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1973/74 PROGRESS REPORT

A DESCRIPTION AND PRELIMINARY USER'S GUIDE TO THE DESERT BIOME STREAM ECOSYSTEM MODEL

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TABLE OF CONTENTS

PROGRESS REVIEW

Modeling activities since the 1972 Progress Report have been aimed at broadening the model and better adapting it to streamflow while maintaining its general characteristics. Although goals were initially hampered by the lack of modeling personnel, the problem was substantially alleviated with the advent of a cooperative use and development of the model between members of the Desert Biome and those of the Central Utah Project under Grant #YNE-074-0.

New state variables have been added to better mimic the diversity found in an ecosystem, and to better track materials in and passing through the system. These include separating dissolved constituents into four categories, the organic and inorganic dissolved constituents in the water column and in interstitial water. In addition to these new state variables, we have gone from two to twelve channels for tracking exchanges of state variables with the surrounding environment. Although connectivity is not yet complete, these channels include exchanges with the atmosphere, upstream, downstream, tributaries, the streambed and materials added by way of overland flow or lost by water removal. In addition, changes of chemical state or the changing from organic nutrients to inorganic constituents or the reverse are also tracked.

Now more than one section of stream can be modeled, each with its own particular set of variables, stream characteristics and parameters. In doing this, the values for the materials that the model predicts as leaving the first section of stream are saved and used as input values for the second section of stream.

The model has gained in "generality" by going from modeling a square meter of stream to modeling a variable length section, with actual length to be decided upon at execution. Streamflow also is allowed to change during the simulation as opposed to the 1972 version, with a corresponding predicted change in ecosystem volume, surface area, depth, and velocity. Many other changes have come about by allowing flow to occur during time steps of simulation as opposed to the original version of between time steps.

As the streamflow changes, so does the host of materials flowing into the ecosystem; and it is now possible to monitor these changes either daily or in any size block of days, with the option of having blocks of data interpolated. Interpolation also occurs with many of the driving variables such as radiation and photoperiod.

Input data may be read either in the often-calculated square meter figure, or as total composition for the stream stretch in question. Output can also be varied, being reported as constituents per average square or cubic meter. In addition to the state variables reported last year, all allochthonous materials and materials leaving the system can be reported this year, as well as net productivity. These features make it possible to study the dynamics of the system, and are a further aid in future development of the model, as well as being an aid in better understanding the ecosystem.

One of the problems that is often overlooked or at least rarely mentioned, but nonetheless tends to be a major time consumer when working with large-scale models, is that of "bookkeeping," or making sure that numbers are where they should be when they should be. The problem grows with the number of individuals working on a particular model, as well as the size of the model. To be sure, the General Stream model has had its share of these difficulties, i.e. bookeeping, and not an overabundance of modelers, but by testing and retesting under a variety of conditions the components or modules that make up the model, this problem has been largely alleviated.

Other major changes have been restructuring of the processes of ingestion and assimilation, and growth, scouring and colonization of both plants and animals, the addition of behavioral drift of invertebrates, and the passage of dissolved materials between the water column and interstitial water.

INTRODUCTION TO MODELS

These models are intended to predict the values of a wide range of variables in the system simultaneously. They may be expected to lack the precision possible in a model intended for a special purpose; but by easy modification (module replacement -- see below) they can serve special purposes reasonably well. And the fact that all elements in the system are considered simultaneously (their prime function of the present state) makes it possible to do a variety of tests to which special-purpose models would not lend themselves, and thus they may serve as a guide to research priorities.

The ecosystem is envisaged as a horizontally homogeneous stretch of water, with the sediments below it, which may receive inputs from adjacent areas and provide output to other adjacent areas.

As a partial means of overcoming the assumption of horizontal homogeneity which is built into the model, the user has the option of linking simulated stream sections, each with its own specific set of state variables, stream characteristics and parameters. In using this option, the state variables which the model predicts as leaving the first section of the stream become the input for the second section, those outputs leaving the second section become inputs for the next section, and so on through an entire stream. This is accomplished by simulating the first section of stream for the period of time needed, while saving the daily output values on tape. This "writing" tape then becomes a "reading" tape for the next section for its entire simulation time.

MODULAR STRUCTURE

The models can be conceived as composed of a set of modules which act as "black boxes" to one another. For each, the inputs and outputs are determined by the general characteristics of the system, so that it operates on inputs and provides outputs which are part of the common "language". Internally, each of the modules or submodels may have a great variety of structure but this is a matter of indifference to the rest of the model, to which it is simply a "black box".

The modules are concerned with the various component parts or sets of processes in the system. Initially, these are the plants, the animals and the abiotic environment in which they exist. These modules or submodels may be further subdivided as required. Each submodel may be developed at different levels of detail, complexity and sophistication, and these alternative submodels can then be combined freely to give models which may be highly sophisticated in respect of some components, simple in others. At the present time each submodel has been developed at only one level of detail or complexity, and it is these with which this report deals.

THE VARIABLES

At the present time the main state variables modeled are the quantities of the different organic chemical constituents which make up the plants, animals, heterotrophic microorganisms, litter and the solute component of water, all of which may be divided in a variety of ways, and the inorganic constituents, either dissolved or in a particulate state.

Population data and their changes are also included, but as real variables representing an average rather than integral variables for a specific delimited region.

Exogenous variables include the materials entering the system from upstream drift and tributaries, which can be most of the state variables. Also included are the dates and daily quantities of precipitation events, with the average composition of the precipitation received; the average daily amount of solid material falling into the water from above, month by month, with its type and composition; the dates of events where overland flow enters the system, with the amounts of water, solutes and detritus of various types carried; the dates and amounts of water withdrawal (e.g., for irrigation); and mean monthly figures for radiation intensity at the water surface, photoperiod, and pan evaporation rate. This list is subject to modification as the model develops further.

CLASSIFICATION OF VARIABLES

In any ecosystem, the variables characterizing it may be classified in different ways for different purposes. Apart from the biological classification itself, one may classify different parts of the system as organ types, by age or stage of development, or by their topographical location, or according to whether they are quantities of chemical elements or population data. Plant and animal species may be classified not only according to their taxonomic position, but by life form, feeding habits, life history, etc. And all these different cross-classifications may be relevant to some part of the functioning of the ecosystem -- some of the processes leading to changes in the values of the state variables.

Cross-classification of state variables (and of some of the parameters of the system) is accordingly a dominant feature of the models. This makes it unnecessary to describe separately the processes in which each state variable is involved. Instead, it is necessary to give separate specifications only for those classifications and classes which are relevant to a particular process in question, all other classificatory sub-divisions of the state variables being ignored for this purpose. If, for instance, for a particular animal species, feeding habits are the same for mature and immature individuals, then the model uses a common description for feeding processes of the different age categories, while in that part of the model describing reproductive behavior it is clearly of first importance to distinguish these age categories.

FUNCTIONAL FORMS

Most of the variables being real, and most changes being continuous, it is usually appropriate to describe the rates of change in terms of differential equations, in which a derivative is equated to a function of state variables and exogenous variables. No restriction is placed, however, on the type of functions used; they may be linear or non-linear, with or without constraints. One very common type of constraint is imposed by the fact that most of the state variables (biomass, population, etc.) are in their very nature non-negative, so that the derivative must be non-negative where the value of a state variable is zero.

Though differential equations are the most common way of representing changes in the model, functions involving discontinuities (such as may be imposed by threshold values of influencing variables) or representing discrete processes are fully acceptable. The general structure of the models is also fully compatible with the introduction of stochastic elements in one or more of the submodels, as well as in exogenous variables.

COMPUTER IMPLEMENTATION

The computer representation of these models is written in FORTRAN IV. The intention has been to avoid features of FORTAN IV which might be peculiar to specific machines or installations so that the models developed might be widely usable. The programs are written as far as possible in general terms, so that they can be applied with minimal modification to a wide variety of ecosystems. In particular, the number of classes in each cross-classification of the data, and their designations, are decided at execution time, and facilities are also provided for specifying or modifying the parameters of the system at that time.

For computer solution, the differential equations expressing the rates of changes in the state variables are replaced by difference equations over a time step of one day. If the approximation by difference equations over this time unit leads to negative values of an essentially non-negative variable, the program reduces the time unit as required.

DESCRIPTIONS OF MODELS

Standardized descriptions of the programs and submodels are included in this report. Though the computer programs implementing the models are covered in these descriptions, their primary purpose is to describe the model itself in verbal and mathematical terms rather than the computer program -- which can speak for itself to those who are interested in the implementation as well as in the conceptualization.

After a brief introduction, a verbal and graphical description is given outlining the various processes treated. For each process submodel, the verbal description will be followed by a mathematical representation of the differential (or other) equations incorporated in the model. For these mathematical representations (which can be skipped by readers who are not mathematically oriented) a standard symbolism is being developed. Since the number of distinct variables and parameters required with proliferation of further submodels may be very large, it is not expected that it will always be possible to use consistently the same symbols for the same variables (or parameters) in all models, though this will be done as far as possible. Consistency is, however, being sought in respect of the classes of symbols, and in the use of subscripts, as follows:

1. State variables are designated by X, subscripted to indicate the particular state variable in question. It is intended to reserve $X_1 \ldots X_9$ for state variables having to do with plants, $X_{11} \ldots X_{19}$ for animals, $X_{21} \ldots X_{29}$ for the heterotrophic microorganisms, $X_{31} \ldots X_{39}$ for dissolved organic material, $X_{41} \ldots X_{49}$ for organic detritus, $X_{51} \ldots X_{59}$ for dissolved inorganic material, $X_{61} \ldots X_{69}$ for inorganic detritus, and $X_{71} \ldots$on for other state variables. It will be convenient to consider the exterior as specified by a series of dummy state variables, whose absolute values may be meaningless, but changes in which represent the exchanges of the ecosystem with its environment. These dummy state variables will be represented by $X_{01} \ldots X_{09}$.
2. Rates of change in state variables are represented by a superposed dot, as:

$$\dot{X} = \frac{dX_2}{dt}$$

3. Parameters of equations in the system -- values not changed by the system, though sometimes varying in step-wise fashion -- are indicated by a P.
4. Exogenous variables are signalled by a V, for instance:

$$V_{12}$$

5. Temporary variables: variables required in the course of calculation, or for purposes of explaining an algorithm -- are designated by a subscripted Z, as:

$$Z_2$$

6. Output variables -- those calculated from state variables for output purposes only, and playing no part in the dynamics of the system -- are signalled by Y, as:

$$Y_3$$

7. A sub-division of the rate of change of a state variable -- usually, a particular flux -- is indicated by an italic capital used as prior subscript. Thus,

$${}_{H}\dot{X}_2$$

may represent that part of the change in X which is attributable to herbivory, say -- that is, the direct flux from plant biomass to animal biomass.

8. Classes of variables or parameters are indicated by lower-case italic letters used as posterior subscripts. Thus, for a state variable classified in two ways (say, by animal species and cohort)

$$X_{1 1_{ah}}$$

would represent its value in the *a*'th species and the *h*'th cohort. The same subscripts may also be applied to parameters.

9. The following posterior subscripts have been standardized:

a	animal species
c	organic constituent
d	organic detritus types
g	plant organ
h	animal cohort
k	dissolved inorganic constituent
l	animal population
m	heterotrophic microorganism
n	particulate inorganic constituent
p	plant species
r	route of exchange
t	inorganic detritus types

10. For certain of these subscripts, different values have meanings which have been standardized in the descriptions of earlier versions of the submodels, as

organic constituent

$f = 1$	carbon
$f = 2$	energy
$f = 3$	nitrogen
$f = 4$	phosphorus
$f = 5$	other ash elements

inorganic dissolved constituents

$k = 1$	carbon pool
$k = 2$	nitrogen pool
$k = 3$	phosphorus pool

organic detritus

$d = 1$	fine
$d = 2$	coarse

route of exchange

$r = 1$	from atmosphere
$r = 2$	to atmosphere
$r = 3$	from overland flow
$r = 4$	by water removal
$r = 5$	from upstream
$r = 6$	to upstream
$r = 7$	from downstream
$r = 8$	to downstream
$r = 9$	from the streambed
$r = 10$	to the streambed
$r = 11$	from tributaries
$r = 12$	to tributaries
$r = 13$	chemical change within the ecosystem

11. Where it is useful to define a subset of subscript values, this subset is symbolized by an italic capital. Thus, of the set of chemical fractions or constituents indicated by the subscript *f* the subset containing the carbon fractions only is designated by

$$C = (3,4,5)$$

The subset of elements other than carbon is designated by

$$M = (1,2)$$

Operations limited to subset of values are indicated by the symbol ε thus,

$$Y_p = P_{1_p} X_{1_{pgf}} \quad , \quad p \varepsilon A$$

indicates that this function applies only to cases where the subscript *p* is included in the subset *A*; and

$$p \varepsilon A$$

indicates that summation is limited to these cases.

12. Some readers may not be familiar with the pi-product notation, parallel with the sigma notation for summation; thus,

$$\prod_{p=1}^{n} X_{1_{pgf}} \equiv P\, X_{1_{pgf}} \equiv X_{1_{1gf}} \cdot X_{1_{2gf}} \cdot X_{1_{3gf}} \cdots\cdots\cdots\cdots X_{1_{ngf}}$$

and

$$p \varepsilon A \quad X_{1_{pgf}} \equiv X_{1_{2gf}} \cdot X_{1_{4gf}} \cdot X_{1_{7gf}}$$

where the subset *A* is defined as:

$$A = (2,4,7)$$

13. Other conventions used consistently include the following: exp is an abbreviation for "exponential"; i.e.

$$\exp\ (a) = e^{a}$$

Ln is used for the natural or Napierian logarithm:

$$\mathrm{Ln}(a) = \log_e\ a$$

Max is the abbreviation for "maximum" and min is an abbreviation for "minimum", thus:

$$\min(X_4, X_5)$$

indicates the smaller of the values X_4 and X_5, while

$$\max(X_4, X_5)$$

indicates the larger of the two values. A subscript placed below max or min:

$$\max(X_{12_{sf}}, Z_{9_{sf}})$$

indicates that the expression which follows it should be evaluated for all values of the subscript, and the largest (or smallest) of the resulting quantities taken.

14. Since materials leaving by way of the downstream vector may become input to another simulated stretch of stream, changes in these output variables are tracked and signalled by $\dot{Y}$

15. The equation forms are those used in FORTRAN IV, where the right hand variable is equivalenced to the left hand side of the equation. Occasionally the same variable will be seen on both sides of the equation. Here the variable on the right side will have a previously assigned value, and after calculating the right side of the equation the answer is assigned to the variable on the left side of the equation. For example:

$$Z_2 = Z_1 X_{11_{hc}} \qquad (1)$$

$$Z_2 = Z_2 / X_{81} \qquad (2)$$

In equation (2) the right side of the equation is calculated using a value for Z_2 assigned in equation (1), and then the new value is assigned to Z_2.

The mathematical description is followed by a list of the symbols used, with their FORTRAN equivalents, units and a list of the equations in which that symbol is used. The means by which particular processes may be deleted or set for zero change are then discussed, followed by limitations imposed by array dimensions. The model description ends with a listing of the parameters and switches needed for that particular model. Program listings and examples of input and output may be found in the Appendices.

The following storage requirements (words) and simulation times (C.P.U.) are for the UNIVAC 1108 for the programs described.

Program	Code	Data	Total
MAIN	3319	7831	11150
REPORT	2193	789	2982
GRAF	533	3800	4333
EXTERN	1378	2255	3633
PHYSIC	662	200	862
VARIED	454	174	628
DYX	193	43	236
SENSIT	917	3346	4263
SENOUT	452	1880	2332
DERIVD	98	441	539
MEDIUM	1218	313	1531
ANIMAL	3155	929	4084
VEGET	1522	310	1832
TOTALS	16094	22311	38405

Besides the above, there is also a requirement for common storage, which is dependent on the needs of the user. The total core storage used for the example given (Appendix L) was 57,730 words.

The C.P.U. time required for initial input was 2.19 seconds; for each day of simulation between 0.150 and 0.162 seconds. In addition output for one time period in tabular form was 1.615 seconds, and between 0.358 and 0.368 seconds were required for each graph.

DESCRIPTION OF MODELS AND USER'S GUIDE

CALLING PROGRAM

INTRODUCTION

The computer program to be described in this section of the report provides a common framework for the aquatic models. It does not itself model the dynamics of the system -- a task performed by subroutines, which may be varied independently of the main program and of one another. The main program described below organizes most of the input operations, including the calculations of quantities required only as collective input to the subroutines, and performs the incrementation of the state variables in accordance with calculations performed by the subroutines.

The program is designed to cover a wide range of stream ecosystems in which the state variables consist of the weight of various organic chemical constituents and energy contained in plant material, subdivided by species or species group, and by organ group (though this last facility is not used in the present implementation); animals, subdivided by species or species group and by stage of development; different types of organic and inorganic detritus, suspended or in bottom sediments; and different types of heterotrophic microorganisms. The state variables also include the population of each animal group, and the dissolved composition of the water mass, along with certain physical characteristics of the water. Additional state variables may be introduced by the subroutines. The main program then treats them in the same way as the other state variables, and provides facilities for printing them out if wished. Exogeneous variables are acquired through the subroutine EXTERN, while output is organized by the subroutines REPORT and GRAF.

The parameters of the system (i.e., the constants incorporated in the equations expressing rates of change in the state variables) do not figure in this program, but are introduced in the programs implementing the process submodels, which are called as subroutines in the course of the main program discussed below.

This calling program, as stated above, is designed for use with a wide variety of process subroutines which may be developed in the future. The process subroutines in use at present, however, do not make use of certain of the options provided. A listing of the calling program can be found in Apendix B. An example of an input deck can be found in Appendix K, and output in Appendix L.

INPUT ORGANIZATION

The successive cards required for input, many of which are optional and determined by the special requirements of the model in question, are detailed below. Constraints are placed on these input data by the array sizes of this report.

I. *Comments and Table Heading*

Any comments to be associated with the output may be printed out before the output proper by inserting cards bearing the comment information at the beginning of the input deck. These cards should finish with a blank, or be replaced by a blank if no comments are needed. The blank ending the comments is followed by a single card providing a heading for tabular output.

II. *Instruction Cards*

II.A Dimensions, specifications, input/output instructions and switches

The next three cards contain (in 16I5 format) the following information in successive fields of five columns, right justified (the FORTRAN name is included in brackets):

Card one

1. The number of plant species or species groups [NSPECV]
2. The number of animal species or species groups [NSPECA]
3. The number of plant organs or organ groups distinguished (one for the model being described) [NORGAN]
4. The number of inorganic particulate elements or compounds [INORGP]
5. The number of dissolved inorganic elements or compounds [INORGD]
6. The number of types or sizes of organic detritus distinguished; the same list of detritus types applies both to suspended as well as benthic sediments [NOLIT]
7. The number of names to be read in for animal cohorts or stages of development [NCHOR]
8. The number of types of heterotrophic microorganisms [MICROB]
9. The time step for simulation (in thousandths of a day); if this field is non-positive, the time step is taken as one day (one-day time steps are used in the models described by this report) [NUNIT]
10. The number of entries in the "Instructions" array (see II.C below) to be passed to the subroutines [NOINST]
11. The number of entries in the "Repetitions" array, determining the time units for the subroutines (II.D below); if this value is zero, all subroutines are assumed to use the same time units as the main program -- that specified in II.A.9 [NOTIME]
12. The number of types or sizes of inorganic

detritus distinguished; the same list of detritus types applies both to suspended as well as benthic sediments [ISTRTM]

13. The numerical designation of the section of stream being simulated. If this value is more than "1" all values for materials entering the ecosystem are read from tape [NSTRCH]
14. The logical unit number where values of constituents flowing downstream are to be saved, or zero if the values are not to be stored [JSAVE]
15. The number of organic constituents distinguished (includes energy in kcal) [NFRELM]
16. A switch pertaining to tributaries flowing into the section of stream being simulated. "0" (zero) indicates no tributaries; "1" indicates values for materials entering from tributaries will be read from cards; "2" indicates materials entering from tributaries will be calculated from material flowing in the main stream [NTRIB] (See also III.A of subroutine EXTERN)

Card two

17. The starting date of the run, counting from the beginning of the year [JDAY]
18. The year in which the run is to begin [IYR]
19. The number of the day on which the run is to finish, counting from the beginning of the year in which the run starts [NDAY]
20. The number of tabulated reports required after the initial reports [NREP]
21. The number of line graphs required [NOGRAF]
22. The number of block graphs required [NOHIST]
23. A switch which allows for state variable output to be specified in square meters (when "2") or cubic meters (when "3") [NPORT]
24. A switch which allows for initial state variable input to be read for the total ecosystem (when "0"), or to be calculated from square meter averages (when "1") [NDATSZ]
25. The numerical designation (see IV.D) of the organic constituent (less than or equal to NFRELM [II.A.15]) which is to be reported in tabular output as material entering or leaving the ecosystem [NPORTI]

Card three

26. A switch for debugging purposes; if this is positive, extra information is printed out by many of the subroutines in the course of their operation, from day of simulation it specifies [MDEBUG]
27. A switch to complete the debugging operation begun under the previous instruction. If this value is less than that in the previous field, the debugging operation will continue to the end of the run [LDEBUG]
28. A switch for timing purposes; if this switch is zero, no timing information will be included in the output; if it is set at "1", timing information will be given for each report and graph produced; if it is set at "2", the C.P.U. time for each time unit simulated will be reported [NOSECS]
29. A switch which must be positive if error sensitivity analysis is to be performed [ISENSE]
30. A switch for tabular reports [NOREP]: 0 = initial and final reports, together with reports on any intermediate dates specified; 1 = all tabular reports are to be omitted; 3 = the initial report is to be omitted
31. This and the next field give facilities for a portion of the parameter list to be printed before simulation starts. If the value in this field is positive, it causes values in the COMMON block /PARAM/, from this address onwards, to be printed out as soon as they have been read in by the process subroutines [IPARAM]
32. This field gives the last address for values in the COMMON block /PARAM/ to be printed out under control of the switch II.A.31 above [JPARAM]
33. A switch to provide (when positive) for the state variables to be read (in binary form) from a mass storage file designated as Unit 0, instead of from cards [NEWBEG]
34. A switch to provide for the state variables to be dumped at specified times, in binary form, into mass storage files designated as Unit 10, Unit 11, etc. The number of such dumps is punched in this field [KDUMP]
35. If the previous field (II.A.34) is occupied, the dates (from January 1, etc., in the first year of simulation) on which dumps are to be made are specified in these fields. The dates must be in order, and the number of fields occupied is equal to the number in II.A.34 [DUMP(I)]

II.B **Tabulated report dates**

If the value at II.A.2 is positive, one or more further cards in format (16I5) are read in giving the dates (calculated from the beginning of the year in which the simulation starts) at which tabulated reports will be required. The number of such entries will be equal to the figure in II.A.20. If II.A.20 is zero, only initial and final reports will be provided (see also II.A.30).

II.C **Instructions to subroutines**

If II.A.10 is positive, a number of integers equal to the value in this field is read in, in (16I5) format.These entries may be used for communicating with subroutines at execution time, and conveying instructions modifying their mode of operation.

II.D Repetitions of subroutines

If II.A.11 above was occupied by a positive value, a series of cards equal in number to the value in this field is read in. Each of these cards has in the first field of five columns a number, right-justified, representing one of the subroutines ("1" for VEGET, "2' for ANIMAL, and "3" for MEDIUM; other designations will be allotted later as required); the second field of five columns (6-10) contains, similarly right-justified, the number of times this subroutine is to be repeated within each of the time units simulated -- or, in the case of a nested subroutine, within each operation of the subroutine which calls it. In other words, this provides a facility for varying the time units within subroutines, but limited to integral submultiples of the time unit used within the main program.

II.E Transformations of elements and compounds

The constituents that make up the ecosystem are described and used as being in one of two chemical states. Both have compartments which may be either particulate or dissolved. They are: (1) organic constituents, which are those that make up the plants, animals, decomposers or the fraction of detritus originating from those compartments, and (2) inorganic constituents which, as an example, may be clays and sands in the particulate form or carbon dioxide in the dissolved form. To allow for cycling, or changes of chemical state of constituents within the ecosystem, or the use of a particular element in an array, a series of switches is used which can be varied at execution time. For example, the carbon used in photosynthesis can come from a different number of inorganic sources, with the following switches allowing for this type of choice. [All cards are in 16I5 format.]

