS"
2930 IF P$="Y" THEN LPRINTVALUES AFTER";L3; ITERATIONS'
2940 PRINT"GROUP MEAN ST DEV PERCENT SIZE"
2950 IF P$="Y" THEN LPRINT"GROUP MEAN ST DEV PERCENT SIZE"
2960 FOR J=1 TO K
2970   SO=SG(J)*XL
2980   XV=MU(J)*XL+XI
2990   PZ=P(J)*SF
3000   PS=P(J)*100!
3010 PRINT J;TAB(11);XV;TAB(21);SO;TAB(32);PS;TAB(44);PZ
3020 IF P$="Y" THEN LPRINT J;TAB(11);XV;TAB(21);SO;TAB(32);PS;TAB(44);PZ
3030 NEXT J
3040 NS%=FIX(SF+.5)
3050 PRINT" TOTAL SAMPLE SIZE"; NS%.
3060 IF P$="Y" THEN LPRINT" ":LPRINT "TOTAL SAMPLE SIZE";NS%.
3070 INPUT"PRESS <RETURN:>";S$
3080 PRINTACTUAL Vs. PREDICTED FREQUENCIES'
3090 IF P$="Y" THEN LPRINT" ":LPRINT"ACTUAL VS. PREDICTED FREQUENCIES
3100 PRINT"ACTUAL"; TAB(12); "PREDICTED'
3110 IF P$="Y" THEN LPRINT"ACTUAL"; TAB(12); "PREDICTED"
3120 NZ%=(N-1)/10+1
3130 FOR I=1 TO NZ%
3140   Q1%=I*10 -9
3150   Q2%=N
3160   IF Q2% > I*10 THEN Q2%=I*10
3170   FOR J=Q1% TO Q2%.
3180     PRINT F(J);TAB(12);FS(J)
3190     IF P$="Y" THEN LPRINT F(J);TAB(12);FS(J)
3200 NEXT J
3210 REM
3220 NEXT I
3230 INPUT"PRESS <RETURN>";S$
3240 PRINT"DEGREES OF FREEDOM="; ND
3250 IF P$="Y" THEN LPRINT" ":LPRINT"DEGREES OF FREEDOM=" ;ND
3260 X1=CH:N1=ND:GOSUB 3390 :S=CH*
3270 PRINT"CHI SQUARE VALUE ";CH;" PROS. ";S
3280 IF P$="Y" THEN LPRINT"CHI SQUARE VALUE= ";CH;" PROB.= ";S
3290 PRINT"LOG OF LIKELIHOOD= ";L1
3300 IF P$="Y" THEN LPRINT"LOG OF LIKELIHOOD= ";L1
3310 REM=====
3320 NEXT LY
3330 REM=====
3340 INPUT"CONTINUE WITH NEXT SAMPLE (Y/N)";S$
3350 IF S$="Y" THEN GOTO 310
3360 RUN "ELEFANO.BAS"
3370 REM
3380 REM .....
3390 REM =====
3400 REM ROUTINE CHISQ(X,N)
3410 REM
3420 REM EXACT FORMULA - SHARE DISTRIBUTION NO.528
3430 REM
3440 REM INPUTS ..... X1
3450 REM ..... N1
3460 REM OUTPUT ..... CH*

```

```

3470 REM
3480 SU=0
3490 IF X 1>0 AND N 1 >0 THEN GOTO 3520
3500 CH#= 1!
3510 RETURN
3520 REM
3530 IF FIX(N1/2)*2 <>N1 THEN GOTO 3650
3540 IF N1 <= 2 THEN GOTW 3620
3550 REM
3560 TE#= 1
3570 FOR IO=1 TO FIX(N1/2-1)
3580   CI#=2*IO
3590   TE#=TE#*X1 /CI#
3600   SU=SU+TE#
3610 NEXT IO
3620 CH#=EXP (-X 1/2 !)*(1!+SU)
3630 REM
3640 RETURN
3650 REM
3660 TE#=1!/X1
3670 REM
3680 REM
3690 FOR IO=1 TO FIX ( (N1-1)/2)
3700   CI#=2!+IO-!
3710   TE#=TE#*X1/CI
3720   SU=SU+TE#
3730 NEXT IO
3740 XS=SQR (X 1)
3750 X=XS: GOSUB 4080 : CH#=2 ! -2 ! *NR+XS*EXP (-X 1/2 ! ) *. 797885*SU: REM" CA
S)
3760 RETURN
3770 REM
3780 REM          END OF ROUTINE CHISQ
3790 REM
3800 REM =====
3810 REM ROUTINE GTRUN (X)
3820 REM
3830 REM G(X) - HALD - MAX-LIKE EST. - ANNALS MATH STAT.
3840 REM          VOL 2 4 , P.557
3850 REM
3860 REM          INPUT . . . . . X
3870 REM          OUTPUT . . . . . GT
3880 REM
3890 SP#=1.12837917*
3900 P# = .32759 1
3910 A1#=. 225836846000000 1#
3920 A2#=-. 252128668#
3930 A3#=1.25969513#
3940 A4#=- 1.28782245#
3950 A5#=. 940646070000000 1#
3960 52#=.7071067810000001#
3970 REM
3980 XN#=!/(1!+P#*ABS(X+S2#))
3990 PH#=SP#*EXP(-X*X/2!)
4000 PS#=1 ! -XN#*(A1#+XN#*(A2#+XN#*(A3#+XN#*(A3#+XN#*(A4#+XN#*A5#))))*PH#
4010 TE#= . 5*PS#
4020 IF X>0 THEN TE#=-TE# .
4030 GT=1!/(PH#/(2.82842712#*(TE#+.5))-X)
4040 RETURN
4050 REM
4060 REM END OF ROUTINE GTRUN
4070 REM
4080 REM =====
4090 REM ROUTINE NORM(X)
4100 REM
4110 REM APPROX. FOR DIG. COMP. - HHSTINGS, P. 169
4120 REM
4130 REM          INPUT . . . . . X
4140 REM          OUTPUT . . . . . NR
4150 REM

```

