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# Computer Programmes Available at St. Andrews Biological Station

by K. Radway Allen

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TECHNICAL REPORT NO. 20

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# COMPUTER PROGRAMMES AVAILABLE AT ST. ANDREWS BIOLOGICAL STATION

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## INTRODUCTION

The programmes described in this report have been written in Fortran II and are at present (June 1967) in operating condition on the IBM 1620 Computer at the University of New Brunswick, Fredericton. This computer has core storage of 60K positions of which 48.5K are available for programmes. All the programmes described have therefore been written with this limitation. In only a few cases, however, is the limit of storage approached. Most of the programmes only utilize a small fraction of it.

The 1620 is a variable word length computer, the standard condition being for floating point, a mantissa length of 8 digits, and for fixed point 4 digits. Except where otherwise noted, the programmes described operate with these word lengths.

Several of the programmes are designed for use in an open-house system where console operation is available either to select options or to enter data through the typewriter.

The programmes fall into four categories:

1. Growth analysis programmes
2. Tabulations of salmon data
3. Miscellaneous
4. Output subroutines

# 1. GROWTH ANALYSIS PROGRAMMES

## 1.1 FITTING VON BERTALANFFY GROWTH CURVE (VONB)

### 1.1.1 Function and Method of Operation

The programme fits data to a von Bertalanffy curve of the form

$$L = L_\infty \left(1-e^{k(t-t_o)}\right)$$

using the method of Allen (1966)*. The procedure is an iterative one, k being the first term estimated, and iterations continue until the correction term falls below a pre-determined value fed in with the data, or until 5 iterations have been made. Execution stops if the estimates fail to converge.

The programme primarily handles length data and fits them directly to the von Bertalanffy equation. It will, however, also handle weight data by converting the weights to a multiple of the length by transforming them to the 1/nth power on the assumption that the weight-length relationship is

$$W = aL^n$$

The transformed data are then processed by the main programme and a final estimate of $W_\infty$ obtained by re-transformation from $L_\infty$.

### 1.1.2 Options

Three options are provided:

Option 1: Estimates the 3 parameters k, $L_\infty$ and $t_o$, and determines their standard errors and ranges.

Option 2: Uses a value of $t_o$ supplied with the data, and estimates k and $L_\infty$ . It does not estimate errors. Since this programme sometimes fails if the supplied $t_o$ diverges too far from the true value, it first obtains an estimate of $t_o$ as an unknown, using the procedure of Option 1. If the supplied $t_o$ lies outside the probable limits thus determined, a warning is printed before attempting to obtain k for the supplied $t_o$. In this second stage, two options are also available; to use a

*Allen, K.R. 1966. A method of fitting growth curves of the von Bertalanffy type to observed data. J. Fish. Res. Bd. Canada, 23(2): 163-179.

new starting value of k (= FK2), or to use as a start the value of k obtained in the Option 1 run. The second procedure is automatically followed if FK2 is left blank on the control card specified below.

Option 3: This deals with situations in which the data consist of a large number of widely-scattered points and a direct fit is difficult to obtain. In this option, the data are first reduced to a single series of points, one for the mean length at each integer of age, weighted according to the number of observations at that age; a fit is then obtained to these points starting with the supplied approximation to k. When this has been done, a fit is made to the original data, using the estimate obtained from the mean points as a starting value.

### 1.1.3 Data Input

The data deck is made up as follows:

(a) A title card which is printed as punched.

(b) A control card specifying the options to be used, and feeding in required constants; these are:

- FK - the initial approximation to k
- TK - the value of the correction to k at which iteration stops
- T - Student's t, used in computing probable ranges
- NØPT - for selection of Options 1, 2 or 3
- TZ - selected value of $t_o$ when Option 2 is being used
- FK2 - the approximation to k to be used with the selected $t_o$ in Option 2; in this option FK is the initial value of k used in determining the probable limits for $t_o$. Leave FK2 blank if the fit for selected $t_o$ is to start with the value of k obtained from the trial fit with unknown $t_o$.
- WEX - weight-length exponent, leave blank when length data are being used
- KR - read-in format selection

The format of the control card is 3F10.8, I10, 3F10.8, I5.

(c) A series of cards containing the observations; one for each combination of age and length (or weight), specifying these parameters and the number in the group. If there is only one observation in the group, the number entry may be left blank. The series must end with a blank card.

As many sets of data as desired may be processed in a single run, each set having its own title, format and control cards.

Success of the programme may depend on the choice of the initial trial value of k, although there is a wide margin of tolerance particularly if the data give a reasonably good fit to a curve. For example, in one test series, in which the value of k was .50, successful fits were obtained with trial values ranging from .10 to .80. A minimum correction (TK) of .0002 is generally satisfactory, but rather higher values are sometimes needed to complete execution with badly-fitting data.

The read-in format for the data is defined in a separate subroutine REDE which can easily be added to accommodate as many formats as desired. The format to be used in any particular run is then defined for each set of data by the variable KR on the control card.

To add an additional format to the REDE subroutine, proceed as follows:

(a) Add the next serial integer inside the parenthesis on the first card of the subroutine programme so that if the original card was

```
GØ TØ (1,2,...n-1), KR
```

it becomes

```
GØ TØ (1,2,...n-1, n), KR
```

(b) Add immediately prior to the END card of the subroutine the following set of three cards:

```
n READ 2n, AK, AGK, ALK
2n FØRMAT (the desired format in standard form)
RETURN
```

(N.B. (a) 2n as used above = 20 + n

(b) On the first card of this set the variables AK (number of observations) AGK (age) and ALK (length) must be written in the appropriate order for the given data cards, and not necessarily as above.)

### 1.1.4 Output

(a) The data are listed as fed in

(b) The options to be used, and the values of the constants are printed out.

(c) For each iteration the values of the intermediate quantities, the correction term, and the adjusted value of k are printed.

(d) When the desired level of precision has been reached: for Option 1, the values of k, $t_0$ and $L_\infty$ are printed together with their standard errors, ranges and upper and lower limits, the sum of the squares of deviations from the fitted curve is also printed. For Option 2, the final values of k and $L_\infty$ are printed.

(e) When weight data are being processed the estimates obtained from the transformed data are printed as lengths, and then transformed back to weights and printed as the best estimate, and upper and lower limits, of $W_\infty$.

A sample output is given in Appendix 1.

### 1.1.5 Subroutines Required

The only subroutine required in addition to those called automatically by the system is REDE which defines the data input format. Placing this in a separate subroutine avoids the need to modify the main programme to take in data in a new format. This makes it possible to use an object deck for the main programme and save compile time.

### 1.1.6 Restrictions

The maximum number of cards, each containing a single group of fish all of the same age and length (or weight), which can be processed is 350. If more cards are submitted the programme lists the entire batch, labels the first 350 and performs the computation on these only.

### 1.1.7 Storage Required

This programme, including the necessary subroutines, uses 46.8K positions of core storage.

## 1.2 FITTING THE VON BERTALANFFY EQUATION (FABENS' METHOD) (FABVB)

### 1.2.1 Function and Method

This programme is developed from one described by Fabens (1965)*. This method is primarily applicable to data from marked fish or other animals, since the information it uses is the lengths of the animal on two occasions and the time interval between them. The method is an iterative one which produces increasingly better estimates of k and $L_{\infty}$ until a predetermined level of accuracy is reached. $t_0$ cannot be estimated directly from the data used in this part of the computation because they do not include any absolute ages. Therefore, the programme, having determined k and $L_{\infty}$, reads in a second set of cards (Part B) which contain observations on length and absolute age and uses these to estimate $t_0$.

The modified version differs from that originally described by Fabens in the following respects:

(a) It will process an indefinite number of sets of data in one operation.

(b) The minimal value of the correction to either k or $L_{\infty}$ at which iteration stops has been increased from $2x10^{-6}$ to $2x10^{-5}$ to meet the requirements of the 1620 computer.

(c) Iteration can be stopped at any time by turning Sense Switch 4 on. The programme then proceeds to Part B.

(d) An option is provided in which it will use one set of data in which the absolute age of the animals at the time of tagging is known for both parts of the computations. It assumes that the interval between time of tagging and recapture is one unit of time.

(e) Having estimated the three parameters, k, $L_{\infty}$ and $t_0$, it computes and prints out the sum of the squares of the deviations from regression of the observations in the Part B data.

### 1.2.2 Options Available

Two pairs of options are available:

(a) That described in 1.2.1 (d); with Sense Switch 3 off, this reads in separately the Part A data for growth

*Fabens, A.J. 1965. Properties and fitting of the von Bertalanffy growth curve. Growth, 29: 265-289.

in known time intervals, and the Part B data of sizes at known ages. With Sense Switch 3 on, one series of data containing age at the time of tagging is read in.

(b) Either linear or weight data may be processed. Weight data is converted to equivalent lengths on the assumption that weight is proportional to the cube of the length. Expected weights are then calculated from the expected lengths fitted to this curve. The choice between these two options is determined by a parameter on a control card.