Cards 1 through 5 are five "sets" of switches which are used when one's interest is the organic elements. The switch indicates from what particular position in an array (say from inorganic dissolved constituents) a particular organic constituent will come from or go to. For each card the number of switches is equal to the number in II.A.15. Cards 6 through 10 are used when the inorganic particulate categories are the main interest. For each card the number of switches is equal to the number in II.A.4. Cards 11 through 15 are used for the inorganic dissolved categories. For each card the number of switches is equal to the number in II.A.5. In the models to be described only the first two sets of switches are used (although 15 cards must be read in), the first for the transfer during respiration of organic constituents to the dissolved inorganic categories, and the second card for the transformation from inorganic dissolved elements to the elements which make up the plants during photosynthesis. If, for example, during a particular simulation the plants are made up of carbon, energy and nitrogen, and the dissolved inorganic elements which are being modeled are calcium bicarbonate, carbon dioxide, carbonic acid, oxygen and a nitrogen pool, the set of switches on the first card would read: 2 0 5

In this case the carbon for photosynthesis would come from carbon dioxide and the nitrogen from the nitrogen pool. [Energy sources come from outside the system.]

II.F Information to be reported

For each tabulated report desired, all or part of the available data may be listed as output. This is controlled by a series of switches in the first 26 columns of the next input card. A "1" in a particular column allows for the printing of a section, while a zero will cause a section to be skipped.

1. Physical stream characteristics
2. Biomass of plant constituents
3. Biomass of animal constituents
4. Animal populations
5. Biomass of heterotrophic microorganism constituents
6. Amounts of suspended litter categories
7. Amounts of benthic litter categories
8. Amounts of dissolved organic elements
9. Average quantities of organic matter in the ecosystem
10. Net gain or loss of organic matter to the ecosystem
11. Amounts of suspended inorganic particulate matter
12. Amounts of benthic inorganic particulate matter
13. Amounts of dissolved inorganic matter
14. pH and temperature
15. Net gain or loss of inorganic matter to the ecosystem
16. Plant biomass entering and leaving the ecosystem
17. Animal biomass entering and leaving the ecosystem
18. Animal numbers entering and leaving the ecosystem
19. Heterotrophic microorganism biomass entering and leaving the ecosystem
20. Amounts of litter entering and leaving the ecosystem
21. Dissolved organic material entering and leaving the ecosystem
23. Suspended inorganic material entering and leaving the ecosystem.
24. Net productivity of plants from the beginning of the simulation
25. Net productivity of animals from the beginning of the simulation
26. Net productivity of heterotrophic microorganisms from the beginning of the simulation

II.G Stream length

One card is read (F10.2 format) specifying the length of the stretch of stream being simulated [REACH].

III. *Stages of Development*

If the value in II.A.7 is greater than one:

1. A card is read in with the number of distinct stages of development for each species of animal, in (16I5) format. The number of entries should equal the number of animal species or groups in II.A.2.
2. This card is followed by one card for each species defined in (1) as having more than one stage of development, and less than the maximum number specified

in II.A.7. Each of these cards contains, in (16I5) format, the numerical designations of these stages of development, corresponding with the names to be used for them in output (see IV.E below).

IV. *Names*

IV.A

If plants occur in the system (if the value at II.A.1 is positive), the names of plant species or groups are read in, two to a card, with up to 28 characters for each (i.e., the fields used are columns 1-28 and columns 29-56). The number of these names should correspond with the value in II.A.1.

IV.B

If there are animals present (if the value at II.A.2 is positive), the names of animal species are read in, in the same way as those for plant species. They should correspond in number with II.A.2.

IV.C

If plant organs are to be distinguished (i.e., if the value at II.A.3 was positive) the names of these organs or organ groups are read in, three to a card, with up to 24 characters for each (i.e., the fields used are columns 1-24, 25-48 and 49-72). Differentiation of plant organs cannot be used in the models presented in this report.

IV.D

The names of organic chemical constituents are read in, up to 12 characters for each, and in (20A4) format. Carbon has the first and energy the second place in the list. The number read in should match the number of II.A.15.

IV.E

If the value at II.A.7 is greater than one, the names of the stages of development for animals are read in, five to a card, each with up to 16 characters (i.e., the fields used consist of columns 1-16, 17-32, 33-48, 49-64, and 65-80). The number of entries is equal to the value at II.A.7.

IV.F

If the value at II.A.6 is positive, the names of different types of detritus are read in, following the same format as for stages of development (IV.E above). The number of entries is equal to the value in II.A.6.

IV.G

If the value at II.A.8 is positive, the names of different groups of heterotrophic microorganisms are read in, following the same format as for stages of development (IV.E above). The number of entries is equal to the value at II.A.8.

IV.H

If the value at II.A.4 is positive, the names of the inorganic particulate categories are read in, following the same format as for reading plant organ names in IV.D above. The number of entries is equal to the value at II.A.4.

IV.I

If the value at II.A.5 is positive, the names of the dissolved inorganic categories are read in, following the format in IV.D above. The number of entries should equal the value in II.A.5.

IV.J

If the value at II.A.12 is positive, the names of the different types or sizes of inorganic particulates are read in, following the format in IV.D above. The number of entries should equal the value in II.A.12.

V. *Initial Values of State Variables*

The cards in this section give values for the state variables at the starting point of simulation. The quantities of the various chemical constituents may be read in grams per square meter or grams per total ecosystem (see II.A.24). All values are in (8F10.4) format. For each card specifying organic chemical constituents (V.A to V.G below) the number of values should equal the number specified in II.A.15, and in the order specified in IV.D.

V.A

For each plant species group and each of the organ types, a card is read in with the initial values of chemical constituents. The first species is taken first, and cards equal in number to the number of organs (II.A.3 above) -- assumed one, if this entry was zero -- are read; these are followed by a similar set for the second species, and so forth. The total number of such cards should accordingly be the value at II.A.1 multiplied by that at II.A.3 if positive.

V.B

For each animal species a card or series of cards is read in giving the population figures for successive stages of development (the number of such figures being equal to the corresponding entry in II.A.2). Then there is a sequence of cards, equal in number to the corresponding entry in III.A.1, each containing the quantitiy of chemical constituents for each of the successive stages of development.

V.C

If the figure at II.A.8 is positive, a series of cards is read in for the quantity of chemical constituents in the different types of heterotrophic microorganisms, one for each type, equal in number to the value at II.A.8.

V.D

One card is read for each of the organic detritus types, giving the quantity of the various chemical constituents in suspended material of this type. The total number of such cards is equal to the figure in II.A.6.

V.E

The quantity of chemical constituents in the diferent types of detritus in the bottom sediments is read in, in a series of cards parallel with those for suspended detritus in V.D.

V.F

One card for the quantity of organic chemical constituents dissolved in the water column is read in.

V.G

One card for the quantity of organic chemical constituents dissolved in the benthos (interstital water) is read in.

V.H

A series of cards equal in number to the value specified in II.A.12 is read in, with each card containing the values of the inorganic suspended particulate materials in the same order as specified in IV.H.

V.I

A parallel series of cards to V.H is read in, this time of the inorganic benthic particulate materials.

V.J

One card is read in for the quantity of inorganic chemical constituents dissolved in the water column. The number of values should equal the number in II.A.5.

V.K

One card is read in for the quantity of inorganic chemical constituents dissolved in the benthos (interstitial water). The number of values should equal the number in II.A.5.

VI. *Parameter Input Required by Subroutines*

Each of the process subroutines may require parameters and other specifications to be read in. Where such information is needed, reading is performed by a NAMELIST statement. The first card for each reading operation begins with

b$NAMEb

where NAME represents the name of that NAMELIST in the subroutine in question, and b represents a blank column. This and subsequent cards then contain entries in the forms:

$$A = a, \quad B(3) = b, \quad C = c,d,e, \quad n^*f,$$

where A is the name of a variable and B and C are names of arrays included in the NAMELIST; *a, b, c, d, e, f,* are constants of the appropriate type; n is an integer, which allows n values of *f* to be inputed into an array. The first column of each card must be a blank. Each NAMELIST input is concluded with

b$END

For this purpose, the NAMELISTS are called in the order, EXTERN, PHYSIC, MEDIUM, ANIMAL, and VEGET. The list of parameters needed for the subroutines covered by this report can be found in the description for the subroutine in question with a partial explanation in the definitions lists (Appendix A).

VII. *Specifications for Graphical Output*

VII.A

If the value at II.A.21 is positive, a series of cards is read in specifying the line graphs required. For each of the graphs in succession, the following cards are needed:

1. A card specifying which variables are to be graphed. These are expressed as addresses in the state variables array (COMMON block /PRINTS/); the addresses in the sums array for state variables (COMMON block /TOTALS/) increased by 10,000; the addresses in the external exchange array (COMMON block /ACC/) increased by 20,000; the addresses in the sums array for productivity (COMMON block /PROSUM/) increased by 30,000; the addresses in the total productivity array from the beginning of the simulation (COMMON block /PRODUC/) increased by 50,000; or the addresses in the array of additional accessible variables (COMMON block /OTHER/) increased by 60,000. These addresses are punched in (16I5) format, and may not exceed eight in number for each line graph.
2. A title card for the graph; all 80 columns may be used.
3. A title for the Y-axis of the graph (the X-axis always being in days). This title may occupy columns 1-40 of the card. If the word "ZERO" is punched in columns 41-44, the Y-axis of the graph will include zero; otherwise, it will extend from the minimum to the maximum value of the variables graphed.
4. If VII.A.1 designates more than one variable, these are followed by a series of cards equal in number to the entries in VII.A.1. Each card gives a brief explanation of one of the variables included in the graph, in the same order as their addresses are listed in VII.A.1. Twenty characters are allowed for each, which should be in columns 1-20 of the card.

VII.B

If the value at II.A.22 is positive, the following cards are required for each graph.

1. A card specifying the variables for which block graphs are desired; these addresses are coded according to the same rules as in VII.A.1.
2. A title card for the graph; all 80 columns may be used.
3. A title card for the Y-axis, limited to the first 40 columns of the card.

VIII. *Sensitivity Specifications*

If the value at II.A.29 is positive, specifications for sensitivity tests are read in. These are discussed in the report on the sensitivity subroutines (Noy-Meir, 1973). Listings of these subroutines can be found in Appendix G.

IX. *Exogenous Variables*

After all other information has been inputed, the exogenous variables are read in. This input is discussed in connection with the EXTERN subroutine.

OPERATION

The central part of the program is responsible for incrementation of the state variables. When calculation of all the increments over a single time unit (of which submultiples may be used for some of the subroutines) has been completed, they are tested to ensure that none of them would cause state variables to become negative, where this constraint is appropriate (which is true of most state variables in ecological systems). If some of the negative increments are "too large" in this sense, all increments are scaled down in such proportions as the most limiting constraint requires, the increments are applied to all state variables, and the subroutines are called again for the recalculation of increments. These increments are then multiplied by the complement of the proportion already applied to the state variables, and the test of their magnitude is repeated. The process continues until a set of increments can be applied *in toto*. Briefly, this is equivalent to dividing the time unit over which the difference equations approximate the underlying differentials into arbitrary portions such that the constraints can be met. This process, central to the program, may be represented as follows: let X_{ij} be the value of the *i*'th state variable at the beginning of the *j*'th iteration, and ΔX_{ij} the increment for one time unit as calculated by the subroutines for that iteration. Then:

$$X_{i,j+1} = X_{i,j} + t_j X_{i,j}$$

where:

$$t_j = -(\quad (-1 \quad \frac{\Delta X_{ij}}{X_{ij}}))^{-1}$$

Iteration is completed when:

$$\sum_j t_j = 1$$

Exchanges between the ecosystem and its surroundings are accumulated by the calling program from data provided, time unit by time unit, by the subroutines. These quantities, together with any state variables not constrained to take non-negative values, are incremented in proportion to the increments mentioned in the previous two paragraphs, so that the whole program is operating in time units shorter than that prescribed whenever this proves necessary.

In order to avoid difficulties when a state variable gradually approaches zero, an arbitrary limit is set below which that variable is set to zero. This limit for the aquatic program is set to 0.000000001. In addition, if one of the variables of a plant, animal or microorganisms group is set to zero, all other variables of that group are also set to zero.

Sums of state variables for all classes and many combinations of classes are required for output, and may also be needed for sensitivity analysis. These summations are performed by the main program initially, and at present after each time unit of simulation if graphical or tabular output is required. If summation is required for sensitivity analysis, the user is cautioned to remove statements MA1560 and MA2005 (Appendix B).

The calling program also calculates state variables from input data in the case where input data is in grams per square meter, simply by multiplying input data by the area. Also, state variables may be divided by the area if output is wished in grams per square meter, or by the volume if desired output is grams per cubic meter.

If the stream section being modeled will receive inflowing materials from upstream by way of a previously simulated stream section (if II.A.13 is greater than 1) a reading tape must be available to the system (logical unit 9). Similarly, if the values from the simulated stream section are to be saved for subsequent sections, a writing tape must be available and is designated as logical unit 8.

ARRAY DIMENSIONS

The use of the program is limited by the dimensions allotted to the arrays, and these limitations need discussion

```
AAQUA(C)
AAQUAB(C)
ABDINR(K)
ABPINR(E,J)
ACBACT(G,C)
ACBIOM(A,C\
ACLIT(D,C)
ACORG(D,C)
ACVEG(F,L,C)
AGAIN(L,C)
AGAINQ(L,C)
AGAINT(C)
ALINAM(D,4)
AMAXI(M)
AMINI(M)
ANIM(B,C)
APBACT(G,C)
APBIOM(A,C)
APOP(A)
APVEG(F,L,C)
AQUA(C)
AQUAB(C)
AQUABQ(C)
AQUAQQ(C)
AQUATT(C)
ASPNAM(B, 7)
AVEIND(A)
AWDINR(K)
AWPINR(E,J)
BACNAM(G,4)
BDINR(K)
BDINRQ(K)
BPINR(E,J)
BPINRT(J)
BPINRQ(E,J)
CBACT(G,C)
CBACTP(G,C)
CBACTQ(G,C)
CBACTT(C)
CBIOM(A,C)
CBIOMA(C)
CBIOMP(A,C)
CBIOMQ(A,C)
CGAIN(L,J)
CGAINQ(L,J)
CGAINT(J)
CHNG(S)
CLIT(D,C)
CLITQQ(D,C)
CLITT(C)
COHNAM(J,4)
COMPIN(C)
CORG(D,C)
CORGQQ(D,C)
CORGT(C)
CVEG(F,L,C)
CVEGO(F,C)
CVEGQQ(F,L,C)
CVEGV(L,C)
CVEGVO(C)
CVEGP(F,L,C)
DADUST(D,C)
DECINC(Q)
DECP(R)
DETIN(D,C)
DGAIN(L,K)
DGAINQ(L,K)
DGAINT(K)
DINAM(K,3)
DNORG(K)
DRIFPO(A)
DRIFTA(A,C)
DRIFTM(G,C)
DRIFTV(F,L,C)
DUSTIP(E,J)
EVERY2(U)
EXOG(A)
EXPLA(5,Q)
EXPLAN(5,N)
FIG(Q,70)
FIGS(N,70)
FLOGO(V)
FRANAM(C,3)
H2O(L)
H2OQQQ(L)
INSTRU(Y)
KINRGD(5,K)
KINRGP(5,J)
KORGSW(5,C)
LIGRAF(N)
LISTER(M)
MGRA(O)
MREP(P)
NCOH(B)
NCOHCU(B)
NDRIFA(A)
NDRIFM(G)
NDRIFV(F)
NPRT(Z)
OMORE(X)
ORGNAM(L,6)
PASUMA(C)
PASUMS(B,C)
PATOTA(C)
PATOTS(D,C)
PBSUM(C)
PBTOT(C)
PCBACT(G,C)
PCBIOM(A,C)
PCVEG(F,L,C)
PINAM(J,3)
PINRTT(J)
PNORG(E,J)
POP(A)
POPQQQ(A)
POPSP(B)
PRTOUT(Q)
PRTP(R)
PSTAT(R)
PVSUM(C)
PVTOT(C)
RAINCO(C)
RAINDI(K)
RUNDEB(D,C)
RUNDNR(K)
RUNPNR(E,J)
RUNSOL(C)
SOURCE(5,L)
STATE(Q)
STNG(S)
STRNAM(E,3)
SUMPR(W)
SUMS(T)
TCOMPN(C)
TDETIN(D,C)
TDNORG(K)
TDRIFA(A,C)
TDRIFM(G,C)
TDRIFO(A)
TDRIFV(F,L,C)
TITLES(M,20)
TOT(C)
TOTAL(C)
TPNORG(E,J)
VSPNAM(F,7)
WDINR(K)
WDINRQ(K)
WDINRT(K)
WPINR(E,J)
WPINRQ(E,J)
WPINRT(J)
XCOMPN(C)
XDETIN(D,C)
XDNORG(K)
XDRIFA(A,C)
XDRIFM(G,C)
XDRIFO(A)
XDRIFV(F,L,C)
XPNORG(E,J)
YAXISS(M,10)
```

so that the user may be in a position to modify them as his particulr requirements indicate. Above is a list of arrays included in the calling program, in which the dimensions which may appropriately be varied are indicated by letters. Dimensions of other arrays, and dimensions indicated by numbers, are subject to other constraints, and changes in them could call for other changes in the program.

The dimensions indicated by letters define the maximum values possible for the following quantities:

		FORTRAN NAME
a	Total number of animal cohorts or size classes	NSPCOH
b	Number of animal species or groups	NSPECA
c	Number of organic components tracked (including energy)	NFRELM
d	Number of types of organic detritus	NOLIT
e	Number of types of inorganic detritus	ISTRTM
f	Number of plant species	NSPECV
g	Number of types of heterotrophic microorganisms	MICROB
h	Number of plant organ types	NORGAN
i	Number of different names for animal cohorts	NCHOR
j	Number of inorganic particulate components tracked	INORGP
k	Number of dissolved inorganic components tracked	INORGD
l	Number of channels for gain or loss to or from the system	NCHAN
m	Number of separate graphs	NOHIST
n	Number of variables to be graphed	
o	Number of curves on a single graph	
p	Number of tabulated reports to be provided	NREP
q	Total number of words in common blocks STAT, CHANGE, and PRINTS	LIMIT
r	Total number of words in common blocks PRODUC, PRODCH, and PRINTP	LIMPRO
s	Total number of words in common blocks ACC and ACCINC	LIMACC
t	Total number of words in common block TOTALS	LIMTOT
u	Total number of words in common block EVERY1	LIMEVR
v	Number of possible materials flowing in and out of the system	NPASS
w	Total number of words in common block PROSUM	LIMSUM
x	Total number of words in common block OTHER	
y	Number of instructions to be transferred to subroutines	NOINST
z	Total number of sections in each report	

It should be noted that, if the dimensions of any of the arrays in the common blocks are changed, not only must these blocks be changed in any subroutines where they occur, but the arrays equivalenced with the common blocks must be changed to correspond, as also the variables specifying their limits where applicable. Thus,

Common Block	Array	Limit
ACC	STNG	LIMACC
ACCINC	CHNG	
PRINTS	PRTOUT	LIMIT
STAT	STATE	
CHANGE	DECINC	
TOTALS	SUMS	LIMTOT
PRINTP	PRTP	LIMPRO
PRODUC	PSTAT	
PRODCH	DECP	
OTHER	OMORE	
PROSUM	SUMPR	LIMSUM
EVERY1	EVERY2	LIMEVR

Also, the variables FLOSEC, COMPIN, DETIN, DRIFTV, DRIFPO, DRIFTA, DRIFTM, PH, PNORG, DNORG, and WTEMP of the /METEOR/ common block are equivalenced with the array FLOGO with the limit being specified by NPASS. Since another part of the /METEOR/ common block is equivalenced in the subprogram EXTERN, care must be taken in adding variables or rearranging the present variables in this common block.

Arrays that must match in their order and dimensions are as follows (as read across):

CVEG	CVEGQQ	ACVEG
CORG	CORGQQ	ACORG
POP	POPQQQ	APOP
CBIOM	CBIOMQ	ACBIOM
AQUA	AQUAQQ	AAQUA
CLIT	CLITQQ	ACLIT
CBACT	CBACTQ	ACBACT
AQUAB	AQUABQ	AAQUAB
WDINR	WDINRQ	AWDINR
WPINR	WPINRQ	AWPINR
BDINR	BDINRQ	ABDINR
BPINR	BPINRQ	ABPINR
PCVEG	CVEGP	APVEG
PCBIOM	CBIOMP	APBIOM
PCBACT	CBACTP	APBACT
AGAIN	AGAINQ	
H2O	H2OQQQ	
CGAIN	CGAINQ	
DGAIN	DGAINQ	
COMPIN	XCOMPN	
DETIN	XDETIN	
DRIFTV	XDRIFV	
DRIFPO	XDRIFO	
DRIFTA	XDRIFA	
DRIFTM	XDRIFM	
PNORG	XPNORG	
DNORG	XDNORG	

SUBROUTINE REPORT

At times when tabulated output has been requested, the values of all state variables may be printed together with their sums. The tabulated report may also include, on all occasions except the initial report, a listing of elements or compounds exchanged with the ecosystems surroundings, and of productivity for the major trophic levels.

Since one may be interested in only certain aspects of the ecosystem, the user has the option of printing in tabular form only those areas of interest. For these options, refer to the calling program sections II.A.30 and II.F.

There are no dimension limitations particular to this subroutine. A listing of this subroutine can be found in Appendix C.

SUBROUTINE GRAF

Graphical output is available on the line printer, in the form of either line or block graphs, in each case occupying a single printer page. Line graphs use continuous strings of the symbols A,B,...H, to represent the time course through the simulation of up to eight different variables. All are plotted on the same scale, which is adjusted so that the extreme values attained can just fit into the page. In the block graphs, the time course of a single variable only is plotted. Each type of graph is provided with the appropriate title.

The X-axis of the graph is always the time in days. The Y-axis is scaled so that all values graphed are within the range $-10 < y < +10$, and an integral power of 10 is specified in the title as the scaling factor. If the values extend outside the limits $\pm 10^{10}$, an error message results. If all values of Y are identical, a small range of Y values around this point is graphed.

The graphs are printed after the final tabulated report. Refer to section VII.A.1 of the calling program for a listing of the variables for which graphs are permitted.

There are no dimension limitations subject to change by the user. A listing of this subroutine can be found in Appendix D.

SUBROUTINE EXTERN

INTRODUCTION

Subroutine EXTERN provides for the initial input of meteorological and other exogenous data and for the supply of values of these variables to the process subroutines requiring them. A listing of the subprogram can be found in Appendix E.

INPUT ORGANIZATION

The list of parameters needed (previously read as input, see section VI of the calling program) are included in the following list. Explanations can be found in the definitions list (Appendix A).

APWIDE
LIMEXO
PHB
PHW
TEMPB
TEMPW
TRBFAC
TRBH2O

The input required when this subroutine is called occurs after all other inputs. Unless otherwise stated all cards are in (8F10.4) format, and the values in grams per cubic meter of water. For each of the cards having to do with organic constituents, the number of values should equal the number specified in II.A.15 of the calling program and in the order specified in IV.D of that same program. The cards or groups of cards required are as follows:

I. *Variables from the Atmosphere, Overland Flow, and for Water Withdrawal.*

I.A

Organic detritus falling into the system from above. For each month of the year, a series of cards equal in number to the value at II.A.6 of the calling program is read in, providing for the quantity of each chemical constituent (in grams per square meter of surface area) contained in a particular detritus type.

I.B

Inorganic detritus falling into the system from above. For each month of the year a series of cards equal in number to the value at II.A.12 of the calling program is read in, providing for the quantity of each inorganic chemical constituent (in grams per square meter of surface area) contained in a particular detritus size class or category. Each card should have the same number of values as specified in II.A.4 of the calling program and in the order specified in IV.H of that program.

I.C

In format (16I5), values for:

1. Number of days for which precipitation is recorded.
2. Number of days for which surface flow from adjoining land surfaces is recorded.
3. Number of days on which water is withdrawn for irrigation or other purposes.

I.D

If the figure in I.C.1 above is positive, the following block of cards is read:

1. The dates (from the beginning of the starting year) of precipitation events are recorded, in 16I5 format.
2. The quantities of precipitation (in mm water) on the dates specified in I.D.1 above are read in.
3. One card is read in which includes the dissolved organic elements in rain water.
4. One card is read in which includes the dissolved inorganic elements in rain water.

