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HANDBOOK OF BRISTOL BAY SOCKEYE SALMON MANAGEMENT

by

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FINAL REPORT

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Director

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SECTION I: BRISTOL BAY SOCKEYE ABUNDANCE

AUTOMATED ANADROMOUS FISHERIES MANAGEMENT SYSTEM (AAFMS)

Final Report for the period 5/1/78 - 10/31/78

INTRODUCTION

The system of estimation of total seasonal and daily numerical abundance of adult sockeye salmon returning to Bristol Bay, Alaska is based on the conservative nature of the entry patterns of anadromous salmonids. The entry pattern or time distribution of abundance, also known as run timing, was first described quantitatively for Bristol Bay sockeye by Thompson (1951) then by Royce (1965). In a previous contract report (Mundy and Mathisen 1977), the quantitative entry patterns for eight rivers tributary to Bristol Bay were summarized and daily abundance profiles of all stocks combined in the period 1956-1975 were presented.

In the 1976 and 1977 fishing seasons entry pattern analysis was employed to estimate daily and total abundance with the error of the total abundance estimates being less than 10% in both cases. Consequently the management agency commissioned the preparation of computer programs which automate the estimation procedures to facilitate harvest management in Bristol Bay.

The system of computer programs described herein is designed to use counts of total run size or observations which are proportional to total run size to estimate total numerical abundance in a dynamic fashion. In the case of observations from the offshore test fishery, the system also generates estimates of daily abundance. The primary emphasis in program

LITERATURE CITED

Mundy, P. R., and O. A. Mathisen. 1977. Handbook of Bristol Bay Sockeye Salmon Management. Fish. Res. Inst. Univ. Washington, Seattle. FRI-UW-7720.

Royce, W. F. 1965. Almanac of Bristol Bay Sockeye Salmon. Circ. 235. Fish. Res. Inst. Univ. Washington, Seattle.

Thompson, W. F. 1951. An outline for salmon research in Alaska. A paper prepared for the meeting of the International Council for the exploration of the sea at Amsterdam, October 1-9, 1951. Circ. 18. Fish. Res. Inst. Univ. Washington, Seattle.

GUIDE TO DOCUMENTATION

The remaining subsections of the Bristol Bay report contain full documentation of program AAFMS from both the vantage point of the user and the computer programmer. Users who are familiar with the University of Alaska Honeywell system need only to scan the User's Guide while carefully studying Tables 1-4 and the subsection on data management. Advanced users may wish to review the subsection describing AAFMS program and subroutines.

For the computer programmer with a need to modify or test AAFMS, Figures 1-9 and Tables 5 & 6 as well as the program list of Table 7 should provide all the prior knowledge necessary. The subsections on data management and subroutine functions will also be of interest to the programmer. The User's Guide contains precise information on the objectives and input variables which may also serve programming requirements.

Documentation for users of the Control Data Corporation system at the University of Washington is available from the Fisheries Analysis Center, WH-10, College of Fisheries.

USER'S GUIDE TO AAFMS ON THE UNIVERSITY OF ALASKA HONEYWELL COMPUTER SYSTEM

The Automated Anadromous Fisheries Management System (AAFMS) is a computer program employing Port Moller offshore test fishing data and inshore return data (catch and escapements) to estimate salmon abundance, run timing and other critical information during the early days of the sockeye run.

AAFMS does the following:

1. Estimates the total inshore return of adult fish for the present year. The estimate is renewed on a daily basis using the latest information from the Port Moller test fishery and catch and escapements reports.
2. Estimates daily passage of fish past Port Moller which is 4-9 days before these installments appear in Bristol Bay.
3. Estimates the present run timing as days early (+) or late (-) as compared to long term average run timing.
4. Estimates the average migration speed of the salmon between Port Moller and the fishing districts.
5. Estimates the catchability (probability of capture by unit gear in unit time) of sockeye by the Port Moller sample vessel as a function of inshore returns.
6. Estimates the probability of capture off Port Moller as a function of the average weight of the sample catches.

AAFMS is used on a daily basis (Mode 1) during the course of the fishing season or as a simulation program (Mode 2) to process all or part of the data from a fishing season in a single run. Assuming that the program is accessible to the user's system, the following is all of the information which is necessary to operate the program in either Mode 1 or Mode 2.

Mode 1 Operation

Since the offshore test fishing program completes one full transect of samples in a twenty-four hour period, each record for AAFMS represents the data from one calendar date. (A record is also known as a line of data or as a card image of data. The exact meaning will become clear from examples which follow). The data items are placed into the record in the following order and format. Consult a FORTRAN manual for definition of format conventions, if necessary.

1. Day number, a sequence number assigned to each day's information e.g. 1,2,...n where n is the total number of days from the beginning of sampling. No day may be omitted even if a sample day is missed. (F2.0)
2. Month of the sample (F2.0)
3. Day of the month (F2.0)
4. Year (F2.0)
5. Cumulative total daily catch per unit effort (CPUE). Daily sample catches from each sample station are converted to catch per hundred fathoms per hour and the converted catches are summed to produce a daily index. The total daily CPUE is added to the sum of all previous daily cpues and this cumulative sum is entered here. (F6.1)

6. Mode 1 option indicator flag. Enter "1" to select Mode 1 operation; put a "1" in column 19 of the record. (F6.1)
7. Average weight of the sample catch in pounds. Multiply the average weight reported by each station by the actual catch at the station, add these products together and divide by the total fish caught on this day. (F6.1)
8. Cumulative Inshore Abundance. Consult the daily report of catch and escapement and add in an estimate for fish which are in the rivers but not past the counting towers. Add this to cumulative total from previous days. (F8.0)
9. Average Mean Passage. The program supplies an average passage rate (inshore returns/Port Moller cpue) of 15048. If this is not correct for your purposes supply the desired figure here. (F6.0)
10. Interpolation indicator. If one or more stations within a transect has been estimated (not actually sampled) then enter "1" to indicate partial interpolation outside the program. If the entire transect (four or more stations) has been estimated, enter "2". (F2.0)
11. Parameter "a" of entry pattern model. If unknown, the program will supply a value of -5.452. (F7.0)
12. Parameter "b" of entry pattern model. If unknown the program will supply a value of 0.3067. (F7.0)
13. Initial estimate of total inshore returns from long range forecasts. This is only meaningful to the program on sample day one. Beyond sample day one the program ignores this variable. (F8.0)

14. Mean passage over-ride flag. Beyond day four of sampling, the program will supply a passage rate based on the average weight of the sample catches. If this is not acceptable you may choose to use the passage rate which you supply as a variable #9 by entering "1" here. (F2.0)

In summary, the format for the daily record is as follows: 4F2.0, 3F6.1,F8.0,F6.0,F2.0,2F7.0,F8.0,F2.0.

Example of Mode 1 Operation

The following are actual examples of mode 1 operation (see Table 1). The lines supplied by the user are underlined. All other words are supplied by the Honeywell system.

In the preceding example the memory area named FILE 4 was used to enter the first record of data for the 1978 season. The computer programmer responsible for AAFMS maintenance had previously established this memory area under the name FILE 4 for the convenience of the user. Since the file was already in existence, the command, EDIT O FILE 4, was given to indicate that we wanted to modify an "old" file designated FILE 4. After entering our line of data and the following "99" line (end of information indicator for AAFMS), we give the command RESAVE to indicate that the data entered supercedes and replaces all previous data known under the name FILE 4. We leave the editor and return to command mode (SYSTEM ?) to run the AAFMS program. The program writes the results to area 06 (EPRINT 06) and to an area named FILE 6. The 06 area may be printed only from within the operating mode known as JOUT (see the line, "JOUT INVOKED FOR 0078t",

Table 1.

```
UACN TSS  Fri Jul 07 1978  11:48  Channel 2211  44 Users

Userid ?agfcst
Passwd ?
[redacted]
**** Resources 96% used.
**** 124 llinks file space left (1876/2000 used).
**11.486** CHANGE : SYSTEM DOWN AT 12:30 ADT 7/07/78 FOR 10 MINUTES **
SYSTEM ?EDIT O FILE4
-I
enter
* 1 61178    63    1     63                                    11534000
*99
*
-RESAVE FILE4
DATA SAVED-FILE4

99

-DONE
SYSTEM ?JRUN AAFMSJCL
  SNUMB # 0078t

0078T - BEIN EXECUTING @ 11.983

0078T-01 - WAIT ALOC @ 11.984

0078T-01 - EXECUTING @ 11.985

0078T - OUTPUT WAITING @ 11.990
normal termination

JOUT INVOKED FOR 0078T

function?EPRINT 06
```

```
ECHO CHECK INPUT 6.11.78.
E( 1)    0.10000E 01
E( 2)    0.60000E 01
E( 3)    0.11000E 02
E( 4)    0.78000E 02
E( 5)    0.59000E 01
E( 6)    0.
E( 7)    0.63000E 01
E( 8)    0.
E( 9)    0.
E(10)    0.
E(11)    0.
E(12)    0.
E(13)    0.11534E 08
E(14)    0.
```

Table 1. (continued)

AFTER DEFAULT SET

E(1)	0.10000E 01
E(2)	0.60000E 01
E(3)	0.11000E 02
E(4)	0.78000E 02
E(5)	0.59000E 01
E(6)	0.
E(7)	0.63000E 01
E(8)	0.
E(9)	0.15048E 05
E(10)	0.
E(11)	-0.54520E 01
E(12)	0.30670E 00
E(13)	0.11534E 08
E(14)	0.

AAFMS BB SOCKEYE RESEARCH SUMMARY

CALENDAR DATE 6.11.78.

SAMPLE DAY 1

RUN DAY 2

EST. TOTAL P. MOLLER CATCH 766.

MEAN PASS.,TOTAL RUN SIZE 15048.

MEAN PASS.,DAILY RUN SIZE 13722.

MEAN PASS.,INSHORE 0.

RESIDUAL MS, EP MODEL 0.13210E-06

RESIDUAL MS, INSHORE EP 0.

EP MODEL SHIFT 1.

INSHORE EP SHIFT 0.

TOTAL RUN INSHORE MP 0.

DATA TABLES FOLLOW

please direct, release, or hold before exit
function?RELE

Table 1. (continued)

```
SYSTEM ?LIST FILE6



                AAFMS BRISTOL BAY SOCKEYE SALMON
                MANAGEMENT SUMMARY FOR 6.11.78.

                SAMPLE DAY NUMBER  1.

                DAILY TOTAL CPUE     6.3
                CUMULATIVE TOTAL CPUE     6.3

                ESTIMATED TOTAL RUN SIZE   12067627.
                YESTERDAY THE ESTIMATE WAS          0.

                ESTIMATED TOTAL NO. PAST P. MOLLER      86450.
                AT RATE OF 13722. FISH/STD CATCH

                RUNNING MEAN WEIGHT (LBS) SAMPLE CATCHES 6.3

                TOTAL INSHORE RETURNS SO FAR          0.

                RUN TIMING IS + 1. DAYS COMPARED TO AVERAGE


SYSTEM ?BYE
**costs  $   0.17 to date:  $ 5283.48= 96%
**on at 11.803 - off at 12.039 on  07/07/78
```

above). If you wish to save this part of the results to make copies later, substitute the command, HOLD, for the command, RELE, in the above example. Note the number which identifies your results, 0078t in the above example, so that you can use it to give the command, JOUT nnnnT, from the SYSTEM? operating mode at a later time to retrieve your results. Here nnnn refers to the four digit number which uniquely identifies this copy of the results.

After leaving the JOUT mode by typing RELE or HOLD we return to the SYSTEM? mode to retrieve the rest of the results from this run. This is done by typing, LIST FILE 6. A complete explanation of the output derived from this action follows:

Line 1. Title

Line 2. Month-Day-Year

Line 3. Number of days since the beginning of Port Moller sampling.

Line 4. Sum of all sockeye taken at Port Moller on this date expressed as #fish/hundred fathoms/hour (standardized catch)

Line 5. Sum of all daily standardized sockeye catches to date.

Line 6. See #1, first paragraph

Line 7. See #1, first paragraph

Line 8. See #2, first paragraph

Line 9. See #6, first paragraph

Line 10. See #5, first paragraph

Line 11. Catch + escapement as compiled by ADF&G King Salmon, Dillingham

Line 12. See #3, first paragraph

Line 13. -N. Cumulative estimated daily abundance, see #2 above, as compared to inshore observed returns. Only tabled at and beyond sample day 10.

To learn more about the output derived from EPRINT 06 in the JOUT mode it is necessary to study the mathematical relationships developed elsewhere (see flowcharts) in this document.

We are now ready to enter the second daily record for the season under Mode 1 operation. The following example will illustrate that FILE 4 has at most one record in it during Mode 1 operation (the end of information line, "99" not being considered a real record) and that we need to save a copy of all records for possible future use under Mode 2 operation (see Table 2).

Reviewing the sequence of events, we modified the existing memory area named FILE 4 to include the record of the sample day. There was no need to add "99" since we inserted (command 1) the record between record #1 and the "99" line. We found the proper line by the command "FS:/61178/" which says "find string June 11, 1978", and "I" command says "insert the line typed in next behind the line just found". The command, VERI, given just after entering the editor causes the system to print the results of all actions taken while in editor. After successful insertion of the new line the system prints the new line and the lines immediately before and after the new line. To save all the data now in the file the command, "SAVE COPY" saves the new FILE 4 to a memory area known as "COPY". Since this is a new file the command, "SAVE", is used.

To enter a new line, EDIT 0 COPY, FS:/previous date/, I new line, RESAVE COPY, B back to the beginning of the file, D;n delete the number of lines given by n where n is the sample day number of the preceding day, and RESAVE FILE 4. Get out of editor (DONE) and JRUN AAFMSJCL. Repeat once a day until the end of the season.

Table 2.


```
UACN TSS  Fri Jul 07 1978  13:43  Channel 2212  44 Users

Userid ?AGFCST
Passwd ?
[redacted]
**** Resources 96% used.
**** 124 llinks file space left (1876/2000 used).

SYSTEM ?EDIT O FILE4
-VERI
-FS:/61178/

 1 61178    59          63       0                     11534000

-I
enter
* 2 61278    78    1     74
*


 1 61178    59          63       0                     11534000
 2 61278    78    1     74
99



99

-SAVE COPY
DATA SAVED-COPY

99

-B

 1 61178    59          63       0                     11534000

-D;1

 2 61278    78    1     74


-RESAVE FILE4
DATA SAVED-FILE4

 2 61278    78    1     74

-LIST

 2 61278    78    1     74
99
```

Table 2. (continued)

```
 2 61278    78    1     74

-DONE
SYSTEM ?JRUN AAFMSJCL
  SNUMB # 4537t

4537T - BEIN EXECUTING @ 13.807

4537T-01 - WAIT ALOC @ 13.809

4537T-01 - EXECUTING @ 13.810

4537T - OUTPUT WAITING @ 13.814
normal termination

JOUT INVOKED FOR 4537T

function?HOLD
SYSTEM ?BYE
**cost: $   0.09 to date: $ 5284.22= 96%
**on at 13.717 - off at 13.822 on  07/07/78
```

Mode 2 Operation

Mode 2 is useful for simulation or when correcting mistakes in the data base for the current season. To illustrate mode 2 an example of correcting the data base and making a mode 2 run to bring the program up to date follows (see Table 3).