### 1.2.3 Data Input

The data deck is made up as follows:

(a) A control card. If the data are lengths, this has a 1 in column 1; if the data are weights, there is a 2 in column 1. The card is otherwise blank.

(b) The Part A data cards. For the original version, these contain a control character and the initial size, final size and time interval in that order. The format is (I1,3F10.0). The control character in the first column must be the same as that on the control card. This section of the data ends with a card with 3 in column 1 and otherwise blank.

For the option in which absolute age is read in initially, the data cards contain the initial age, initial size and final size in that order, the format being (5X,F2.0,F5.1,18X,F5.1). This part of the deck is terminated with a card with 3 in column 5.

(c) Part B data cards for original version only. These have a 4 or 5 in column 1 for linear size or weight respectively, followed by size and age in that order. The format is (I1,2F10.0). This section ends with a card with 6 in column 1.

For the other option there are, of course, no cards in this section.

If other sets of data are to be processed, they follow the preceding sets immediately without further control cards. After the last set of data a blank card is inserted.

If a card with an incorrect control index is encountered at any time, execution stops and a message is printed "Data error in card X" where X is the number of the card in the data set being processed.

1.2.4 Output

The printed output includes:

(a) A statement whether the data is linear or weight.

(b) The results of Part A. These include the estimates of k and A (equals $L_\infty$) for each iteration and the final values; statements of the relation between "chrons" and the standard units of time. The chron is a physiological unit of time proposed by Fabens, being equal to the time required for an animal to make half the remaining growth towards its final size; it equals $\frac{.69}{k}$. This part of the output also includes the number of observations.

(c) The Part B results. If the second option is being used, the fact that the same data are used for both parts is stated. Values are given for B (= $e^{kt_o}$), $t_o$, and the sums of squares of deviations from regression.

(d) Part C tabulates the expected size against a range of values of t, and restates $t_o$ in chrons as "extrapolated zero."

A sample output is given in Appendix 2.

1.2.5 Subroutines Required

No subroutines other than those called by the system are required.

1.2.6 Restrictions

Not more than 400 cards can be read into either part of the programme.

1.2.7 Storage Required

The number of positions of core storage utilized by the programme, including subroutines, is 28.6K.

## 1.3 TABULATION OF VON BERTALANFFY GROWTH CURVE (VBTAB)

### 1.3.1 Function and Method

This simple programme tabulates the points on a von Bertalanffy growth curve for any given parameters. The number of points desired is specified and the first half are calculated for intervals of .5 units of time and the second half for intervals of 1 unit of time.

### 1.3.2 Options

No options are provided.

### 1.3.3 Data Input

As many curves as desired can be computed in one operation, the parameters for each being specified by a single control card. The control cards list $L_{\infty}$, k, $t_o$ and the number of points required in that order, the format being (3F10.4,I10). Operation is terminated with a blank card.

### 1.3.4 Output

The output lists, for each curve, the values of the parameters and the number of points, and then tabulates computed length against age. A sample output is given in Appendix 3.

### 1.3.5 Subroutines Required

No subroutines other than those called by the system are required.

### 1.3.6 Restrictions

No restrictions other than those implicit in the format and the system are imposed.

### 1.3.7 Storage Required

The programme requires 2420 positions of core storage.

## 1.4 GOMPERTZ GROWTH CURVE - TABULATION AND ERROR ESTIMATION (GOMP)

### 1.4.1 Function and Method

This programme tabulates the computed lengths for a series of ages for the Gompertz growth curve,

$$L = L_{\infty} e^{-e^{-k(t-t_o)}}$$

using supplied values of the parameters. It then reads a set of data cards, each containing a single age and length, and estimates the sum of the squares of the deviations from the expected values, and the root mean square.

### 1.4.2 Options

No options are available for this programme.

### 1.4.3 Data Input

This consists of

(a) A control card containing values of k, $t_o$ and $L_{\infty}$ in that order, with the format (3F10.4).

(b) Data cards each containing an age and a length in that order, with the format (5X,I2,23X,F5.1).

(c) A blank card.

Only one data set may be processed at a time.

### 1.4.4 Output

The printed output gives the supplied values of the parameters, the expected length at each age, the sum of squares and root mean square of the deviations. A sample is given in Appendix 4.

### 1.4.5 Subroutines Required

No additional subroutines are required.

1.4.6 Restrictions

There is no restriction on the number of data points which can be tested against a given curve.

1.4.7 Storage Required

4K positions of core storage are required by this programme.

## 1.5 FITTING OF THE GENERALISED VON BERTALANFFY EQUATION (GENVB)

### 1.5.1 Function and Method

This programme fits to observed data on length and age the generalised von Bertalanffy growth equation with an additional exponent,

$$L = L_\infty \left(1-e^{-k(t-t_o)}\right)^n$$

This is done by a combination of least square and trial and error methods. The programme takes a supplied value of n and fits a regression line to a Walford plot of $\frac{1}{L^n}$ and so estimates k and $L_\infty$ for that value of n.

It then estimates $t_o$ as the mean of a series of values worked out for each data point in the central part of the length range using the computed values of k and $L_\infty$. The central part of the length range is defined for this purpose as the range of lengths between half the length at the point of inflection, and the mean of the length at point of inflection and $L_\infty$.

Having estimated all parameters, the programme then computes a measure of the goodness of fit for the supplied value of n as the sum of the squares of the deviations of the observed from the expected lengths.

To determine the optimum value of n, two trial and error procedures are used. Initially, a set of values of $\frac{1}{n}$ is read in by defining on a data card the initial value, the interval between successive values, and the number of trials to be made. If a wide range of values is used in this initial run, the approximate value for minimal sum of squares can be easily estimated by inspection. The computer then goes to console operation enabling other values of $\frac{1}{n}$ to be entered through the typewriter. The corresponding sum of squares then appears on the typewriter while full output continues to be produced on the printer. By trying manually a succession of appropriately chosen values, the optimum $\frac{1}{n}$ is easily determined. The limit of accuracy appears to be three places of decimals.

In the printed output, the symbol B-A is used for $\frac{1}{n}$. This notation is derived from Taylor (1962)* where some

*Taylor, C.C. 1962. Growth equations with metabolic parameters. J. Cons. Int. Explor Mer, 27(3): 270-286.

discussion of the properties of this generalised equation may be found.

Any number of sets of data may be processed in a single operation. At the end of the initial run for each data set, the computer stops and types a message calling for Sense Switch 1 to be turned on if values of B-A are to be inserted manually, or to be turned off before restarting if it is desired to proceed to the next data set. In the latter case it then types a further message calling for Sense Switch 3 to be turned off to proceed to the next data set, or to be turned on to terminate operation.

### 1.5.2 Options

No options as to computing procedure or data accepted are included in this programme.

### 1.5.3 Data Input

Each data set should consist of the following cards:

(a) A title card which is printed on the output exactly as it appears on the card.

(b) A card containing the initial value of B-A, the interval and the number of runs to be made; format (2F10.4,I10).

(c) A set of data cards. These contain lengths at successive integers of age starting at age 1. As many cards as desired may be used to accommodate the range of ages available, there being 12 ages on each card. Care must be taken to make sure that the cards are read in in the right order. If lengths are not available for the younger age-groups, the corresponding positions on the card must be left blank. There must not be any gaps in the set of lengths at age after the series has been begun. Any spaces on the last data card beyond the maximum age for which a length is available should be left blank. The format of the data card is (2X,13F6.2).

(d) An end of data card with 99 in columns 1 and 2.

### 1.5.4 Output

The printed output consists of:

(a) The title of the data set.

(b) The value of B-A for each run.

(c) A tabulation of observed and expected lengths at each age.

(d) The parameters of the Walford plot.

(e) The parameters of the generalised von Bertalanffy equation ($L_\infty$, k, $t_o$), the age and length at the inflection point.

(f) The sum of squares of the deviations from regression. A sample output is given in Appendix 5.

### 1.5.5 Subroutines Required

No subroutines other than those provided by the system are used.

### 1.5.6 Restrictions

The only restriction other than those imposed by the system and by input formats is that the maximum age should not exceed 99.

### 1.5.7 Storage Required

The programme uses 11.2K positions of core storage.

## 1.6 GROWTH EXPERIMENT ANALYSIS (SALMON) (SALGRO)

### 1.6.1 Function and Method

This programme was set up to analyse data from experiments by Dr. R.L. Saunders on the effect of environmental conditions (temperature and salinity) on the growth of young salmon. In any one experiment a number of batches of fish were kept under different conditions and at intervals all the fish in each batch were weighed and measured. Not all the fish in a batch at any weighing were necessarily continued into the next period.

The programme begins by computing for all the fish in each batch at each weighing the mean, variance, standard deviation and standard error for length, weight and condition factor. For each occasion it then applies a t-test for the significance of the differences in length, weight and condition factor between each pair of batches. Finally, it computes for each batch the linear and instantaneous growth rate over each period.