```

4160 SP#=1.12837917#
4170 P# =. 327591
4180 A1#=.2258368460000001#
4190 A2#=-. 252128668#
4200 A3#=1.25969513#
4210 A4#=- 1 .28782245#
4220 A5#=.9406460700000001#
4230 S2#=.7071067810000001#
4240 XN#=1!/(1!+P#+ABS(X+S2#))
4250 PH#=SP#*EXP(-X*X/2!)
4260 PS#=1!- XN#*(A1#+XN#*(A2#+XN#*(A3#+XN#*(A4#+XN#*A5#))))*PH#
4270 TE#=. 5*PS#
4280 IF X < 0 THEN TE#=-TE#
4290 NR = .5+TE#
4300 REM
4310 RETURN
4320 REM
4330 REM      END OF ROUTINE NORM
4340 REM
4350 REM =====
4360 REM      ROUTINE TRUNC
4370 REM
4380 REM      INPUT . . . . . X
4390 REM      OUTPUT . . . . . TR
4400 REM
4410 AO#=34.758 138#
4420 A1#=-69.1654
4430 A2#=38.338991#
4440 A3#=-5.38194
4450 B1#=5.019750360000001#
4460 82#=-7.0780578#
4470 B3#=1.6336409#
4480 REM
4490 Z#=SQR(-2!*LOG(X-.5))
4500 TR=((((A3#+Z#+A2#)+Z#+A1#)*Z#+A0#)/(((B3#*Z#+B2#)*Z#+B1#)*Z#+1!))
4510 REM
4520 RETURN
4530 REM
4540 REM
4550 REM      END OF ROUTINE TRUNC
4560 REM
4570 REM
4580 REM =====
4590 REM
4600 REM      *****      READ DATA FROM FILE      *****
4610 REM
4620 REM =====> . . .
4630 LINE INPUT"ENTER FILENAME? ";FT$
4640 OPEN "I" , 1,FT$
4650 REM READING CATCH AT LENGTH DATA FROM DISK
4660 INPUT#1,N1,N,XL,XI,XH
4670 FOR I=1 TO N
4680 INPUT#1,SN,L,F(I),M,D
4690 NEXT I
4700 IF' S1>=9999 THEN CLOSE #1
4710 RETURN

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Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings out six types of publications :

Reports (BOBP/REP/) describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/) are progress reports that discuss the findings of ongoing BOBP work.

Manuals and Guides (BOBP/MAG/) are instructional documents for specific audiences.

Miscellaneous Papers (BOBP/MIS/) concern work not originated by BOBP staff or consultants - but which is relevant to the Programme's objectives

Information Documents (BOBP/INF/) are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (*Bay of Bengal News*). issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP REP, I