I.E

If the figure in I.C.2 above is positive the following block of cards is read:

1. In format (16I5), the date (from the beginning of the starting year) of surface flow events.
2. The quantities of water imported (in cubic meters) on the dates specified in I.E.1.
3. For each date specified in I.E.1 the following cards are read:
   a. The amounts of dissolved organic material imported on each surface flow event.
   b. The amounts of dissolved inorganic material imported on each surface flow event.
   c. A series of cards (equal to the number in II.A.6 of of the calling program) with the amounts of the constituents of the different organic detritus types.
   d. A series of cards (equal to the number in II.A.12 of the calling program) with the amounts of the inorganic particulate elements of different types or size classes.

I.F

If the figure of I.C.3 is positive, the following cards are read:

1. The dates (from beginning of the starting year) on which water is withdrawn.
2. The amounts (cubic meters) of water withdrawn on the dates specified in I.F.1 above.

I.G

Two cards giving the monthly mean pan evaporation rate per day (in mm).

I.H

Two cards giving the monthly mean photoperiod per day (in hours).

I.I

Two cards giving the monthly mean radiation intensity (kcal per meter square per hour).

If II.A.13 of the calling program is equal to or greater than "2", materials in the water column entering the system as drift or suspended material are read in from tape (logical unit number "9"). Information concerning the running of more than one section of stream can be found under Operation of the calling program and limitations under Array Dimensions below, and the user should skip the following input concerning the materials from upstream. If the values at II.A.13 and II.A.16 are both 1, and more than one block of data for either will be read in, the user is cautioned to read the section on Operation below.

II. *Materials from Upstream*

If the value at II.A.13 of the calling program is 1, the following cards are read:

II.A

Daily values for the stream discharge in cubic meters per second (366 values).

II.B

For each block of data on inflowing material the following cards are needed:

1. A card in 20I5 format containing
   a. A number signifying the number of days for which a block of inflowing data will be used.
   b. A switch which indicates the use of a block of inflowing data:
      "1" = no interpolation
      "2" = interpolation with the next set of data
      "3" = interpolation with the previous data set
      "4" = interpolation with the previous data set as well as the next data set (see Operation below).
2. The concentration of dissolved organic nutrients or elements.
3. A card for each litter category specified in II.A.6 of the calling program specifying the elemental concentration of that category.
4. For each plant species group a card is read in with their concentrations of chemical constituents. The total number of cards read should be the same as read in V.A of the calling program.
5. For each animal group or cohort a card is read in with their populations and concentrations of chemical constituents. The number of cards should be the same as for the initial state variables for constituents read in at V.B of the calling program. Populations are punched in columns 1 to 10 and the constituents from 11 on.
6. For each heterotrophic microorganism category (II.A.8 of the calling program) a card is read in with their concentrations of chemical constituents.
7. One card is read in with the water temperature (Celcius) and pH.

8. For each inorganic particulate litter category (II.A.12 of the calling program) a card is read in with the concentrations of matter for that category. The number of concentrations for each card should equal the number of specified in II.A.4 of the calling program.
9. One card is read with the concentrations of dissolved inorganic elements or compounds, the number corresponding to II.A.5 of the calling program.

III. *Materials from Tributaries*

III.A.

If the value at II.A.16 of the main calling program equals "1", the following cards are read for each block of data:

1. A card in 15 format containing the number of days a block of data is to be used.
2. The discharge in cubic meters per second.
3. The concentrations of dissolved organic nutrients or elements.
4. Litter material as specified in II.B.3.
5. Plant material as specified in II.B.4.
6. Animal material as specified in II.B.5.
7. Heterotrophic microorganisms material as specified in II.B.6.
8. Inorganic litter as specified in II.B.8.
9. Dissolved inorganic material as specified in II.B.9.

If the value at II.A.16 of the main calling program equals "2", the parameters TRBFAC and TRBH20 must be set. Explanations can be found in the definitions list (Appendix A).

OPERATION

After input cards have been read in (including a set of materials from upstream and from tributaries if II.A.13 and II.A.16 of the calling program are "1") control returns to the main program. The subroutine is called again at the entry point EXOGE2 whenever a new day is simulated. If rainfall, surface flow, or water withdrawal occurs on that day, the appropriate values are transferred from storage to the METEOR common block. Similarly, appropriate monthly values for other meteorological variables are transferred.

If more than one block of data for materials from upstream and from tributaries is available, care must be taken to sequence them properly through time, which may mean mixing of these blocks of data. Special care must be taken with materials from upstream, for initially two blocks of data are read if interpolation is to be used.

Information concerning materials flowing into the system from upstream are usually not available on a daily basis, and monthly values seem to be more in line with most studies. To help alleviate the problems that may be caused by "surges" or "depletions" of material in inflowing water, the user has the option of having blocks of the data interpolated in a linear fashion according to:

$$V_{31_c} = Z_{31_c} + Z_{91}/P_1\ (Z_{32_c} - Z_{31_c}) \tag{1}$$

$$V_{41_{dc}} = Z_{41_{pc}} + Z_{91}/P_1\ (Z_{42_{dc}} - Z_{41_{dc}}) \tag{2}$$

$$V_{1_{pgc}} = Z_{1_{pgc}} + Z_{91}/P_1\ (Z_{2_{pgc}} - Z_{1_{pgc}}) \tag{3}$$

$$V_{11_{hc}} = Z_{11_{hc}} + Z_{91}/P_1\ (Z_{12_{hc}} - Z_{11_{hc}}) \tag{4}$$

$$V_{21_{mc}} = Z_{21_{mc}} + Z_{91}/P_1\ (Z_{22_{mc}} - Z_{21_{mc}}) \tag{5}$$

$$V_{11_l} = Z_{11_l} + Z_{91}/P_1\ (Z_{12_l} - Z_{11_l}) \tag{6}$$

$$V_{73} = Z_{73} + Z_{91}/P_1\ (Z_{74} - Z_{73}) \tag{7}$$

$$V_{51_k} = Z_{51_k} + Z_{91}/P_1\ (Z_{52_k} - Z_{51_k}) \tag{8}$$

$$V_{61_{tn}} = Z_{61_{tn}} + Z_{91}/P_1\ (Z_{62_{tn}} - Z_{61_{tn}}) \tag{9}$$

where:

V_{31_c} = The quantity of the *c*'th organic dissolved constituent in the inflowing water [COMPIN(C)]

$V_{41_{dc}}$ = The quantity of the *c*'th constituent of the *d*'th organic detritus type in the inflowing water [XDETIN(D,C)]

$V_{1_{pgc}}$ = The quantity of the *c*'th constituent of the *g*'th organ of the *p*'th plant in the inflowing water [XDRIFV(P,1,C)]

$V_{11_{hc}}$ = The quantity of the *c*'th constituent of the *h*'th animal cohort in the inflowing water [XDRIFA(H,C)]

$V_{21_{mc}}$ = The quantity of the *c*'th constituent of the *m*'th type of heterotrophic microorganisms in the inflowing water [XDRIFM(M,C)]

V_{11_l} = The population (in numbers per cubic meter of water) of the *l*'th animal cohort [XDRIFO(L)]

V_{73} = pH of inflowing water [XPH]

V_{51_k} = The quantity of the *k*'th inorganic dissolved constituent in the inflowing water [XDNORG(K)]

$V_{61_{tn}}$ = The quantity of the *n*'th constituent of the *t*'th type of inorganic detritus in the inflowing water [XPNORG(T,N)]

and Z_{91}/P_1 is a fraction of the number of days expired since a block of data has been used to the number of days it will be used and the temporary values (Z) are for the materials read in under II.B above. Variables not defined are the second set needed for interpolation.

Certain rules also govern the use of the switch for interpolation (II.B.1.b above).

1. If only one block of data will be read in for an entire simulation the switch (JFROM) must be "1".
2. "1" cannot follow "2" or "4", or be in front of "3".
3. "2" cannot follow "2", "3" or "4", or be in front of "1".
4. "3" cannot follow "1" or "3", or be in front of "4".
5. "4" cannot follow "1" or "3", or be in front of "1" or "2".

Values that are read in as monthly means are also interpolated. The subscript "*b*" will be used to signify months.

$$Y_{82} = Z_{82_b} + [(Z_{92}/Z_{93_b})\ (Z_{82_{b+1}} - Z_{82_b})] \tag{10}$$

$$V_{42_{dc}} = Z_{42_{bdc}} + [(Z_{92}/Z_{93_b})\ (Z_{42_{b+1,dc}} - Z_{42_{bdc}})] \tag{11}$$

$$V_{62_{tn}} = Z_{62_{btn}} + [(Z_{92}/Z_{93_b})\ (Z_{62_{b+1,tn}} - Z_{62_{btn}})] \tag{12}$$

$$V_{78} = Z_{78_b} + [(Z_{92}/Z_{93_b})\ (Z_{78_{b+1}} - Z_{78_b})] \tag{13}$$

$$V_{77} = Z_{77_b} + [(Z_{92}/Z_{93_b})\ (Z_{77_{b+1}} - Z_{77_b})] \tag{14}$$

where:

Z_{92} = The current day of the month [NUMMON]

Z_{93_b} = The number of days in the current month [MONDAY(B)]

Y_{82} = Pan evaporation in millimeters per day [EVAP]

Z_{82_b} = Pan evaporation for the *b*'th month in millimeters per day [EVAPOR(B)]

$V_{42_{dc}}$ = The amount of the *c*'th constituent for the *d*'th organic detritus type falling into the system from the atmosphere in grams per square meter per day [DADUST(D,C)]

$V_{62_{tn}}$ = The amount of the *n*'th constituent for the *t*'th inorganic detritus type falling into the system from the atmosphere in grams per square meter per day [DUSTIP(T,N)]

V_{78} = Daily radiation in kilocalories per square meter per day [DAYRAD]

V_{77} = Daily photoperiod in hours [DAPHOT]

The following table lists the symbols used in the previous equations, their FORTRAN equivalent, the number of the equations where the symbol is used and the units for that symbol. Many exogenous (V) variables have for units "variable", for they are first used as grams per cubic meter of water flowing into the system from upstream and then as grams per ecosystem per day entering the system from all sources. The following abbreviations are used:

cu = cubic
g = gram or grams
hr = hour
kcal = kilocalories
mm = millimeter
pop = populations
sq = square

Variable	Fortran Equivalent	Equations where used	Units
P_1	DIFROM	1 to 9	dimensionless
$V_{1_{pgc}}$	XDRIFV(P,G,C)	3	variable
$V_{11_{hc}}$	XDRIFA(H,C)	4	variable
V_{11_l}	XDRIFO(L)	6	variable
$V_{21_{mc}}$	XDRIFM(M,C)	5	variable
V_{31_c}	XCOMPN(C)	1	variable
$V_{41_{dc}}$	XDETIN(D,C)	2	variable
$V_{42_{dc}}$	DADUST(D,C)	11	$g \cdot sq\ m^{-1} \cdot day^{-1}$
V_{51_k}	XPNORG(K)	8	variable
$V_{61_{tn}}$	XDNORG(T,N)	9	variable
$V_{62_{tn}}$	DUSTIP(T,N)	12	$g \cdot sq\ m^{-1} \cdot day^{-1}$
V_{73}	XPH	7	
V_{77}	DAPHOT	14	$hr \cdot day^{-1}$
V_{78}	DAYRAD	13	$kcal \cdot sq\ m^{-1} \cdot day^{-1}$
Y_{82}	EVAP	10	$mm \cdot day^{-1}$
$Z_{1_{pgc}}$	ZDRIFV(P,G,C)	3	$g \cdot cu\ m^{-1}$
$Z_{2_{pgc}}$	YDRIFV(P,G,C)	3	$g \cdot cu\ m^{-1}$
$Z_{11_{hc}}$	ZDRIFA(H,C)	4	$g \cdot cu\ m^{-1}$
Z_{11_l}	ZDRIFO(L)	6	$pop \cdot cu\ m^{-1}$
$Z_{12_{hc}}$	YDRIFA(H,C)	4	$g \cdot cu\ m^{-1}$
Z_{12_l}	YDRIFO(L)	6	$pop \cdot cu\ m.^{-1}$
$Z_{21_{mc}}$	ZDRIFM(M,C)	5	$g \cdot cu\ m^{-1}$
$Z_{22_{mc}}$	YDRIFM(M,C)	5	$g \cdot cu\ m^{-1}$
Z_{31_c}	ZCOMPN(C)	1	$g \cdot cu\ m^{-1}$
Z_{32_c}	YCOMPN(C)	1	$g \cdot cu\ m^{-1}$
$Z_{41_{dc}}$	ZDETIN(D,C)	2	$g \cdot cu\ m^{-1}$
$Z_{42_{dc}}$	YDETIN(D,C)	2	$g \cdot cu\ m^{-1}$
$Z_{42_{b+1,dc}}$	DUST(B+1,D,C)	11	$g \cdot sq\ m^{-1} \cdot day^{-1}$
$Z_{42_{bdc}}$	DUST(B,D,C)	11	$g \cdot sq\ m^{-1} \cdot day^{-1}$
Z_{51_k}	ZPNORG(K)	8	$g \cdot cu\ m^{-1}$
Z_{52_k}	YPNORG(K)	8	$g \cdot cu\ m^{-1}$
$Z_{61_{tn}}$	ZDNORG(T,N)	9	$g \cdot cu\ m^{-1}$
$Z_{62_{b+1,tn}}$	DUSTPI(B+1,T,N)	12	$g \cdot sq\ m^{-1} \cdot day^{-1}$
$Z_{62_{b+n}}$	DUSTPI(B,T,N)	12	$g \cdot sq\ m^{-1} \cdot day^{-1}$
$Z_{62_{tn}}$	YDNORG(T,N)	9	$g \cdot cu\ m^{-1}$
Z_{73}	ZPH	7	
Z_{74}	YPH	7	
$Z_{77_{b+1}}$	PHOTOP(B)	14	$hr \cdot day^{-1}$
Z_{77_b}	PHOTOP(B+1)	14	$hr \cdot day^{-1}$
$Z_{78_{b+1}}$	RADIA(B)	13	$kcal \cdot sq\ m^{-1} \cdot day^{-1}$
Z_{78}	RADIA(B+1)	13	$kcal\ ,sq\ m^{-1} ,day^{-1}$
$Z_{82_{b+1}}$	EVAPOR(B+1)	10	$m.m. \cdot day^{-1}$
Z_{82_b}	EVAPOR(B)	10	$m.m. \cdot day^{-1}$
Z_{91}	DIFROM	1 to 9	dimension less
Z_{92}	NUMMON	10, 11, 12, 13, 14	day
Z_{93_b}	MONDAY(B)	10, 11, 12, 13, 14	$day \cdot month^{-1}$

ARRAY DIMENSIONS

Limitations imposed by dimensions for arrays used in the EXTERN subroutine, but not in the main program, are as follows:

DUST (12,g,f)
DUSTPI (12,h,c)
ERODED (b)
EXO (c)
FLOPAS (n)
MIRRIG (e)
MRAIN (a)
MRUNON (b)
RAIN (a)
RUNDIN (b,j)
RUNMIN (b,f)
RUNON (b)
RUNORG (b,g,f)
RUNPIN (b,h,i)
WATIRR (e)
YCOMPN (f)
YDETIN (g,f)
YDRIFV (l,d,f)
YDRIFO (k)
YDRIFA (k,f)
YDRIFM (m,f)
YPNORG (h,i)
YDNORG (j)
ZCOMPN (f)
ZDETIN (g,f)
ZDRIFV (l,d,f)
ZDRIFO (k)
ZDRIFA (k,f)
ZDRIFM (m,f)
ZPNORG (h,i)
ZDNORG (j)

The dimensions indicated by letters define the maximum values possible for the following quantities:

		FORTRAN NAME
a.	Number of days of precipitation to be read	NRAIN
b.	Number of days with surface flow to be read	NRUNON
c.	Total number of words in COMMON/METEOR/ that must be reinitialized at the start of each day	LIMEXO
d.	Number of plant organ types	NORGAN
e.	Number of days on which water is withdrawn to be read	NIRRIG
f.	Total number of organic constituents tracked	NFRELM
g.	Number of organic detritus categories	NOLIT
h.	Number of inorganic detritus categories	ISTRTM
i.	Number of particulate inorganic constituents tracked	INORGP
j.	Number of dissolved inorganic constituents tracked	INORGD
k.	Total number of animal cohorts	NCOHOR
l.	Number of plant species or groups	NSPECV
m.	Number of types of heterotrophic microorganisms	MICROB
n.	Number of possible materials "flowing" in and out of the system	NPASS

Care must be taken if array dimensions in the COMMON block/METEOR/ are changed. Variables WIRRIG, RUNSOL, RUNDEB, DARAIN, DAYRUN, RUNPNR and RUNDNR are equivalenced with EXO and their number should equal the value of LIMEXO. Variables FLOWIN, XCOMPN, XDETIN, XDRIFV, XDRIFO, XDRIFA, XDRIFM, XPH, XPNORG, XDNORG and XWTEMP are equivalent with FLOPAS and their number should equal the value of NPASS. Since another part of the /METEOR/ common block is equivalenced in the calling program, care must be taken in adding variables or rearranging the present variables in this common block.

Arrays that must match in their order and dimensions are as follows:

COMPIN	XCOMPN	YCOMPN	ZCOMPN
DETIN	XDETIN	YDETIN	ZDETIN
DNORG	XDNORG	YDNORG	ZDNORG
DRIFTA	XDRIFA	YDRIFA	ZDRIFZ
DRIFTM	XDRIFM	YDRIFM	ZDRIFM
DRIFPO	XDRIFO	YDRIFO	ZDRIFO
DRIFTV	XDRIFV	YDRIFV	ZDRIFV
PNORG	XPNORG	YPNORG	ZPNORG

SUBROUTINES PHYSIC, VARIED AND DYX

Subprograms PHYSIC, VARIED, and DYX are being developed in cooperation with the Central Utah Project, under Bureau of Sport Fisheries and Wildlife Grant # YNE-074-0. Descriptions and explanations of expanded versions of these subprograms are given by Jeppson (1974). Because these subprograms are an integral part of the general stream model, the user should be aware of their use and implementation.

Subroutine PHYSIC is called by the MAIN program immediately after calling subroutine EXTERN, which passes on the average amount of water entering the ecosystem in cubic meters per second. With this and other informations received through the NAMELIST, this subroutine, along with the subprograms VARIED and DYX which it calls, calculates and passes to the biological process subroutines the following information:

a. the average depth of water of the ecosystem [DEPTH]
b. the average amount of water in the ecosystem [WATSYS]
c. the average water velocity [VELOCT]
d. the surface area of the ecosystem [AREA]
e. the wetted perimeter of the ecosystem [PERIM]
f. the average width of the ecosystem [WIDTH]

Since information concerning the physical characteristics of the ecosystem are controlled by factors upstream and generally also downstream from the ecosystem, a longer reach of stream is "looked at" by these subprograms, and the ecosystem then becomes a subset of these waters. For this reason, care must be taken not to confuse the section of stream being modeled biologically (calling program II.A.13 [NSTRCH]) with the sections of stream used in the physical subprograms. Also, the input data for these subprograms do not have to match the boundaries for sections. To better explain this, the following example is given. Please refer to Figure P 1.

On a particular study, stream characteristics were measured starting from some arbitrary point A and moving downstream to point L. Starting 10 meters downstream from point A is a homogeneous stretch of stream lasting for 20 meters which we decide to model. It is known that the water in this stretch of stream may be controlled by factors from point A to point L. We arbitrarily pick a size for stream sections, keeping them about the same distance as used for measuring stream characteristics. Five meters is selected for this example. For this simulation, the following subset of switches and parameters is used.

NSI = 12 (water in the stretch of interest is controlled by 12 points, A through L)

NSO = 13 (points of prediction, 1 through 13)

NSECB = 3

NSECE = 7

XBEG = 0

XI(1) = 0 XI(2) = 4 XI(3) = 11

XI(4) = 14 XI(5) = 18 XI(6) = 26

XI(7) = 34 XI(8) = 38 XI(9) = 46

XI(10) = 49 XI(11) = 54 XI(12) = 59

If a second ecosystem (NSTRCH = 2) is to be simulated for the next 15 meters downstream, the parameter set used above would still be valid except for NSECB and NSECE, which would become 7 and 10, respectively.

The values passed to the biological subroutines are the averages of the values between and including sections NSECB to NSECE.

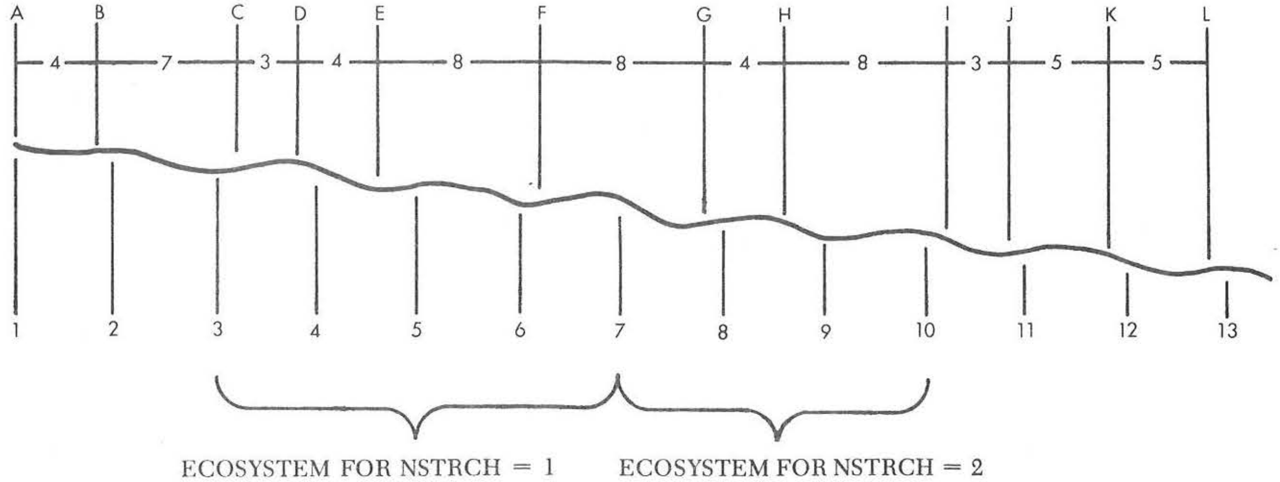

Figure P1. Relationship between stretch of stream being modeled biologically [NSTRCH], input data for stream characteristics (letters), and points of stream characteristic prediction (bottom row of numbers). The top row of numbers refer to the distance between input data sets.

ARRAY DIMENSIONS

The use of the program is limited by the dimensions allotted to the arrays, and these limitations need discussion so that the user may be in a position to modify them as his particular requirements indicate. Below is a list of arrays peculiar to the subroutines PHYSIC, VARIED and DYX, in which the dimensions which may appropriately be varied are indicated by letters. Dimension limitation of other arrays used in these subprograms can be found in the main program.

```
AA(a)          SI(b)
BI(b)          S7(a)
B7(a)          TOP(a)
FM(a)          V7(a)
FMI(b)         XI(b)
FN(a)          X7(a)
FNI(b)         YN(a)
PP(a)          Y7(a)
Q7(a)
```

The dimensions indicated by letters define the maximum quantities possible for the following quantities:

	Fortran equivalent
a. the number of points of prediction of stream characteristics	NSO
b. the number of input data sets for stream characteristics	NSI

PARAMETERS AND SWITCHES

A list of all the parameters and switches for the subroutines PHYSIC, VARIED and DYX follows. Explanations can be found in the definitions list, Appendix A. Letters used for dimensions are explained above under Array Dimensions.

```
BI(b)          NSI
FLODIF         NSO
FMI(b)         Q7(a)
FNI(b)         SI(b)
INFLOW         XBEG
NSECB          XI(b)
NSECE          XINC
               YSTART
```

A listing of these subroutines can be found in Appendix F.

SUBROUTINE MEDIUM

INTRODUCTION

One of the purposes of the aquatic model is to track separately water and allochthonous material entering the ecosystem from different sources, as well as leaving through different pathways. All bookkeeping for values representing materials entering the ecosystem is handled by the subroutine MEDIUM, and it is here that concentrations of constituents of any dissolved or suspended material are calculated to flow through the system. Coagulation of dissolved materials, scouring or deposition of organic and inorganic detritus, and transport of dissolved materials between the interstitial water and water column are also handled. A listing of the MEDIUM subprogram can be found in Appendix H.

VERBAL DESCRIPTION

It is assumed that all incoming material, be it water, organic or inorganic constituents, enter the ecosystem at the head of the stretch being modeled, and that uniform mixing takes place so that concentrations of dissolved and suspended materials through the system remain constant over the time unit of simulation.