At the end of the programme the summarized data for each batch at each weighing remain in storage. It will thus be possible by reading in additional data on amounts of food consumed to add a further section to the programme computing food consumption rates and efficiency of conversion. For this purpose provision has been made in reading in the fish data to include those fish which died during a period between weighings, although they are ignored in the calculations at present carried out by the programme.

### 1.6.2 Options

No options are provided in this programme.

### 1.6.3 Data Input

Any number of experiments can be processed in a single computer operation, and a reference number for each experiment is read in and printed out.

Separate data cards are read in for each fish in each batch on each occasion in which it is weighed. Within each experiment, the cards for each batch must be loaded together but the batches need not be in numerical order. Within each batch the cards must be in date order. The following information is placed on each data card:

| | Column Nos. |
|---|---|
| (a) Experiment number | 3,4 |
| (b) Batch number | 5,6 |
| (c) Initial temperature | 7,8 |
| (d) Final temperature | 10-12 |
| (e) Initial salinity | 13-15 |
| (f) Final salinity | 16-18 |
| (g) Day | 19,20 |
| (h) Month | 21,22 |
| (i) Year | 23,24 |
| (j) Day from start of experiment | 25-27 |
| (k) Length in mm | 50-52 |
| (l) Weight in 100th grams (no decimal point) | 53-58 |
| (m) Survival code (continued to next period = blank; removed at the time of weighing = 1; died during period = 2) | 59 |
| (n) Card identification number (10) | 79,80 |

The data deck for each experiment except the last is ended with a card with 98 in columns 79 and 80. The entire deck is ended with a card with 99 in columns 79,80.

### 1.6.4 Output

The printed output consists of three tables

(a) Means, variances and standard errors by batches and dates. This also records for each batch and date, the salinity and temperature at the beginning and end of the period.

(b) A comparison between each pair of batches at each weighing showing, for length, weight and condition, the degrees of freedom, the difference between the means, the standard error of the difference and the value of t.

(c) For each batch over each interval, the mean length and weight at the beginning and end of interval, and the instantaneous and linear growth rates in both length and weight.

A sample output is given in Appendix 6.

### 1.6.5 Subroutines Required

The only subroutine used other than those called by the system is RULE which is described later in this report.

### 1.6.6 Restrictions

Any one data run is limited to six batches and ten dates for each batch. It is assumed that all batches are weighed on the same dates. If data for more than ten dates for any batch are included a message to this effect is printed, operation continues but only the first ten dates are processed. Reference numbers of the batches must be in the range.

### 1.6.7 Storage Required

This programme uses 42.9K positions of core storage.

# 2. SALMON DATA TABULATIONS

## 2.1 AGE DISTRIBUTION FROM SCALE READINGS (AGDIST)

### 2.1.1 Function and Method

This programme reads the standard cards on which scale readings are recorded, and computes for each river and each year a two-way table of the actual numbers and percentages of fish for each combination of smolt age and sea life.

### 2.1.2 Options

No options are provided.

### 2.1.3 Data Input

Any number of sets of data can be processed in a single run. Each set of data cards is composed as follows:

(a) A title card which is printed exactly as punched.

(b) A card showing in columns 1 to 5 the page number of the first page of the printed output for that set. Subsequent pages are numbered automatically.

(c) Sets of cards for each river. These river sets consist of the data cards for that river, not in any required order, followed by a card with the identification number and the name of the river. This river card has the river identification number in columns 14 to 18, the river name in columns 23 to 54, and 8 in column 80.

(d) A blank card. The computer will stop at the end of each data set and type a call to turn Sense Switch 3 on if operation is to cease and to restart with Sense Switch 3 off if a further data set is to be processed. This stop allows the correct page number to be inserted at the beginning of each new data set.

### 2.1.4 Output

The printed output consists for each locality, or river, of a series of two-way tables of smolt length against sea age, showing both number and percentage for each combination of ages. The table is also summed, and percentages worked out, both vertically and horizontally. A table is printed for each year for which there are data and there is an overall summary for each locality of smolt age distribution for all years combined.

A sample output is given in Appendix 7.

2.1.5 Subroutines Required

In addition to the system routines, this programme requires HEAD and COLUM.

2.1.6 Restrictions

As at present set up, the programme will handle data for a 20-year period ending in 1969. The table lists sea ages up to 3 years and smolt ages up to 8 years. If fish of greater age in either category are encountered, they are included in the last age-group and a message stating that this has been done and how many fish were involved is printed at the end of the table.

2.1.7 Storage Required

This programme requires 27.5K core storage positions.

2.1.8 Word Length

Floating point word length is standard for this programme, but fixed word length is increased to 5.

## 2.2 COMMERCIAL SALMON CATCH SUMMARY (COMCAT)

### 2.2.1 Function and Method

This reads cards prepared from the catch statistics supplied by the Fishery Officers of the Department of Fisheries. For each Fishery District there is a pair of cards for each month, one containing the quantities (weights and numbers) of fish caught by each type of gear, and the other the amount of each gear in use. The output tabulates the total weight of fish caught and the average weight and catch-per-unit effort of each type of gear.

### 2.2.2 Options

If Sense Switch 4 is off, monthly and yearly summaries are printed. With Sense Switch 4 on, only yearly summaries are produced.

### 2.2.3 Data Input

The input deck consists of

(a) A title card printed at the head of the first page of the output exactly as punched.

(b) A card with the page number of the first page in columns 1 to 5.

(c) The data deck. This consists of pairs of cards, the catch card preceding the gear card. They are sorted by Fishery Districts, years, and months. The layout of these cards is

| (1) Catch Card | Column Nos. |
|---|---|
| Fishery District | 1-3 |
| Year | 4-5 |
| Month (13 for Annual Summary) | 6-7 |
| Set-net, catch weight (lb) | 8-13 |
| number | 14-18 |
| Drift-net, weight (lb) | 19-24 |
| number | 25-29 |

| | Column Nos. |
|---|---|
| Traps, weight (lb) | 30-35 |
| number | 36-40 |
| Other, weight (lb) | 41-46 |
| number | 47-51 |
| Subareas (given = 1, not given = 0) | 75 |
| No. of fish (indicated = 1, not indicated = 0) | 76 |
| Card identification (02) | 79-80 |

(2) Gear Card

| | |
|---|---|
| Fishery District | 1-3 |
| Year | 4-5 |
| Month | 6-7 |
| Set-nets, number | 8-11 |
| length (fathoms) | 12-17 |
| Drift-nets, number | 18-21 |
| length (fathoms) | 22-27 |
| Traps, number | 28-31 |
| length (fathoms) | 32-37 |
| Other, number | 38-41 |
| length (fathoms) | 42-47 |
| Card identification (03) | 79-80 |

The formats are (I3,2I2,4(F6.0,F5.0),24X,I1,2X,I2) and (I3,2I2,4(F4.0,F6.0),31X,I2) respectively.

(d) Blank card at end of the entire deck.

2.2.4 Output

The printed output consists for each district of a series of annual tables giving for each month

(a) The average weight and catch per unit of effort for each of the four types of gear.

(b) The total weight of catch.

(c) The number of fish weighed

(d) The average weight per fish for all gears combined. Annual totals and means are also given. For set-nets and drift-nets the unit of effort is 10 fms of net per month; for traps and other gears, it is per unit of gear per month.

A sample output is given in Appendix 8.

2.2.5 Subroutines Required

In addition to the subroutines called by the system, this programme uses HEAD, COLUM and MISER. The last is a subroutine in the U.N.B. programme library which stores the contents of a card on disc and enables it to be recalled when desired for rereading.

2.2.6 Restrictions

There are no special restrictions on this programme.

2.2.7 Storage Required

The programme uses 18.2K of core storage.

2.2.8 Word Length

The standard floating point word length is used but fixed word length is increased to 6.

## 2.3 SALMON ANGLING CATCH SUMMARY (ANGCAT)

### 2.3.1 Function and Method

This programme reads in cards containing angling data derived from the returns sent in by the Fishery Officers of the Department of Fisheries. It tabulates for each river, year and month the quantities of fish caught, the catch per effort and the average weight.

### 2.3.2 Options

No options are provided in this programme.

### 2.3.3 Data Input

The input deck consists of:

(a) A title card which is printed out as punched.

(b) A card containing the number of the first page of the output in columns 1 to 5.

(c) Blocks of cards for each river. Each block consists of (1) a river name card with the river identification number in columns 5 to 9, the river name in columns 14 to 45 and 09 in columns 79 and 80; (2) the data cards sorted by year and month.

The layout of the data cards is

| | Column Nos. |
|---|---|
| Year | 1-2 |
| Month | 3-4 |
| River | 5-9 |
| County | 10-11 |
| Effort (rod days) | 12-16 |
| Large salmon, number | 17-21 |
| weight (lb) | 22-26 |
| Large salmon, bright | 27-31 |
| weight (lb) | 32-36 |

| | Column Nos. |
|---|---|
| Large salmon, black | 37-41 |
| weight (lb) | 42-46 |
| Grilse, number | 47-51 |
| weight (lb) | 52-56 |
| Grilse, bright, number | 57-61 |
| weight (lb) | 62-66 |
| Grilse, black, number | 67-70 |
| weight (lb) | 71-75 |
| Combination of catch (salmon = 0, salmon or grilse = 2, bright or black = 3) | 76 |
| Card identification (04) | 79-80 |

(d) Blank card at end of complete deck.