In the preceding example upon listing the file COPY we noticed there were characters out of place which would cause the program to run incorrectly. Using the editor command, RS, replace string, we removed these characters. Then we removed the "1" from column 19 (variable 6) to indicate that the data were to be run as Mode 2. The entire corrected file was then resaved under the name FILE 4 for the AAFMS run. In mode 2, the basic input file, FILE 4 has more than one record as opposed to mode 1 where FILE 4 never has more than one record. In Mode 2 variable number 6 is empty in all cases whereas in mode 1 variable 6 is always equal to "1".

Notes For Advanced Users Of AAFMS

The source deck of AAFMS consists of a main program and nine subroutines and functions. In the operating system described above the source deck is compiled into object code (named AAFMSOBJ) by the control cards of the file AAFMSSRC. If a change is made in the source deck, the source deck is compiled by running AAFMSSRC before any new run is made on the control language of AAFMSJCL which executes the object deck after bringing the requisite storage files into the program area.

The storage files are named FILE 1, FILE 2, FILE 3 and AAFMSBK. The daily input file (Mode 1) or the input for simulation (Mode 2) is

Table 3.

```
UACN TSS  Fri Jul 07 1978  14:23  Channel 2213  41 Users

Userid ?AGFCST
Passwd ?
[redacted]
**** Resources 96% used.
**** 123 llinks file space left (1877/2000 used).

SYSTEM ?EDIT O COPY
-VERI
-LIST

 1 61178    59    1     63       0    1         1        11534000
 2 61278    74    1     74
 3 61378   139    1     72
 4 61478   165    1          1          2
 5 61578   231    1     59
 6 61678   276    1     58    1         1
 7 61778   327    1          1          2
 8 61878   386    1     62
 9 61978   469    1     66
10 62078   784    1     62    1600
11 62178   981    1          35733      2
12 62278  1267    1          69866      2
13 62378  1613    1     55  104000      2
14 62478  1992    1     57  247100      1
15 62578  2165    1     62  376800
16 62678  2838    1     61  450000      2
17 62778  3330    1     61 1250000      2
18 62878  3817    1     60 2076000      2
19 62978  4066    1     59 3000000
20 63078  4230    1     58 4149300
21 70178  4485    1     61 4690000
22 70278  4547    1        5500000      1
23 70378  4799    1     64 6000000      1
24 70478  4917    1     56 6500000
25 70578  5008    1     53 8000000
26 70678  5122    1     53 8500000
99

 1 61178    59    1     63       0    1         1        11534000

-RS:/0    1          1/:/                   /

 1 61178    59    1     63                                11534000

-RS:/1          1/:/1          /

 4 61478   165    1                         2

-RS:/58    1/:/58     /

 6 61678   276    1     58                  1

-RS:/1          1/:/1          /

 7 61778   327    1                         2
```

Table 3. (continued)

-LIST

1	61178	59	1	63			11534000
2	61278	74	1	74			
3	61378	139	1	72			
4	61478	165	1			2	
5	61578	231	1	59			
6	61678	276	1	58		1	
7	61778	327	1			2	
8	61878	386	1	62			
9	61978	469	1	66			
10	62078	784	1	62	1600		
11	62178	981	1		35733	2	
12	62278	1267	1		69866	2	
13	62378	1613	1	55	104000	2	
14	62478	1992	1	57	247100	1	
15	62578	2165	1	62	376800		
16	62678	2838	1	61	450000	2	
17	62778	3330	1	61	1250000	2	
18	62878	3817	1	60	2076000	2	
19	62978	4066	1	59	3000000		
20	63078	4230	1	58	4149300		
21	70178	4485	1	61	4690000		
22	70278	4547	1		5500000	1	
23	70378	4799	1	64	6000000	1	
24	70478	4917	1	56	6500000		
25	70578	5008	1	53	8000000		
26	70678	5122	1	53	8500000		
99							

7 61778 327 1 2

-RS:/ 1 /:/ /

7 61778 327 2

-B

1 61178 59 1 63 11534000

-RS:/ 1 /:/ /

1 61178 59 63 11534000

-RS:/ 1 /;*:/ /

Table 3. (continued)

```
end of file - request executed  24 times

--B

 1 61178    59            63                                     11534000

--LIST

 1 61178    59            63                                     11534000
 2 61278    74            74
 3 61378   139            72
 4 61478   165                             2
 5 61578   231            59
 6 61678   276            58               1
 7 61778   327                             2
 8 61878   386            62
 9 61978   469            66
10 62078   784            62     1600
11 62178   981                  35733      2
12 62278  1267                  69866      2
13 62378  1613            55   104000      2
14 62478  1992            57   247100      1
15 62578  2165            62   376800
16 62678  2838            61   450000      2
17 62778  3330            61  1250000      2
18 62878  3817            60  2076000      2
19 62978  4066            59  3000000
20 63078  4230            58  4149300
21 70178  4485            61  4690000
22 70278  4547                5500000      1
23 70378  4799            64  6000000      1
24 70478  4917            56  6500000
25 70578  5008            53  8000000
26 70678  5122            53  8500000
99


 1 61178    59            63                                     11534000

--RESAVE FILE4
DATA SAVED-FILE4

 1 61178    59            63                                     11534000

--DONE
SYSTEM ?JRUN AAFMSJCL
  SNUMB # 4640t
```

named FILE 4. The file structures for these files are given by the format statements where the files are read, SUB CONTROL, or written, SUB RITE. AAFMSBK is a copy of FILE 1-3 which can be used to save a re-start of AAFMS in the event that FILE 1-3 are inadvertantly wiped from the system.

A detailed flow chart and other aids to understanding AAFMS are available elsewhere in this document. See lists of AAFMSSRC and AAFMSJCL below (see Table 4).

Table 4.

```
SYSTEM ?LIST AAFMSSRC

##M,J N
$:IDENT:AGFCST
$:OPTION:FORTRAN,NOMAP
$:FORTRAN:XREF,DECK,MAP
$:PRMFL:C*,W,S,AGFCST/AAFMSOBJ
$:SELECTA:AGFCST/PAAFMS
$:SELECTA:AGFCST/CONTROL
$:SELECTA:AGFCST/FC2
$:SELECTA:AGFCST/FC3
$:SELECTA:AGFCST/DAYONE
$:SELECTA:AGFCST/BPROF
$:SELECTA:AGFCST/DAYTWO
$:SELECTA:AGFCST/SYNCH
$:SELECTA:AGFCST/RITE
$:SELECTA:AGFCST/REPORT
$:SELECTA:AGFCST/PLOT
$:ENDJOB


SYSTEM ?LIST AAFMSJCL

##A,J N
$:IDENT:AGFCST
$:OPTION:FORTRAN
$:USE:.GTLIT
$:SELECT:AGFCST/AAFMSOBJ
$:EXECUTE
$:LIMITS:,17K
$:PRMFL:04,R,S,AGFCST/FILE4
$:PRMFL:07,W,S,AGFCST/FILE6
$:PRMFL:01,W,S,AGFCST/FILE1
$:PRMFL:02,W,S,AGFCST/FILE2
$:PRMFL:03,W,S,AGFCST/FILE3
$:PRMFL:09,W,S,AGFCST/AAFMSBK


SYSTEM ?BYE
**cost: $   0.24 to date:  $ 5285.46= 96%
**on at 14.378 - off at 14.727 on  07/07/78
```

DATA MANAGEMENT BY AAFMS

A. Mode 1 (in-season management)

1. Each day the operator creates a new input data set, named FILE4, which holds the variables, E(1)-E(14), see Table 1. Some values may be zero which indicates that a default value will be assigned within the program. g, R and, for Di.GT.1, $\hat{N}_0$, are control flags.

2. AAFMS places FILE4 into memory. If this is the first run, AAFMS computes values of additional variables of interest, sorts the computed variables and input variables into three data sets and writes each data set to output devices which are named FILE1, FILE2, FILE3. FILE4 is discarded since its values are now part of FILE1 or FILE2 or FILE3 or all of them. The files named FILE1, FILE2, FILE3 are stored for future use.

   If this is the 2nd or nth run (D.GE.2), AAFMS will put the data sets named FILE1, FILE2, FILE3, FILE4 into memory and execute. At the end of successful execution, the input data sets named FILE1, FILE2, FILE3 and FILE4 are discarded and three output data sets are saved under the names FILE1, FILE2, FILE3 for the next execution of AAFMS.

B. Control sequence, Mode 1.

1. First run, day one (D.EQ.1)

   a. Attach data set named FILE4 to the program area and assign it to input device #4.

b. RESERVE three output files and assign them to output devices 7, 8, 9.

c. EXECUTE AAFMS.

d. DISCARD the data set named FILE4.

e. SAVE the data sets written to output devices 7, 8, 9 under the names FILE1, FILE2, FILE3,

2. nth run (D.GE.2)

a. ATTACH data sets named FILE1, FILE2, FILE3, FILE4 to the program area and assign them to input device numbers 1, 2, 3, 4, respectively.

b. RESERVE three output files and assign them to output device numbers 7, 8, 9.

c. EXECUTE AAFMS.

d. DISCARD the data sets named FILE1, FILE2, FILE3, FILE4.

e. SAVE the data sets written to output devices 7, 8, 9 under the respective names FILE1, FILE2, FILE3.

C. Mode 2 (Simulation or re-start in-season management).

1. The operator prepares an input data set, named FILE4, which contains more than one data set, E(1)-E(14), see Table 1.

2. AAFMS takes one data set at a time, E(1)-E(14), executes and assigns the result of execution i to H(i,*), G(i,*), F(i,*), and repeats these steps until the end of run condition is satisfied.

3. When the end of run condition is satisfied, AAFMS writes arrays H, F, G to output devices 7, 8, 9, named FILE1, FILE2, FILE3, respectively, and these files are stored for possible future use.
4. If a second or n-th run on additional E records of the same year is made, AAFMS reads the results from previous mode 2 runs from input devices 1, 2, 3 as well as the E records from input device 4. The end of execution is the same as step 3 above.

D. Control sequence, Mode 2.

1. E array (FILE4) contains data set for day one.
   a. ATTACH data sets named FILE4 to the program area and assign to input device #4.
   b. RESERVE three output files and assign them to output devices numbered 7, 8, 9.
   c. EXECUTE AAFMS.
   d. DISCARD the data set named FILE4 or store it under another name.
   e. SAVE the data sets written to output devices 7, 8, 9 under the names FILE1, FILE2, FILE3.
2. First record of E array contains observations for day greater than day one.
   a. ATTACH data sets named FILE1, FILE2, FILE3, FILE4 to program area and assign them to input devices numbered 1, 2, 3, 4, respectively.
   b. Same as above.
   c. Same as above.
   d. Same as above.
   e. Same as above.

AAFMS PROGRAM AND SUBROUTINE DESCRIPTIONS

I. Program AAFMS.

The main program does very little but the role it plays is crucial. It assigns zeroes to the elements of all storage arrays (E is an input array), sets the end of execution control to a neutral position and tests for the end of execution condition. The main program calls CONTROL one or more times and issues one call to RITE and one to REPORT just prior to termination.

Common variables assigned

H(I,J), I=1,40, J=1,20

F(I,J), I=1,40, J=1,3

G(I,J), I=1,40, J=1,4

S(I,J), I=1,40, J=1,8

Local variables or subroutine arguments assigned

KSTOP

I,J,K,L

II. Subroutine CONTROL.

The primary function of CONTROL is input; however, it also determines and sets the end of execution condition, sets default values for input variables, assigns input variables to storage arrays, computes the value of mean passage as a function of weight, H(i,9) or $\hat{A}$, and controls the sequence of calls to DAYONE, BPROF, DAYTWO and SYNCH. CONTROL is called only from AAFMS.

Common variables assigned

KBIG, E(7), E(9), E(11), E(12), E(13), F(i,2), G(i,I), I=1,4, H(i,I), I=1,4, H(i,8), H(i,9), H(i,I), I=17,20, S(40,i), i=7,8

III. Subroutine DAYONE.

Subroutine DAYONE executes only when the value of E(1), D_i, is one. It initiates the curve fitting process for the entry pattern model. DAYONE is called only by CONTROL.

Common variables assigned

F(i,I), I=1,3, G(i,I), I=5,6, G(i,I), I=11,14

Local variables assigned

DF, I, IP, J, M, P, T

IV. Subroutine BPROF.

Subroutine BPROF is concerned with fitting the predicted profile of daily abundance, H(i,13) to the observed profile of inshore abundance, G(i,4) by the least squares method. BPROF is called only by CONTROL.

Common variables assigned

H(i,10), H(i,I), I=15,16, S(I,J), I=1,39, J=1,8, S(40,8)

Local variables assigned

B, BF, FF, I, J, K, KBT, KP, KT, L, LA, LU, M, ND, NZ, SSUM, SUM.

V. Subroutine DAYTWO.

Subroutine DAYTWO fits the sample catch to the EP model for day numbers greater than one. It continues the preparation of the expected inshore abundance profile initiated by DAYØNE. DAYTWØ is the computational heart of AAFMS; most critical variables in the abundance estimation procedure are assigned in this routine. DAYTWO is called only from CONTROL.

Common variables assigned

H(i,I), I=5,7, H(i,I), I=11,13, F(i,3)

Local variables assigned

I, J, K, KAP, KRD, KS, L, LKOPY, M, RUN, SUM, SUMC, SUMP, SUMY.

VI. Subroutine SYNCH.

Subroutine SYNCH allows the full array of estimated proportions, T_i, to float over the time axis in shifts of one day to fix the best shift by the least squares criterion. SYNCH provides the shift on day i which drives DAYTWO on day i+1. SYNCH is called only from CONTROL.

Common variables assigned

H(i,14)

Local variables assigned

B, I, IZ, J, KHOLD, KL, KRD, KSFT, LL, LT, LY, M, S, SSUM, SUM, T.

V. Subroutine RITE.

Subroutine RITE writes the F, G and H arrays to type. It assigns zero to some variables in the H array if called on the first day of sampling. The output formats in RITE should be identical to the input formats for F, G, H in CONTROL. RITE is called only from AAFMS.

Common variables assigned (D.EQ.1 only)

H(i,7), H(i,10), H(i,15), H(i,16).

Local variables assigned

I, J, L. T.

VI. Subroutine REPORT.

Subroutine REPORT prepareslabeled lists of variables of interest for general consumption. One variable is computed within REPORT for output, daily sample catch, since H(i,4) is cumulative sample catch. No common variables are assigned in REPORT. REPORT is called only from AAFMS.