Water in the system is incremented from upstream flow, from tributary flow, and from precipitation and overland flow. Decrements occur as water flows downstream, is withdrawn for irrigation, or is evaporated. All of these figures are input data except for water flowing downstream, which is calculated taking into account the above factors as well as the average amount of water in the system for the present as well as previous time periods. Water contains dissolved constituents, and these are tracked as they enter the system through the same four sources as water. All particulate detritus categories, both organic and inorganic, are accounted for as they enter the system from upstream, tributaries and overland flow as well as falling into the system from the atmosphere. Live material, or those constituents which make up the plants, animals and heterotrophic microorganisms can enter the system from upstream or tributary flow.

Coagulation of dissolved organic carbon and its associated energy in the water column takes place at a constant rate, with the products incrementing the finest organic detrital category specified.

Organic and inorganic detritus may be scoured or deposited, with this occurring as a function of water velocity. Graphical representation for scouring is presented in Figure M1, and for deposition in Figure M2.

Dissolved constituents pass between the water column and the interstitial water, this occurring as a function of the number of times the water in the column has been exchanged in a time period and as a measure of the thickness of the benthos and the constituent concentration difference between the two areas (Fig. M3).

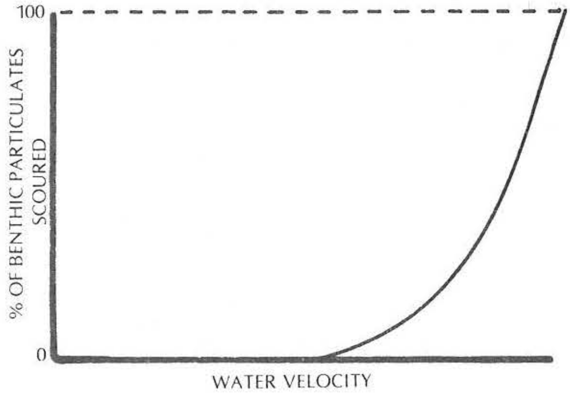

Figure M1. Scouring of detritus as a function of water velocity.

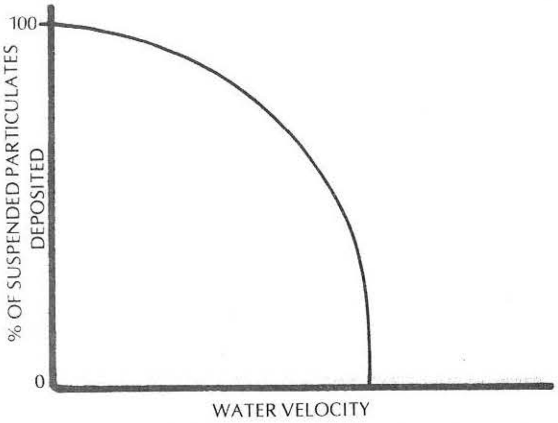

Figure M2. Suspended detritus deposition as a function of water velocity.

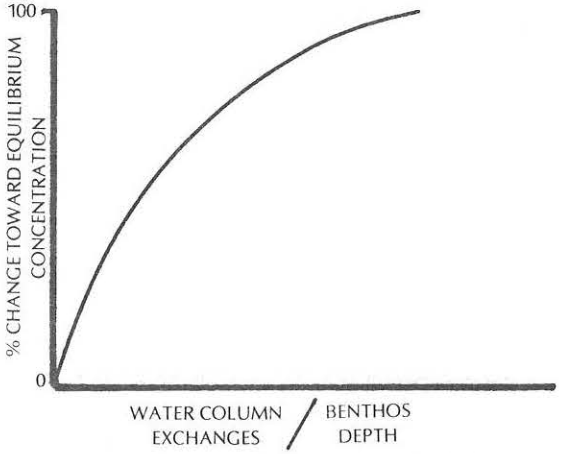

Figure M3. Exchanges of dissolved constituents between the sediments and water column.

MATHEMATICAL DESCRIPTION

The equations described here follow the order in the program itself, except where a particular "thought train" or process is being developed. The equations are numbered on the right side of the page, while the numbers in brackets preceded by an "ME" refer to the actual FORTRAN program equation in Appendix H. The names in brackets for the variable explanations are their FORTRAN equivalents. At the end of the Mathematical Description is a table listing the symbols, their FORTRAN equivalent, all equations where that symbol is used as well as the units for that variable. The classification as to types of symbols used for variables is explained in the MAIN Introduction.

Water Balance

The amount of water in cubic meters flowing out of the system is calculated as:

$$Y_{80} = \max(0., Z_1 - Z_2 + Z_3 + V_{79} - Y_{86} + Z_4 - X_{75} + Z_5) \quad \text{[ME0375]} \quad 1$$

where:

Y_{80} = The amount of water flowing out of the system [FLOUT]
Z_1 = V_{83} 86400 [FLOWS] and
V_{83} = Flow from upstream in cubic meters per second [FLOWIN]
Z_2 = $Y_{82}/1000X_{81}$ [EVAPO] and
Y_{82} = Evaporation per day in millimeters per day [EVAP]
X_{81} = Surface area of ecosystem [AREA]
Z_3 = $V_{85}/1000X_{81}$ [PRECIP] and
V_{85} = Amount of rainfall in millimeters per day [DARAIN]
V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]
Y_{86} = The amount of water withdrawal for the current day (in cubic meters) [WIRRIG]
Z_4 = The amount of water in the system on the previous day [WATDAY]
X_{75} = The amount of water in the system [WATSYS]
Z_5 = V_{84} 86400 [FLOWTR] and
V_{84} = the amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

The total amount of water in and passing through the system in a time unit becomes:

$$Z_6 = \max(X_{75}, Z_1 + V_{79} + Z_3 - Z_2 + Z_4 + Z_5) \quad \text{[ME0390]} \quad 2$$

where:

Z_6 = The total amount of water in and passing through the system [WATTOT]
Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]
V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]
Z_3 = $V_{85}/1000\ X_{81}$ [PRECIP] and V_{85} = Amount of rainfall in millimeters per day [DARAIN]
Z_2 = $Y_{82}/1000\ X_{81}$ [EVAPO] and Y_{82} = Evaporation per day in millimeters per day [EVAP]
X_{81} = Surface area of ecosystem [AREA]
Z_4 = The amount of water in the system on the previous day [WATDAY]
Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]
X_{75} = The amount of water in the system [WATSYS]

Exchanges with the surroundings are tracked according to:

$${}_{E}\dot{X}_{76_{1}} = Z_3 \quad \text{[ME0395]} \quad 3$$

$${}_{E}\dot{X}_{76_{2}} = -Z_2 \quad \text{[ME0400]} \quad 4$$

$${}_{E}\dot{X}_{76_{3}} = V_{79} \quad \text{[ME0405]} \quad 5$$

$${}_{E}\dot{X}_{76_{4}} = -Y_{86} \quad \text{[ME0410]} \quad 6$$

$${}_{E}\dot{X}_{76_{5}} = Z_1 \quad \text{[ME0415]} \quad 7$$

$${}_{E}\dot{X}_{76_{8}} = -Y_{80} \quad \text{[ME0420]} \quad 8$$

$${}_{E}\dot{X}_{76_{11}} = Z_5 \quad \text{[ME0425]} \quad 9$$

where:

Z_3 = $V_{85}/1000\ X_{81}$ [PRECIP] and V_{85} = Amount of rainfall in millimeters per day [DAYRUN]
Z_2 = $Y_{82}/1000\ X_{81}$ [EVAPO] and Y_{82} = Evaporation per day in millimeters per day [EVAP]
X_{81} = Surface area of ecosystem [AREA]
V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]
Y_{86} = The amount of water withdrawal for the current day (in cubic meters) [WIRRIG]
Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flows from upstream in cubic meters per second [FLOWIN]
Y_{80} = The amount of water flowing out of the system [FLOUT]
Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Thus, the water level is allowed to fluctuate, but only down to a level which would allow a pool to exist if all water incrementation went to zero. If bottom geometry is such that a pool would not exist the program is stopped when water incrementation goes to zero.

Most of the state variables can be gained to the system by the same pathways as water. It is assumed that all increments occur evenly over a time unit, that they are added to the head of the stretch being modeled, and that immediate mixing takes place. Thus, the inflowing water for a time unit contains the same constituents as to types and amounts.

Incoming Dissolved and Particulate Organic Constituents

For each of the incoming dissolved organic constituents:

$$Z_{7_{1,b}} = Z_3 V_{32_c} \qquad [\text{ME0525}] \quad 10$$

$$Z_{7_{3,b}} = V_{79} V_{34_c} \qquad [\text{ME0530}] \quad 11$$

$$Z_{7_{5,b}} = Z_1 V_{31_c} \qquad [\text{ME0535}] \quad 12$$

$$Z_{7_{11,b}} = Z_5 V_{37_c} \qquad [\text{ME0540}] \quad 13$$

$$Z_{7_{13,b}} = X_{31_c} \qquad [\text{ME0545}] \quad 14$$

where:

V_{32_c} = The amount of the *c*'th organic constituent dissolved in incoming rain in grams per cubic meter [RAINCO(C)]

V_{34_c} = The amount of the *c*'th dissolved organic constituent in water from overland flow in grams per cubic meter [RUNSOL(C)]

V_{31_c} = The amount of the *c*'th organic constituent dissolved in water from upstream in grams per cubic meter [XCOMPN(C)]

V_{37_c} = The amount of the *c*'th organic constituent dissolved in incoming water from tributaries in grams per cubic meter [TCOMPN(C)]

X_{31_c} = The amount of the *c*'th organic constituent dissolved in the water in the ecosystem [AQUA(C)]

b = One plus the number of litter categories

Z_3 = $V_{85}/1000\ X_{81}$ [PRECIP] and V_{85} = Amount of rainfall in millimeters per day [DARAIN]

V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Totals, averages and amounts of dissolved organic matter incoming, outgoing and in the ecosystem for the new time unit are calculated for each particular constituent.

$$Z_8 = \sum_{r=1}^{13} Z_{7_{r,b}} \qquad [\text{ME0590}] \quad 15$$

$$Z_9 = Z_8/Z_6 \qquad [\text{ME0595}] \quad 16$$

$$Y_{31_c} = Z_9(Z_6 - X_{75}) \qquad [\text{ME0600}] \quad 17$$

$$V_{31_c} = Z_8 - X_{31_c} \qquad [\text{ME0605}] \quad 18$$

$$X_{31_c} = X_{75} Z_9 \qquad [\text{ME0660}] \quad 19$$

Z_8 = Total amount of an organic solute in the system during a day for the constituent in question [TOTSOL]

$Z_{7_{r,b}}$ = A means of tracking the constituent in question [A, (R,NOLITI)]

Z_9 = The average amount of an organic solute in the system in grams per cubic meter of water [SOLAVE]

Z_6 = Total amount of water in the system during any part of a day [WATTOT]

X_{75} = The amount of water in the system [WATSYS]

X_{31_c} = The amount of the *c*'th organic constituent dissolved in the water in the ecosystem [AQUA(C)]

V_{31_c} = The total amount of the *c*'th organic solute entering the system in a time unit [XCOMPN(C)]

Y_{31_c} = Total amount of the *c*'th organic solute leaving the system in a time unit [COMPIN(C)]

For each constituent of incoming particulate organic matter,

$$Z_{10_{1,b}} = V_{42_{dc}} X_{81} \qquad [\text{ME0555}] \quad 20$$

$$Z_{10_{3,b}} = V_{79} V_{44_{dc}} \qquad [\text{ME0560}] \quad 21$$

$$Z_{10_{5,b}} = Z_1 V_{41_{dc}} \qquad [\text{ME0565}] \quad 22$$

$$Z_{10_{11,b}} = Z_5 V_{47_{dc}} \qquad [\text{ME0570}] \quad 23$$

$$Z_{10_{13,b}} = X_{41_{dc}} \qquad [\text{ME0575}] \quad 24$$

where:

$V_{42_{dc}}$ = The amount in grams of particulate organic material per square meter entering the system from above [DADUST(D,C)]

X_{81} = Surface area of the ecosystem [AREA]

$V_{44_{dc}}$ = The amount of particulate organic matter in grams per cubic meter entering the system in overland flow [RUNDEB(D,C)]

$V_{41_{dc}}$ = The amount of particulate organic matter in grams per cubic meter entering the ecosystem from upstream in a time unit [XDETIN(D,C)]

$V_{47_{dc}}$ = The amount of particulate organic matter in grams per cubic meter entering the ecosystem from tributaries in a time unit [TDETIN(D,C)]

$X_{41_{dc}}$ = The amount of particulate organic matter in the ecosystem [CLIT(D,C)]

V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [TRFLOW]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Totals, averages and amounts of suspended particulate organic matter incoming, outgoing and in the ecosystem for the new time unit are calculated for each particular constituent.

$$Z_{11_d} = \sum_{r=1}^{13} Z_{10_{rd}} \qquad [\text{ME0620}] \quad 25$$

$$Z_{12_d} = Z_{11_d}/Z_6 \qquad [\text{ME0630}] \quad 26$$

$$Y_{41_d} = Z_{12_d}(Z_6 - X_{75}) \qquad [\text{ME0635}] \quad 27$$

$$V_{41_d} = Z_{11_d} - X_{41_{dc}} \qquad [\text{ME0640}] \quad 28$$

$$X_{41_d} = Z_{12_d} X_{75} \qquad [\text{ME0655}] \quad 29$$

where:

Z_{11_d} = The total amount of the *d*'th suspended particulate organic matter category for the constituent in question that is in the system during the day [TOTLIT(D)]

$Z_{10_{rd}}$ = Amount of the *d*'th detritus category entering through the *r*'th route of exchange [A(R,D)]

Z_{12_d} = The average amount of the *d*'th detritus category in grams per cubic meter for the constituent in question [AVELIT(D)]

$Y_{41_{dc}}$ = The total amount of the *c*'th organic constituent of the *d*'th litter category leaving the system in a time period [DETIN(D,C)]

$V_{41_{dc}}$ = Total amount of the *c*'th constituent of the *d*'th litter category entering the system in a time period [XDETIN(D,C)]

$X_{41_{dc}}$ = Amount of the *c*'th constituent of the *d*'th litter category in the system [CLIT(D,C)]

Z_6 = The total amount of water in and passing through the system [WATTOT]

X_{75} = The amount of water in the ecosystem [WATSYS]

The gains of organic constituents to the ecosystem are tracked.

$${}_E\dot{X}_{01_{r,c}} = \sum_{b=1}^{NOLIT1} Z_{7_{rb}} \qquad 30$$

where:

${}_E\dot{X}_{01_{r,c}}$ = The change of the *c*'th organic constituent by the *r*'th channel [AGAINQ(R,C)]

$Z_{7_{rb}}$ = A means of tracking the constituent in question [A,(R,NOLITI)]

NOLIT1 = One plus the number of litter categories.

For each incoming dissolved inorganic constituent:

$$Z_{13_1} = Z_3 V_{52_k} \qquad [\text{ME0720}] \quad 31$$

$$Z_{13_3} = V_{79} V_{54_k} \qquad [\text{ME0725}] \quad 32$$

$$Z_{13_5} = Z_1 V_{51_k} \qquad [\text{ME0730}] \quad 33$$

$$Z_{13_{11}} = Z_5 V_{57_k} \qquad [\text{ME0735}] \quad 34$$

$$Z_{13_{13}} = X_{51_k} \qquad [\text{ME0740}] \quad 35$$

where:

V_{52_k} = The amount of the *k*'th dissolved inorganic constituent in rain in grams per cubic meter [RAINDI(K)]

V_{54_k} = The amount of the *k*'th dissolved inorganic constituent in overland flow in grams per cubic meter [RUNDNR(K)]

V_{51_k} = The amount of the *k*'th dissolved inorganic constituent entering the system from upstream in grams per cubic meter [XDNORG(K)]

V_{57_k} = The amount of the *k*'th dissolved inorganic constituent entering the system from tributaries in grams per cubic meter [TDNORG(K)]

X_{51_k} = The total amount of the *k*'th dissolved inorganic constituent in the system [WDINR(K)]

Z_3 = $V_{85}/1000\ X_{81}$ [PRECIP] and V_{85} = Amount of rainfall in millimeters per day [DARAIN]

V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]

Z_1 = $V_{83}\ 86400$ [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = $V_{84}\ 86400$ [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Incoming Dissolved Inorganic Constituents

Totals, averages and amounts of dissolved inorganic matter incoming, outgoing, and in the ecosystem for the new time unit are calculated for each constituent.

$$Z_{14} = \sum_{r=1}^{13} Z_{13_r} \qquad [\text{ME0750}] \quad 36$$

$$Z_{15} = Z_{14}/Z_6 \qquad [\text{ME0755}] \quad 37$$

$$Y_{51_k} = Z_{15}(Z_6 - X_{75}) \qquad [\text{ME0760}] \quad 38$$

$$V_{51_k} = Z_{14} - X_{51_k} \qquad [\text{ME0765}] \quad 39$$

$$X_{51_k} = X_{75}\ Z_{15} \qquad [\text{ME0770}] \quad 40$$

where:

Z_{14} = Total amount of a dissolved inorganic constituent in the system during the day [TOTNRD]

Z_{15} = The average amount of a dissolved inorganic constituent in the system for a time unit [AVENRD]

Y_{51_k} = The amount of the *k*'th dissolved inorganic constituent leaving the system in a time unit [DNORG(K)]

V_{51_k} = Total amount of the *k*'th dissolved inorganic constituent entering the system in a time unit [XDNORG(K)]

X_{51_k} = The amount of the *k*'th dissolved inorganic constituent in the system [WDINR(K)]
Z_{13_r} = The gain of the dissolved constituent in question by the *r*'th route of exchange [AINRD(R)]
Z_6 = Total amount of water in and passing through the system [WATTOT]
X_{75} = The amount of water in the ecosystem [WATSYS]

The gains of dissolved constituents to the ecosystem are tracked.

$${}_E\dot{X}_{03_{rk}} = Z_{13_r} \qquad \text{[ME0780]} \quad 41$$

where:

${}_E\dot{X}_{03_{rk}}$ = The change of the *k*'th inorganic dissolved constituent by the *r*'th channel [DGAINQ(R,K)]
Z_{13_r} = The gain of the dissolved constituent in question by the *r*'th route of exchange [AINRD(R)]

Incoming Particulate Inorganic Constituents

For each inorganic constituent of a particulate category:

$$Z_{16_{1t}} = X_{81}\, V_{62_{t,n}} \qquad \text{[ME0845]} \quad 42$$
$$Z_{16_{3t}} = V_{79}\, V_{64_{t,n}} \qquad \text{[ME0850]} \quad 43$$
$$Z_{16_{5t}} = Z_1\, V_{61_{t,n}} \qquad \text{[ME0855]} \quad 44$$
$$Z_{16_{11t}} = Z_5\, V_{67_{t,n}} \qquad \text{[ME0860]} \quad 45$$
$$Z_{16_{13t}} = X_{61_{t,n}} \qquad \text{[ME0865]} \quad 46$$

where:

$V_{62_{t,n}}$ = The amount of the *n*'th inorganic constituent of the *t*'th detritus type entering the system from above in grams per square meter [DUSTIP(T,N)]
$V_{64_{t,n}}$ = The amount of the *n*'th inorganic constituent of the *t*'th detritus type entering the system through overland flow in grams per cubic meter of water [RUNPNR(T,N)]
$V_{61_{t,n}}$ = The amount of the *n*'th inorganic constituent of the *t*'th detritus type entering the system from upstream in grams per cubic meter [XPNORG(T,N)]
$V_{67_{t,n}}$ = The amount of the *n*'th inorganic constituent of the *t*'th detritus type entering the system from tributaries in grams per cubic meter [TPNORG(T,N)]
$X_{61_{t,n}}$ = The amount of the *n*'th inorganic constituent of the *t*'th detritus type in the system [WPINR(T,N)]
Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW
X_{81} = Surface area of the ecosystem [AREA]
V_{79} = The amount of overland flow for the current time unit in cubic meters [DAYRUN]
Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Totals, averages and amounts of suspended particulate inorganic matter incoming, outgoing and in the ecosystem for the new time unit are calculated for each particular constituent.

$$Z_{17_n} = \sum_{r=1}^{13} Z_{16_{rt}} \qquad \text{[ME0885]} \quad 47$$
$$Z_{18_n} = Z_{17_n}/Z_6 \qquad \text{[ME0890]} \quad 48$$
$$Y_{61_{tn}} = Z_{18_n}(Z_6 - X_{75}) \qquad \text{[ME0895]} \quad 49$$
$$V_{61_{tn}} = Z_{17_n} - X_{61_{tn}} \qquad \text{[ME0900]} \quad 50$$
$$X_{61_{tn}} = X_{75}\, Z_{18_n} \qquad \text{[ME0915]} \quad 51$$

where:

Z_{17_n} = The amount of the *n*'th suspended particulate inorganic matter category for the constituent in question that is in the system during the day [TOTNRP(N)]
$Z_{16_{rt}}$ = The amount of the *t*'th inorganic detritus category entering the system through the *r*'th route of exchange [AINRP(R,T)]
Z_{18_n} = The average amount of the *n*'th inorganic detritus category in grams per cubic meter for the constituent in question [AVENRP(N)]
$Y_{61_{tn}}$ = The total amount of the *n*'th inorganic constituent of the *t*'th detritus type leaving the system in a time period [PNORG(T,N)]
$V_{61_{tn}}$ = Total amount of the *n*'th inorganic constituent of the *t*'th detritus type entering the system in a time unit [XPNORG(T,N)]
$X_{61_{tn}}$ = The amount of the *n*'th inorganic constituent of the *t*'th litter category in the system [WPINR(T,N)]
X_{75} = The amount of water in the ecosystem [WATSYS]
Z_6 = The total amount of water in and passing through the system in a day [WATTOT]

The gains of a particulate constituent to the ecosystem are tracked.

$${}_E\dot{X}_{04_{rn}} = \sum_{t=1}^{\text{ISTRTM}} Z_{16_{rt}} \qquad \text{[ME0930]} \quad 52$$

where:

${}_E\dot{X}_{04_{rn}}$ = The change of the *n*'th inorganic particulate constituent by the *r*'th channel [CGAINQ(R,N)]
$Z_{16_{rt}}$ = The amount of the *t*'th inorganic detritus category entering the system through the *r*'th route of exchange [AINRP(R,T)]
ISTRTM = Number of inorganic detritus categories.

Incoming Animals

The animals coming into the system are handled in one of two ways. The zooplankton are handled in the same manner as incoming detritus, but since the normally non-planktonic animals that may be drifting are not considered as state variables, they must be treated differently.