2.3.4 Output

This provides under each river annual tables showing monthly totals for number and weight of salmon and grilse, and for effort; the catch per effort; and the average weight of salmon and grilse. Annual totals and averages are also provided.

A sample output is given in Appendix 9.

2.3.5 Subroutines Required

In addition to those called by the system, this programme requires HEAD, COLUM, MISER and REREAD. The last two are U.N.B. library subroutines.

2.3.6 Restrictions

This programme imposes no special restrictions.

2.3.7 Storage Required

The programme requires 12.4K positions of core storage.

2.3.8 Word Length

Floating point word length is normal but fixed point word length is increased to 5.

# 3. MISCELLANEOUS

## 3.1 BINOMIAL EXPANSION (BINOM)

### 3.1.1 Function and Method

This programme computes the terms of the binomial expansion

$(p+q)^n$ where $(p+q) = 1$ for any desired values of p and n. It also provides the cumulative sum of the terms.

This programme may be useful where it is desired to obtain exact solutions to probability situations involving two categories.

### 3.1.2 Options

No options are provided in this programme.

### 3.1.3 Data Input

A single data card is read. This contains

(a) The initial value of n.

(b) The interval between successive values of n.

(c) The final value of n.

(d) The number of values of p.

(e) The initial value of p, which is also the interval between subsequent values.

The format is (4I5,F10.3).

### 3.1.4 Output

The programme runs through each of the desired values of n for each successive value of p. The values of n and p are printed each time they change. The output for each combination of p and n consists of two blocks of figures in rows of 10. The upper block consists of the terms of the binomial expansion and the lower block is the cumulative sums of these terms beginning from $p^n$.

A sample output is given in Appendix 10.

3.1.5 Subroutines Required

No special subroutines are required for this programme.

3.1.6 Restrictions

The maximum value of n is at present 60 for this programme.

3.1.7 Storage Required

3.2K positions of core storage are required.

## 3.2 THE ESTIMATION OF EXPLOITED POPULATIONS (WHALE2)

### 3.2.1 Function and Method

This programme obtains an estimate of the size of an exploited population where catch and effort are known for each series of years and estimates of recruitment rate are available. It uses the method based on the comparison of actual and expected catches described in Allen (1966b)*. While the total catch in each year must be known, it is not necessary to know the total effort, provided that the catch obtained by a known amount of effort is known in each year. Recruitment rate is expressed as the proportion of new recruits in the exploitable part of the population in each year. The programme has to be supplied with an estimate of the annual instantaneous natural mortality rate, but provision is made to obtain a series of population estimates for different values of this in a single operation.

### 3.2.2 Options

No options are provided by this programme.

### 3.2.3 Data Input

The input data deck consists of

(a) A title card which is printed as punched.

(b) A card containing the number of natural mortality rates which it is desired to use, and a set of up to 10 values for this rate.

The format is (12X,I2,10F6.4).

(c) A card defining the period of years over which the population estimates are to be computed. This permits estimates to be obtained for only part of a data set. These years are entered on the card as the last two digits of the first columns (21-22) and last years of the period (26-27).

---

*Allen, K.R. 1966b. Some methods for estimating exploited populations. J. Fish. Res. Bd. Canada, 23(10): 1553-1574.

(d) A set of cards containing the catch and effort data. There is one card for each year and these contain

(1) The last two digits of the year.

(2) The total catch of males.

(3) The total catch of females.

(4) The catch of males with a known effort.

(5) The catch of females with a known effort.

(6) The known amount of effort corresponding to (4) and (5).

(7) An effort modifier which can be used to adjust the effort for weather or similar variables.

This section of the deck is terminated with a card with 9 in column 2. The format of the catch and effort cards is (5X,I2,5X,5F10.1,F6.4).

(e) A set of recruitment rate cards. These also are one for each year and contain the last two digits of the year and the recruitment rate. The format is (5X,I2,5X,F7.4). This set also is terminated with a card with 9 in column 2.

As many sets as desired made up as above can be processed in one run and, after the last set, operation is terminated by a blank card.

Note that the title card must never be completely blank in columns 1 to 4 since this will terminate operation.

### 3.2.4 Output

The printed output for each set of data includes

(a) A statement of the period for which estimates are being computed.

(b) A tabulation of the catch and effort data including catch per unit effort for each sex and for the combined population in each year, and an estimated total effort on the assumption that the catch per unit effort was the same for the entire catch as for that part of it for which effort was known.

(c) A tabulation of the recruitment rate in each year.

(d) A tabulation of the estimated populations, actual and expected catches, and their difference, and the squares of the differences for each year. There is also a statement of the sum of the squares of the deviations from expectation and an estimate of q, the catchability factor. Each section of the tables is headed with the title of the data set.

A sample output is given in Appendix 11.

### 3.2.5 Subroutines Required

This programme consists of a MAIN programme and the subroutines CEFF, RECCY, and LSTSQ. It also uses the subroutine RULE.

### 3.2.6 Restrictions

The only restriction other than those imposed by the input formats is that the years to which the data are referred must lie between 1940 and 1969 inclusive.

### 3.2.7 Storage Required

The programme requires 19.1K positions of core storage.

# 4. OUTPUT SUBROUTINES

## 4.1 RULE

This programme is designed to rule a line composed of one of the three characters (-, =, *). The length of the line and the width of the left-hand margin can be controlled as can the spacing before and after the line. The subroutine is called by the statement

```
CALL RULE (JGAP, JLINE, JTYPE, JSP1, JSP2)
```

In this JGAP = number of characters in left-hand margin

JLINE = number of characters in line

JTYPE = character control (1 = -, 2 = =, 3 = *)

JSP1 = space control before line (0 = no space, 1 = one space, 2 = new page)

JSP2 = space control after line. The value given to it equals the number of spaces that will be left.

This subroutine requires 1300 positions of core storage.

## 4.2 HEAD and COLUM

This pair of subroutines is intended to provide a page control in an output in which the pages are to be numbered and a heading is to be repeated on all pages. It is therefore particularly suitable for use in programmes giving an output which is to be used as a published or duplicated report.

Only the subroutine HEAD should be called in the main programme. COLUM is called only by HEAD when required and functions only as a store of available headings. It is thus possible to place additional headings in the store without disturbing the principal subroutine.

HEAD is called by the statement

CALL HEAD (LINE, IP, IST, NEXT, LPAGE, NCØL)

LINE is the number of lines which have been printed on the page and a suitable statement adding the appropriate number to it must follow every print statement in the main programme. It is automatically restored by the subroutine when a new page is started.

IP is the number of the first page to be printed. In a report which is to stand by itself it would of course be 1.

IST. If this is set at 1 the first time the subroutine is called, the printing of the first line of the first page with the page number on it is omitted by the subroutine. This enables the main programme to print a title on this line; if this is done the main programme should also print the page number at the right-hand end of the line to match those printed by the subroutine on subsequent pages. After the first call the subroutine sets IST at 2 which enables it to print the page number on the first line of subsequent pages. There should be no further definition of IST in the main programme.

NEXT. This defines the number of lines which it is desired to print next as a block. If there are not sufficient lines left on the page for this block the subroutine goes to a new page.

LPAGE. This defines the number of lines to be printed on the page. This would usually be fixed for any particular job and should be defined at the beginning of the main programme.

NCØL. This defines which heading is to be drawn out of the store in subroutine COLUM and printed at the head of each page.

Additional headings may be placed in store in COLUM by inserting an additional argument in the second card, and adding a block of cards with the same argument and containing the necessary print instructions. That is, change

GØ TØ (1, 2, - - n), NCØL

to GØ TØ (1, 2, - - n, n+1), NCØL

and add immediately before the END card

n PRINT 10n

10n FØRMAT (as required to produce heading)

RETURN

where 10n signifies the number 100+n.

It is, of course, possible to call different headings at different points in one programme.

HEAD requires 800 positions of core storage. The amount of storage required for COLUM depends on the number of headings stored in it at any time. It requires approximately 500 positions for each 2-line heading to be printed.