- 1 Report of the First Meeting of the Advisory Committee. Colombo, Sri Lanka, 28-29 October 1976. (Published as Appendix 1 of IOFC/DEV/78/44.1. FAO, Rome. 1978)
- 2 Report of the Second Meeting of the Advisory Committee. Madras, India, 29-30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/441, FAO, Rome, 1978)
- 3 Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, 1-10 November 1978. Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)
4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.
5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3-8 September 1979. Madras, India, April 1980.
6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8-12 October 1979. Madras, India, June 1980.
7. Report of the Fourth Meeting of the Advisory Committee. Phuket, Thailand, 27-30 November 1979. Madras, India, February 1986
8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.
9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India 3-14 December 1979. Madras, India, September 1980.
- 10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 1 : Proceedings. Madras, India, September 1980.
- 10.2 Report of the Consultation of Stock Assessment for Small Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 2 : Papers. Madras, India, October 1980
- 11 Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4-7 November 1980. Madras, India, January 1981.
12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh. Hyderabad. India, 11-26 November 1980. Madras, India, September 1981.
13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, 1-5 December 1981. Madras, India, February 1982.
14. Report of the First Phase of the 'Aquaculture Demonstration for Small-Scale Fisheries Development Project in Phang Nga Province, Thailand. Madras, India, March 1982.
15. Report of the Consultation-cum-Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27-November 6, 1981. Madras, India, May 1982.
- 16 Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983. Madras, India, March 1983.
17. Report of Investigations to Improve the Kattumaram of India's East Coast. Madras, India, July 1984
- 18 Motorization of Country Craft, Bangladesh. Madras, India, July 1984.
- 19 Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16-19, 1984. Madras, India, May 1984.
20. Coastal Aquaculture Project for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.
- 21 Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Eueltraud Drewes. Madras, India, September 1985.
- 22 Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25-26, 1985. Madras, India, May 1985.
- 23 Summary Report of BOBP Fishing Trials and Demersal Resource Studies in Sri Lanka. Madras, India, March 1986.

24. Fisherwomen's Activities in Bangladesh : A Participatory Approach to Development Patchanee Natpracha Madras, India, May 1986.
25. Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinam, India. Patchanee Natpracha, V.L.C. Pietersz. Madras, India, May 1986.
26. Report of the Tenth Meeting of the Advisory Committee. Male, Maldives, 17-18 February 1986. Madras, India, April 1986.
27. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India. Edeltraud Drewes. Madras, India, May 1986.
28. Small-Scale Aquaculture Development Project in South Thailand : Results and Impact. E. Drewes. Madras, India, May 1986.
29. Towards Shared Learning : An Approach to Nonformal Adult Education for Marine Fisherfolk of Tamil Nadu, India. L. S. Saraswathi and Patchanee Natpracha (In preparation)
30. Summary Report of Trials with Large-Mesh Driftnets in Bangladesh. Madras, India, May 1986.

Working Papers (BOBPI/WPI.)

1. Investment Reduction and Increase in Service Life of Kattumaram Logs. R. Balan. Madras, India, February 1980.
2. Inventory of Kattumarams and their Fishing Gear in Andhra Pradesh and Tamil Nadu. T. R. Menon. Madras, India, October 1980.
3. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Sri Lanka. G. Pajot. Madras, India, June 1980.
4. Inboard Motorisation of Small G.R.P. Boats in Sri Lanka. Madras, India, September 1980.
5. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Bangladesh. G. Pajot. Madras, India, September 1980.
6. Fishing Trials with Bottom-Set Longlines in Sri Lanka. G. Pajot, K. T. Weerasooriya. Madras, India, September 1980.
7. Technical Trials of Beachcraft Prototypes in India. O. Gulbrandsen, G. P. Gowing, R. Ravikumar. Madras, India, October 1980.
8. Current Knowledge of Fisheries Resources in the Shelf Area of the Bay of Bengal. B. T. Antony Raja. Madras, India, September 1980.
9. Boatbuilding Materials for Small-Scale Fisheries in India. Madras, India, October 1980.
10. Fishing Trials with High-Opening Bottom Trawls in Tamil Nadu, India. G. Pajot, John Crockett. Madras, India, October 1980.
11. The Possibilities for Technical Cooperation between Developing Countries (TCDC) in Fisheries. E. H. Nichols. Madras, India, August 1981.
12. Trials in Bangladesh of Large-Mesh Driftnets of Light Construction. G. Pajot, T. K. Das. Madras, India, October 1981.
13. Trials of Two-Boat Bottom Trawling in Bangladesh. G. Pajot, J. Crockett. Madras, India, October 1981.
14. Three Fishing Villages in Tamil Nadu. Edeltraud Drewes. Madras, India, February 1982.
15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982.
16. Further Trials with Bottom Longlines in Sri Lanka. Madras, India, July 1982.
17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh. Soleh Samsi. Sihar Siregar and Martono. Madras, India, August 1982.
18. Review of Brackishwater Aquaculture Development in Tamil Nadu. Kasemsant Chalayondeja and Anant Saraya. Madras, India, September 1982.
19. Coastal Village Development in Four Fishing Communities of Adirampattinam, Tamil Nadu, India. F. W. Blase. Madras, India, December 1982.
20. Further Trials of Mechanized Trawling for Food Fish in Tamil Nadu. G. Pajot, J. Crockett, S. Pandurangan. P. V. Ramamoorthy. Madras, India, December 1982.
21. Improved Deck Machinery and Layout for Small Coastal Trawlers. G. Pajot, J. Crockett, S. Pandurangan and P. V. Ramamoorthy. Madras, India, June 1983.
22. The Impact of Management Training on the Performance of Marketing Officers in State Fisheries Corporations. U. Tietze. Madras, India, June 1983.
23. Review of Experiences with and Present Knowledge about Fish Aggregating Devices. M. Bergstrom. Madras, India, November 1983.
24. Traditional Marine Fishing Craft and Gear of Orissa. P. Mohapatra. Madras, India, April 1986.
25. Fishing Craft Development in Kerala : Evaluation Report. O. Gulbrandsen. Madras, India, June 1984.
26. Commercial Evaluation of IND-13 Beachcraft at Uppada, India. R. Ravikumar. Madras, India, June 1984.
27. Reducing Fuel Costs of Fishing Boats in Sri Lanka. (In preparation)