Table 5. AAFMS FILE CONTENTS

File 1 - Master

Symbol		
Program	Flow	Name
H(i,1)	D_i	Sample day number
H(i,2)	M_i	Month
H(i,3)	d_i	Day of month
H(i,4)	c_i	Total cumulative standardized sample catch
H(i,5)	$\hat{C}_i$	Estimated total sample catch
H(i,6)	$\hat{N}_i$	Estimated total run size $\bar{A}$, $\hat{A}$
H(i,7)	$\hat{I}_i$	Estimated total run size $\widehat{AB}$
H(i,8)	$\bar{A}_i$	Average mean passage
H(i,9)	$\hat{A}_i$	Mean passage, weight
H(i,10)	$\widehat{AB}_i$	Mean passage, inshore
H(i,11)	AU_i	Mean passage for $\hat{N}$; $\bar{A}$ or $\hat{A}$
H(i,12)	SSQ_i	Residual about EP model
H(i,13)	r_i	Estimated daily run size
H(i,14)	sh_i	Shift for fit of Y to p
H(i,15)	SQ_i	Residual about inshore profile
H(i,16)	T_i	Shift for fit of r to Z
H(i,17)	g_i	Execution mode flag, 1 or 0
H(i,18)	w_i	Average weight of sample catch
H(i,19)	f_i	Interpolation flag /(lbs)
H(i,20)	yr_i	Sample year

File 2 - EP model

Program	Flow	Name
F(i,1)	D_i	Sample day number
F(i,2)	Y_i	Expected cumulative daily proportion
F(i,3)	$\hat{P}_i$	Estimated cumulative daily proportion

File 3 - Inshore Abundance Profile

Program	Flow	Name
G(i,1)	D_i	Sample day number
G(i,2)	m_i	Month
G(i,3)	d_i	Day of month
G(i,4)	z_i	Observed daily inshore abundance (cumulative)

Table 5. AAFMS FILE CONTENTS - Continued

File 4 - Daily Input

Symbol: Program	Symbol: Flow	Name
E(1)	D_i	Sample day number
E(2)	m_i	Month
E(3)	d_i	Day of month
E(4)	yr_i	Year
E(5)	c_i	H(i,4)
E(6)	g_i	H(i,17)
E(7)	w_i	H(i,18)
E(8)	$\underline{z}_i$	G(i,4)
E(9)	$\bar{A}_i$	H(i,8)
E(10)	f_i	H(i,19)
E(11)	a_i	Entry pattern model parameter
E(12)	b_i	Entry pattern model parameter
E(13)	$\hat{N}_o$	Initial total run size estimate (day 1)
E(14)	R_i	Mean passage over ride flag

File structure, FILE1, see FORMAT 100, Sub RITE
File structure, FILE2, see FORMAT 101, Sub RITE
File structure, FILE3, see FORMAT 102, Sub RITE
File structure, FILE4, see FORMAT 100, Sub CONTROL

Table 6. Alphabetic list of flow chart variables, storage locations, sources, and uses.

Flow	Storage	Source	Use
$\bar{A}$	H(i,8)	I, DF	D1, D2
$\hat{A}$	H(i,9)	C	D2
$\hat{A}B$	H(i,10)	B	D2
AU	H(i,11)	D1, D2	ref
a	n	I, DF	C, FC2
b	n	I, DF	C, FC2
c	H(i,4)	I	B, D1, Dw, 5
$\hat{C}$	H(i,5)	D1, D2	D1, D2
d	F,G,H(i,3)	I	RP
D	F,G,H(i,1)	I	all
f	H(i,19)	I	ref
g	H(i,17)	I	D2
I	H(i,7)	B	RP
kbig	n	I	all
m	F,G,H(i,2)	I	RP
$\hat{N}$	H(i,6)	D1, D2	RP
$\hat{N}_o$	n	I	D1, C
p	F(i,3)	D1, D2	ref
r	H(i,13)	D1, D2	B
R	n	I	D2
sh	H(i,14)	S	ref
SQ	H(i,15)	B	ref
SSQ	H(i,12)	D1, D2	ref
T	H(i,16)	B	ref
w	H(i,18)	I, DF	C, FC2
Y	F(i,2)	FC3	D1, D2, S
z	G(i,4)	I	B

B, sub BPROF
C, sub CONTROL
DF, default
D1, sub DAYONE
D2, sub DAYTWO
FC3, function FC3
I, input
i, sample day
n, no storage
ref, reference
RP, sub REPORT
S, sub SYNCH

Table 7. List of AAFMS, subroutines and functions.

```
      PROGRAM AAFMS(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE6=OUT
     1PUT,TAPE7,TAPE8,TAPE9,TAPE11=INPUT)
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      DO 2 I = 1,40
      DO 3 J = 1,20
    3 H(I,J)= 0.0
      DO 5 J=1,3
    5 F(I,J) = 0.0
      DO 6 K=1,4
    6 G(I,K) = 0.0
      DO 7 L = 1,8
    7 S(I,L) = 0.0
    2 CONTINUE
      KSTOP = 0
    1 CONTINUE
      CALL CONTROL(KSTOP)
      IF(KSTOP.LT.41) GO TO 1
      CALL RITE
      CALL REPORT
      STOP
      END
```

Table 7. List of AAFMS, subroutines and functions - Continued.

```
      SUBROUTINE CONTROL(KSTOP)
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      READ(4,100) (E(I),I=1,14)
      IF(E(1).GT.40.)GO TO 999
  100 FORMAT(4F2.0,3F6.1,F8.0,F6.0,F2.0,2F7.0,F8.0,F2.0)
      KSTOP = KSTOP + 1
      IF(KSTOP.GT.1) GO TO 54
      WRITE(6,104) (E(I),I=2,4)
  104 FORMAT(1H1///14X,16HECHO CHECK INPUT,3F3.0/)
      DO 40 I = 1,14
   40 WRITE(6,105) I,E(I)
  105 FORMAT(1H ,13X,2HE(,I2,4H) = ,E12.5)
   54 CONTINUE
      KBIG=INT(E(1))
      M=KBIG
      Z = 0.0
      WFLAG = 0.
      NFLAG = 0
    2 IF(E(7).GT.0.0) GO TO 4
      E(7)=6.1
      WFLAG = 1.
      GO TO 3
    4 IF(M.GT.1) GO TO 3
      H(M,9)=FC2(E(7))
    3 IF(E(9).GT.0.0) GO TO 5
      E(9) = 15048.
    5 IF(E(11).NE.0.0) GO TO 6
      E(11)= -5.452
    6 IF(E(12).GT.0.0) GO TO 7
      E(12)= 0.3067
      GO TO 8
    7 NFLAG=1
    8 CONTINUE
      IF(KSTOP.GT.1) GO TO 55
      WRITE(6,106)
  106 FORMAT(1H0,13X,17HAFTER DEFAULT SET)
      DO 41 I = 1,14
   41 WRITE(6,105) I,E(I)
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
 55 CONTINUE
    DO 1 I=1,3
    H(M,I)=E(I)
  1 G(M,I)=E(I)
    H(M,4)=E(5)
    H(M,17)=E(6)
    H(M,18)=E(7)
    H(M,8)=E(9)
    H(M,19)=E(10)
    G(M,4)=E(8)
    H(M,20) = E(4)
    IF(KBIG.GT.1) GO TO 9
    IF(E(13).LT.1.0) E(13) = 10000000.
    CALL DAYONE
    S(40,8) = 0.0
    S(40,7) = E(7)
    GO TO 16
  9 L = KBIG - 1
    IF(E(6).LT.1.) GO TO 50
    DO 10  I=1,L
 10 READ(1,101) (H(I,J),J=1,19)
101 FORMAT(3F2.0,F6.1,F5.0,2E12.5,
   14F6.0,2E12.5,    ,F3.0,
   2E12.5,F3.0,F4.1,F3.1,2F2.0)
 19 DO 11 I=1,40
    READ(2,102) (F(I,J),J=1,3)
102 FORMAT(F2.0,2F8.6)
    IF(NFLAG.GT.0) GO TO 12
    GO TO 11
 12 T=FLOAT(I)
    F(I,2)=FC3(T,E(10),E(11))
 11 CONTINUE
    IF(E(12).LT.1.0) GO TO 13
    K=5
    GO TO 14
 13 K=3
 14 DO 15 I=1,L
 15 READ(K,103) (G(I,J),J=1,4)
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
103 FORMAT(3F2.0,E12.5)
 50 CONTINUE
    DO 21 I = 1,M
 21 Z = Z + H(I,18)
    W = Z/FLOAT(M)
    S(40,7) = W
    H(M,9) = FC2(W)
    IF(WFLAG.LT.1.0) GO TO 51
    H(M,18) = W
 51 CONTINUE
    CALL BPROF
    CALL DAYTWO
    CALL SYNCH
 16 CONTINUE
    RETURN
999 KSTOP = 99
    RETURN
    END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      FUNCTION FC2(A)
C.....MEAN PASSAGE, THE INVERSE OF CATCHABILITY, IS DEFINED
C.....AS A FUNCTION OF AVERAGE WEIGHT  OF SAMPLE CATCHES ONLY
C.....FOR AVERAGE WEIGHTS UP TO 8.4 POUNDS.
C.....IT IS HIGHLY UNLIKELY THAT THE AVERAGE WEIGHTS FOR A SEASON
C.....WOULD FALL OUTSIDE THIS UPPER BOUNDARY.
      AKOPY = A
      IF(A.GT.8.40) A=8.4
    4 FC2 = 54704.3 - ( 6505.1*A)
      A = AKOPY
      RETURN
      END
```

```
      FUNCTION FC3(T,A,B)
      FC3 = 1./(1. + EXP(-(A+B*T)))
      RETURN
      END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE DAYONE
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      DIMENSION DF(40)
      M=KBIG
      H(M,5)= E(13)/E(9)
      P= E(5)/H(M,5)
      J=1
      DO 1 I=1,40
      T=FLOAT(I)
      F(I,1) = T
      F(I,2)=FC3(T,E(11),E(12))
      DF(I)= (P-F(I,2))**2
      F(I,3)=0.0
      IF(DF(I).GT.DF(J)) GO TO 1
      J=I
    1 CONTINUE
      H(M,6) = (E(5)/F(J,2)) * H(M,8)
      H(M,11)= H(M,8)
      H(M,12)= DF(J)
      H(M,13)= H(M,4)*H(M,9)
      F(J,3)=P
      IP = J - 1
      H(M,14) = FLOAT(IP)
      RETURN
      END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE BPROF
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      DIMENSION SSUM(9)
      DO 16 I =1,39
      DO 17 J = 1,8
   17 S(I,J) = 0.0
   16 CONTINUE
      BF=0.
      M=KBIG
      DO 1 I=1,M
      IF(G(I,4).GT.0.0) GO TO 2
      GO TO 1
    2 IF(BF.GT.0.0) GOTO 3
      ND = I
    3 BF=BF+1.
    1 CONTINUE
      S(40,8) = BF
      IF(ND.LT.5) GO TO 12
    4 DO 5 I=1,9
    5 SSUM(I)=0.0
      SUM=0.0
      KP=ND
      DO 6 J=4,9
      L=ND-J
      IF(L.GT.0) GO TO 7
      KP=KP+1
      L=1
    7 DO 8 I=KP,M
      SUM= (H(L,13)-G(I,4))**2 + SUM
    8 L=L+1
      LA=(M-KP)+1
      FF=FLOAT(LA)
      SSUM(J)= SUM/FF
      SUM=0.0
      IF(M.EQ.KP) GO TO 18
    6 CONTINUE
      LU = 9
      GO TO 19
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
18 LU = J
19 CONTINUE
   KT=4
   B=SSUM(4)
   DO 9 I=5,LU
   IF(B.LT.SSUM(I)) GO TO 9
   B=SSUM(I)
   KT=I
 9 CONTINUE
   H(M,15)=SSUM(KT)
   H(M,16)= FLOAT(KT)
   IF(M.LT.10) GO TO 40
   N = M - KT
   H(M,10) = G(M,4)/H(N,4)
40 CONTINUE
   J=ND-KT
   IF(J.GT.0) GO TO 10
   KP=ND+(-J)+1
   J=1
10 K = 1
   DO 11 I=KP,M
   DO 14 NZ = 1,4
14 S(K,NZ) = G(I,NZ)
   S(K,5) = H(J,13)
   KBT = 1
   DO 15 NZ = 6,8
   S(K,NZ) = H(J,KBT)
15 KBT = KBT + 1
   K = K + 1
   J=J+1
11 CONTINUE
   GO TO 13
12 H(M,15)=0.0
   H(M,16)=0.0
   H(M,10)=0.0
   S(40, 8) = 0.0
13 RETURN
   END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE DAYTWO
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      M=KBIG
      K  =M-1
      KAP=H(K  ,14)
      KRD=KAP+M
      IF(KAP) 1,2,3
    1 KS=1
      L=(-KAP)+1
      GOTO 4
    2 KS=1
      L=1
      GOTO 4
    3 KS=KAP+1
      L=1
    4 LKOPY=L
      SUMY=0.0
      SUMC=0.0
      SUMP=0.0
      SUM =0.0
      DO 5 I=KS,KRD
      SUMP=H(L,4)*F(I,2)+SUMP
      SUMC=H(L,4)**2 + SUMC
      SUMY=F(I,2)**2 + SUMY
      L=L+1
    5 CONTINUE
      H(M,5)=SUMC/SUMP
      H(M,12)= SUMY-((2./H(M,5)*SUMP))+((1./H(M,5)**2)*SUMC)
      RUN = (H(M,4) - H(K,4))* H(M,9)
      H(M,13) = H(K,13) + RUN
      H(M,7) =H(M,5)*H(M,10)
      IF(E(14).LT.1.0) GOTO 6
      IF(E(14).GT.1.0) GOTO 7
      GO TO 8
    6 IF(M.GT. 4) GO TO 8
    7 H(M,6)= H(M,5) * H(M,8)
      H(M,11)= H(M,8)
      GOTO 10
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
 8 J = 1
   DO 9 I=J,M
 9 SUM=SUM+ H(I,9)
   SUM=SUM/FLOAT(M)
   H(M,6)=SUM*H(M,5)
   H(M,11)= SUM
10 L=LKOPY
   DO 12 I = 1,40
12 F(I,3) = 0.0
   DO 11 I=KS,KRD
   F(I,3)=H(L,4)/H(M,5)
   L=L+1
11 CONTINUE
   RETURN
   END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE SYNCH
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      DIMENSION SSUM(13),KHOLD(13),T(40)
      SUM=0.0
      M=KBIG
      DO 1 I=1,13
    1 SSUM(I)=0.0
      DO 2 I=1,M
    2 T(I)= H(I,4)/H(M,5)
      KL=M/2
      IF(KL.LT.7) GO TO 3
      KL=6
    3 KSFT=(-KL)
      LL=1
    4 CONTINUE
      IF(KSFT) 5,6,7
    5 LT=(-KSFT)+1
      LY=1
      GOTO8
    6 LT=1
      LY=1
      GOTO8
    7 LT=1
      LY=KSFT+1
    8 J=LT
      KRD=KSFT+M
      DO 9 I=LY,KRD
      SUM=SUM+(F(I,2)-T(J))**2
      J=J+1
    9 CONTINUE
      SSUM(LL)= SUM/FLOAT(KRD)
      SUM=0.0
      KHOLD(LL)=KSFT
      LL=LL+1
      KSFT=KSFT+1
      IF(KSFT.GT.KL) GOTO 10
      GOTO4
   10 B=SSUM(1)
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      LL=1
      IZ=(2*KL)+1
      DO 11 I=2,IZ
      IF(B.LT.SSUM(I)) GOTO 11
      B=SSUM(I)
      LL=I
   11 CONTINUE
      H(M,14)=KHOLD(LL)
      RETURN
      END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE RITE
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
      L=KBIG
      IF(L.GT.1) GOTO1
C5.2 *IF THIS IS DAY ONE ZERO OUT SOME VARIABLES
      H(L,7)=0.0
      H(L,10)=0.0
      H(L,15)=0.0
      H(L,16)=0.0
C5.4.0*WRITE FILE1 TO OUTPUT DEVICE NO. 7, FILE3 TO 9
    1 DO 2 I=1,L
      WRITE(7,100) (H(I,J),J=1,20)
  100 FORMAT(3F2.0,F6.1,F5.0,2E12.5,4F6.0,
     12E12.5    ,F3.0,
     2E12.5,F3.0,F4.1,
     3F3.1,2F2.0)
      WRITE(9,101) (H(I,J),J=1,3), G(I,4)
  101 FORMAT(3F2.0,E12.5)
    2 CONTINUE
C5.5.0*WRITE FILE2 TO OUTPUT DEVICE NO. 8
      DO 3 I=1,40
      T=FLOAT(I)
      WRITE(8,102) T,(F(I,J),J=2,3)
  102 FORMAT(F2.0,2F8.6)
    3 CONTINUE
      DO 4 I=7,9
    4 ENDFILE I
      RETURN
      END
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      SUBROUTINE REPORT
      COMMON/ /H(40,20),F(40,3),G(40,4),E(14),KBIG,S(40,8)
C    *SET UP THE DAILY MANAGEMENT SUMMARY
      KX = 0
      WRITE(6,100) H(KBIG,2),H(KBIG,3),H(KBIG,20)
      KX = KX + 2
  100 FORMAT(1H1,///14X,32HAAFMS BRISTOL BAY SOCKEYE SALMON/
     114X,22HMANAGEMENT SUMMARY FOR,1X,F2.0,1H/,F2.0,1H/,F2.0)
      WRITE(6,101) H(KBIG,1)
      KX = KX + 2
  101 FORMAT(1H0,13X,17HSAMPLE DAY NUMBER,1X,F2.0)
      J=KBIG
      IF(J.GT.1) GO TO 18
      WRITE(6,134) E(5)
      WRITE(6,135) E(5)
  134 FORMAT(1H0,13X,18HDAILY SAMPLE CATCH,F8.1)
  135 FORMAT(1H ,13X,23HCUMULATIVE SAMPLE CATCH,F8.1)
      WRITE(6,102) H(J,6), E(13)
      KX = KX + 2
      GO TO 19
   18 K=J-1
      X = H(J,4) - H(K,4)
      WRITE(6,134) X
      WRITE(6,135) H(J,4)
      WRITE(6,102) H(J,6),H(K,6)
      KX = KX + 2
  102 FORMAT(1H0,13X,24HESTIMATED TOTAL RUN SIZE,1X,E11.4/
     114X,26HYESTERDAY THE ESTIMATE WAS,1X,E11.4)
   19 CONTINUE
      WRITE(6,103) H(J,13)
      KX = KX + 2
  103 FORMAT(1H0,13X,34HESTIMATED TOTAL NO. PAST P. MOLLER,1X,E11.4)
      WRITE(6,104)H(J, 9)
      KX = KX + 2
  104 FORMAT(1H ,13X,10HAT RATE OF,1X,F6.0,1X,14HFISH/STD CATCH/)
      WRITE(6,136) S(40,7)
  136 FORMAT(1H0,13X,34HMEAN WEIGHT(POUNDS),SAMPLE CATCHES,F4.1)
      KX = KX + 6
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      WRITE(6,105) G(J,4)
      KX = KX + 2
  105 FORMAT(/14X,28HTOTAL INSHORE RETURNS SO FAR,1X,E11.4/)
      IF(H(J,14)) 3,4,5
    3 A=1H-
      GOTO 6
    4 A=1H
      GOTO 6
    5 A=1H+
    6 WRITE(6,106) A,H(J,14)
      KX = KX + 2
  106 FORMAT(/14X,13HRUN TIMING IS,1X,A1,F2.0,1X,16HDAYS WRT AVERAGE)
C    *CHECK FLAG FROM BPROF
      IF(S(40,8).GT.4.) GO TO 11
      GO TO 17
   11 CONTINUE
      WRITE(6,111)
      KX = KX + 4
  111 FORMAT(/14X,29HESTIMATED/OBSERVED CUMULATIVE/
     114X,29HTOTAL INSHORE RETURNS BY DATE)
      WRITE(6,109)
      KX = 30
  109 FORMAT(//14X,4HDATE,6X,8HEXPECTED,6X,8HOBSERVED)
      DO 12 I=1,40
      IF(S(I,1).LT.1.) GO TO 17
      WRITE(6,110) S(I,2),S(I,3),S(I,5),S(I,4)
      KX = KX + 2
      IF(KX.LT.60) GO TO 12
      KX = 3
      WRITE(6,100) H(J,2),H(J,3),H(J,20)
      WRITE(6,109)
  110 FORMAT(/14X,2F2.0,3X,E11.4,3X,E11.4)
   12 CONTINUE
C    *GENERATE RESEARCH SUMMARY
   17 CONTINUE
      KX = 0
      WRITE(6,112)
  112 FORMAT(1H1///14X,33HAAFMS BB SOCKEYE RESEARCH SUMMARY)
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      WRITE(6,113) H(J,2),H(J,3) ,H(J,20)
  113 FORMAT(1H0,13X,13HCALENDAR DATE,1X,F2.0,1H/,F2.0,1H/,F2.0)
      WRITE(6,114) J
  114 FORMAT(1H0,13X,10HSAMPLE DAY,1X,I2)
      LB=  INT(H(J,14))
      KZ=LB+J
      WRITE(6,115) KZ
  115 FORMAT(1H0,13X, 7HRUN DAY,1X,I2)
      WRITE(6,116) H(J,5)
  116 FORMAT(1H0,13X,26HEST. TOTAL P. MOLLER CATCH,1X,F6.0)
      WRITE(6,117) H(J,11)
  117 FORMAT(1H0,13X,25HMEAN PASS.,TOTAL RUN SIZE,1X,F7.0)
      WRITE(6,118) H(J,9)
  118 FORMAT(1H0,13X,25HMEAN PASS.,DAILY RUN SIZE,1X,F7.0)
      WRITE(6,119) H(J,10)
  119 FORMAT(1H0,13X,18HMEAN PASS.,INSHORE,1X,F7.0)
      WRITE(6,120) H(J,12)
  120 FORMAT(1H0,13X,21HRESIDUAL MS, EP MODEL,1X,E11.5)
      WRITE(6,121) H(J,15)
  121 FORMAT(1H0,13X,23HRESIDUAL MS, INSHORE EP,1X,E11.5)
      WRITE(6,122) H(J,14)
  122 FORMAT(1H0,13X,14HEP MODEL SHIFT,1X,F3.0)
      WRITE(6,123) H(J,16)
  123 FORMAT(1H0,13X,16HINSHORE EP SHIFT,1X,F3.0)
      WRITE(6,124) H(J,7)
  124 FORMAT(1H0,13X,20HTOTAL RUN INSHORE MP,1X,E11.5)
C    *DUMP STORAGE FILES
      WRITE(6,125)
  125 FORMAT(1H0,13X,18HDATA TABLES FOLLOW)
      WRITE(6,112)
      WRITE(6,113) H(J,2),H(J,3) ,H(J,20)
      WRITE(6,130)
  130 FORMAT(1H0,13X,13HDUMP FILE ONE/)
      KX = 7
      DO 13 I=1,J
      WRITE(6,126)(H(I,KK),KK=1,20)
      KX = KX + 3
      IF (KX.LT.46)  GO TO 13
```