While neither of these subroutines needs non-standard word lengths, it must be noted that if they are to be used with a programme which does use special word lengths they must, for this purpose, be loaded with the same word length as the main programme. This is done by preceding them with an appropriate FANDK card.

```
FITTING OF VON BERTALANFFY GROWTH EQUATION

SALMON MARINE GROWTH -AGE IN MONTHS FROM BEGINNING OF SMOLT YEAR

        NUMBER      AGE      LENGTH

         662.     4.9000    14.5700
         386.     7.5000    29.5600
          36.    19.5000    65.4700
          48.    21.3000    64.5500
           2.    30.9000    83.1000
           1.    38.8000    87.4000
         523.    42.9000    91.9500


T(O) UNKNOWN, OPTION  1

TRIAL VALUE OF K =  .07700000          MINIMUM CORRECTION =    .000200

     SLSQ          A           B           C           D           E           F           G           H           I
5.2754E+06  1.6580E+03  7.4854E+04  7.0739E+02  1.5932E+04  4.3720E+02  1.7997E+05  5.0364E+03  2.5415E+03  1.7134E+04
     J           L           M           P           Q           R           S           T           U           V
6.5997E+04  4.2663E+06  2.1456E+07 -2.6535E+07  2.2447E+05 -6.5117E+05  7.8610E+07 -1.5235E+07  2.1333E+09 -1.7794E+08
     X           Y           Z
1.5347E+08  1.8206E+06  1.7508E+05
ALPHA =  36.665300E+10     D(K)ALPHA =  23.408530E+12      D2(K)ALPHA = -86.973000E+13
CORRECTION(TRUE) =  .012677  CORRECTION(APPR) =   .012782  CORRECTION(USED) =   .012677  ADJUSTED K =   .064322
SUM OF SQUARES =  .398400E+04

     SLSQ          A           B           C           D           E           F           G           H           I
5.2754E+06  1.6580E+03  7.4854E+04  7.7724E+02  1.8616E+04  5.0770E+02  2.4582E+05  6.0464E+03  3.0446E+03  2.3161E+04
     J           L           M           P           Q           R           S           T           U           V
9.5779E+04  6.8154E+06  2.3534E+07 -2.7314E+07  2.3765E+05 -3.4842E+05  4.0058E+07 -3.4199E+07  4.1304E+09 -1.4985E+08
     X           Y           Z
2.5793E+08  2.9792E+06  3.2229E+05
ALPHA =  28.004000E+08     D(K)ALPHA =  33.499090E+12      D2(K)ALPHA = -62.856700E+13
CORRECTION(TRUE) =  .000083  CORRECTION(APPR) =   .000083  CORRECTION(USED) =   .000083  ADJUSTED K =   .064233
SUM OF SQUARES =  .246170E+04

FINAL ESTIMATE OF K =  .06423896        ESTIMATE OF T(O) =   2.312640        ESTIMATE OF L(INF) =  99.055024

CONFIDENCE LIMITS FOR T =  1.960000

        VARIABLE      STANDARD ERROR        T X S.E.        LOWER LIMIT        UPPER LIMIT
            K             .000374           .000733           .063505            .064972
          T(O)            .017005           .033330          2.279309           2.345971
        L(INF)            .139277           .272984         98.782940          99.328908
```

```
FITTING THE DECAYING EXPONENTIAL GROWTH CURVE
X = A(1 - B EXP(-KT)) WHERE X IS LINEAR SIZE

PART A       10 OBSERVATIONS
AFTER    1 ITERATIONS, K = 9.9986E-02, A = 1.0004E+02
AFTER    2 ITERATIONS, K = 9.9986E-02, A = 9.9995E+01

FINAL VALUES      3 ITERATIONS

     K = 9.9984E-02          A= 9.9995E+01

     1 CHRON= 6.932E+00 UNITS OF TIME.
     1 UNIT OF TIME =  1.442E-01 CHRONS.
PART B  SAME OBSERVATIONS AS IN PART A
             B=   1.0001E+00
          T(0) =   1.6001E-03
          SUM OF SQUARES OF DEVIATIONS (PART B DATA) =  6.0000E-03

PART C   CALCULATED VALUES FOR PLOTTING
     AGE          LINEAR SIZE
   0.000E-99      -1.599E-02
   5.000E-01       4.860E+00
   1.000E+00       9.499E+00
   1.500E+00       1.391E+01
   2.000E+00       1.811E+01
   2.500E+00       2.210E+01
   3.000E+00       2.590E+01
   3.500E+00       2.951E+01
   4.000E+00       3.295E+01
   4.500E+00       3.622E+01
   5.000E+00       3.933E+01
   6.000E+00       4.510E+01
   7.000E+00       5.032E+01
   8.000E+00       5.505E+01
   9.000E+00       5.932E+01
   1.000E+01       6.319E+01
   1.100E+01       6.669E+01
   1.200E+01       6.986E+01
   1.300E+01       7.273E+01
   1.400E+01       7.532E+01
   1.600E+01       7.979E+01
   1.800E+01       8.345E+01
   2.000E+01       8.645E+01
   2.200E+01       8.891E+01
   2.400E+01       9.091E+01
   2.600E+01       9.256E+01
   2.800E+01       9.391E+01
   3.000E+01       9.501E+01
   3.500E+01       9.697E+01
   4.000E+01       9.816E+01
   4.500E+01       9.888E+01
   5.000E+01       9.932E+01
   5.500E+01       9.958E+01
   6.000E+01       9.974E+01
   6.500E+01       9.984E+01
   7.000E+01       9.990E+01
   ASYMPTOTE       9.999E+01

EXTRAP ZERO-2.308E-04 CHRONS BEFORE BIRTH
```

SAMPLE OUTPUT - VBTAB

| | |
|---|---|
| L(INF) = | 100.0000 |
| K = | .1000 |
| T(0) = | 0.0000 |
| NO OF POINTS = | 30 |

| AGE | LENGTH |
|---|---|
| .5 | 4.8770 |
| 1.0 | 9.5162 |
| 1.5 | 13.9292 |
| 2.0 | 18.1269 |
| 2.5 | 22.1199 |
| 3.0 | 25.9181 |
| 3.5 | 29.5312 |
| 4.0 | 32.9680 |
| 4.5 | 36.2371 |
| 5.0 | 39.3469 |
| 5.5 | 42.3050 |
| 6.0 | 45.1188 |
| 6.5 | 47.7954 |
| 7.0 | 50.3414 |
| 7.5 | 52.7633 |
| 8.0 | 55.0671 |
| 9.0 | 59.3430 |
| 10.0 | 63.2120 |
| 11.0 | 66.7129 |
| 12.0 | 69.8805 |
| 13.0 | 72.7468 |
| 14.0 | 75.3403 |
| 15.0 | 77.6869 |
| 16.0 | 79.8103 |
| 17.0 | 81.7316 |
| 18.0 | 83.4701 |
| 19.0 | 85.0431 |
| 20.0 | 86.4664 |
| 21.0 | 87.7543 |
| 22.0 | 88.9196 |

ERROR ESTIMATION FOR GOMPERTZ GROWTH CURVE WITH GIVEN PARAMETERS

L=L(INF) X EXP(-EXP(-K(T-T(0))))

K = .2500

L(INF) = 81.0000

T(0) = 3.5600

CALCULATED VALUES

| AGE | LENGTH |
|---|---|
| .20 | 7.989 |
| .40 | 8.944 |
| .60 | 9.959 |
| .80 | 11.031 |
| 1.00 | 12.157 |
| 1.20 | 13.335 |
| 1.40 | 14.562 |
| 1.60 | 15.833 |
| 1.80 | 17.145 |
| 2.00 | 18.494 |
| 2.20 | 19.875 |
| 2.40 | 21.285 |
| 2.60 | 22.718 |
| 2.80 | 24.172 |
| 3.00 | 25.640 |
| 3.20 | 27.120 |
| 3.40 | 28.606 |
| 3.60 | 30.096 |
| 3.80 | 31.585 |
| 4.00 | 33.069 |
| 4.20 | 34.546 |
| 4.40 | 36.012 |
| 4.60 | 37.464 |
| 4.80 | 38.900 |
| 5.00 | 40.316 |
| 5.50 | 43.761 |
| 6.00 | 47.044 |
| 6.50 | 50.146 |
| 7.00 | 53.062 |
| 7.50 | 55.787 |
| 8.00 | 58.258 |
| 8.50 | 60.558 |
| 9.00 | 62.664 |
| 9.50 | 64.582 |
| 10.00 | 66.324 |
| 10.50 | 67.900 |
| 11.00 | 69.322 |
| 11.50 | 70.602 |
| 12.00 | 71.751 |
| 12.50 | 72.781 |
| 13.00 | 73.701 |
| 13.50 | 74.524 |
| 14.00 | 75.257 |
| 14.50 | 75.916 |
| 15.00 | 76.491 |
| 15.50 | 77.008 |
| 16.00 | 77.466 |
| 16.50 | 77.873 |
| 17.00 | 78.234 |
| 17.50 | 78.554 |
| 18.00 | 78.838 |
| 18.50 | 79.089 |
| 19.00 | 79.311 |
| 19.50 | 79.507 |
| 20.00 | 79.681 |

SUM OF SQUARES = 1.06373E+04

ROOT MEAN SQUARE = 5.51294E+00

NO. OF OBSERVATIONS = 350.