For the planktonic-like animals (biomass):

$Z_{19} = Z_1 V_{11_{hc}} + X_{11_{hc}} + Z_5 V_{17_{hc}}$ [ME0975] 53

$Z_{20} = Z_{19}/Z_6$ [ME0980] 54

${}_E\dot{X}_{01_{5c}} = Z_1 V_{11_{hc}}$ [ME0985] 55

${}_E\dot{X}_{01_{11c}} = Z_5 V_{17_{hc}}$ [ME0990] 56

$Y_{11_{hc}} = Z_{20}(Z_6 - X_{75})$ [ME0995] 57

$V_{11_{hc}} = Z_{19} - X_{11_{hc}}$ [ME1000] 58

$X_{11_{hc}} = X_{75} Z_{20}$ [ME1005] 59

where:

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Z_6 = Total amount of water in and passing through the ecosystem [WATTOT]

X_{75} = The amount of water in the ecosystem [WATSYS]

${}_E\dot{X}_{01_{5c}}$ = The change in the *c*'th constituent due to flow in from upstream [AGAINQ(5,C)]

${}_E\dot{X}_{01_{11c}}$ = The change in the *c*'th constituent due to flow in from tributaries [AGAINQ(11,C)]

Z_{19} = Total amount of animals for the constituent being considered that enter the system in a day [ANTOT]

$V_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system in a time unit. In equation 55 this is in grams per cubic meter from upstream, and in equation 58 this is total grams from all sources

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group in the ecosystem [CBIOM(H,C)]

$V_{17_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system from tributaries in grams per cubic meter [TDRIFA(H,C)]

Z_{20} = The average amount of the animal constituent in question entering the system in grams per cubic meter [ANAVE]

$Y_{11_{hc}}$ = Total amount of the *c*'th constituent of the *h*'th animal group leaving the system in a time period [DRIFTA(H,C)]

For the zooplankton (populations):

$Z_{21} = Z_1 V_{11_l} + X_{11_l} + Z_5 V_{17_l}$ [ME1015] 60

$Z_{22} = Z_{21}/Z_6$ [ME1020] 61

$Y_{11_l} = Z_{22}(Z_6 - X_{75})$ [ME1025] 62

$V_{11_l} = Z_{21} - X_{11_l}$ [ME1030] 63

$X_{11_l} = Z_{22}\ X_{75}$ [ME1035] 64

where:

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Z_6 = Total amount of water in and passing through the ecosystem [WATTOT]

X_{75} = The amount of water in the ecosystem [WATSYS]

Z_{21} = Total population of animals in the system during a time period [POPTOT]

V_{11_l} = In equation 60 the population in numbers per cubic meter of the *l*'th group entering the system from upstream, and in equation 63 it is the total population entering from all sources [XDRIFO(L)]

X_{11_l} = The population of the *l*'th animal group in the system [POP(L)]

V_{17_l} = The population of the *l*'th animal group entering the system from tributaries [TDRIFO(L)]

Z_{22} = The average population in grams per cubic meter for the animal group being considered [POPAVE]

Y_{11_l} = The total population of animals of the *l*'th group leaving the system in a time unit [DRIFPO(L)]

For the non-planktonic animals (biomass);

$Y_{11_{hc}} = V_{11_{hc}}\ Z_1 + Z_5\ V_{17_{hc}}$ [ME1050] 65

${}_E\dot{X}_{01_{5c}} = V_{11_{hc}}\ Z_1$ [ME1055] 66

${}_E\dot{X}_{01_{11c}} = Z_5\ V_{17_{hc}}$ [ME1060] 67

$V_{11_{hc}} = V_{11_{hc}}\ Z_1 + Z_5\ V_{17_{hc}}$ [ME1065] 68

where:

$V_{11_{hc}}$ = In equation 65 and 66 the amount of the *c*'th constituent of the *h*'th animal group in grams per cubic meter entering the system from upstream, and in equation 68 the total amount entering the system in a time period [XDRIFA(H,C)]

$Y_{11_{hc}}$ = Total amount of the *c*'th constituent of the *h*'th animal group leaving the system in a time period [DRIFTA(H,C)]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

${}_{E}\dot{X}_{01_{11c}}$ = The change in the *c*'th constituent due to flow in from tributaries [AGAINQ(11,C)]

${}_{E}\dot{X}_{01_{5c}}$ = The change in the *c*'th constituent due to flow in from upstream [AGAINQ(5,C)]

$V_{17_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system from tributaries in grams per cubic meter [TDRIFA(H,C)]

For the non-planktonic animals (populations):

$$Y_{11_l} = Z_1\, V_{11_l} + V_{17_l}\, Z_5 \qquad \text{[ME1075]} \quad 69$$

$$V_{11_l} = Z_1\, V_{11_l} + V_{17_l}\, Z_5 \qquad \text{[ME1080]} \quad 70$$

where:

V_{11_l} = The population of the *l*'th animal group entering the system from upstream (grams per cubic meter) in equation 69 and the total population entering the system in equation 70

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

V_{17_l} = The population of the *z*'th animal group entering the system from tributaries [TDRIFO(L)]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Incoming Vegetation

Vegetation coming into the system is handled like the animals.

For phytoplankton:

$$Z_{23} = Z_1\, V_{1_{p1c}} + X_{1_{p1c}} + Z_5\, V_{7_{p1c}} \qquad \text{[ME1125]} \quad 71$$

$$Z_{24} = Z_{23}/Z_6 \qquad \text{[ME1130]} \quad 72$$

$${}_{E}\dot{X}_{01_{5c}} = Z_1\, V_{1_{p1c}} \qquad \text{[ME1135]} \quad 73$$

$${}_{E}\dot{X}_{01_{11c}} = Z_5\, V_{7_{p1c}} \qquad \text{[ME1140]} \quad 74$$

$$Y_{1_{p1c}} = Z_{24}(Z_6 - X_{75}) \qquad \text{[ME1145]} \quad 75$$

$$V_{1_{p1c}} = Z_{23} - X_{1_{p1c}} \qquad \text{[ME1150]} \quad 76$$

$$X_{1_{p1c}} = Z_{24}\, X_{75} \qquad \text{[ME1155]} \quad 77$$

where:

Z_{23} = The total amount of the constituent being considered for the plant group under question entering the system [VGTOT]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

$V_{1_{p1c}}$ = In equation 71 the amount of the *c*'th constituent of the *p*'th plant group in grams per cubic meter entering the system from upstream, and in equation 76 the total amount entering the system [XDRIFV(P,1,C)]

$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group in the ecosystem [CVEG(P,1,C)]

$V_{7_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group entering the system from tributaries in grams per cubic meter [TDRIFV(P,1,C)]

$Y_{1_{p1c}}$ = Total amount of the *c*'th constituent of the *p*'th plant leaving the system [DRIFTV(P,1C)]

X_{75} = The amount of water in the ecosystem [WATSYS]

Z_6 = The total amount of water in and passing through the ecosystem [WATTOT]

For non-planktonic plants:

$$Y_{1_{p1c}} = Z_1\, V_{1_{p1c}} + Z_5\, V_{7_{p1c}} \qquad \text{[ME1050]} \quad 78$$

$${}_{E}\dot{X}_{01_{5c}} = Z_1\, V_{1_{p1c}} \qquad \text{[ME1055]} \quad 79$$

$${}_{E}\dot{X}_{01_{11c}} = Z_5\, V_{7_{p1c}} \qquad \text{[ME1060]} \quad 80$$

$$V_{1_{p1c}} = Z_1\, V_{1_{p1c}} + Z_5\, V_{7_{p1c}} \qquad \text{[ME1065]} \quad 81$$

where:

$Y_{1_{p1c}}$ = Total amount of the *c*'th constituent of the *p*'th plant leaving the system [DRIFTV(P,1C)]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

$V_{7_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group entering the system from tributaries in grams per cubic meter [TDRIFV(P,1,C)]

$V_{1_{p1c}}$ = In equation 78 the amount of the *c*'th constituent of the *p*'th plant group entering the system from upstream in grams per cubic meter and in equation 81 the total amount entering the ecosystem [XDRIFV(P,1,C]

Incoming Microorganisms

Heterotrophic microorganisms coming into the system are handled like the animals.

For planktonic microorganisms:

$Z_{25} = Z_1 V_{21_{mc}} + X_{21_{mc}} + Z_5 V_{27_{mc}}$ [ME1240] 82

$Z_{26} = Z_{25}/Z_6$ [ME1245] 83

${}_E\dot{X}01_{5c} = Z_1 V_{21_{mc}}$ [ME1250] 84

${}_E\dot{X}01_{11c} = Z_5 V_{27_{mc}}$ [ME1255] 85

$Y_{21_{mc}} = Z_{26}(Z_6 - X_{75})$ [ME1260] 86

$V_{21_{mc}} = Z_{25} - X_{21_{mc}}$ [ME1265] 87

$X_{21_{mc}} = X_{75} Z_{26}$ [ME1270] 88

where:

Z_{25} = The total amount of the constituent being considered of the microorganism in question which enters the system [HETTOT]

$V_{21_{mc}}$ = In equation 82 the amount of the c'th constituent of the m'th group of heterotrophic microorganisms entering the system from upstream in grams per cubic meter and in equation 87 the total amount entering the system [XDRIFM(M,C)]

$V_{27_{mc}}$ = The amount of the c'th constituent of the m'th microorganism category entering the system from tributaries in grams per cubic meter [TDRIFM(M,C)]

$Y_{21_{mc}}$ = The amount of the c'th constituent of the m'th category of microorganism leaving the system [DRIFTM(M,C)]

$X_{21_{mc}}$ = The amount of the c'th constituent of the m'th microorganism group in the system [CBACT(M,C)]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

Z_6 = Total amount of water in and passing through the ecosystem [WÁTTOT]

X_{75} = The amount of water in the ecosystem [WATSYS]

For attached or benthic microorganisms:

$Y_{21_{mc}} = Z_1 V_{21_{mc}} + Z_5 V_{27_{mc}}$ [ME1290] 89

${}_E\dot{X}01_{5c} = Z_1 V_{21_{mc}}$ [ME1295] 90

${}_E\dot{X}01_{11c} = Z_5 V_{27_{mc}}$ [ME1300] 91

$V_{21_{mc}} = Z_1 V_{21_{mc}} + Z_5 V_{27_{mc}}$ [ME1305] 92

where:

$Y_{21_{mc}}$ = The amount of the c'th constituent of the m'th category of microorganism leaving the system [DRIFTM(M,C)]

Z_1 = V_{83} 86400 [FLOWS] and V_{83} = Flow from upstream in cubic meters per second [FLOWIN]

Z_5 = V_{84} 86400 [FLOWTR] and V_{84} = The amount of water added to the system from the tributaries in cubic meters per second [TRFLOW]

$V_{27_{mc}}$ = The amount of the c'th constituent of the m'th microorganism category entering the system from tributaries in grams per cubic meter [TDRIFM(M,C)]

$V_{21_{mc}}$ = In equation 89 the amount of the c'th constituent of the m'th type of microorganisms entering the system from upstream in grams per cubic meter, and in equation 92 the total amount entering the system[XDRIFM(M,C)]

Coagulation

Organic matter in solution may coagulate at a fixed rate. It is assumed that the transfer includes only organic carbon and chemical energy.

$Z_{27} = P_1/Z_{28}$ [ME1340] 93

${}_C\dot{X}31_c = -Z_{27} X_{31_c}$ c = 1 and 2 [ME1350] 94

${}_C\dot{Y}31_c = -V_{31_c}[(Z_{27} Z_{28}) - Z_{27}]$ c = 1 and 2 [ME1355] 95

${}_C\dot{Y}41_{1,c} = V_{31_c}[(Z_{27} Z_{28}) - Z_{27}]$ c = 1 and 2 [ME1360] 96

${}_C\dot{X}41_{1,c} = Z_{27} X_{31}$ c = 1 and 2 [ME1365] 97

where:

Z_{27} = The fraction of coagulation occurring during one "change" of water in the system [COAG]

P_1 = The fraction of dissolved material coagulating in one day [COAGUL]

Z_{28} = Z_6/X_{75} = The number of exchanges of water in a day minus 1 [CYCLE]

${}_C\dot{X}31_c$ = The change in the dissolved c'th constituent due to coagulation [AQUAQQ(C)]

${}_C\dot{Y}31_c$ = The change in the c'th dissolved constituent leaving the system [COMPIN(C)]

${}_C\dot{Y}41_{1,c}$ = The change in the c'th particulate constituent leaving the system [DETIN(1,C)]

${}_C\dot{X}41_{1,c}$ = The change in the c'th particulate constituent in the system [CLITQQ(1,C)]

Scouring and Deposition of Inorganic Materials

Inorganic particulate material may be scoured or deposited depending on the water velocity.

For scouring (when X_{73} is greater than P_{2_t})

$$Z_{29} = \min[P_3, \max(0., \{P_{4_t}^{X_{73}} - P_{4_t}^{P_{2_t}}\})] \qquad \text{[ME1430]} \quad 98$$

$$Z_{30} = Z_{29} X_{63_{tn}} / Z_6 \qquad \text{[ME1450]} \quad 99$$

$${}_{S}\dot{X}_{61_{tn}} = Z_{30} X_{75} \qquad \text{[ME1455]} \quad 100$$

$${}_{S}\dot{Y}_{61_{tn}} = Z_{30}(Z_6 - X_{75}) \qquad \text{[ME1460]} \quad 101$$

$${}_{S}\dot{X}_{63_{tn}} = -Z_{30} Z_6 \qquad \text{[ME1465]} \quad 102$$

where:

Z_{29} = The fraction of the particulate constituent in question which is scoured in a day [SCOUR]

P_3 = The largest fraction of a state variable which can be decremented in a days period due to a process [ALIMAX]

P_{4_t} = A quadratic coefficient [SDRF2(T)]

X_{73} = Water velocity [VELOCT]

P_{2_t} = The water velocity above which particulates will be scoured [STRHI(T)]

Z_{30} = The amount of detritus for the constituent in question which is scoured in grams per cubic meter [GOES]

$X_{63_{tn}}$ = The amount of the n'th constituent of the t'th particulate type of inorganic detritus in the system as benthos

Z_6 = Total amount of water in and passing through the system [WATTOT]

${}_{S}\dot{X}_{61_{tn}}$ = The amount of the n'th constituent of the t'th type of suspended inorganic particulate category incremented as a function of scouring [WPINRQ(T,N)]

${}_{S}\dot{Y}_{61_{tn}}$ = The material leaving the system which is incremented as a function of scouring [PNORG(T,N)]

${}_{S}\dot{X}_{63_{tn}}$ = The benthic particulates decremented as a function of velocity [BPINRQ(T,N)]

For deposition (when X_{73} is less than P_{5t})

$$Z_{31} = \min[P_3, \max(0., \{P_{6_t}^{P_{5_t}} - P_{6_t}^{X_{73}}\})] \qquad \text{[ME1480]} \quad 103$$

$$Z_{32} = Z_{31}/Z_{28} \qquad \text{[ME1490]} \quad 104$$

$${}_{P}\dot{X}_{61_{tn}} = -X_{61_{tn}} Z_{32} \qquad \text{[ME1505]} \quad 105$$

$${}_{P}\dot{Y}_{61_{tn}} = -Z_{32} V_{61_{tn}} \qquad \text{[ME1510]} \quad 106$$

$${}_{P}\dot{X}_{63_{tn}} = Z_{32} V_{61_{tn}} + X_{61_{tn}} Z_{32} \qquad \text{[ME1515]} \quad 107$$

where:

Z_{31} = The fraction of suspended material being deposited in a time period [FALLS]

P_{6_t} = A quadratic coefficient [SDRF3(T)]

P_{5_t} = The velocity of water below which settling occurs [STRLO(T)]

Z_{32} = The fraction of suspended material being deposited during one "Flowthru" of water [DEPOS]

$V_{61_{tn}}$ = The amount of the n'th constituent of the t'th type of particulate material entering the system in a day [XPNORG(T,N)]

${}_{P}\dot{X}_{61_{tn}}$ = The change in suspended material due to deposition [WPINRQ(R,N)]

${}_{P}\dot{Y}_{61_{tn}}$ = The change in suspended material leaving the system due to deposition[PNORG(T,N)]

${}_{P}\dot{X}_{63_{tn}}$ = The change in benthic material due to deposition [BPINRQ(T,N)]

P_3 = The largest fraction of a state variable which can be decremented in a days period due to a process [ALIMAX]

X_{73} = Water velocity [VELOCT]

Z_{28} = Z_6/X_{75} = The number of exchanges of water in a day minus 1 [CYCLE]

Scouring and Deposition of Organic Litter

Organic particulate material may be scoured or deposited depending on the water velocity.

For scouring (when X_{73} is greater than P_{7d})

$$Z_{29} = \min[P_3, \max(0., \{P_{8_d}^{X_{73}} - P_{8_d}^{P_{7_d}}\})] \qquad \text{[ME1570]} \quad 108$$

$$Z_{30} = Z_{29} X_{43_{dc}} / Z_6 \qquad \text{[ME1580]} \quad 109$$

$${}_{S}\dot{X}_{41_{dc}} = Z_{30} X_{75} \qquad \text{[ME1610]} \quad 110$$

$${}_{S}\dot{Y}_{41_{dc}} = Z_{30}(Z_6 - X_{75}) \qquad \text{[ME1615]} \quad 111$$

$${}_{S}\dot{X}_{43_{dc}} = -Z_{30} Z_6 \qquad \text{[ME1620]} \quad 112$$

where:

P_{8_d} = A quadratic coefficient [CDRF2(D)]

P_{7_d} = The velocity above which organic detritus will be scoured [CLITHI(D)]

$X_{43_{dc}}$ = The amount of the c'th organic constituent of the d'th benthic detritus type in the system [CORG(D,C)]

${}_{S}\dot{X}_{41_{dc}}$ = The change in suspended detritus due to scouring [CLITQQ(D,C)]

${}_{S}\dot{Y}_{41_{dc}}$ = The change in suspended detritus leaving the system due to scouring [DETIN(D,C)]

${}_{S}\dot{X}_{43_{dc}}$ = The change in benthic detritus due to scouring [CORGQQ(D,C])

Z_{29} = The fraction of the particulate constituent in question which is scoured in a day [SCOUR]

P_3 = The largest fraction of a state variable which can be decremented in a days period due to a process [ALIMAX]

X_{73} = Water velocity [VELOCT]

Z_{30} = The amount of detritus for the constituent in question which is scoured in grams per cubic meter [GOES]

Z_6 = Total amount of water in and passing through the ecosystem [WATTOT]

X_{75} = The amount of water in the ecosystem [WATSYS]

For deposition (when X_{73} is less than P_9d)

$$Z_{31} = \min[P_3, \max(0., P_{10_d}^{P_{9_d}} - P_{10_d}^{X_{73}})] \quad [ME1635]\ 113$$

$$Z_{32} = Z_{31}/Z_{28} \quad [ME1645]\ 114$$

$$_P\dot{X}_{41_{dc}} = -X_{41_{dc}} Z_{32} \quad [ME1670]\ 115$$

$$_P\dot{Y}_{41_{dc}} = -V_{41_{dc}} Z_{32} \quad [ME1675]\ 116$$

$$_P\dot{X}_{43_{dc}} = Z_{32} X_{41_{dc}} + V_{41_{dc}} Z_{32} \quad [ME1680]\ 117$$

where:

Z_{31} = The fraction of suspended material being deposited in a time period [FALLS]
P_3 = The largest fraction of a state variable which can be decremented in a days period due to a process [ALIMAX]
X_{73} = Water velocity [VELOCT]
Z_{32} = The fraction of suspended material being deposited during one "Flowthru" of water [DEPOS]
$V_{41_{dc}}$ = The amount of particulate organic matter in grams per cubic meter entering the ecosystem from upstream in a time unit [XDETIN(D,C)]
$X_{41_{dc}}$ = The amount of particulate organic matter in the ecosystem [CLIT(D,C)]
Z_{28} = Z_6/X_{75} = The number of exchanges of water in a day minus 1 [CYCLE]
P_{9_d} = The velocity below which organic particulate material of the d'th type will start settling out [CLITLO(D)]
P_{10_d} = A quadratic coeffieicnt [CDRF3(D)]
$_P\dot{X}_{41_{dc}}$ = The change in the c'th constituent of the d'th organic suspended detritus type due to decomposition [CLITQQ(D,C)]
$_P\dot{Y}_{41_{dc}}$ = The change in detritus leaving the system due to deposition [DETIN(D,C)]
$_P\dot{X}_{43_{dc}}$ = The change in benthic detritus due to deposition [CORGQQ(D,C)]

Mixing of Dissolved Constituents

Dissolved materials pass between the water column and the sediments at a rate dependent on the weight of benthos and the amount of times the water in the column has been exchanged. The fraction mixed equals:

$$Z_{33} = 1. - \exp\{-Z_{34}(Z_{28} - 1.)\} \quad [ME1760]\ 118$$

where:

Z_{33} = The fraction of dissolved constituents mixed [AMIX]
Z_{28} = Z_6/X_{75} = The number of exchanges of water in a day minus 1 [CYCLE]

and

$$Z_{34} = [1./\{Z_{35}/(X_{77} P_{12})\}]P_{11} \quad [ME1755]\ 119$$

where:

Z_{34} = Temporary variable used in calculating mixing of dissolved constituents [CURVI]
X_{77} = The wetted perimeter of a section of stream in meters [PERIM]
P_{12} = The length of the stream section being modeled in meters [REACH]

and

$$Z_{35} = \sum X_{43_{d1}} P_{13} + \sum X_{63_{tn}} \quad [ME1735, ME1750]\ 120$$

where:

Z_{35} = The amount of benthic materials in grams per square meter [BENTH]
X_{43d1} = The amount of carbon in the d'th organic litter category [CORG(D,1)]
P_{13} = A factor for converting grams carbon litter to wet weight [WETFAC]
$X_{63_{tn}}$ = The amount of the n'th constituent of the t'th particulate type of inorganic detritus in the system as benthos

The actual amount of organic solutes mixed depends on the fraction mixed and the concentration difference of the two areas according to:

$$Z_{36} = Z_{33} Z_{37} \quad [ME1795]\ 121$$

where:

Z_{36} = The amount of solutes mixed [AMIX2]
Z_{33} = The fraction of dissolved constituents mixed [AMIX]

and

$$Z_{37} = (X_{31_c}/X_{75}) - (X_{33_c}/Z_{38}) \quad [ME1790]\ 122$$

where:

Z_{37} = The difference in concentration between the sediments and water column [DIF]
X_{31_c} = The amount of the cth organic constituent dissolved in the water in the ecosystem [AQUA(C)]
X_{75} = The amount of the water in the ecosystem [WATSYS]
X_{33_c} = The amount of the c'th dissolved organic constituent in the benthos [AQUAB(C)]

and

$$Z_{38} = Z_{35} P_{14} \quad [ME1765]\ 123$$

where:

Z_{35} = The amount of benthic materials in grams per square meter [BENTH]

P_{14} = A factor which converts the weight of benthos to the weight of water contained in the benthos [CFAC2]

Z_{38} = The amount of water in the benthos in cubic meters [BENWAT]

Appropriate variables are then incremented or decremented.

$${}_M\dot{X}_{33_c} = Z_{36}\ Z_{38} \qquad \text{[ME1800] 124}$$

$${}_M\dot{Y}_{31_c} = -Z_{36}\ Z_{38}\ Z_{39} \qquad \text{[ME1805] 125}$$

$${}_M\dot{X}_{31_c} = -Z_{36}\ Z_{38}(1. - Z_{39}) \qquad \text{[ME1810] 126}$$

where:

${}_M\dot{X}_{33_c}$ = The amount of change of the *c*'th dissolved organic constituent in the benthos [AQUABQ(C)]

Z_{36} = The amount of solutes mixed [AMIX2]

Z_{38} = The amount of water in the benthos in cubic meters [BENWAT]

${}_M\dot{Y}_{31_c}$ = The amount of change of the *c*'th dissolved organic constituent flowing out of the system [COMPIN(C)]

${}_M\dot{X}_{31_c}$ = The amount of change of the *c*'th dissolved organic constituent in the water column [AQUAQQ(C)]

and

$$Z_{39} = (Z_{28} - 1.)/Z_{28} \qquad \text{[ME1700] 127}$$

where:

Z_{39} = Proportion of water leaving to total water in and passing through the system [C]

Z_{28} = The number of exchanges of water in a day minus 1 [CYCLE]

Inorganic solutes are handled in a like manner.

$$Z_{37} = (X_{51_k}/X_{75}) - (X_{53_k}/Z_{38}) \qquad \text{[ME1820] 128}$$

$$Z_{36} = Z_{33}\ Z_{37} \qquad \text{[ME1825] 129}$$

$${}_M\dot{X}_{53_k} = Z_{36}\ Z_{38} \qquad \text{[ME1830] 130}$$

$${}_M\dot{Y}_{51_k} = -Z_{36}\ Z_{38}\ Z_{39} \qquad \text{[ME1835] 131}$$

$${}_M\dot{X}_{51_k} = -Z_{36}\ Z_{38}(1. - Z_{39}) \qquad \text{[ME1840] 132}$$

where:

Z_{37} = The difference in concentration between the benthos and water column [DIF]

Z_{36} = The amount of solutes mixed [AMIX2]

Z_{33} = The fraction of dissolved constituents mixed [AMIX]

Z_{38} = The amount of water in the benthos in cubic meters [BENWAT]

X_{75} = The amount of water in the ecosystem [WATSYS]

X_{51_k} = The amount of the *k*'th dissolved inorganic constituent entering the system from upstream in grams per cubic meter [XDNORG(K)]

X_{53_k} = The amount of the *k*'th dissolved inorganic consituent in the benthos [BDINR(K)]

${}_M\dot{X}_{53_k}$ = The amount of change of the *k*'th dissolved inorganic constituent in the benthos [BDINRQ(K)]

${}_M\dot{Y}_{51_k}$ = The amount of change of the *k*'th dissolved inorganic constituent flowing out of the system [DNORG(K)]

${}_M\dot{X}_{51_k}$ = The amount of change of the *k*'th dissolved inorganic constituent in the water column [WDINRQ(K)]

TABLE OF SYMBOLS

The following table is supplied as a user's aid. It lists the symbols used in the mathematical description, the FORTRAN equivalent, the equations where the symbol is used, and the units for the symbol. The classification of symbols is explained in the Introduction; listings in the table are alphabetical according to variable type and then numerically according to subscript number. The following abbreviations are used:

C = centigrade
cu = cubic
ecsys = ecosystem
g = gram
hr = hour
kcal = kilocalories
mm = millimeters
pop = populations
sq = square

Many of the exogenous variables (V) have for units "variable" for they are first used as grams per cubic meter of water flowing into the system from upstream, and then as grams per ecosystem per day of material entering the system from all sources. Also Y is used as grams per ecosystem per day leaving the system, or as grams per cubic meter of water leaving the ecosystem as downstream flow.