28. Fishing Trials with Small-Mesh Driftnets in Bangladesh. G. Pajot and T. K. Das. Madras, India, March 1984.
29. Artisanal Marine Fisheries of Orissa : a Techno-Demographic Study. M. H. Kalavathy and U. Tietze. Madras, India, December 1984.
30. Mackerels in the Malacca Straits. Colombo. Sri Lanka, February 1985.
31. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. Coimbo, Sri Lanka, February 1985.
32. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu : A Study of Techno-economic and Social Feasibility. Rathindra Nath Roy. Madras, India, January 1985.
33. Factors that influence the Role and Status of Fisherwomen. Karuna Anbarasan. Madras, India, April 1985.
34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashem. Madras, India, August 1985.
35. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu. M. Karim and S. Victor Chandra Bose. Madras, India, May 1985.
36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam. Cololnbo, Sri Lanka, October 1985.
37. A Review of the Biology and Fisheries of Hilsa *lilsha* in the Upper Bay of Bengal. B. T. Antony Raja. Colombo, Sri Lanka, October 1985.
38. Credit for Fisherfolk : The Adirampattinam Experience. R. S. Anbarasan and Ossie Fernandez. Madras, India. March 1986.
39. The Organization of Fish Marketing in Madras Fishing Harbour. M. H. Kalavathy. Madras, India, September 1985.
40. Promotion of Bottom Set Longlining in Sri Lanka. K. T. Weerasooriya, S. S. C. Pieris, M. Fonseka. Madras, India, August 1985.
41. The Demersal Fisheries of Sri Lanka. K. Sivasubramaniam and R. Maldeniya. Madras, India, December 1985.
42. Fish Trap Trials in Sri Lanka. (Based on the report of Ted Hammerman). Madras, India, January 1986.
43. Demonstration of Simple Hatchery Technology for Prawns in Sri Lanka. Madras, India, June 1986.
44. Pivoting Engine Installation for Beachlanding Boats. A. Overa, R. Ravikumar. Madras, India, June 1986.

Manuals and Guides (BOBP/MAGI.)

1. Towards Shared Learning : Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual. Madras, India, June 1985.
2. Towards Shared Learning : Non-formal Adult Education for Marine Fisherfolk. Animator's Guide. Madras, India, June 1985.
3. Fishery Statistics on the Microcomputer : A BASIC version of Hasselblad's NORMSEP Program. Colombo, Sri Lanka, June 1986.

Miscellaneous Papers (BOBP/MISI.)

1. Fishermen's Cooperatives in Kerala : A Critique. John Kurien. Madras, India, October 1980.
2. Consultation on Social Feasibility of Coastal Aquaculture. Madras, India, 26 November-I December 1984. Madras, India, November 1985.

Newsletters (Bay of Bengal News)

21 issues quarterly from January 1981 to March 1986.

Information Documents (BOBP/INFI.)

1. Women and Rural Development in the Bay of Bengal Region : Information Sources. Madras, India, February 1982.
2. Fish Aggregation Devices : Information Sources. Madras, India, February 1982.
3. Marine Small-Scale Fisheries of India : A General Description. Madras, India, March 1983.
4. Marine Small-Scale Fisheries of Andhra Pradesh : A General Description. Madras, India, June 1983.
5. Marine Small-Scale Fisheries of Tamil Nadu : A General Description. Madras, India, December 1983.
6. Marine Small-Scale Fisheries of Sri Lanka : A General Description. Madras, India, November 1984.
7. Marine Small-Scale Fisheries of Orissa : A General Description. Madras, India, December 1984.
8. Marine Small-Scale Fisheries of Bangladesh : A General Description. Madras, India, September 1985.
9. Food and Nutrition Status of Small-Scale Fisher-folk in India's East Coast States : A Desk Review and Resources Investigation. V. Bhavani. Madras, India, April 1986.

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