APPENDIX 4

SAMPLE OUTPUT - GOIP

APPENDIX 5
SAMPLE OUTPUT - GENVB

```
FITTING OF TAYLOR-VON BERTALANFFY CURVE
  (B-A)          (B-A)      -K(B-A)(T-T(0))
 (T)      =L(INF)      X(1-E                   )
CHAR DATA - GRAINGER  J.F.R.B  10 P326 TAB.5 - CALCULATED LENGTHS
```

B-A = .0320

| AGE | OBS. LEN | CAL. LEN |
|---|---|---|
| 1 | 1.399 | 1.353 |
| 2 | 2.499 | 2.679 |
| 3 | 4.999 | 4.694 |
| 4 | 7.999 | 7.450 |
| 5 | 11.599 | 10.915 |
| 6 | 15.399 | 14.975 |
| 7 | 19.599 | 19.469 |
| 8 | 23.999 | 24.215 |
| 9 | 28.499 | 29.036 |
| 10 | 33.499 | 33.777 |
| 11 | 38.199 | 38.318 |
| 12 | 42.699 | 42.571 |
| 13 | 46.799 | 46.482 |
| 14 | 50.299 | 50.024 |
| 15 | 53.499 | 53.190 |
| 16 | 56.299 | 55.990 |
| 17 | 58.599 | 58.445 |
| 18 | 60.399 | 60.581 |
| 19 | 62.299 | 62.428 |
| 20 | 63.899 | 64.017 |
| 21 | 65.299 | 65.378 |
| 22 | 66.399 | 66.540 |
| 23 | 67.499 | 67.528 |
| 24 | 68.599 | 68.367 |

```
PARAMETERS OF WALFORD PLOT
    INTERCEPT =    .1862      SLOPE =    .937[illegible]

PARAMETERS OF T-VON B EQUATION
    L(INF) =   72.8548      K =   [illegible].5382      T(0) = -10.9755
    TIME AT INFLECTION =   8.4461      LENGTH AT INFLECTION =  26.3671
    SUM OF SQUARES =  2.0741E+00
```

# APPENDIX 6
## SAMPLE OUTPUT - SALGRO

MEANS, VARIANCES AND STANDARD ERRORS BY BATCHES AND DATES

EXPERIMENT NO. 1

| DATE | DAY | | | NO. | MEAN | VARIANCE | S.E.OF MEAN | SALINITY BEG | SALINITY END | TEMPERATURE BEG | TEMPERATURE END |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BATCH NO. 1 | | | | | | | | | | | |
| 1/10/65 | 1 | | | | | | | 14.0 | 14.0 | 15.0 | 15.0 |
| | | END | LEN | 5 | 1.16000E+0 | 1.30000E+00 | 5.09901E-01 | | | | |
| | | | WGT | | 1.32000E+0 | 5.20000E+00 | 1.01980E+00 | | | | |
| | | | CON | | 8.50042E-0 | 1.07875E-02 | 4.64490E-02 | | | | |
| | | NEW | LEN | 5 | 1.16000E+0 | 1.30000E+00 | 5.09901E-01 | | | | |
| | | | WGT | | 1.32000E+0 | 5.20000E+00 | 1.01980E+00 | | | | |
| | | | CON | | 8.50042E-0 | 1.07875E-02 | 4.64490E-02 | | | | |
| BATCH NO. 1 | | | | | | | | | | | |
| 3/12/65 | 64 | | | | | | | 14.0 | 14.0 | 15.0 | 15.0 |
| | | END | LEN | 5 | 1.40000E+0 | 2.50000E+00 | 7.07106E-01 | | | | |
| | | | WGT | | 1.86000E+0 | 6.30000E+00 | 1.12249E+00 | | | | |
| | | | CON | | 6.95969E-0 | 2.19409E-02 | 6.62434E-02 | | | | |
| | | NEW | LEN | 3 | 1.36666E+0 | 4.33333E+00 | 1.20185E+00 | | | | |
| | | | WGT | | [illegible] | 1.23333E+01 | 2.02758E+00 | | | | |
| | | | CON | | 7.41487E-0 | 3.19223E-02 | 1.03154E-01 | | | | |
| BATCH NO. 1 | | | | | | | | | | | |
| 5/ 1/66 | 97 | | | | | | | 14.0 | 14.0 | 15.0 | 15.0 |
| | | END | LEN | 3 | 1.93333E+0 | 2.33335E+00 | 8.81920E-01 | | | | |
| | | | WGT | | 2.76666E+0 | 1.43333E+01 | 2.18581E+00 | | | | |
| | | | CON | | 3.84422E-0 | 1.74938E-03 | 2.41480E-02 | | | | |
| | | NEW | LEN | 3 | 1.93333E+0 | 2.33335E+00 | 8.81920E-01 | | | | |
| | | | WGT | | 2.76666E+0 | 1.43333E+01 | 2.18581E+00 | | | | |
| | | | CON | | 3.84422E-0 | 1.74938E-03 | 2.41480E-02 | | | | |
| BATCH NO. 2 | | | | | | | | | | | |
| 1/10/65 | 1 | | | | | | | 18.0 | 18.0 | 0.0 | 0.0 |
| | | END | LEN | 5 | 1.16000E+0 | 1.30000E+00 | 5.09901E-01 | | | | |
| | | | WGT | | 1.32000E+0 | 5.20000E+00 | 1.01980E+00 | | | | |
| | | | CON | | 8.50042E-0 | 1.07875E-02 | 4.64490E-02 | | | | |
| | | NEW | LEN | 5 | 1.16000E+0 | 1.30000E+00 | 5.09901E-01 | | | | |
| | | | WGT | | 1.32000E+0 | 5.20000E+00 | 1.01980E+00 | | | | |
| | | | CON | | 8.50042E-0 | 1.07875E-02 | 4.64490E-02 | | | | |

COMMERCIAL SALMON CATCH SUMMARY- TEST DECK 

| YEAR MONTH | SET NETS AV WT | SET NETS CAT/NET | DRIFT NETS AV WT | DRIFT NETS CAT/NET | TRAPS AV WT | TRAPS CAT/NET | OTHER AV WT | OTHER CAT/NET | TOTAL WEIGHT | TOTAL NUMBER | TOTAL AV WT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTRICT NO. 13 | | | | | | | | | | | |
| 1964 | | | | | | | | | | | |
| 6 | 13.33 | 20.0 | 8.75 | 233.3 | 0.00 | 0.00 | 0.00 | 0.00 | 1100 | 110 | 10.00 |
| TOTAL | 13.33 | 20.0 | 8.75 | 233.3 | 0.00 | 0.00 | 0.00 | 0.00 | 1100 | 110 | 10.00 |
| 1965 | | | | | | | | | | | |
| 7 | 10.00 | 20.0 | 10.00 | 166.6 | 0.00 | 0.00 | 0.00 | 0.00 | 900 | 90 | 10.00 |
| 8 | 10.00 | 25.0 | 10.00 | 200.0 | 0.00 | 0.00 | 0.00 | 0.00 | 1100 | 110 | 10.00 |
| TOTAL | 10.00 | 45.0 | 10.00 | 366.6 | 0.00 | 0.00 | 0.00 | 0.00 | 2000 | 200 | 10.00 |
| DISTRICT NO. 18 | | | | | | | | | | | |
| 1965 | | | | | | | | | | | |
| 4 | 0.00 | 0.0 | 0.00 | 0.0 | 10.00 | 200.00 | 0.00 | 0.00 | 400 | 40 | 10.00 |
| 5 | 0.00 | 0.0 | 0.00 | 0.0 | 10.00 | 200.00 | 0.00 | 0.00 | 400 | 40 | 10.00 |
| 6 | 0.00 | 0.0 | 0.00 | 0.0 | 10.00 | 200.00 | 0.00 | 0.00 | 400 | 40 | 10.00 |
| 7 | 0.00 | 0.0 | 0.00 | 0.0 | 10.00 | 200.00 | 0.00 | 0.00 | 400 | 40 | 10.00 |
| 8 | 13.33 | 20.0 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 400 | 30 | 13.33 |
| TOTAL | 13.33 | 20.0 | 0.00 | 0.0 | 10.00 | 800.00 | 0.00 | 0.00 | 2000 | 190 | 10.52 |

| YEAR MONTH* | NUMBER GRILSE | SALMON | ** TOTAL | WEIGHT GRILSE | SALMON | TOTAL | *ROD DAYS* EFFORT | CATCH* TOT/EFF | AVERAGE WEIGHT GRILSE | SALMON | * TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MIRAMICHI R. | | | | | | | | | | | |
| 1960 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |
| 1961 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |
| 1962 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |
| 1963 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |
| 1964 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |
| 1965 | | | | | | | | | | | |
| 7 | 250 | 65 | 315 | 1255 | 500 | 1755 | 300 | 1.05 | 5.02 | 7.69 | 5.57 |
| 8 | 0 | 0 | 455 | 0 | 0 | 1250 | 800 | .56 | 0.00 | 0.00 | 2.74 |
| TOTAL | 250 | 65 | 770 | 1255 | 500 | 3005 | 1100 | .70 | 5.02 | 7.69 | 3.90 |