Symbol	Fortran Equivalent	Equations where used	Units
P_1	COAGUL	93	$g \cdot g^{-1}\ day^{-1}$
P_{2_t}	STRHI(T)	98	$m \cdot second^{-1}$
P_3	ALLMAX	98, 103, 108, 113,	dimensionless
P_{4_t}	SDRF2(T)	98,	dimensionless
P_{5_t}	STRLO(T)	103	$m \cdot second^{-1}$
P_{6_t}	SDRF3(T)	103	dimensionless
P_{7_d}	CLITHI(D)	108	$m \cdot second^{-1}$
P_{8_d}	CDRF2(D)	108	dimensionless
P_{9_d}	CLITLO(D)	113	$m \cdot second^{-1}$
P_{10_d}	CDRF3(D)	113	dimensionless
P_{11}	CFAC1	119	$m \cdot g^{-1}$
P_{12}	REACH	119	m
P_{13}	WETFAC	120	dimensionless

Symbol	Fortran Equivalent	Equations where used	Units
P_{14}	CFAC2	123	cu m·g^{-1}
$V_{1_{p1c}}$	XDRIFV(P,1,C)	71, 73, 76, 78, 79, 81	variable
$V_{7_{p1c}}$	TDRIFV(P,1,C)	71, 74, 78, 80, 81	g·cu m^{-1}
V_{11_l}	XDRIFO(L)	60, 63, 69, 70	variable
$V_{11_{hc}}$	XDRIFA(H,C)	53, 55, 58, 65, 66, 68	variable
V_{17_l}	TDRIFO(L)	60, 60, 70	pop·cu m^{-1}
$V_{17_{hc}}$	TDRIFA(H,C)	53, 56, 65, 67, 68	g·cu m^{-1}
$V_{21_{mc}}$	XDRIFM(M,C)	82, 84, 87, 89, 90, 92	variable
$V_{27_{mc}}$	TDRIFM(M,C)	82, 85, 89, 91, 92	g·cu m^{-1}
V_{31_c}	XCOMPN(C)	12, 18, 95, 96	variable
V_{32_c}	RAINCO(C)	10	g·cu m^{-1}
V_{34_c}	RUNSOL(C)	11	g·cu m^{-1}
V_{37_c}	TCOMPN(C)	13	g·cu m^{-1}
$V_{41_{dc}}$	XDETIN(D,C)	22, 28, 116, 117	variable
$V_{42_{dc}}$	DADUST(D,C)	20	g·sq m^{-1}. day^{-1}
$V_{44_{dc}}$	RUNDEB(D,C)	21	g·cu m^{-1}
$V_{47_{dc}}$	TDETIN(D,C)	23	g·cu m^{-1}
V_{51_k}	XDNORG(K)	33, 39	variable
V_{52_k}	RAINDI(K)	31	g·cu m^{-1}
V_{54_k}	DUNDNR(K)	32	g·cu m^{-1}
V_{57_k}	TDNORG(K)	34	g·cu m^{-1}
$V_{61_{tn}}$	XPNORG(T,N)	50, 106, 107	variable
$V_{62_{tn}}$	DUSTIP(T,N)	42	g·sq m^{-1}.day^{-1}
$V_{64_{tn}}$	RUNPNR(T,N)	43	g·cu m^{-1}
$V_{67_{tn}}$	TPNORG(T,N)	45	g·cu m^{-1}
V_{79}	DAYRUN	1, 2, 5, 11, 21, 32, 43	cu m·ecsys^{-1}·day^{-1}
V_{83}	FLOWIN	1	cu m·ecsys^{-1}·second^{-1}
V_{84}	TRFLOW	9	cu m·ecsys^{-1}·second^{-1}
V_{85}	DARAIN	1	mm·day^{-1}
${}_{E}\dot{X}_{01_{rc}}$	AGAINQ(R,C)	30	g·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{01_{5c}}$	AGAINQ(5,C)	55, 66, 73, 79, 84, 90	g·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{01_{11c}}$	AGAINQ(11,C)	56, 67, 74, 80, 85, 91	g·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{03_{rk}}$	DGAINQ(R,K)	41	g·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{04_{rn}}$	CGAINQ(R,N)	52	g·ecsys^{-1}·day^{-1}
$X_{1_{p1c}}$	CVEG(P,1,C)	71, 76, 77	g·ecsys^{-1}
$X_{11_{hc}}$	CBIOM(H,C)	53, 58, 59	g·ecsys^{-1}
X_{11_l}	POP(L)	60, 63, 64	pop·ecsys^{-1}
$X_{21_{mc}}$	CBACT(M,C)	82, 87, 88	g·ecsys^{-1}
X_{31_c}	AQUA(C)	14, 18, 19, 94, 97, 122	g·ecsys^{-1}
${}_{C}\dot{X}_{31_c}$	AQUAQQ(C)	94	g·ecsys^{-1}·day^{-1}
${}_{M}\dot{X}_{31_c}$	AQUAQQ(C)	126	g·ecsys^{-1}·day^{-1}
X_{33_c}	AQUAB(C)	122	g·ecsys^{-1}
${}_{M}\dot{X}_{33_c}$	AQUABQ(C)	124	g·ecsys^{-1}.day^{-1}
$X_{41_{dc}}$	CLIT(D,C)	24, 28, 29, 115, 117	g·ecsys^{-1}
${}_{C}\dot{X}_{41_{1c}}$	CLITQQ(1,C)	97	g·ecsys^{-1}· day^{-1}
${}_{P}\dot{X}_{41_{dc}}$	CLITQQ(D,C)	115	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{X}_{41_{dc}}$	CLITQQ(D,C)	110	g·ecsys^{-1}·day^{-1}
$X_{43_{dc}}$	CORG(D,C)	109	g·ecsys^{-1}·
$X_{43_{d1}}$	CORG(D,1)	120	g·ecsys^{-1}
${}_{P}\dot{X}_{43_{dc}}$	CORGQQ(D,C)	117	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{X}_{43_{dc}}$	CORGQQ(D,C)	112	g·ecsys^{-1}·day^{-1}
X_{51_k}	WDINR(K)	35, 39, 40, 128	g·ecsys^{-1}
${}_{M}\dot{X}_{51_k}$	WDINRQ(K)	132	g·ecsys^{-1}·day^{-1}
X_{53_k}	BDINR(K)	128	g·ecsys^{-1}
${}_{M}\dot{X}_{53_k}$	BDINRQ(K)	130	g·ecsys^{-1}·day^{-1}
$X_{61_{tn}}$	WPINR(T,N)	44, 46, 50, 51, 105, 107	g·ecsys^{-1}
${}_{P}\dot{X}_{61_{tn}}$	WPINRQ(T,N)	105	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{X}_{61_{tn}}$	WPINRQ(T,N)	100	g·ecsys^{-1}·day^{-1}
$X_{63_{tn}}$	BPINR(T,N)	99, 120	g·ecsys^{-1}
${}_{P}\dot{X}_{63_{tn}}$	BPINRQ(T,N)	107	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{X}_{63_{tn}}$	BPINRW(T,N)	102	g ecsys^{-1} day^{-1}
X_{73}	VELOCT	98, 103, 108, 113	m second^{-1}
X_{75}	WATSYS	1, 17, 19, 27, 29, 38, 40, 49, 51 57, 59, 62, 64, 75, 77, 86, 88, 100, 101, 110, 111, 122, 128	cu m·ecsys^{-1}
${}_{E}\dot{X}_{76_1}$	H20QQQ(1)	3	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_2}$	H20QQQ(2)	4	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_3}$	H20QQQ(3)	5	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_4}$	H20QQQ(4)	6	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_5}$	H20QQQ(5)	7	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_8}$	H20QQQ(8)	8	cu m·ecsys^{-1}·day^{-1}
${}_{E}\dot{X}_{76_{11}}$	H20QQQ(11)	9	cu m·ecsys^{-1}·day^{-1}
X_{77}	PERIM	119	m
X_{81}	AREA	20, 42	sq m·ecsys^{-1}
$Y_{1_{p1c}}$	DRIFTV(P,1,C)	75, 78	variable
$Y_{11_{hc}}$	DRIFTA(H,C)	57,65	variable
Y_{11_l}	DRIFPO(L)	62,69	variable
$Y_{21_{mc}}$	DRIFTM(M,C)	86,89	variable
Y_{31_c}	COMPIN(C)	17	variable
${}_{C}\dot{Y}_{31_c}$	COMPIN(C)	95	g·ecsys^{-1}·day^{-1}
${}_{M}\dot{Y}_{31_c}$	COMPIN(C)	125	g·ecsys^{-1}·day^{-1}
$Y_{41_{dc}}$	DETIN(D,C)	27	variable
${}_{C}\dot{Y}_{41_{1c}}$	DETIN(1,C)	96	g·ecsys^{-1}·day^{-1}
${}_{P}\dot{Y}_{41_{dc}}$	DETIN(D,C)	116	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{Y}_{41_{dc}}$	DETIN(D,C)	111	g·ecsys^{-1}·day^{-1}
Y_{51_k}	DNORG(K)	38	variable
${}_{M}\dot{Y}_{51_k}$	DNORG(K)	131	g·ecsys^{-1}·day^{-1}
$Y_{61_{tn}}$	PNORG(T,N)	49	variable
${}_{P}\dot{Y}_{61_{tn}}$	PNORG(T,N)	106	g·ecsys^{-1}·day^{-1}
${}_{S}\dot{Y}_{61_{tn}}$	PNORG(T,N)	101	g·ecsys^{-1}·day^{-1}
Y_{80}	FLOUT	1, 8	cu m·ecsys^{-1}.day^{-1}
Y_{82}	EVAP	1	mm·day^{-1}
Y_{86}	WIRRIG	1, 6	cu m·ecsys^{-1}·day^{-1}
Z_1	FLOWS	1, 2, 7, 12, 22, 33, 44, 53, 55, 60, 65, 66, 68, 69, 70, 71, 73, 78, 79, 81, 82, 84, 89, 90, 92	cu m·ecsys^{-1}·day^{-1}
Z_2	EVAPO	1, 2, 4	cu m·ecsys^{-1}·day^{-1}
Z_3	PRECIP	1, 2, 3, 10, 31	cu m·ecsys^{-1}·day^{-1}
Z_4	WATDAY	1, 2	cu m·ecsys^{-1}
Z_5	FLOWTR	1, 2, 13, 23, 34, 45, 53, 56, 60, 65, 67, 68, 69, 70, 71, 74, 78, 80, 82, 85, 89, 91, 92, 81	cu m·ecsys^{-1}·day^{-1}
Z_6	WATTOT	2, 16, 17, 26, 27, 37, 38, 48, 49, 54, 57, 61, 62, 72, 75, 83, 86, 99, 101, 102, 109, 111, 112	cu m·ecsys^{-1}·day^{-1} + cu m·ecsys^{-1}
$Z_{7_{1b}}$	A(1,NOLIT1)	10	g·ecsys^{-1}·day^{-1}
$Z_{7_{3b}}$	A(3,NOLIT1)	11	g·ecsys^{-1}·day^{-1}
$Z_{7_{5b}}$	A(5,NOLIT1)	12	g·ecsys^{-1}·day^{-1}
$Z_{7_{11b}}$	A(11,NOLIT1)	13	g·ecsys^{-1}·day^{-1}
$Z_{7_{13b}}$	A(13,NOLIT1)	14	g·ecsys^{-1}

Symbol	FORTRAN Equivalent	Equations where used	Units
$Z_{7_{rb}}$	A(R,B)	15, 30	variable
Z_8	TOTSOL	15, 16, 18	g·ecsys^{-1}·day^{-1} + g·ecsys^{-1}
Z_9	SOLAVE	16, 17, 19	g·cu m^{-1}
$Z_{10_{1d}}$	A(1,D)	20	g·ecsys^{-1}·day^{-1}
$Z_{10_{3d}}$	A(3,D)	21	g·ecsys^{-1}·day^{-1}
$Z_{10_{5,d}}$	A(5,D)	22	g·ecsys^{-1}·day^{-1}
$Z_{10_{11,d}}$	A(11,D)	23	g·ecsys^{-1}·day^{-1}
$Z_{10_{13,d}}$	A(13,D)	24	g·ecsys^{-1}
$Z_{10_{rd}}$	A(R,D)	25	variable
Z_{11d}	TOTLIT(D)	25, 26, 28	g·ecsys^{-1}·day^{-1} + g·ecsys^{-1}
Z_{12_d}	AVELIT(0)	26, 27, 29	g·cu m^{-1}
Z_{13_r}	AINRD(R)	36, 41	g·ecsys^{-1}·day^{-1}
Z_{13_1}	AINRD(1)	31	g·ecsys^{-1}·day^{-1}
Z_{13_3}	AINRD(3)	32	g·ecsys^{-1}·day^{-1}
Z_{13_5}	AINRD(5)	33	g·ecsys^{-1}·day^{-1}
$Z_{13_{11}}$	AINRD(11)	34	g·ecsys^{-1}·day^{-1}
$Z_{13_{13}}$	AINRD(13)	35	g·ecsys^{-1}
Z_{14}	TOTNRD	36, 37, 39	g·ecsys^{-1}·day^{-1} + g·ecsys^{-1}
Z_{15}	AVENRD	37, 38, 40	g·cu m^{-1}
$Z_{16_{1t}}$	AINRP(1,T)	42	g·ecsys^{-1}·day^{-1}
$Z_{16_{3t}}$	AINRP(3,T)	43	g·ecsys^{-1}·day^{-1}
$Z_{16_{5t}}$	AINRP(5,T)	44	g·ecsys^{-1}·day^{-1}
$Z_{16_{11t}}$	AINRP(11,T)	45	g·ecsys^{-1}·day^{-1}
$Z_{16_{13t}}$	AINRP(13,T)	46	g·ecsys^{-1}
$Z_{16_{rt}}$	AINRGP(R,T)	47, 52	variable
Z_{17_n}	TOTNRP(N)	47, 48, 50	g·ecsys^{-1}·day^{-1}+g·ecsys^{-1}
Z_{18_n}	AVENRP(N)	48, 49, 51	g·cu m^{-1}
Z_{19}	ANTOT	53, 54, 58	g·ecsys^{-1}·day^{-1}+g·ecsys^{-1}
Z_{20}	ANAVE	54, 57, 59	g·cu m^{-1}
Z_{21}	POPTOT	60, 61, 63	pop·ecsys^{-1}·day^{-1} + pop·ecsys^{-1}
Z_{22}	POPAVE	61, 62, 64	pop·cu m^{-1}
Z_{23}	VGTOT	71, 72, 76	g·ecsys^{-1}·day^{-1}+g·ecsys^{-1}
Z_{24}	VGAVE	72, 75, 77	g·cu m^{-1}
Z_{25}	HETTOT	82, 83, 87	g·ecsys^{-1}·day^{-1}+g·ecsys^{-1}
Z_{26}	HETAVE	83, 86, 88	g·cu m^{-1}
Z_{27}	COAG	93, 94, 95, 96, 97	dimensionless
Z_{28}	CYCLE	93, 95, 96, 104, 114, 118, 127	day^{-1}
Z_{29}	SCOUR	98, 99, 108, 109	
Z_{30}	GOES	99, 100, 101, 102, 109, 110, 111, 112	
Z_{31}	FALLS	103, 104, 113, 114	
Z_{32}	DEPOS	104, 105, 106, 107, 114, 115, 116, 117	
Z_{33}	AMIX	118, 121, 129	
Z_{34}	CURV1	118, 119	
Z_{35}	BENTH	119, 120, 123	g·ecsys^{-1}
Z_{36}	AMIX2	121, 124, 125, 126, 129, 130, 131, 132	
Z_{37}	DIF	121, 122, 128, 129	
Z_{38}	BENWAT	122, 123, 124, 125, 126, 128, 130, 132	cu m·ecsys^{-1}
Z_{39}	C	125, 126, 127, 131, 132	dimensionless

PROCESS DELETION

Just as the MEDIUM subroutine acts as a "black box" to other subroutines and the main program, sections within the subroutine act as "black boxes" to each other. The user may elect not to use some of these functions, and this may be accomplished in two ways. One, a particular section may be left out of the program during compilation, or two, parameters or switches may be set to skip certain sections, or to predict a change of zero. The latter is by far the most useful, for the user may wish to change particular state variables by a process and not others, and a recompilation would not be necessary. Both methods will be treated. The numbers prefixed with (ME) refer to the program sequence number (Appendix H).

PROCESS	PROGRAM SECTION
Coagulation	ME1325 to ME1370
Inorganic detritus scouring and deposition	ME1395 to ME1530
Organic detritus scouring and deposition	ME1535 to ME1695
Mixing of dissolved material between the benthos and water column	ME1705 to ME1840

Switches and parameters should be set as follows to "set to zero" certain processes.

PROCESS	PARAMETER	FORTRAN EQUIVALENT	SETTING
Coagulation	P_1	COAGUL	0
Inorganic detritus scouring	P_{4_t}	SDRF2(T)	1
Inorganic detritus deposition	P_{6_t}	SDRF3(T)	1
Organic litter scouring	P_{8_d}	CDRF2(D)	1
Organic litter deposition	P_{10_d}	CDRF3(D)	1
Dissolved constituent mixing	P_{11}	CFAC1	0

ARRAY DIMENSIONS

The use of the program is limited by the dimensions allocated to the arrays, and these limitations need discussion so that the user may be in a position to modify them as his particular requirements indicate. Below is a list of arrays peculiar to the MEDIUM submodel, in which the dimension which may appropriately be varied are indicated by letters.

A(13,a)
AINRD(13)
AINRP(13,b)
AVELIT(C)
AVENRP(b)
CDRF2(c)
CDRF3(c)
CLITHI(c)
CLITLO(c)
SDRF2(b)
SDRF3(b)
STRHI(b)
STRLO(b)
TOTLIT(c)
TOTNRP(b)

The dimensions indicated by letters define the maximum values possible for the following quantities:

		FORTRAN NAME
a	Number of organic detritus categories plus one	NOLIT1
b	Number of inorganic detritus types or size classes	ISTRTM
c	Number of organic detritus categories	NOLIT

Parameters and Switches

A list of all the parameters and switches needed for the MEDIUM subroutine follows. Explanations can be found in the definitions list, Appendix A. Letters used for dimensions are explained above under Array Dimensions.

ALLMAX
CDRF2(c)
CDRF3(c)
CFAC1
CFAC2
CLITHI(c)
CLITLO(c)
COAGUL
SDRF2(b)
SDRF3(b)
STRHI(b)
STRLO(b)
WATDAY
WETFAC

SUBROUTINE ANIMAL

INTRODUCTION

All processes concerning a change in the biomass or populations of animals are handled by the subroutine ANIMAL, except for those changes in zooplankton due to flow. At present, these processes include ingestion, egestion, respiration, assimilation, scouring and colonization, mortality, cohort transfer, birth, emergence, and drift. This subroutine also handles the processes of the heterotrophic microorganisms.

For a generalized model flow chart of the animal processes, refer to Diagram A 1, and to A 2 for the heterotrophic microorganism processes. A listing of the animal subroutine can be found in Appendix I.

VERBAL DESCRIPTION

The animals within the system may ingest any plant, animal, detritus type or microorganism, whether it be suspended or benthic. The foods they actually ingest are controlled by a preference-availability factor for each of the possible foods, as well as by the amounts of each of those foods. Thus, Figure A2 shows it would take larger amounts of a food source with a lower preference-availability factor for an animal to have the same intake as for a food with smaller amounts but a larger preference-availability factor. Also, if the food sources all contained the same amounts, the ratio of the intake would equal the ratio of the preference-ability factors.

The maximum amount of food ingested by an animal group is controlled by an input parameter which is a scaler multiplier of the weight of that group, with this amount being scaled down by a number of factors. First, the amount of weighted foods available to the animal group lowers actual ingestion according to Figure A2.

A further reduction in ingestion occurs as a consumer reaches its maximum size (Figure A3). Finally, temperature affects ingestion (Figure A 4).

Respiration occurs as a modified exponential function of temperature (Figure A 5), and since assimilation is a constant proportion of ingestion, and growth equals assimilation minus respiration, growth occurs in an envelope as a function of temperature (Figure A6).

The maximum ingestion of Figure 2 can only be reached with unlimited food supplies by a cohort that is at its minimum weight and at a temperature for maximum growth. When the individuals of a cohort are at their maximum weight, ingestion balances respiration and egestion, which occurs at assimilation rates below unity. Part of the egested material may go into solution, with the remainder being added to specified litter categories. All ratios of chemical constituents or energy to carbon are kept constant within an animal group, with possible variations because of the diet being egested. Energy of respiration is considered lost to the ecosystem by way of the atmosphere, with other respired products entering the dissolved inorganic compartments, either benthos or water column, depending on the habitat of the organism in question.

For the transfer of animals of one size class or cohort of a species to the next larger size or older cohort, several alternatives are provided:

1. The rate of transfer may be a function of accumulated mean daily temperatures, in excess of a specified threshold, starting from when animals entered a particular cohort, with the transferred animals remaining within the ecosystem.
2. The rate of transfer may be as an exponential function of temperature on a particular day.
3. The transfer is regulated the same as for number 1, except here the transferred animals leave the system as flying adults.
4. Transfer occurs on the last day of the year.
5. Transfer occurs as a function of the weight of an average individual above a certain specified weight.
6. No transfer occurs.

At the time of transfer, not all of the biomass may enter the more mature cohort. A fixed proportion may be transferred as exuviae to specified detrital categories.

A number of alternatives are also provided for the type of transfer from cohorts to the eggs of the same species:

1. Transfer to eggs occurs during specified times of the year if the temperature lies within a certain range.
2. A constant reproduction occurs between upper and lower threshold temperatures.
3. If the species is of the variety that has aerial adults, and if adults hatched on that day, then a constant number of eggs are laid for that species.
4. No eggs are laid by the group.

Animals also have non-predatory mortality, which is fixed for each group, with the dead entering any of the detrital categories specified at execution.

Many invertebrates drift into and out of the ecosystem; this is divided into two categories in the model, catastrophic and behavioral drift. Catastrophic drift occurs as a function of water velocity, with animals drifting into the system being allowed to colonize during periods of low flow (Figure A7), or animals in the system being swept away during high water periods (Figure A8).