Table 7. List of AAFMS, subroutines and functions. - Continued.

```
      WRITE(6,112)
      WRITE(6,130)
      KX=5
   13 CONTINUE
  126 FORMAT(1H0,13X,3F3.0,F6.1,F6.0,
     12E12.5,3F7.0/14X,
     2 F7.0,E12.5,
     3E12.5,F4.0,
     4E12.5,
     5F4.0,F5.1,F4.1,2F3.0)
      WRITE(6,112)
      WRITE(6,113) H(J,2),H(J,3) ,H(J,20)
      WRITE(6,131)
  131 FORMAT(1H0,13X,13HDUMP FILE TWO/)
      DO 14 I=1,40
   14 WRITE(6,127) (F(I,KK),KK=1,3)
  127 FORMAT(1H ,13X,F3.0,2F9.6)
      IF(S(40,8).LT.5.) GO TO 27
      WRITE(6,112)
      WRITE(6,113) H(J,2),H(J,3) ,H(J,20)
      WRITE(6,132)
  132 FORMAT(1H0,13X,15HDUMP FILE THREE/)
      DO 15 I=1,J
   15 WRITE(6,128) (G(I,KK),KK=1,4)
  128 FORMAT(1H ,13X,3F3.0,F8.0)
      WRITE(6,112)
      WRITE(6,113) H(J,2),H(J,3) ,H(J,20)
      WRITE(6,133)
  133 FORMAT(1H0,13X,29HDUMP OFFSHORE/INSHORE PROFILE/)
      DO 26 I = 1,40
      IF(S(I,1).LT.1.0) GO TO 27
   26 WRITE(6,129) (S(I,J),J=1,8)
  129 FORMAT(/14X,3(F2.0,2X),2(E11.4,2X),3(F2.0,2X))
   27 CONTINUE
      RETURN
      END
```