APPENDIX 2
SAMPLE OUTPUT - ANGCAT

COMPARISON OF BATCHES

| EXPT DAY | BATCH A | BATCH B | | DEG. FREE | DIFFERENCE | S.E. OF DIFF | T |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | LEN | 8 | 0.00000E-99 | 7.21110E-01 | 0.0000 |
| | | | WGT | 8 | 0.00000E-99 | 1.44222E+00 | 0.0000 |
| | | | CON | 8 | 0.00000E-99 | 6.56888E-02 | 0.0000 |
| 1 | 1 | 3 | LEN | 8 | 8.00000E-01 | 7.21110E-01 | 1.1094 |
| | | | WGT | 8 | 1.40000E+00 | 1.48323E+00 | .9438 |
| | | | CON | 8 | 8.03787E-02 | 6.21020E-02 | 1.2942 |
| 1 | 2 | 3 | LEN | 8 | 8.00000E-01 | 7.21110E-01 | 1.1094 |
| | | | WGT | 8 | 1.40000E+00 | 1.48323E+00 | .9438 |
| | | | CON | 8 | 8.03787E-02 | 6.21020E-02 | 1.2942 |
| 64 | 1 | 2 | LEN | 8 | 4.00000E-01 | 8.71779E-01 | .4588 |
| | | | WGT | 8 | 8.00000E-01 | 1.31148E+00 | .6099 |
| | | | CON | 8 | 3.58987E-02 | 8.14696E-02 | .4406 |
| 64 | 1 | 3 | LEN | 8 | 3.20000E+00 | 1.01980E+00 | 3.1378 |
| | | | WGT | 8 | 6.00000E+00 | 2.05426E+00 | 2.9207 |
| | | | CON | 8 | 2.07655E-01 | 7.38162E-02 | 2.8131 |
| 64 | 2 | 3 | LEN | 8 | 2.80000E+00 | 8.94427E-01 | 3.1304 |
| | | | WGT | 8 | 5.20000E+00 | 1.84932E+00 | 2.8118 |
| | | | CON | 8 | 1.71756E-01 | 5.75303E-02 | 2.9854 |
| 97 | 1 | 2 | LEN | 5 | 1.16666E+00 | 1.06197E+00 | 1.0985 |
| | | | WGT | 5 | 5.83334E-01 | 2.30187E+00 | .2534 |
| | | | CON | 5 | 5.43811E-02 | 2.94884E-02 | 1.8441 |
| 97 | 1 | 3 | LEN | 6 | 3.86666E+00 | 1.00958E+00 | 3.8299 |
| | | | WGT | 6 | 1.09333E+01 | 2.66444E+00 | 4.1034 |
| | | | CON | 6 | 7.44100E-02 | 2.28539E-02 | 3.2558 |
| 97 | 2 | 3 | LEN | 7 | 2.70000E+00 | 8.70960E-01 | 3.1000 |
| | | | WGT | 7 | 1.03500E+01 | 2.09002E+00 | 4.9520 |
| | | | CON | 7 | 2.00288E-02 | 2.01754E-02 | .9927 |

CALCULATION OF GROWTH RATES

| | | | | GROWTH IN LENGTH | | | | GROWTH IN WEIGHT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BATCH | FIRST DAY | LAST DAY | INTER -VAL | MEAN 1 | MEAN 2 | INST. RATE | LIN. RATE | MEAN 1 | MEAN 2 | INST. RATE | LIN. RATE |
| 1 | 1 | 64 | 63 | 11.600 | 14.000 | 2.9849E-03 | 3.8095E-02 | 13.200 | 18.600 | 5.4635E-03 | 8.571[illegible]E-02 |
| 1 | 64 | 97 | 33 | 13.666 | 19.333 | 1.0511E-02 | 1.7171E-01 | 18.333 | 27.666 | 1.24[illegible]E-02 | 2.[illegible]E-01 |
| 2 | 1 | 64 | 63 | 11.600 | 14.400 | 3.4321E-03 | 4.4444E-02 | 13.200 | 19.400 | 6.1120E-03 | 9.841[illegible]E-02 |
| 2 | 64 | 97 | 33 | 14.500 | 20.500 | 1.0493E-02 | 1.9191E-01 | 19.250 | 28.250 | 1.1[illegible]E-02 | 2.[illegible]E-01 |
| 3 | 1 | 64 | 63 | 12.400 | 17.200 | 5.1938E-03 | 7.6190E-02 | 14.600 | 24.600 | [illegible] | 1.[illegible] |
| 3 | 64 | 97 | 33 | 17.200 | 23.200 | 9.0679E-03 | 1.8181E-01 | 24.600 | [illegible].600 | 1.3651E-02 | 4.24[illegible]E-01 |

## APPENDIX 7
## SAMPLE OUTPUT - AGDIST

AGE GROUPING OF COMMERCIAL SALMON --TEST DECK PAGE 1

| LOCALITY | YEAR | SEA AGE | SMOLT AGE 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ST JOHN R | | | | | | | | | | | | |
| | 1962 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | | | 0.00 | 0.00 | 40.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 40.00 |
| | | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 3 |
| | | | 0.00 | 0.00 | 0.00 | 20.00 | 20.00 | 20.00 | 0.00 | 0.00 | 0.00 | 60.00 |
| | | TOTAL | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 5 |
| | | | 0.00 | 0.00 | 40.00 | 20.00 | 20.00 | 20.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| | 1961 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | | | 0.00 | 75.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 75.00 |
| | | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | 0.00 | 25.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 25.00 |
| | | TOTAL | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | | | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |

## APPENDIX 10
## SAMPLE OUTPUT - BINOM

```
P =    .050

N =  25
 2.98023E-33 1.41561E-30 3.22759E-28 4.70152E-26 4.91309E-24 3.92064E-22 2.48307E-20 1.28055E-18 5.47438E-17 1.96469E-15
 5.97267E-14 1.54746E-12 3.43021E-11 6.51741E-10 1.06140E-08 1.47889E-07 1.75618E-06 1.76651E-05 1.49172E-04 1.04420E-03
 5.95198E-03 2.69256E-02 9.30157E-02 2.30517E-01 3.64985E-01 2.77389E-01
 2.98023E-33 1.41859E-30 3.24177E-28 4.73394E-26 4.96043E-24 3.97025E-22 2.52277E-20 1.30578E-18 5.60496E-17 2.02074E-15
 6.17475E-14 1.60921E-12 3.59113E-11 6.87652E-10 1.13017E-08 1.59191E-07 1.91537E-06 1.95805E-05 1.68752E-04 1.21296E-03
 7.16494E-03 3.40905E-02 1.27106E-01 3.57623E-01 7.22609E-01 9.99998E-01

N =  30
 9.31322E-40 5.30853E-37 1.46250E-34 2.59350E-32 3.32616E-30 3.28625E-28 2.60161E-26 1.69476E-24 9.25767E-23 4.29967E-21
 1.71556E-19 5.92651E-18 1.78289E-16 4.69037E-15 1.08213E-13 2.19313E-12 3.90651E-11 6.11254E-10 8.38777E-09 1.00653E-07
 1.05182E-06 9.51652E-06 7.39693E-05 4.88840E-04 2.70899E-03 1.23530E-02 4.51359E-02 1.27049E-01 2.58636E-01 3.38902E-01
 2.14638E-01
 9.31322E-40 5.31785E-37 1.46782E-34 2.60818E-32 3.35225E-30 3.31977E-28 2.63481E-26 1.72111E-24 9.42978E-23 4.30297E-21
 1.75950E-19 6.10246E-18 1.84391E-16 4.87477E-15 1.13088E-13 2.30622E-12 4.13713E-11 6.52626E-10 9.04039E-09 1.09493E-07
 1.16152E-06 1.06780E-05 8.46474E-05 5.73488E-04 3.28248E-03 1.56354E-02 6.07714E-02 1.87820E-01 4.46457E-01 7.85360E-01
 9.99998E-01

N =  35
 2.91038E-46 1.93540E-43 6.25135E-41 1.30653E-38 1.98593E-36 2.33942E-34 2.22245E-32 1.74938E-30 1.16334E-28 6.63106E-27
 3.27574E-25 1.41452E-23 5.37519E-22 1.80689E-20 5.39486E-19 1.43503E-17 3.40820E-16 7.23742E-15 1.37511E-13 2.33768E-12
 3.55328E-11 4.82231E-10 5.83061E-09 6.26157E-08 5.94849E-07 4.97294E-06 3.63407E-05 2.30158E-04 1.24942E-03 5.73014E-03
 2.17745E-02 6.67284E-02 1.58479E-01 2.73738E-01 3.05942E-01 1.66083E-01
 2.91038E-46 1.93831E-43 6.27073E-41 1.31280E-38 1.99905E-36 2.35941E-34 2.24604E-32 1.77184E-30 1.18106E-28 6.74916E-27
 3.34323E-25 1.44795E-23 5.51999E-22 1.86209E-20 5.58107E-19 1.49084E-17 3.55729E-16 7.59315E-15 1.45104E-13 2.48279E-12
 3.80156E-11 5.20247E-10 6.35086E-09 6.89666E-08 6.63816E-07 5.63676E-06 4.19775E-05 2.72135E-04 1.52156E-03 7.25170E-03
 2.90262E-02 9.57546E-02 2.54234E-01 5.27972E-01 8.33915E-01 9.99998E-01

N =  40
 9.09494E-53 6.91215E-50 2.56095E-47 6.16336E-45 1.08321E-42 1.48183E-40 1.64236E-38 1.51566E-36 1.18790E-34 8.02495E-33
 4.72669E-31 2.44928E-29 1.12463E-27 4.60234E-26 1.68642E-24 5.55397E-23 1.64883E-21 4.42275E-20 1.07374E-18 2.36224E-17
 4.71267E-16 8.52770E-15 1.39931E-13 2.08072E-12 2.80030E-11 3.40517E-10 3.73259E-09 3.67729E-08 3.24390E-07 2.55037E-06
 1.77676E-05 1.08898E-04 5.81925E-04 2.68038E-03 1.04850E-02 3.41512E-02 9.01213E-02 1.85114E-01 2.77671E-01 2.70551E-01
 1.28511E-01
 9.09494E-53 6.92125E-50 2.56787E-47 6.18904E-45 1.08940E-42 1.49272E-40 1.65729E-38 1.53224E-36 1.20322E-34 8.16527E-33
 4.80815E-31 2.49737E-29 1.14960E-27 4.71730E-26 1.73360E-24 5.72733E-23 1.70610E-21 4.59336E-20 1.11968E-18 2.47421E-17
 4.96009E-16 9.02370E-15 1.48955E-13 2.22968E-12 3.02327E-11 3.70750E-10 4.10334E-09 4.08763E-08 3.65266E-07 2.91564E-06
 2.06832E-05 1.29581E-04 7.11507E-04 3.39189E-03 1.38769E-02 4.80281E-02 1.38149E-01 3.23263E-01 6.00934E-01 8.71486E-01
 9.99998E-01
```