Fig. 1. AAFMS

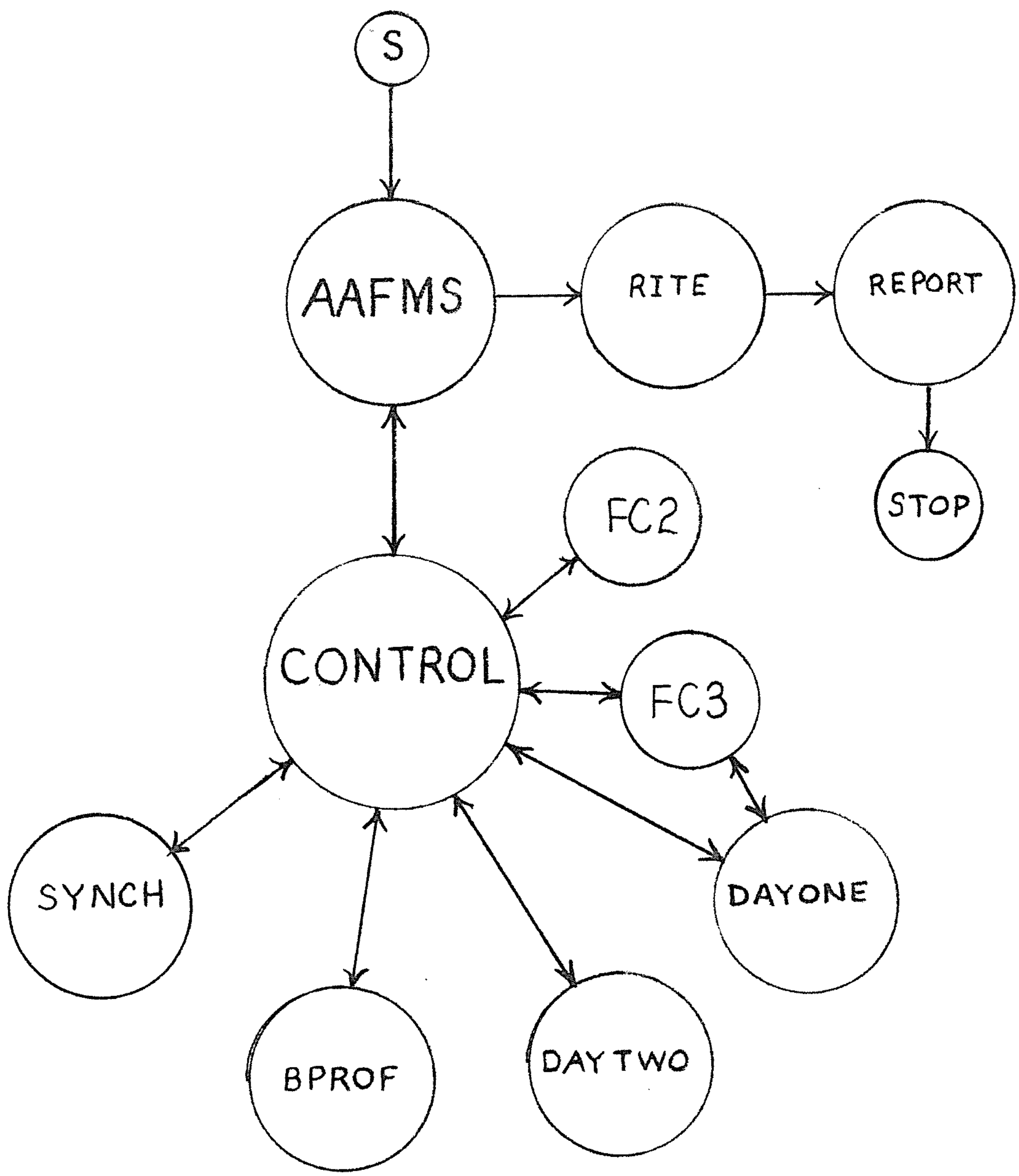

S
AAFMS
RITE
REPORT
STOP
FC2
CONTROL
FC3
SYNCH
DAYONE
BPROF
DAYTWO

Fig. 2. AAFMS

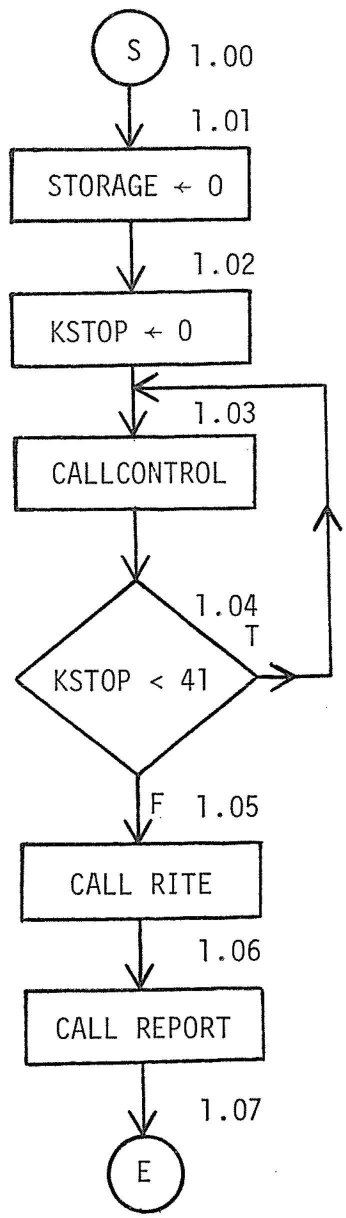

S
1.00
1.01
STORAGE ← 0
1.02
KSTOP ← 0
1.03
CALLCONTROL
1.04
T
KSTOP < 41
F
1.05
CALL RITE
1.06
CALL REPORT
1.07
E

Fig. 3. Subroutine CONTROL

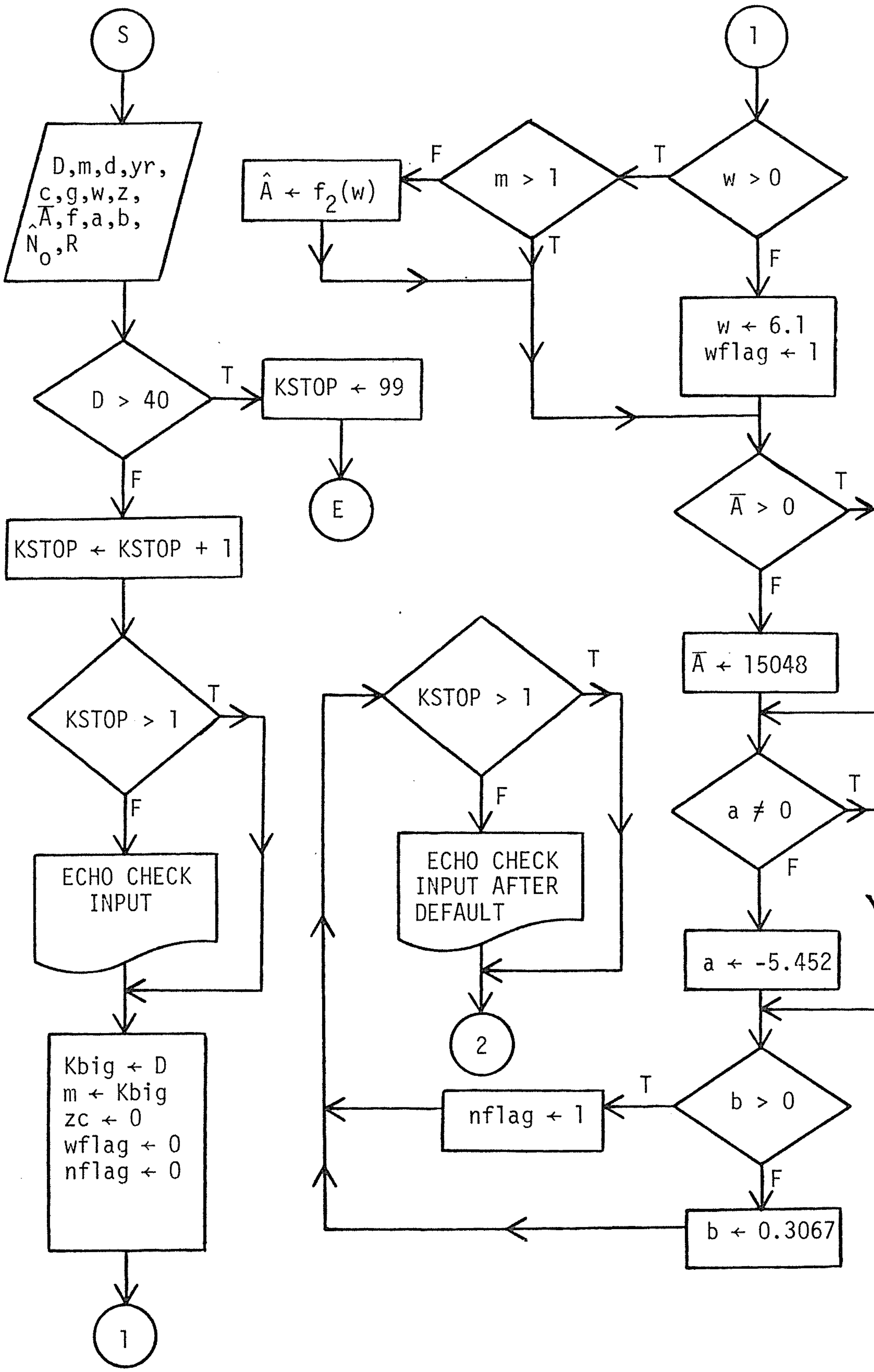


Fig. 3. (continued)

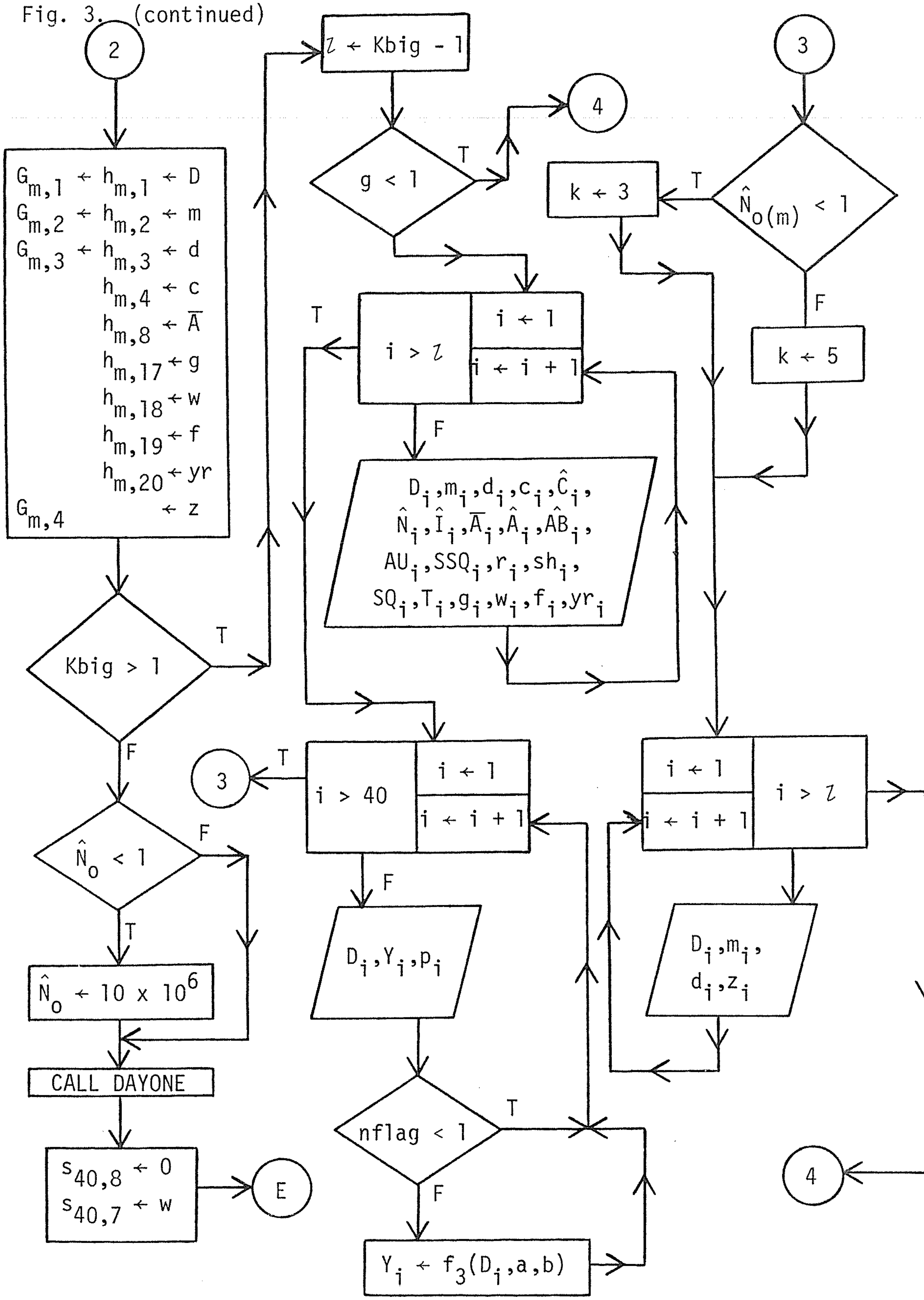


Fig. 3. (continued)

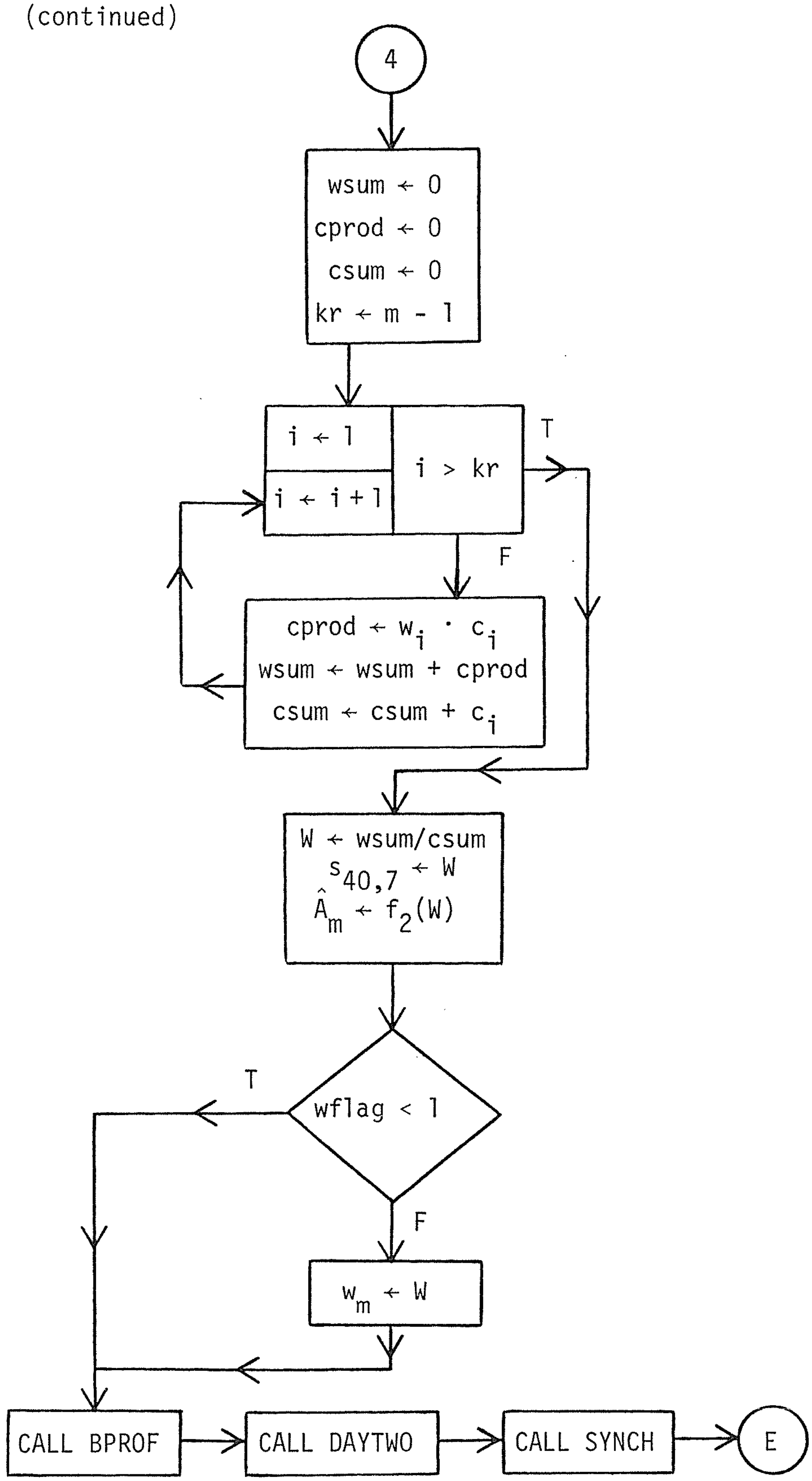


Fig. 4. Subroutine DAYONE

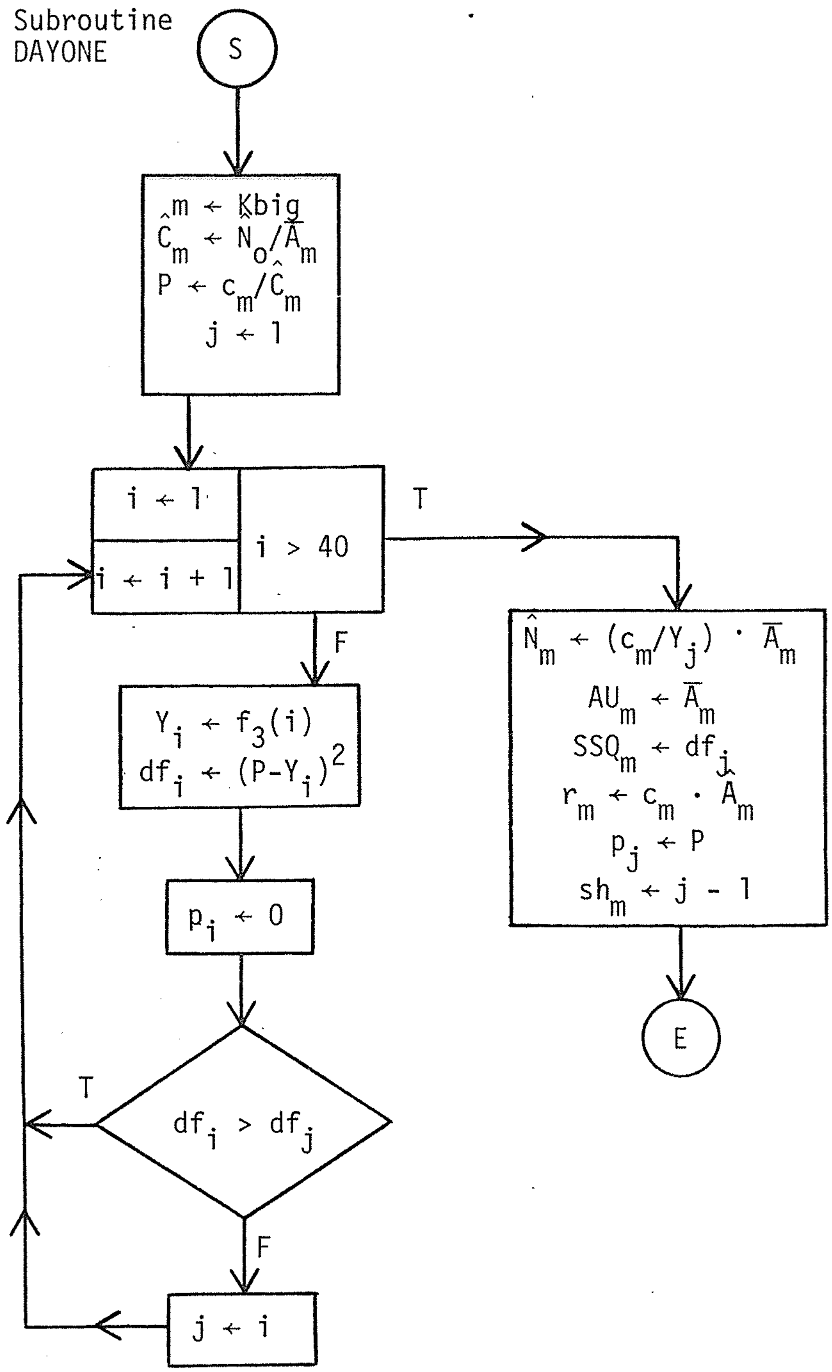
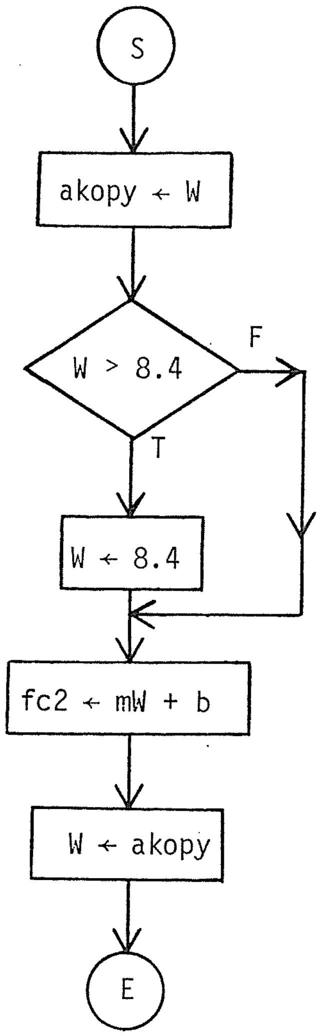


Fig. 5. Functions FC2 and FC3



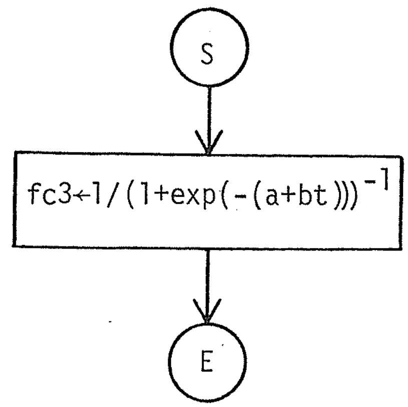


Fig. 6. Subroutine BPROF

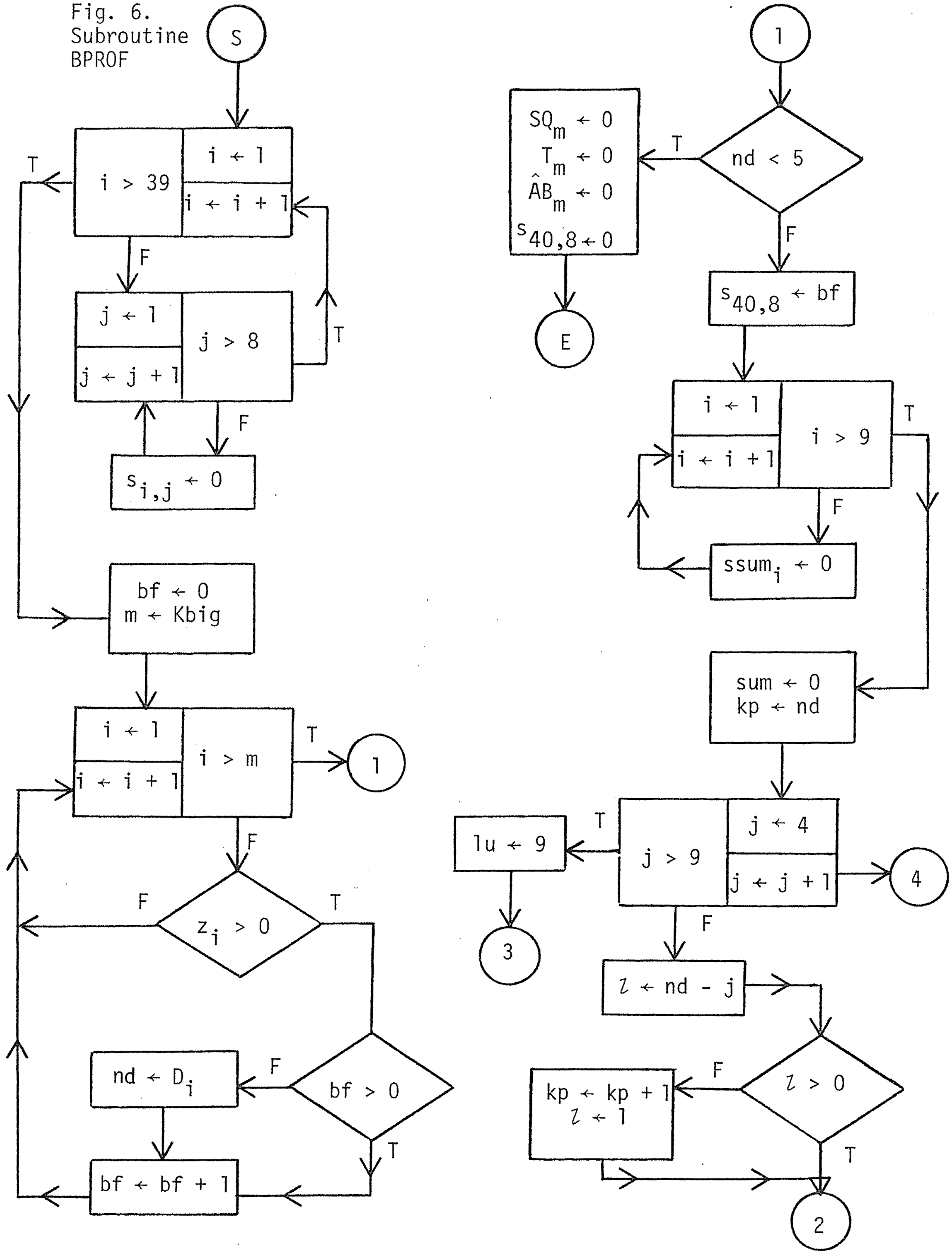


Fig. 6. (continued)

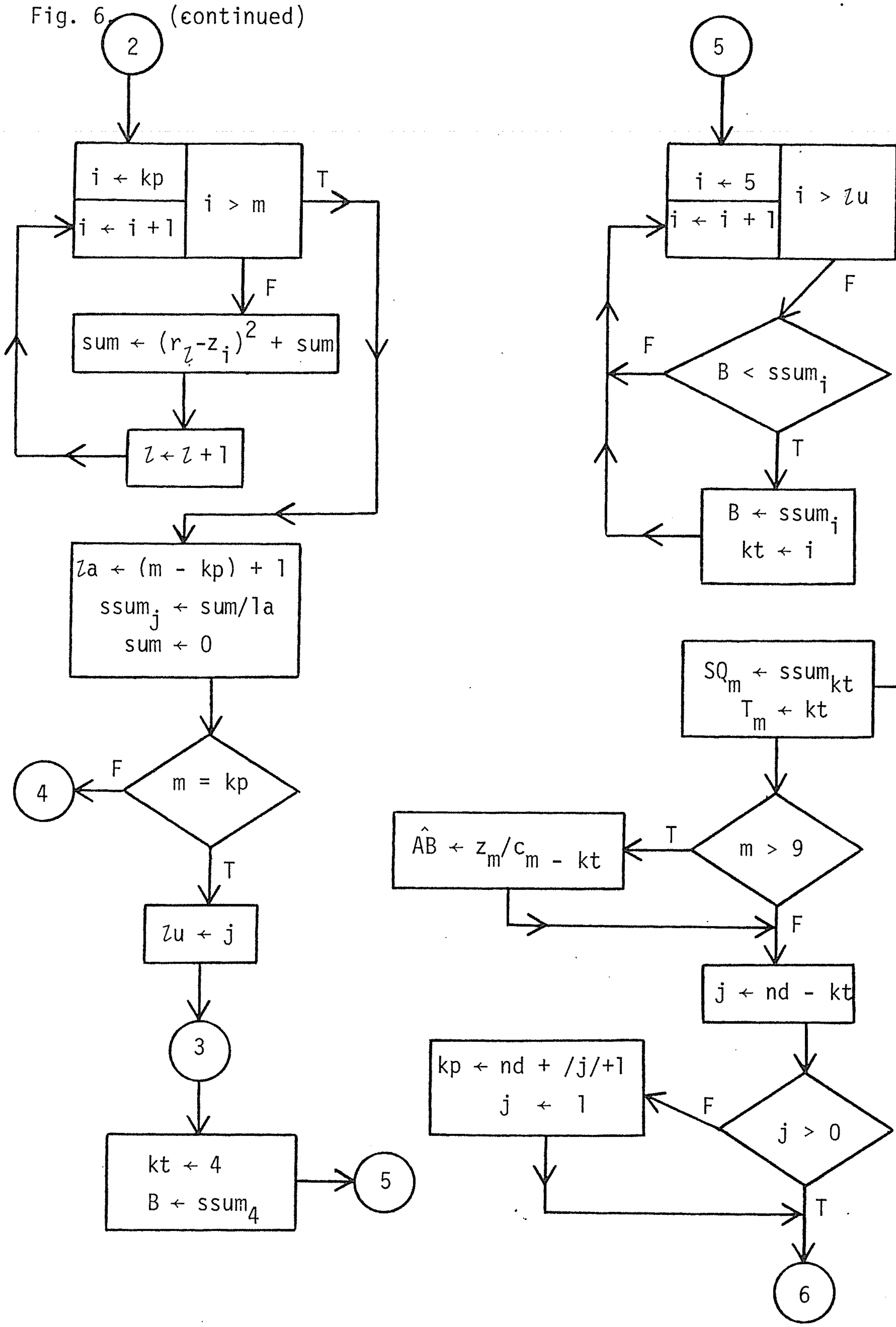


Fig. 6. (continued)

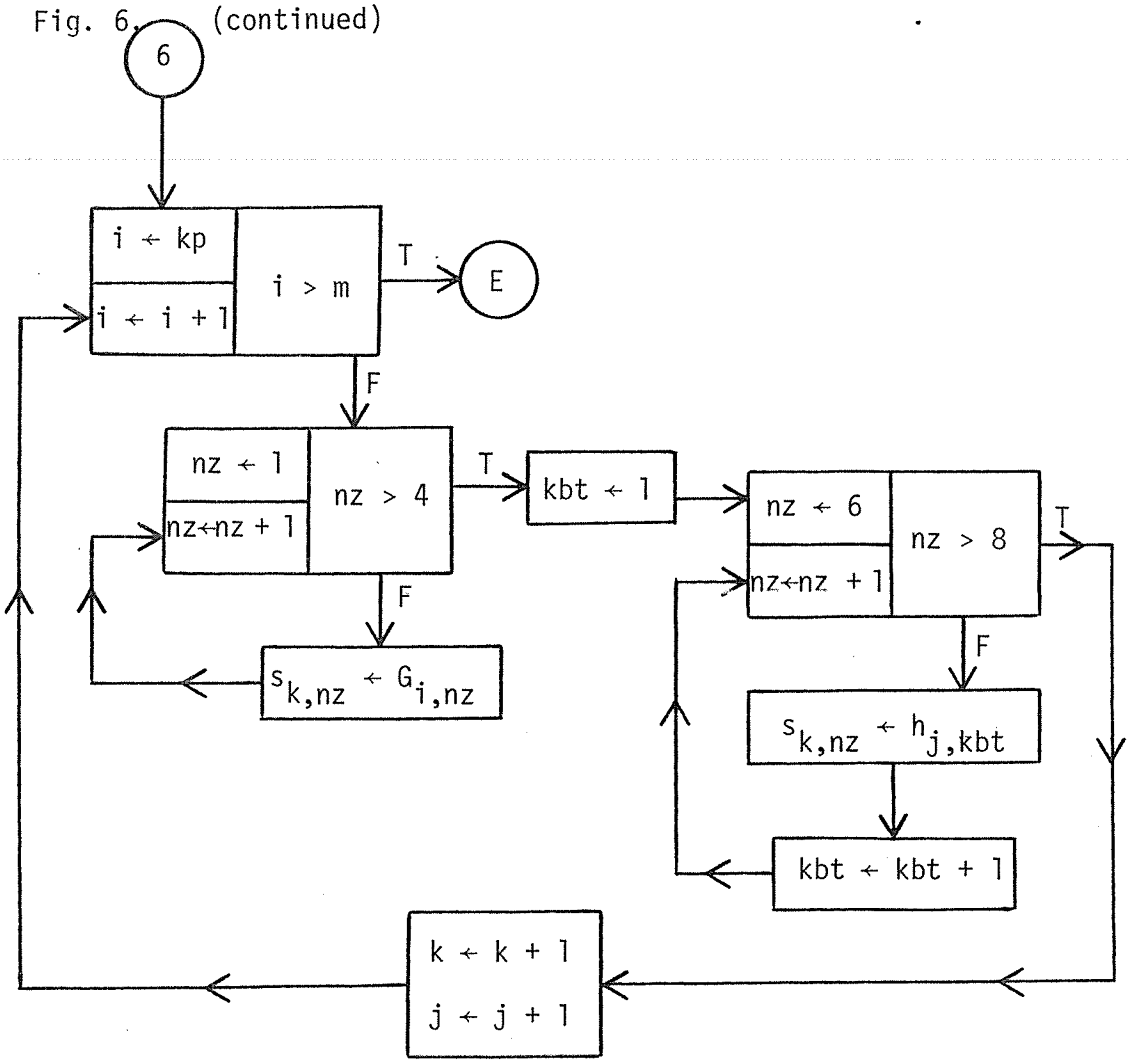


Fig. 7. Subroutine DAYTWO

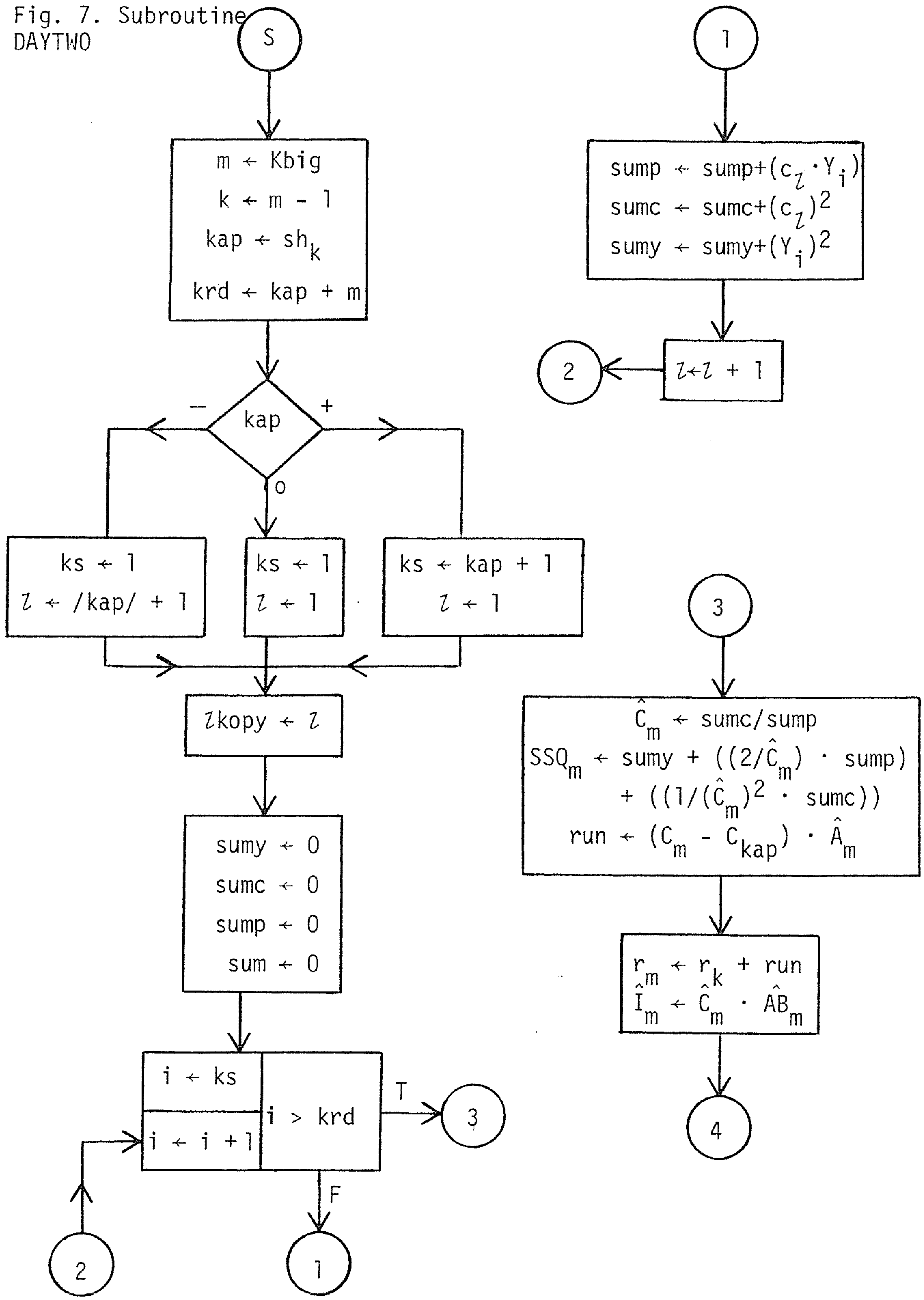


Fig. 7. (continued)