APPENDIX 11
SAMPLE OUTPUT - WHALE2

FIN WHALES BC + USA 1949-1966 POP. EST. 1958-66

STARTING YEAR FOR POPULATION ESTIMATES=1958, FINISHING YEAR=1966

FIN WHALES BC + USA 1949-1966 POP. EST. 1958-66

| YEAR | KNOWN EFFORT CATCH MALE | KNOWN EFFORT CATCH FEMALE | TOTAL MALE | TOTAL FEMALE | EFFORT | MODIFIER | CATCH PER EFFORT MALE | CATCH PER EFFORT FEMALE | CATCH PER EFFORT TOTAL | TOTAL EFFORT | TOT.MOD. EFFORT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1949 | 56. | 49. | 56. | 49. | 264.0 | 1.0000 | .2121 | .1856 | .3977 | 264.0 | 264.0 |
| 1950 | 70. | 80. | 70. | 80. | 220.0 | 1.0000 | .3181 | .3636 | .6818 | 220.0 | 220.0 |
| 1951 | 100. | 117. | 100. | 117. | 721.0 | 1.0000 | .1386 | .1622 | .3009 | 721.0 | 721.0 |
| 1952 | 121. | 119. | 121. | 119. | 491.0 | 1.0000 | .2464 | .2423 | .4887 | 491.0 | 491.0 |
| 1953 | 91. | 90. | 91. | 90. | 423.0 | 1.0000 | .2151 | .2127 | .4278 | 423.0 | 423.0 |
| 1954 | 90. | 61. | 90. | 61. | 311.0 | 1.0000 | .2893 | .1961 | .4855 | 311.0 | 311. |
| 1955 | 50. | 70. | 50. | 70. | 500.0 | 1.0000 | .1000 | .1400 | .2400 | 500.0 | 500.0 |
| 1956 | 81. | 90. | 81. | 90. | 404.0 | 1.0000 | .2004 | .2227 | .4232 | 404.0 | 404.0 |
| 1957 | 140. | 165. | 140. | 165. | 749.0 | 1.0000 | .1869 | .2202 | .4072 | 749.0 | 749.0 |
| 1958 | 381. | 301. | 381. | 301. | 1146.0 | 1.0000 | .3324 | .2626 | .5951 | 1146.0 | 1146.0 |
| 1959 | 243. | 234. | 243. | 234. | 1062.0 | 1.0000 | .2288 | .2203 | .4491 | 1062.0 | 1062.0 |
| 1960 | 64. | 74. | 64. | 74. | 379.0 | 1.0000 | .1688 | .1952 | .3641 | 379.0 | 379.0 |
| 1961 | 64. | 54. | 64. | 54. | 372.0 | 1.0000 | .1720 | .1451 | .3172 | 372.0 | 372.0 |
| 1962 | 132. | 149. | 132. | 149. | 1376.0 | 1.0000 | .0959 | .1082 | .2042 | 1376.0 | 1376.0 |
| 1963 | 107. | 130. | 107. | 130. | 1245.0 | 1.0000 | .0859 | .1044 | .1903 | 1245.0 | 1245.0 |
| 1964 | 128. | 159. | 128. | 159. | 1525.0 | 1.0000 | .0839 | .1042 | .1881 | 1525.0 | 1525.0 |
| 1965 | 95. | 101. | 95. | 101. | 955.0 | 1.0000 | .0994 | .1057 | .2052 | 955.0 | 955.0 |
| 1966 | 87. | 89. | 87. | 89. | 1579.4 | 1.0000 | .0550 | .0563 | .1114 | 1579.4 | 1579.4 |

FIN WHALES BC + USA 1949-1966 POP. EST. 1958-66

| YEAR | RECRUITMENT RATE |
|---|---|
| 1959 | .2600 |
| 1960 | .0700 |
| 1961 | .2000 |
| 1962 | .4100 |
| 1963 | .2000 |
| 1964 | .2400 |
| 1965 | .2600 |
| 1966 | .2300 |

APPENDIX 11
SAMPLE OUTPUT - WHALE2
(cont'd.)

FIN WHALES BC + USA 1949-1966 POP. EST. 1958-66
POPULATION ESTIMATE BY LEAST SQUARES METHOD
INSTANTANEOUS NATURAL MORTALITY RATE = .0400

| YEAR | AT(I) | FC(I-1) | EST. POP. | ACT. CATCH | EXP. CATCH | DIFFERENCE | DIFF(SQ) |
|---|---|---|---|---|---|---|---|
| 1958 | 1.0000 | 0. | 1561. | 682.0 | 596.3 | 85.6 | 7340.00 |
| 1959 | 1.2983 | 682. | 1142. | 477.0 | 409.1 | 67.8 | 4609.82 |
| 1960 | 1.3413 | 1049. | 687. | 138.0 | 99.8 | 38.1 | 1453.23 |
| 1961 | 1.6109 | 1152. | 659. | 118.0 | 95.2 | 22.7 | 517.94 |
| 1962 | 2.6233 | 1225. | 882. | 281.0 | 434.9 | -153.9 | 23693.89 |
| 1963 | 3.1506 | 1332. | 721. | 237.0 | 320.1 | -83.1 | 6918.44 |
| 1964 | 3.9829 | 1407. | 612. | 287.0 | 305.1 | -18.1 | 328.84 |
| 1965 | 5.1713 | 1479. | 423. | 196.0 | 132.3 | 63.6 | 4050.42 |
| 1966 | 6.4527 | 1517. | 283. | 176.0 | 131.5 | 44.4 | 1974.70 |

ESTIMATE OF Q= .000426 SUM OF SQUARES= 50887.31

ESTIMATED SUM OF SQUARES = 50893.00

| I | SUMK | SUML | SUMU | SUMP | SUMR | SUMS |
|---|---|---|---|---|---|---|
| 18 | 46.512400E+04 | 53.303210E+07 | 15.271369E+10 | -15.631440E+05 | -89.568151E+07 | 13.133160E+05 |
| 19 | 69.265300E+04 | 16.717944E+08 | 15.775646E+11 | -28.785788E+05 | -41.874983E+08 | 32.145777E+05 |
| 20 | 71.169700E+04 | 18.262517E+08 | 18.907483E+11 | -30.188892E+05 | -47.564960E+08 | 34.730189E+05 |
| 21 | 72.562100E+04 | 19.943939E+08 | 23.983581E+11 | -31.603170E+05 | -56.104173E+08 | 38.321439E+05 |
| 22 | 80.458200E+04 | 45.892083E+08 | 23.716040E+12 | -51.889844E+05 | -38.943427E+09 | 16.862283E+06 |
| 23 | 86.075100E+04 | 71.368566E+08 | 52.604356E+12 | -70.482525E+05 | -81.108687E+09 | 32.248340E+06 |
| 24 | 94.312000E+04 | 12.170964E+09 | 12.952116E+13 | -10.534760E+06 | -18.765032E+10 | 69.142495E+06 |
| 25 | 98.153600E+04 | 15.072688E+09 | 18.431608E+13 | -12.470713E+06 | -26.076573E+10 | 93.532820E+06 |
| 26 | 10.125120E+05 | 20.566582E+09 | 42.791493E+13 | -16.058095E+06 | -57.889429E+10 | 19.739802E+07 |