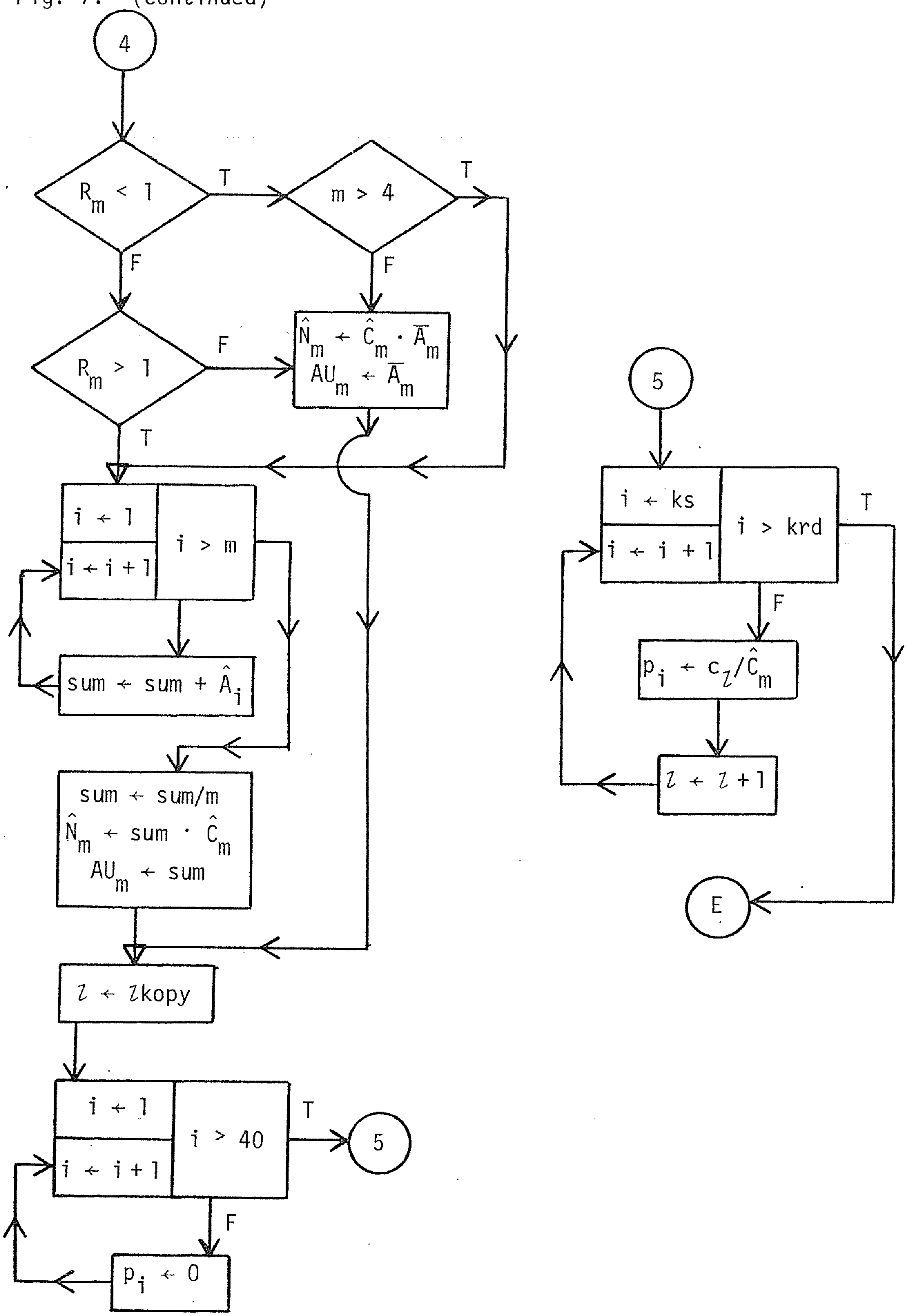


Fig. 8. Subroutine SYNCH

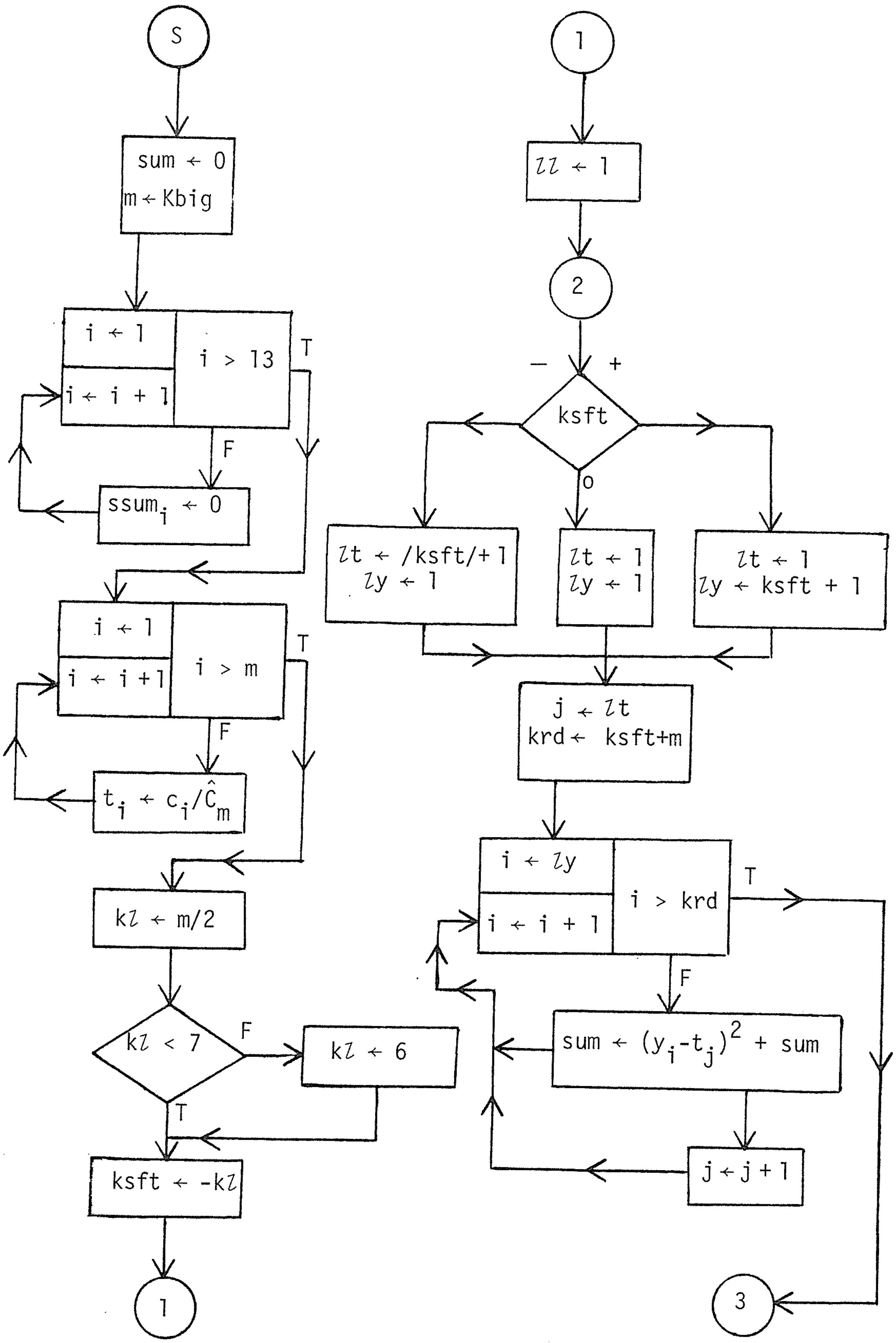


Fig. 8. (continued)

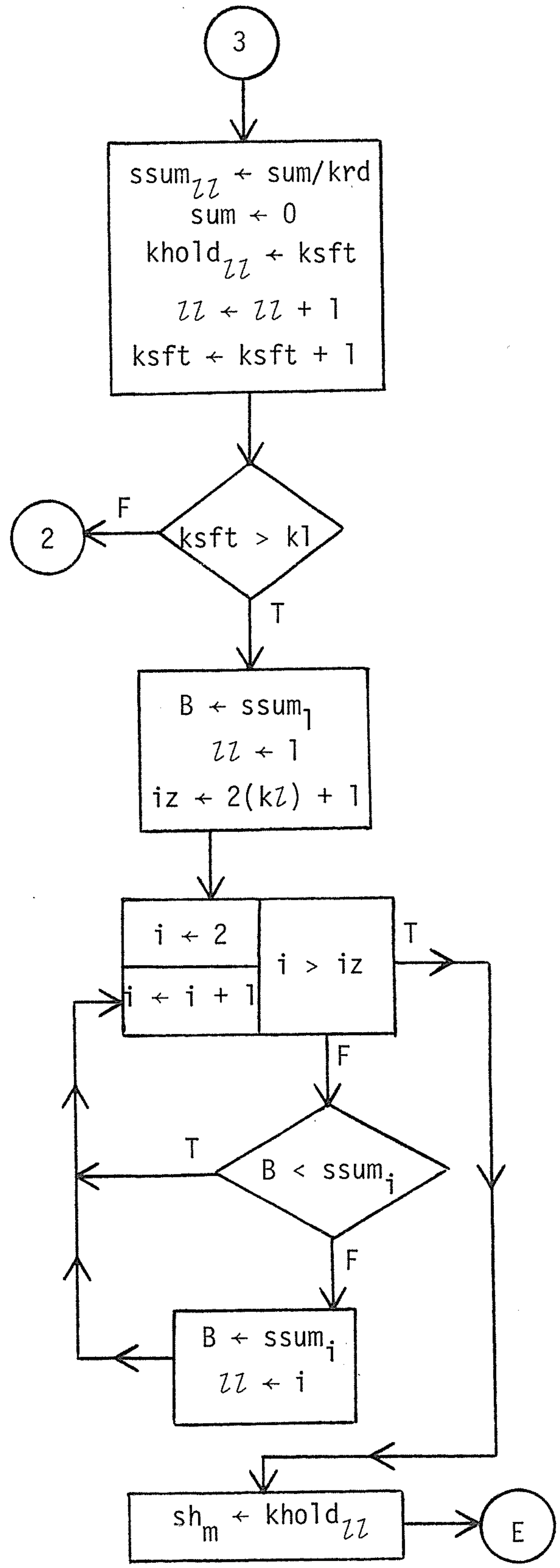
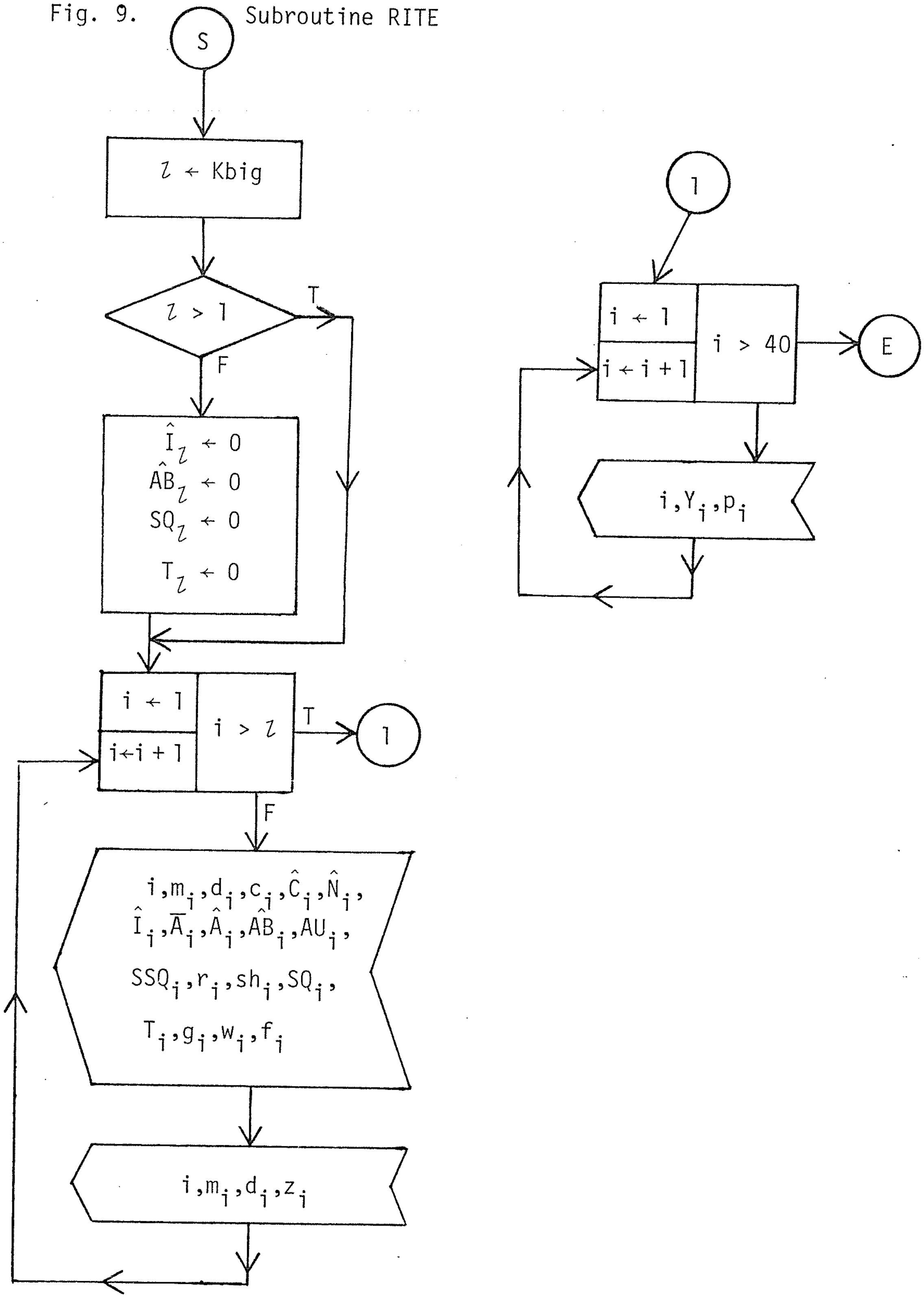


Fig. 9. Subroutine RITE



SECTION II: COOK INLET SOCKEYE ABUNDANCE

Introduction

The latter part of the 1978 field season was devoted to studying those Cook Inlet fisheries management problems which require abundance estimates for solution. The fishing districts of Central Cook Inlet contain two of the three major point sources of Cook Inlet salmon production (Kenai, Kasilof) with the third source being found to the north (Susitna).

Central Cook Inlet may be considered as a compartment in a dilution experiment.[1] The rate of entry can be measured by offshore test fishing while the rate of exit can be determined from catch, escapement and district test fishing. Catch and escapement monitoring and offshore test programs already exist.

The first subsection contains suggested modifications to the offshore test fishing program which reflect experience gained in the Bristol Bay offshore test fishing program. The second subsection, in the form of a budget proposal, suggests a district test fishing program and public participation via a logbook system. Additional funding which is badly needed for fisheries management in Cook Inlet is quantified.

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1 Simon, W. (1972) Mathematical Techniques for Physiology and Medicine. Academic Press.

Cook Inlet, Alaska: Salmon Abundance Estimation from Offshore Test Fishing

Recommendations for Project Design

Phil Mundy, July 11, 1978

Summary of Conclusions

1) Offshore test fishing which precedes the commercial salmon fishery in time and space should be conducted along a transect line which connects Anchor Point to Sea Otter Point.

2) The location of sample stations along the Anchor Point transect should coincide with the best available knowledge of the migratory behavior of the salmon.

3) Fishing gear on the sample vessel should duplicate the fishing gear used in the Port Moller offshore test fishing program.

4) Continuous records of salinity, air and water temperature and wind direction and velocity should be taken by the sample vessel.

5) The primary objective of the Cook Inlet offshore test fishing program should be to estimate sockeye abundance through time for the Central and Northern Districts. Abundance estimates for other species will follow if the program can be successfully implemented for sockeye.

Introduction

The Cook Inlet offshore test fishing program is primarily intended to provide an estimate of total abundance for adult sockeye salmon while secondarily developing the basis of abundance estimation for chum, coho and pink salmon.

Target Populations

The fundamental assumption in test fishing by any means is that the abundance of fish in unit time and space captured by unit effort is proportional to the measure returned by the sampling program from the same time-space interval. For sample day t

$$C_t = fqN_t$$

$$C_t/f = qN_t \qquad (1)$$

where C is catch, f is effort, q is catchability, and N is total population size. Since the population being sampled from a fixed point in space is assumed to be migrating in one direction, the daily estimates of total run size may be summed to provide an estimate of the total fish passing the sample locality.

The preceding development is applicable to Cook Inlet if, and only if, the fish within the sample space belong exclusively or almost exclusively to the target salmon populations of Cook Inlet. If populations from other areas, i.e., Chignik, Kodiak, Prince William Sound, are integrated with Cook Inlet stocks within the sample space, the estimator will fail.

Consider the following example. Let N_1 be the true total number present in the sample space of some species from Cook Inlet, and let N_2 be the true total number of the same species from some other region of origin, also present in the sample space. Substituting N_1+N_2 for N in equation (1) at fixed time,

$$C/f = q(N_1+N_2) \qquad (2)$$

but the required measure is actually

$$C_1/f = qN_1 \qquad (3)$$

so the percent error of (2) relative to (3) is,

$$\frac{q(N_1+N_2) - qN_1}{qN_1} \times 100$$

or

$$\frac{N_2}{N_1} \times 100 \qquad (4)$$

If N_2 is small relative to N_1, then the error will be small. The obvious strategy is to select a sampling locality whereby N_2 is minimized. (Call this requirement constraint C1).

Location of Sampling

In addition to the constraint imposed by mixing of target populations with extraneous populations, C1, it is desirable to maximize the time between estimation of daily abundance and the entrance of the fish into the commercial fishery, C2. Given the physiography of Cook Inlet, there are two logical localities for offshore test fishing, each of which would precede the major commercial fisheries; Cape Douglas and Anchor Point.

While Cape Douglas satisfies C2 quite well, C1 would not be well met. The Anchor Point locale would satisfy C1 but not C2 since Anchor Point is at the southern boundary of the Central District of Cook Inlet.

The necessary compromise is quite clear; without an adequate estimate of abundance, lead time prior to the commencement of fishing is meaningless. The intrusion of extraneous stocks at Cape Douglas is virtually a certainty given the historical tagging reports assembled by Tom Namtvedt(ADF&G, Soldatna) and the initial results of scale pattern recognition studies conducted by

Paul Krasnowski (ADF&G, Anchorage). Intrusion of extraneous stocks at Anchor Point is also certain; however, the tagging studies indicate that presence of outside sockeye stocks in the Anchor Point area is limited to the month of June with Anchor Point being virtually free of outside sockeye stocks during July. Since the majority of the Cook Inlet sockeye run and harvest occurs in the Central District during July, intrusion of extraneous sockeye at Anchor Point is expected to be a minor contribution to the error of abundance estimation. Estimates made from the offshore program prior to July 1, as an arbirary rule, should be viewed with extreme caution, if indeed they are viewed at all.

Distribution of Sampling Effort in Time and Space

It is assumed from prior experience (Tom Namtvedt, pers. comm.) that the majority of the target populations are to be found at the center of the transect (Anchor Point to Sea Otter Point) at the middle of the flood tide. This assumption is derived from the distribution of commercial fishing effort in the past. Further consideration of models of migratory behavior is given below.

Since tidal influence is strong in the sampling area, it is necessary to sample each station at the same tidal stage from day to day. If only one vessel is employed in the program, it will not be possible to sample all stations at the same tidal stage within one day. As many stations as possible should be sampled within one day with the centrally located station being sampled at the center of the flood tide.

Further results from sampling will have to be evaluated before an optimum design for sampling localities along the transects can be specified.

For example, the localities may be selected to coincide with tidal rips or other hydrographical features of the waters surrounding the transect such as salinity or temperature gradients. Physical factors such as the velocity or direction of the wind may also influence the migration of salmon.

All of the preceding is meant to emphasize the fact that comprehensive models of the migratory behavior of salmon are lacking for Cook Inlet. The known fragments of such a model will have to suffice at present, but it is clear that the sampling design for offshore test fishing ultimately depends entirely on the distribution of the fish within the sample space.

The results from each year of sampling should be tested for differences in abundance between stations through time under the assumption of a random spatial distribution of abundance. Should the random assumption be violated, alternative models of the spatial distribution of abundance should be advanced and tested.

Sample Gear

The practical experience and data of an analogous offshore test fishing program off Port Moller has been studied to determine the catchability in gillnet gear for sockeye salmon of various sizes. Gear specifications are available from Bristol Bay Research, Comm. Fish., Anchorage. Since the catchability information from Port Moller has been purchased at a considerable price, there is no reason to start again from ground zero in Cook Inlet.

Inferences regarding the catch of the commercial gillnet drift fleet at any particular net mesh size are not to be made directly from offshore data. The central objective of offshore test fishing is to estimate abundance through time. Projected commercial catches can be made by applying an exploitation rate to estimated abundance. Given the preceding, there is no need to tie the sample gear mesh size to the legal commercial mesh size.

Physical and chemical parameters measured should include salinity, air and water temperature, wind direction and velocity. The use of continuously recording instruments would provide two advantages over manually operated instruments; reduced work load for crew and observations between fishing stations.

These data are essential because it is not known whether salmon may be oriented in migration toward thermal or saline gradients. Wind velocity has considerable known effect on gear efficiency and wind velocity and direction may exert direct physical influence on salmon migration as well as indirect influence through mixing of surface waters.

1. Project Title: COOK INLET STOCK ABUNDANCE ASSESSMENT PROGRAM

2. Project Objectives:

A. Long range -

Implement a fisheries management program capable of apportioning Cook Inlet sockeye salmon runs between catch and escapement to a maximum error of twenty percent relative to specified escapement goals for each identifiable stock.

B. Short range -

1. Provide an accurate and timely estimate of total abundance of adult sockeye salmon entering and leaving the Central District of Cook Inlet.

2. Provide an accurate and timely estimate of the distribution of abundance of sockeye within the Central District of Cook Inlet throughout the season.

3. Provide an accurate and timely estimate of total abundance for adult sockeye originating in the Kasilof, Kenai and Susitna Rivers.

4. Increase public understanding of the fisheries management process through direct involvement of the public in basic data collection.

3. Project Duration: Continuously applied.

4. Project Location: Soldotna-Anchorage.

5. Funding Source: General Fund.

6. Personnel:

7. Project Narrative:

A. Justification. Modern fisheries management is focused on the attainment of three objectives. By rank of priority the objectives are conservation, orderly fishing, and product quality. In order to secure the objectives exactly, the fisheries manager must know the abundance and distribution through time and space of each identifiable stock under his jurisdiction prior to the date of harvest. Cook Inlet fisheries managers presently lack the human and material resources necessary to adequately answer the questions of abundance and distribution in advance of fishing.

The advent of hatchery production in Cook Inlet has introduced a new level of complexity to harvest management. Each new facility represents a point source of production which must be protected and harvested no less wisely than a natural point source of production. The management precision necessary to the full utilization and protection of hatchery production in Cook Inlet does not presently exist.

Public misunderstanding of the objectives and dividends of fisheries management in Cook Inlet presently constitutes a serious impediment to efficient resource utilization. The man-hours now consumed in explaining and defending routine fisheries management actions are badly needed in the prosecution of the management program. Increased involvement of the public in data collection will produce useful and essential information, e.g. Kodiak crab logbook program, while serving to increase the level of public responsibility for the welfare of the fisheries resources.

The monies returned to the General Fund by fish sale as a result of the research activities will fully defray the cost of the program.

B. Procedures. Fishing vessels from Cook Inlet and adjacent areas will be chartered to conduct sampling for abundance estimation. The mechanical and statistical techniques to be applied are extensions of proven methods used in the Bristol Bay Fisheries Management Program and elsewhere. The performance of estimators of abundance will be evaluated with respect to catch and escapement data collected by existing programs.

The statewide stock separation program presently in operation will provide the expertise for stock identification. Additional material and human resources will increase the speed and volume of data processing for direct application of proven stock identification techniques to fisheries management problems during the fishing seasons.

Participants in the logbook program will be solicited from local fishermen's associations and directly through local communications media. Applicants will be selected according to performance criteria. Information will be collected directly from participants with intensive follow-up and uncooperative participants will be promptly eliminated. Reimbursement of expenses to participants is essential to the success of the program.

Fiscal Year 1980

Project: COOK INLET STOCK ABUNDANCE ASSESSMENT PROGRAM.

I. Test Fishing:

A. Lower Cook Inlet: relocation of existing program from Cape Douglas to Point Adam to a line between Anchor Point and Spring Point.

Period of operation - anticipated a single vessel charter of approximately 30 days (June 15-July 15).

Line 100	$ 6.0		
" 200	.5		
" 300	36.0		
" 400	1.0		
" 500	.5		
	$44.0	Sub Total:	$44.0

Comments: 1) Towed or scanning sonar in lieu of gillnetting? 2) Does not include any cost factors for tagging to test milling and migration patterns and rate. Purse seining might be used in conjunction with the gillnet vessel - the gillnet vessel could operate as a "scout" for the seiner to locate fish. The addition of a tagging component would at least double the cost of the existing program.

B. District Test Fishing: Ten gillnet vessels operating in 10 horizontal grids (east to west).

Test fish receipts estimated on the basis of 300 fish/day X 20 days @ $10/fish = $600,000. Fishermen would be reimbursed at the rate of 15 percent of fish ticket receipts, or approximately $90,000. Therefore, the General Fund would net about $510,000 from the program.

Line 100:	10 MM F.B.I (observers)	$20,000
Line 200:		2,000
Line 300:		
	Air Charter - (directing vessels and fish spotting)	
	4 hrs/day X 20 days @ $125 =	$10,000
	Vessel Charter - 10 boats X 20 days	
	@ $500 =	$100,000
Line 400:	Groceries, misc. supplies	$4,000
Line 500:	Computer terminal	$2,000

Sub Total: $138,000

C. Upper Central District Test Fishing:

Continuous transect fishing that parallels the lower district entry transect.

Period of operation - July 1-August 1

Line 100:	Tech. or F.B.I temp-time	$ 4.0
" 200:		.2
" 300:	Vessel charter, 30 days @ $1,200	36.0
" 400:	Groceries, etc.	1.0

Sub Total: $41.2*

*Test fish receipts anticipated at $45.0 minimum.

II. Logbook Program:

One hundred fishermen reporting for 20 days of fishing @ $5/sheet. Catch X species X period X area.

Line 100:	2 temps. 1 MM each	$ 4.0
Line 300:	logbook payment	10.0
	data entry	1.0
	computer time	.2
	printing and postage	1.3
		$15.5

Sub Total: $15.5

III. Stock Separation:

Envisions 500 samples/day with operational base in Anchorage - relay of samples via A.A.I. (airlines and special pickup at both ends). This project would also enhance the establishment of a regional Stock I.D. lab. and core staff.

Line 100: 9 scale readers,	18 MM F.T. II		
2 "known" samplers	2 MM		
	20 MM	$22.4	
	O.T.	12.4	
		$34.8	
F.B.I level basis (temp.)			
1 - Data Processor	3 MM		
1 - Crew Leader	2 MM		
1 - Staff Coordinator	2 MM		
1 - Clerical (perm.)	12 MM		
F.B.I equivalent:	19 MM	$77.9	
Line 100 sub total:			$112.7
Line 200:			$ 3.0
Line 300: Office rent, 2 mos.		$ 3.0	
Air charter		5.0	
Telephone, Xerox etc.		1.0	
Computer time		1.0	
6 ea. Scale tables @ 3.0		18.0	
Line 300 sub total:			$ 28.0

Line 400:	Misc.	$ 1.0
Line 500:		
	1) 5 ea. Micro Fishe readers @ 3.0	15.0
	2) Date storage ASR 33	1.5
	3) 1 Computer terminal	2.0
	4) 2 ea. Digitizers	25.0
	5) 2 ea. Boston whalers	14.0
	6) 4 ea. 40-hp outboards	5.0
	7) 1 ea. scale press	2.5
	8) office furniture	2.0
	9) Miscellaneous	5.0
	Sub total:	$216.7
	GRAND TOTAL	$455.5

I.	Test Fish	$223.2
II.	Log Book	15.5
III.	Stock I.D.	216.7
	G.T. =	$455.4

F.B.III - Project Leader: Cook Inlet and Bristol Bay Stock I.D. coordinator and Cook Inlet test fishing - 43.0

OR - Contract Phil Mundy for 9 months - ~60.0