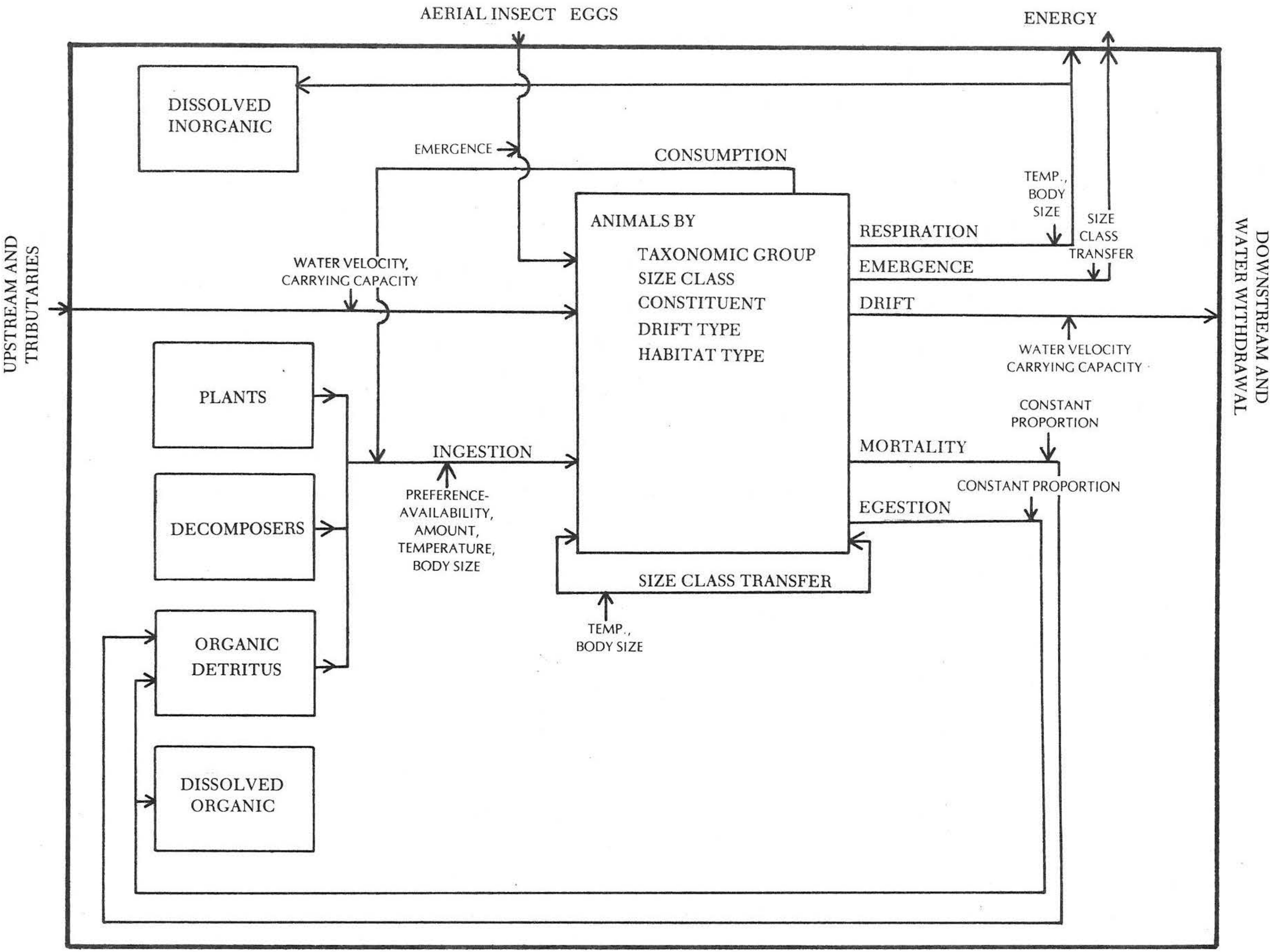

Diagram A1. Generalized flow model of animal processes.

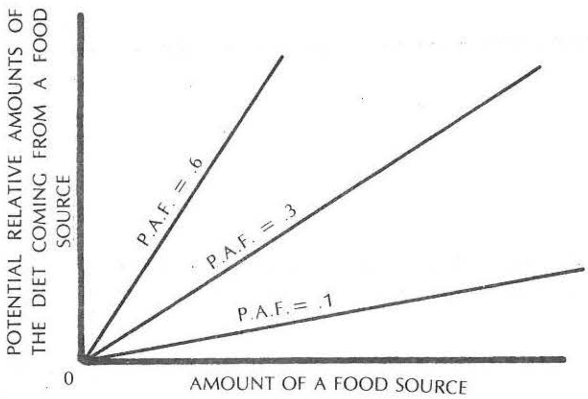

Figure A1. Potential relative amounts of the diet coming from a food source as regulated by the preference-availability factor (P.A.F.).

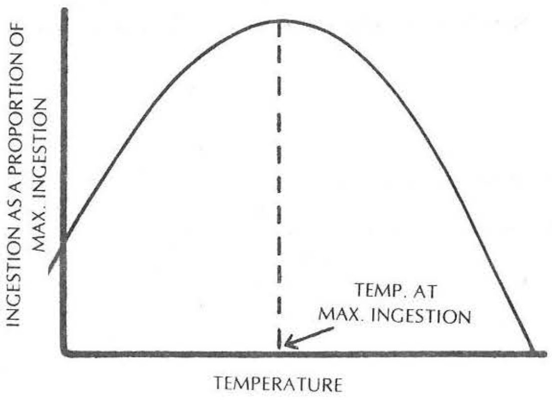

Figure A4. Ingestion as affected by temperature.

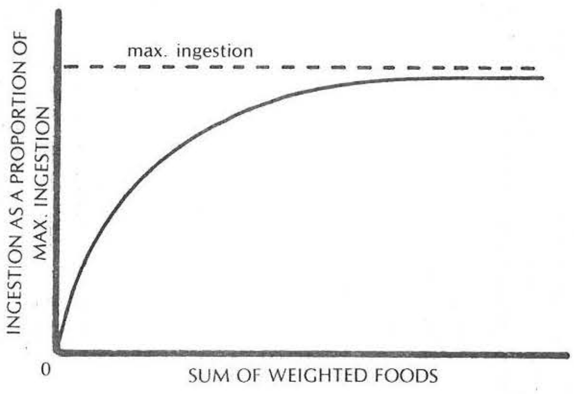

Figure a 2. Ingestion as affected by amounts of food available.

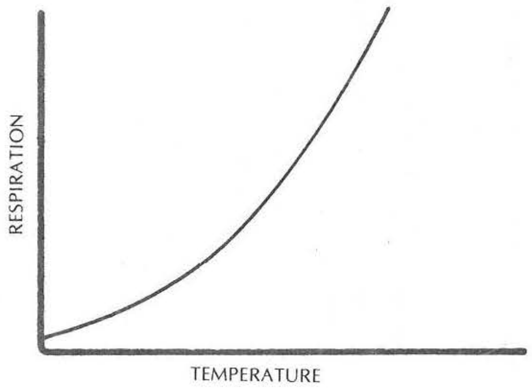

Figure A5. Respiration as affected by temperature.

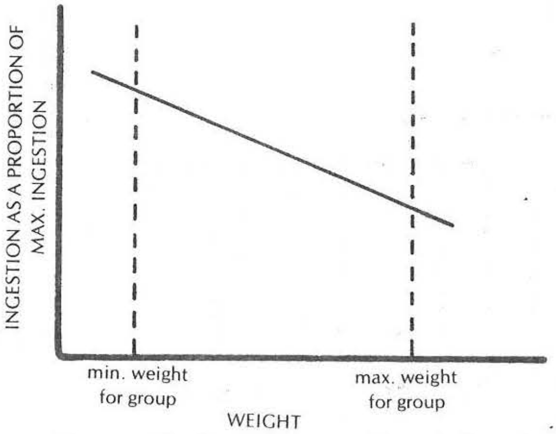

Figure A3. Ingestion as affected by the weight of an individual.

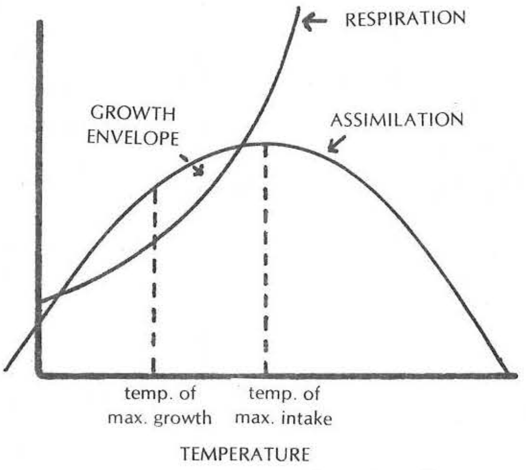

Figure A6. Growth as a function of temperature.

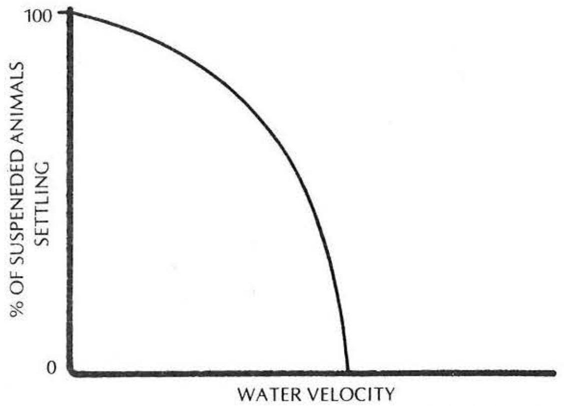

Figure A7. Settling of normally benthic animals found in the water column as a function of velocity.

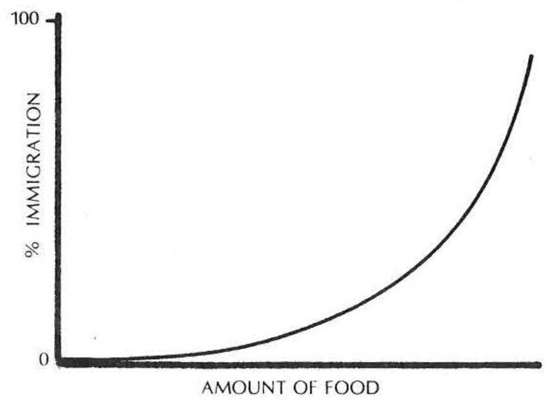

Figure A10. Percent of suspended animals remaining in the system as a function of food supplies.

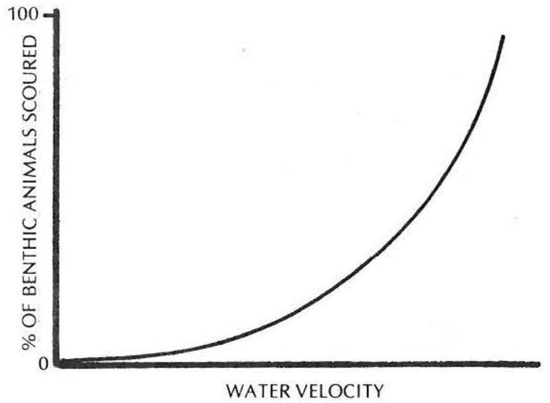

Figure A8. Scouring of benthic animals as a function of velocity.

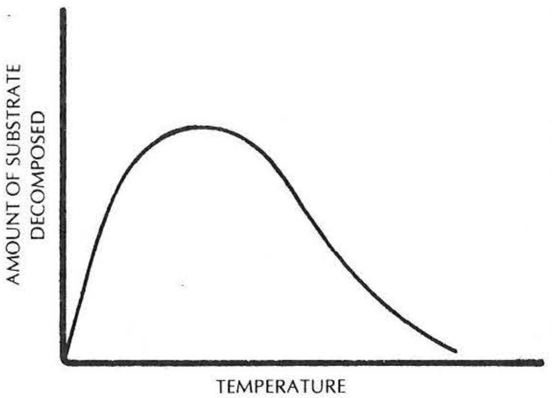

Figure A11. Decomposition as a function of temperature.

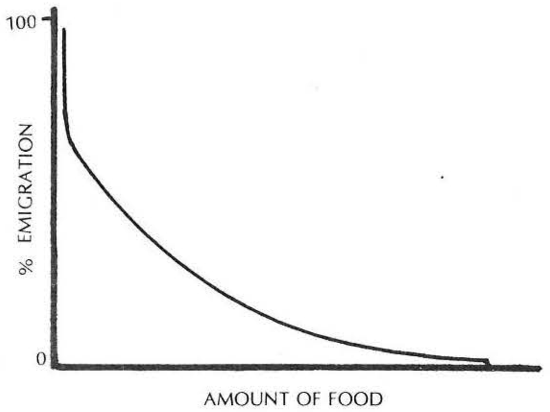

Figure A9. Percent of animals emigrating from the system as a function of food supplies.

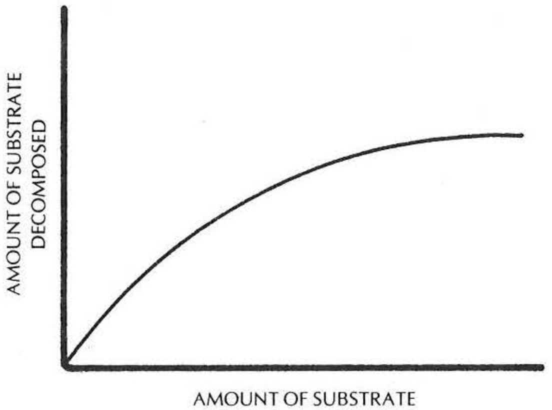

Figure A12. Decomposition as a function of substrate available.

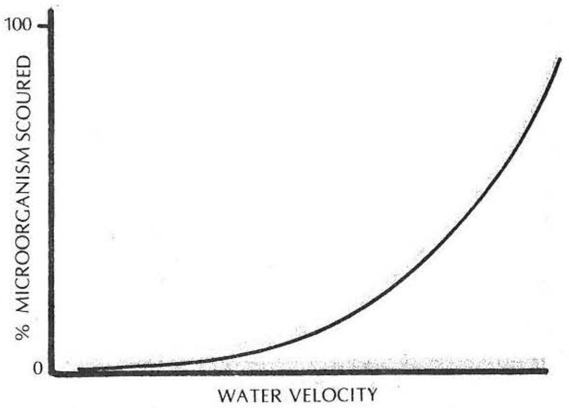

Figure A13. Scouring of microorganisms as a function of water velocity.

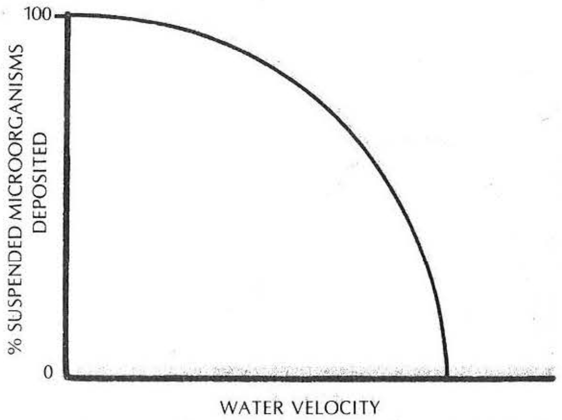

Figure A14. Deposition of microorganisms as a function of water velocity.

Behavioral drift is considered as a function of carrying capacity monitored as the difference between the amount of food an animal "wants" to ingest and the amount it is allowed to ingest as a function of food quantities (Figure A2. Thus, the lower the food supplies, the greater fraction of animals leaving the stream section (Figure A9). Immigration is calculated as the complement of emigration (Figure A10).

Microorganisms

The microorganisms of the system act to decompose any of the benthic or suspended detrital categories and the dissolved organic constituents. The use of these substrates by different categories of microbes is expressed, as in the case of animals, by a preference table. The total substrate utilization is calculated by a Michaelis-Menton function using temperature and the weighted total of the substrates available (Figures A11 and A12).

The amount of substrate mineralized is a constant fraction of the substrate used, with the elements entering the dissolved inorganic compartments of the system. Another constant fraction is added to the protoplasm, with the remainder being lysed or leaked and added to the dissolved organic compartments. The microorganisms that are attached to substrates in the water column or that are in the benthos may also be scoured or deposited as a function of water velocity (Figures A13 and A14).

MATHEMATICAL DESCRIPTION

The equations described here follow the order in the program itself, except where a particular "thought train" or process is being developed. The equations are numbered on the right side of the page, while the numbers in brackets preceded by an "A" refer to the actual FORTRAN program equations in Appendix I. The names in brackets for the variable explanations are their FORTRAN equivalents. At the end of the mathematical description a table can be found listing the symbols, their FORTRAN equivalent, all equations where the symbol is used as well as the units for that variable. The classification as to types of symbols used for variables is explained in the MAIN Introduction.

The following table lists the processes that affect the animals along with the equations which treat these processes:

PROCESS	EQUATIONS
Ingestion	1- 48
Respiration-Egestion-Assimilation	49- 95
Cohort Transfer	96-131
Non-predatory Mortality	132-143
Animal Scouring and Deposition	144-149
Behavioral Drift	150-156

For the animals the following subsets are defined:

$A = (1)$
$B = (2, 3, 4)$
$C = (2, 3)$
$D = (4)$

Where 1 = plankters, 2 = animals scoured because of high water velocities, 3 = behavioral drifters, and 4 = free swimmers found in the water column [as specified by NDRIFA(H)].

Also: $J = 1,2$; $K = 3$

where:

1 = animals whose habitat is open water
2 = animals whose habitat is in vegetation
3 = benthic dwellers
as specified by LIVEAN(H)

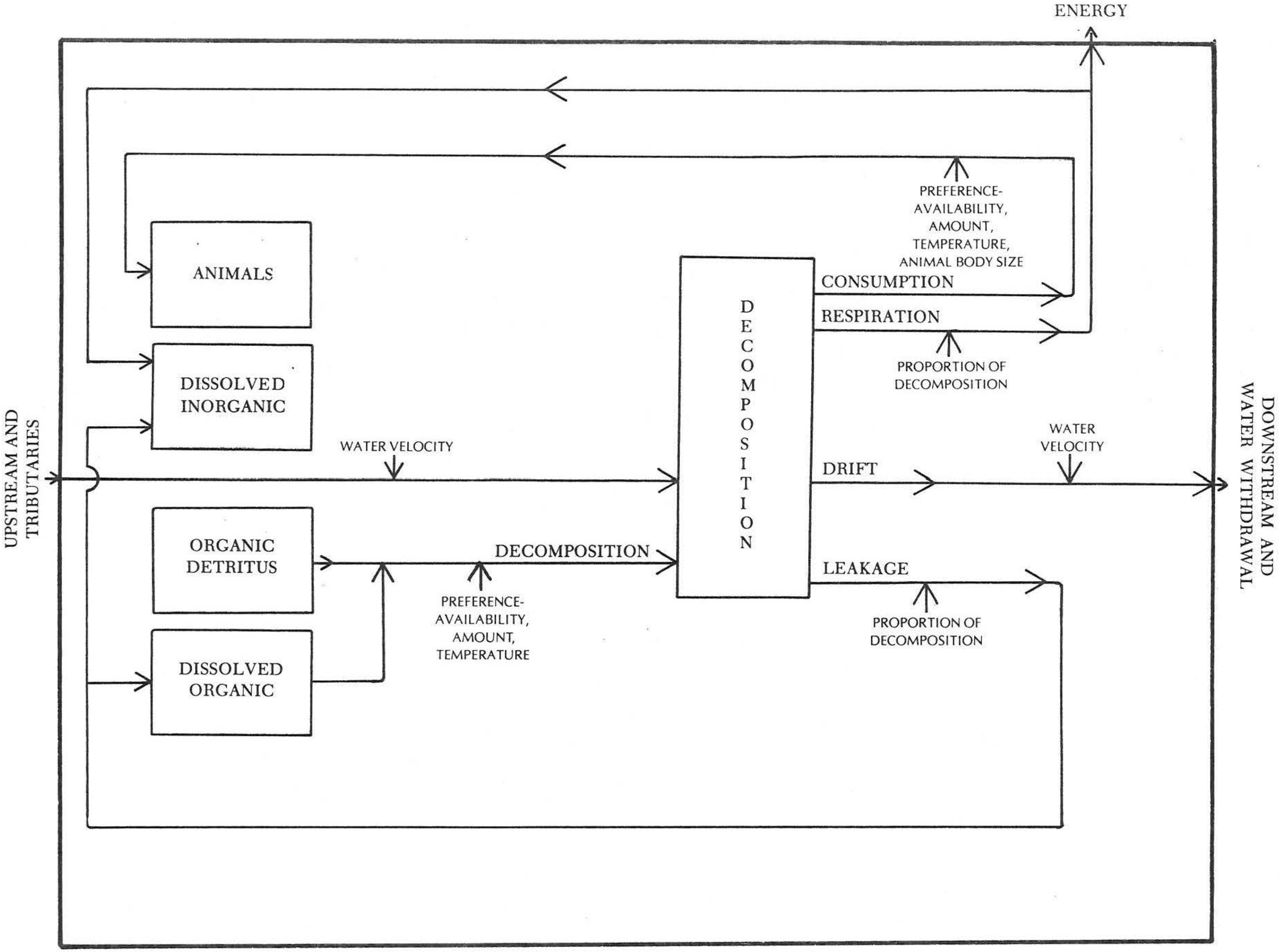

Diagram A2. Generalized flow model of heterotrophic microorganisms.

Ingestion

The amount of food available to a group of animals is determined by an availability-preference factor for foods, as well as the amounts of those foods.

The amount of vegetation available to an animal group is calculated by:

$$Z_{1_p} = X_{1_{p1,1}} P_{1_{hp}} \quad \text{or} \quad \begin{matrix} h \in A \text{ and } p \in E \\ h \in B \text{ and } p \in F \end{matrix} \qquad [\text{A0560}] \qquad 1$$

or

$$Z_{1_p} = (X_{1_{p1,1}} + V_{1_{p1,1}})P_{1_{hp}} \qquad h \in B \text{ and } p \in E \qquad [\text{A0575}] \qquad 2$$

where:

E = phytoplankton
F = sessile plants

Z_{1_p} = The weighted amount of the *p*'th plant category available to the animal in question [FEEDV(P)]
$X_{1_{p1,1}}$ = The carbon content of the *p*'th plant species [CVEG(P,1,1)]
$P_{1_{hp}}$ = The preference-availability factor of the *h*'th animal group for the *p*'th plant group [PREFV(H,P)]
$V_{1_{p1,1}}$ = The amount of carbon of the *p*'th plant group entering the system in a time period [XDRIFV(P,1,1)]

For the animals (as prey): (Predator = ***h***)

$$Z_{2_h} = X_{11_{h1}} P_{2_{\underline{h}h}} \qquad \begin{matrix} h \in A \text{ and } \underline{h} \in A \\ h \in C \text{ and } \underline{h} \in C \\ h \in D \text{ and } \underline{h} \in D \end{matrix} \qquad [\text{A0635}] \qquad 3$$

$$Z_{2_h} = (X_{11_{h1}} + V_{11_{h1}})P_{2_{\underline{h}h}} \qquad h \in A \text{ and } \underline{h} \in B \qquad [\text{A0650}] \qquad 4$$

$$Z_{3_h} = V_{11_{h1}} P_{2_{\underline{h}h}} P_{3_{\underline{h}}} \qquad [\text{A0665}] \qquad 5$$

$$h \in C \text{ and } \underline{h} \in D$$

$$Z_{2_h} = X_{11_{h1}} P_{2_{\underline{h}h}} (1-P_{3_{\underline{h}}}) \qquad [\text{A0675}] \qquad 6$$

where:

Z_{2_h} = The weighted amount of the *h*'th animal category (as prey) available to the animal (predator) currently under consideration [FEEDA(H)]
$X_{11_{h1}}$ = The carbon content of the *h*'th animal category [CBIOM(H,1)]
$P_{2_{\underline{h}h}}$ = The preference and availability factor of the *h*'th animal group (as predators) for the *h*'th animal group (as prey) [PREFA(H,H)]
$P_{3_{\underline{h}}}$ = The fraction of a normally sessile animal (prey) which is taken from the drift by the *h*'th animal group (predator) [FEDFRM(H)]
$V_{11_{h1}}$ = The amount of carbon of the *h*'th animal group (as prey) drifting into the system in a time period [XDRIFA(H,1)]
Z_{3_h} = The weighted amount of the *h*'th animal category (as prey -- normally sessile animals) available to the animal (predator-free swimmer) currently under consideration [FEEDAD(H)]

For suspended detritus:

$$Z_{4_d} = X_{41_{d1}} P_{4_{hd}} \qquad h \in A \qquad [\text{A0745}] \qquad 7$$

$$Z_{4_d} = (X_{41_{d1}} + V_{41_{d1}})P_{4_{hd}} \qquad h \in B \qquad [\text{A0755}] \qquad 8$$

where:

Z_{4_d} = The weighted amount of the *d*'th suspended detritus category available to the animal in question [FEEDL(D)]
$X_{41_{d1}}$ = The carbon content of suspended detritus in the ecosystem [CLIT(D,1)]
$P_{4_{hd}}$ = The preference-availability factor of the *h*'th animal group for the *d*'th suspended detritus type [PREFL(H,D)]
$V_{41_{d1}}$ = The carbon of the *d*'th suspended detritus type entering the ecosystem in a time unit [XDETIN(D,1)]

For benthic detritus:

$$Z_{5_d} = X_{43_{d1}} P_{5_{hd}} \qquad h \in B \qquad [\text{A0730}] \qquad 9$$

where:

Z_{5_d} = The weighted amount of the *d*'th type of benthic detritus available to the animal in question [FEEDO(D)]
$X_{43_{d1}}$ = The carbon content of the *d*'th type of benthic litter [CORG(D,1)]
$P_{5_{hd}}$ = The preference-availability factor of the *h*'th animal group for the *d*'th type of benthic litter [PREFO(H,D)]

For heterotrophic microorganisms:

$$Z_{6_m} = X_{21_{m1}} P_{6_{hm}} \quad \text{or} \quad \begin{matrix} h \in A \text{ and } m \in G \\ h \in B \text{ and } m \in H \end{matrix} \qquad [\text{A0815}] \qquad 10$$

or

$$Z_{6_m} = (X_{21_{m1}} + V_{21_{m1}})P_{6_{hm}} \qquad h \in B \text{ and } m \in G \qquad [\text{A0830}] \qquad 11$$

where:

G = planktonic microorganisms
H = attached or benthic microorganisms

Z_{6_m} = The weighted amount of the *m*'th microorganisms category available to the animal group in question [FEEDM(M)]

$X_{21_{ml}}$ = The carbon content of the *m*'th type of heterotrophic microorganism [CBACT(M,1)]

$P_{6_{hm}}$ = The preference-availability factor of the *h*'th animal category for the *m*'th category of microorganisms [PREFM(H,M)]

$V_{21_{ml}}$ = The carbon content of the *m*'th group of microorganisms entering the ecosystem in a time unit [XDRIFM(M,1)]

The total possible intake for a unit of biomass of a consumer is scaled down based on the amount of weighted foods available.

$$Z_{25_h} = P_{25_h}\{1. - \exp(-P_{26_h} Z_{8_h})\} \qquad [A0905] \quad 12$$

where:

Z_{25_h} = The proportion of the weight of a consumer ingested in a time period based on the amount of foods available [EATS(H)]

P_{25_h} = The maximum possible intake of the *h*'th animal group in grams per gram animal [TAKE(H)]

P_{26_h} = Rate of curvature factor [CURVE(H)]

and

$$Z_{8_h} = Z_7/X_{81} \qquad [A0870] \quad 13$$

where:

Z_{8_h} = The weighted amounts of food available to the *h*'th cohort in grams per square meter [EATS(H)]

X_{81} = Surface area of the ecosystem in square meters [AREA]

and

$$Z_7 = \Sigma_p Z_{1_p} + \Sigma_h Z_{2_h} + \Sigma_h Z_{3_h} + \Sigma_d Z_{4_d} + \Sigma_d Z_{5_d} + \Sigma_m Z_{6_m} \qquad 14$$

where:

Z_7 = The sum of the weighted foods for the animal group currently being considered [SUM]

Z_{1_p} = The weighted amount of the *p*'th plant category available to the animal in question [FEEDV(P)]

Z_{2_h} = The weighted amount of the *h*'th animal category (as prey) available to the animal (predator) currently under consideration [FEEDA(H)]

Z_{3_h} = The fraction of a normally sessile animal (prey) which is taken from the drift by the *h*'th animal group (predator) [FEDFRM(H)]

Z_{4_d} = The weighted amount of the *d*'th suspended detritus category available to the animal in question [FEEDL(D)]

Z_{5_d} = The weighted amount of the *d*'th type of benthic detritus available to the animal in question [FEEDO(D)]

Z_{6_m} = The weighted amount of the *m*'th microorganisms category available to the animal group in question [FEEDM(M)]

Each animal group that ingests (if TAKE for that group is greater than zero) is checked for maximum possible growth, and if this is zero or negative the program is stopped.

$$Z_{26} = P_{25_h} P_{27_h} - \{P_{28_h}{}^{P_{29_h}} P_{30_h} (2.^{P_{31_h}/10.})\} \qquad [A0920, A0925] \quad 15$$

where:

Z_{26} = The maximum possible growth for the cohort currently being considered [GMAX]

P_{25_h} = The maximum intake of the *h*'th cohort in grams per gram animal [TAKE(H)]

P_{27_h} = The proportion of ingested material which is assimilated by the *h*'th cohort [ASSIM(H)]

P_{28_h} = The minimum weight of an individual of the *h*'th cohort [WMIN(H)]

P_{29_h} = Rate of increase of log respiration rate with log individual biomass of the *h*'th animal cohort [SLOPE(H)]

P_{30_h} = Respiration per time unit by an animal of the *h*'th cohort of minimum biomass at zero degrees centigrade [CONST(H)]

P_{31_h} = Temperature at maximum growth for the *h*'th animal cohort [TOPT(H)]

The total possible intake for a unit of biomass of a consumer is further scaled down as a function of body size and temperature. For body size:

$$Z_{27} = \{Z_{26} P_{32_h}/(P_{32_h} - P_{28_h})\} - \{(X_{11_{hc}}/X_{12_l})Z_{26}/(P_{32_h} - P_{28_h})\} \qquad [A0975, A0980] \quad 16$$

where:

Z_{27} = The growth potential for the cohort currently under consideration [GPOT]

P_{28_h} = The minimum weight of an individual of the *h*'th cohort [WMIN(H)]

P_{32_h} = The maximum weight of an animal of the *h*'th cohort [WMAX(H)]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

X_{12_l} = The population of the *l*'th animal cohort [POP(L)]

For temperature:

$$Z_{30} = 2P_{33_h} P_{31_h} - P_{31_h}{}^2 - 2P_{33_h} X_{72} \qquad [A0985] \quad 17$$

$$Z_{31} = Z_{30} + X_{72}{}^2 \qquad [A0990] \quad 18$$

$$Z_{32} = Z_{31}/\{2(P_{33_h} - P_{31_h})\} \qquad [A0995] \quad 19$$

$$Z_{33} = \{Z_{32}Z_{34}(-.069314) + Z_{27} + Z_{34}\}/(P_{27_h} P_{25_h}) \qquad [A1005] \quad 20$$

where:

Z_{30} = Temporary variable for intake scaling factor [B]

Z_{31} = Temporary variable for intake scaling factor [B]

Z_{32} = Temporary variable for intake scaling factor [B]

Z_{33} = Scaling factor for calculating intake for the animal group currently under consideration [B]

P_{31_h} = Temperature at maximum growth for the *h*'th animal cohort [TOPT(H)]

P_{27_h} = The amount of ingested material which is assimilated by the *h*'th cohort [ASSIM(H)]

P_{25_h} = The maximum intake of the *h*'th cohort in grams per gram animal [TAKE(H)]

P_{33_h} = The temperature at maximum ingestion for the *h*'th cohort [TMAX(H]

X_{72} = The water temperature in degrees centigrade [WTEMP]

Respiration for the cohort under consideration is calculated for use only as output.

$$Z_{34} = (X_{11_{hc}}/X_{12_l})^{P_{29_h}} P_{30_h}(2^{P_{31_h}/10.}) \qquad \text{[A0915]} \quad 21$$

where:

Z_{34} = Respiration for the cohort under consideration at the temperature for their maximum growth [RESPAC]

$X_{11_{hc}}/X_{11_l}$ = The average size of an individual of the *h*'th cohort [BODSIZ]

P_{29_h} = Rate of increase of log respiration rate with log individual biomass of the *h*'th animal cohort [SLOPE(H)]

P_{30_h} = Respiration per time unit by an animal of the *h*'th cohort at zero degrees centigrade [CONST(H)]

P_{31_h} = Temperature at maximum growth for the *h*'th animal cohort [TOPT(H)]

This final temporary variable [Z_{33}] is used to calculate the actual amount of intake of a particular cohort.

For planktonic animals:

$$Z_{35_{hl}} = Z_{25_h}/Z_{16} \qquad h \varepsilon A \qquad \text{[A1040]} \quad 22$$

$$Z_{10} = Z_{35_{hl}} X_{11_{hc}} Z_{33} \qquad h \varepsilon A \qquad \text{[A1045]} \quad 23$$

For non-planktonic animals:

$$Z_{10} = Z_{25_h} X_{11_{hc}} Z_{33} \qquad h \varepsilon B \qquad \text{[A1055]} \quad 24$$

where:

$Z_{35_{hl}}$ = The amount of carbon ingested by the *h*'th animal cohort during the time they spent in the ecosystem [FOOD(H,1)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{25_h} = The proportion of the weight of a consumer ingested in a time period based on the amount of foods available [EATS(H)]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

Z_{33} = Scaling factor for calculating intake for the animal group currently under consideration [B]

The actual amount of each particular food consumed is calculated taking into account the total amount of food ingested for a time unit, the preference-availability factors and the amounts of different foods available.

The amount of vegetation removed by animal consumption equals:

$${}_I\dot{X}_1 = -\{X_{1_{p1c}} Z_{10} Z_{1_p}/(Z_7 X_{1_{p1,1}})\} \qquad \begin{matrix} h\varepsilon A \text{ and } p\varepsilon E \\ \text{or } h\varepsilon B \text{ and } p\varepsilon E \end{matrix} \qquad \begin{matrix} \text{[A1130, A1115]} \\ \text{[A1205, A1195]} \end{matrix} \quad 25$$

$${}_I\dot{Y}_1 = -\{V_{1_{p1c}} Z_{10} Z_{1_p}/(Z_7 X_{1_{p1,1}})\} \qquad h\varepsilon A \text{ and } p\varepsilon E \qquad \text{[A1135, A1115]} \quad 26$$

$$\left.\begin{matrix} {}_I\dot{X}_1 = -[X_{1_{p1c}} Z_{10} Z_{1_p}/\{Z_7(X_{1_{p1c}} + X_{1_{p1,1}})\}] \\ {}_I\dot{Y}_1 = -[V_{1_{p1c}} Z_{10} Z_{1_p}/\{Z_7(X_{1_{p1c}} + X_{1_{1p,1}})\}] \end{matrix}\right\} \begin{matrix} \text{[A1185,A1155]} \quad 27 \\ h\varepsilon B \text{ and } p\varepsilon E \\ \text{[A1185,A1150]} \quad 28 \end{matrix}$$

where:

${}_I\dot{X}_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group ingested by the animal group currently under consideration [CVEGQQ(P,1,C)]

$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group present in the system [CVEG(P,1,C)]

${}_I\dot{Y}_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group which would have been washed out of the system but instead has been ingested [DRIFTV(P,1,C)]

$V_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group entering the system in a time period [XDRIFV(P,1,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{1_p} = The weighted amount of the p'th plant category available to the animal in question [FEEDV(P)]

Z_7 = The sum of the weighted foods of the animal group currently being considered [SUM]

$X_{1_{p1,1}}$ = The carbon content of the p'th plant species [CVEG(P,1,1)]

$V_{1_{p1,1}}$ = The amount of carbon of the p'th plant group entering the system in a time period [XDRIFV(H,P)]

The amount and populations of animals (as prey) consumed by predators is calculated and removed (predator = $\underline{h}$). For zooplankton eating zooplankton or non-planktonic animals eating non-planktonic animals:

$$\left.\begin{array}{l} {}_{I}\dot{X}_{11_{hc}} = -\{X_{11_{hc}}\ Z_{10}\ Z_{2_h}/(Z_7\ X_{11_{h1}})\} \\ {}_{I}\dot{X}_{12_l} = -\{X_{12_l}\ Z_{10}\ Z_{2_h}/(Z_7\ X_{11_{h1}})\} \end{array}\right\} \begin{array}{ll} \text{[A1280, A1260]}\ \text{[A1350, A1365]} & 29 \\ h\ \varepsilon\ A \text{ and } \underline{h}\ \varepsilon\ A & \\ h\ \varepsilon\ B \text{ and } \underline{h}\ \varepsilon\ B & \\ \text{[A1260, A1265]}\ \text{[A1350, A1355]} & 30 \end{array}$$

$$\left.\begin{array}{l} {}_{I}\dot{Y}_{11_{hc}} = -\{V_{11_{hc}}\ Z_{10}\ Z_{2_h}/(Z_7\ X_{11_{h1}})\} \\ {}_{I}\dot{Y}_{12_l} = -\{V_{12_l}\ Z_{10}\ Z_{2_h}/(Z_7\ X_{11_{h1}})\} \end{array}\right\} \begin{array}{ll} \text{[A1295, A1260]} & 31 \\ h\ \varepsilon\ A \text{ and } \underline{h}\ \varepsilon\ A & \\ \text{[A1270, A1260]} & 32 \end{array}$$

For nonplanktonic animals consuming zooplankton:

$$\left.\begin{array}{l} {}_{I}\dot{X}_{11_{hc}} = -[X_{11_{hc}}\ Z_{10}\ Z_{2_h}/\{Z_7(V_{11_{h1}} + X_{11_{h1}})\}] \\ {}_{I}\dot{X}_{12_l} = -[X_{12_l}\ Z_{10}\ Z_{2_h}/\{Z_7(V_{11_{h1}} + X_{11_{h1}})\}] \\ {}_{I}\dot{Y}_{11_{hc}} = -[V_{11_{hc}}\ Z_{10}\ Z_{2_h}/\{Z_7(V_{11_{h1}} + X_{11_{h1}})\}] \\ {}_{I}\dot{Y}_{12_l} = -[V_{12_l}\ Z_{10}\ Z_{2_h}/\{Z_7(V_{11_{h1}} + X_{11_{h1}})\}] \end{array}\right\} \begin{array}{ll} \text{[A1280, A1330]} & 33 \\ \text{[A1265, A1330]} & 34 \\ h\ \varepsilon\ A \text{ and } \underline{h}\ \varepsilon\ D & \\ \text{[A1295, A1330]} & 35 \\ \text{[A1270, A1330]} & 36 \end{array}$$

For normally benthic animals that are drifting and being consumed:

$$\left.\begin{array}{l} {}_{I}\dot{Y}_{11_{hc}} = -\{V_{11_{hc}}\ Z_{10}\ Z_{3_h}/(Z_7\ V_{11_{h1}})\} \\ {}_{I}\dot{Y}_{12_l} = -\{V_{12_l}\ Z_{10}\ Z_{3_h}/(Z_7\ V_{11_{h1}})\} \end{array}\right\} \begin{array}{ll} \text{[A1395, A1410]} & 37 \\ h\ \varepsilon\ C \text{ and } \underline{h}\ \varepsilon\ D & \\ \text{[A1395, A1400]} & 38 \end{array}$$

where:

${}_{I}\dot{X}_{11_{hc}}$ = The c'th constituent of the h'th animal group ingested by the animal group (as predator) currently under consideration [CBIOMQ(H,C)]

$X_{11_{hc}}$ = The c'th constituent of the h'th animal group present in the ecosystem [CBIOM(H,C)]

${}_{I}\dot{X}_{12_l}$ = The population of the l'th animal group ingested by the predator currently under consideration [POPQQQ(L)]

X_{12_l} = The population of the l'th animal group present in the ecosystem [POP(L)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{2_h} = The weighted amount of the h'th animal category (as prey) available to the animal (predator) currently under consideration [FEEDA(H)]

Z_7 = The sum of the weighted foods of the animal group currently being considered [SUM]

$X_{11_{h1}}$ = The carbon content of the h'th animal category [CBIOM(H,1)]

${}_{I}\dot{Y}_{11_{hc}}$ = The amount of the c'th constituent of the h'th animal group which would have been washed out of the system but instead has been ingested [DRIFTA(H,C)]

$V_{11_{hc}}$ = The amount of the c'th constituent of the h'th animal group entering the system in a time unit [XDRIFA(H,C)]

${}_{I}\dot{Y}_{12_l}$ = The population of the l'th animal group which would have been washed out of the system but instead has been ingested by the animal group currently under consideration [DRIFPO(L)]

V_{12_l} = The population of the l'th animal category entering the ecosystem in a time unit [XDRIFO(L)]

$V_{11_{h1}}$ = The amount of carbon of the h'th animal group (as prey) drifting into the system in a time period [XDRIFA(H,1)]

Z_{3_h} = The weighted amount of the h'th animal category (as prey -- normally sessile animals) available to the animal (predator-free swimmer) currently under consideration [FEEDAD(H)]

The amount of suspended detritus taken equals:

$$\left.\begin{array}{l} {}_{I}\dot{X}_{41_{dc}} = -\{X_{41_{dc}}\ Z_{10}\ Z_{4_d}/(Z_7\ X_{41_{d1}})\} \\ {}_{I}\dot{Y}_{41_{dc}} = -\{V_{41_{dc}}\ Z_{10}\ Z_{4_d}/(Z_7\ X_{41_{d1}})\} \end{array}\right\} \begin{array}{ll} \text{[A1465, A1475]} & 39 \\ h\ \varepsilon\ A & \\ \text{[A1465, A1480]} & 40 \end{array}$$

$$\left.\begin{array}{l} {}_{I}\dot{X}_{41_{dc}} = -[X_{41_{dc}}\ Z_{10}\ Z_{4_d}/\{Z_7(X_{41_{d1}} + V_{41_{d1}})\}] \\ {}_{I}\dot{Y}_{41_{dc}} = -[V_{41_{dc}}\ Z_{10}\ Z_{4_d}/\{Z_7(X_{41_{d1}} + V_{41_{d1}})\}] \end{array}\right\} \begin{array}{ll} \text{[A1495, A1510]} & \\ h\ \varepsilon\ B & 41 \\ \text{[A1495, A1505]} & \\ & 42 \end{array}$$

where:

${}_{I}\dot{X}_{41_{dc}}$ = The amount of the c*th* constituent of the d'th type of suspended detritus ingested by the animal group currently under consideration [CLITQQ(D,C)]

$X_{41_{dc}}$ = The amount of the c'th constituent of the d'th type of suspended detritus present in the system [CLIT(D,C)]

${}_{I}\dot{Y}_{41_{dc}}$ = The amount of the c'th constituent of the d'th type of suspended detritus which would have been washed out of the system but instead has been ingested [DETIN(D,C)]

$V_{41_{dc}}$ = The amount of the c'th constituent of the d'th type of suspended detritus entering the system in a time unit [XDETIN(D,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{4_d} = The weighted amount of the d'th suspended detritus category available to the animal in question [FEEDL(D)]

Z_7 = The sum of the weighted foods of the animal group currently being considered [SUM]

$X_{41_{d1}}$ = The carbon content of suspended detritus in the ecosystem [CLIT(D,1)]

$V_{41_{d1}}$ = The carbon of the d'th suspended detritus type entering the ecosystem in a time unit [XDETIN(D,1)]

The amount of benthic detritus taken equals:

$$ {}_I\dot{X}_{43_{dc}} = -X_{43_{dc}} Z_{10} Z_{5_d} / (Z_7 X_{43_{d1}}) \qquad h \in B $$

[A1555, A1565] 43

where:

${}_I\dot{X}_{43_{dc}}$ = The amount of the c'th constituent of the d'th type of benthic detritus ingested by the animal group currently under consideration [CORGQQ(D,C)]

$X_{43_{dc}}$ = The amount of the c'th constituent of the d'th type of benthic detritus present in the system [CORG(D,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{5_d} = The weighted amount of the d'th type of benthic detritus available to the animal in question [FEEDM(M)]

Z_7 = The sum of the weighted foods of the animal group currently being considered [SUM]

The amount of heterotrophic microorganisms taken equals:

$$ {}_I\dot{X}_{21_{mc}} = -\{X_{21_{mc}} Z_{10} Z_{6_m} / (Z_7 X_{21_{m1}})\} \quad \text{or} \quad \begin{matrix} h \in A \text{ and } m \in G \\ h \in A \text{ and } m \in H \end{matrix} $$

[A1615, A1630]
[A1690, A1700] 44

$$ {}_I\dot{Y}_{21_{mc}} = -\{V_{21_{mc}} Z_{10} Z_{6_m} / (Z_7 X_{21_{m1}})\} \qquad h \in A \text{ and } m \in G $$

[A1615, A1635] 45

$$ \left.\begin{aligned} {}_I\dot{X}_{21_{mc}} &= -[X_{21_{mc}} Z_{10} Z_{6_m} / \{Z_7 (X_{21_{m1}} + V_{21_{m1}})\}] \\ {}_I\dot{Y}_{21_{mc}} &= -[V_{21_{mc}} Z_{10} Z_{6_m} / \{Z_7 (X_{21_{m1}} + V_{21_{m1}})\}] \end{aligned}\right\} \begin{matrix} \text{[A1680, A1655] 46} \\ h \in B \text{ and } m \in G \\ \text{[A1680, A1650] 47} \end{matrix} $$

where:

${}_I\dot{X}_{21_{mc}}$ = The amount of the c'th constituent of the m'th type of microorganism ingested by the animal group currently under consideration [CBACTQ(M,C)]

$X_{21_{mc}}$ = The amount of the c'th constituent of the m'th type of microorganism present in the system [CBACT(M,C)]

${}_I\dot{Y}_{21_{mc}}$ = The amount of the c'th constituent of the m'th microorganism category which would have been washed out of the system but instead has been ingested [DRIFTM(M,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{6_m} = The weighted amount of the m'th microorganisms category available to the animal group in question [FEEDM(M)]

Z_7 = The sum of the weighted food of the animal group currently being considered [SUM]

$X_{21_{m1}}$ = The carbon content of the m'th type of heterotrophic microorganism [CBACT(M,1)]

$V_{21_{mc}}$ = The amount of the c'th constituent of the m'th type of microorganism entering the system in a time period [XDRIFM(M,C)]

$V_{21_{m1}}$ = The carbon content of the m'th group of microoganisms entering the ecosystem in a time unit [XDRIFM(M,1)]

The total intake for a time period for an animal group thus becomes:

$$ Z_{9_{hc}} = -\sum_p {}_I\dot{X}_{1_{p1c}} - \sum_p {}_I\dot{Y}_{1_{p1c}} - \sum_h {}_I\dot{X}_{11_{hc}} - \sum_h {}_I\dot{Y}_{11_{hc}} - \sum_d {}_I\dot{X}_{41_{dc}} - \sum_d {}_I\dot{Y}_{41_{dc}} - \sum_d {}_I\dot{X}_{43_{dc}} - \sum_m {}_I\dot{X}_{21_{mc}} - \sum_m {}_I\dot{Y}_{21_{mc}} \qquad 48 $$

where:

$Z_{9_{hc}}$ = The total amount of the c'th constituent ingested by the h'th animal group [FOOD(H,C)]

${}_I\dot{X}_{1_{p1c}}$ = The amount of the c'th constituent of the p'th plant group present in the system [CVEG(P,1,C)]

${}_I\dot{Y}_{1_{p1c}}$ = The amount of the c'th constituent of the p'th plant group which would have been washed out of the system but instead has been ingested [DRIFTV(P,1,C)]

${}_I\dot{X}_{11_{hc}}$ = The c'th constituent of the h'th animal group ingested by the animal group (as predator) currently under consideration [CBIOMQ(H,C)]

${}_I\dot{Y}_{11_{hc}}$ = The amount of the c'th constituent of the h'th animal group which would have been washed out of the system but instead has been ingested [DRIFTA(H,C)]

${}_I\dot{X}_{41_{dc}}$ = The amount of the c'th constituent of the d'th type of suspended detritus ingested by the animal group currently under consideration [CLITQQ(D,C)]

${}_I\dot{Y}_{41_{dc}}$ = The amount of the c'th constituent of the d'th type of suspended detritus which would have been washed out of the system but instead has been ingested [DETIN(D,C)]

${}_I\dot{Y}_{21_{mc}}$ = The amount of the c'th constituent of the m'th microorganism category which would have been washed out of the system but instead hass been ingested [DRIFTM(M,C)]

${}_{I}\dot{X}_{43_{dc}}$ = The amount of the *c*'th constituent of the *d*'th type of benthic detritus ingested by the animal group currently under consideration [CORGQQ(D,C)]

${}_{I}\dot{X}_{21_{mc}}$ = The amount of the *c*'th constituent of the *m*'th type of microorganism ingested by animal group currently under consideration [CBACTQ(M,C)]

Respiration, Egestion and Assimilation

Respiration, egestion and assimilation are calculated for all animal cohorts, although only respiration will be positive for the animal groups that had not ingested. Respiration and assimilation are first calculated on the basis of carbon content.

Respiration equals:

$$Z_{36} = X_{11_{h1}} / X_{12_{l}} \exp\ (P_{29})\ X_{11_{h1}}\ P_{30_{h}}\ (2.^{X_{72/10.}}) \qquad [\text{A1770}] \quad 49$$

Assimilation equals:

$$Z_{37} = P_{27_{h}}\ Z_{35_{h1}} \qquad [\text{A1785}] \quad 50$$

where:

Z_{36} = The amount of carbon respired for the animal cohort currently under consideration [RESPAC]

Z_{37} = The amount of carbon assimilated for the animal cohort currently under consideraation [ASSICA]

$P_{29_{h}}$ = Rate of increase of log respiration rate with log individual biomass of the *h*'th animal cohort [SLOPE(H)]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

$X_{12_{l}}$ = The population of the *l*'th animal cohort [POP(L)]

$P_{30_{h}}$ = Respiration per time unit by an animal of *h*'th cohort at zero degrees centigrade [CONST(H)]

X_{72} = The water temperature in degrees centigrade [WTEMP]

$P_{27_{h}}$ = The amount of ingested material which is assimilated by the *h*'th cohort [ASSIM(H)]

$Z_{35_{h1}}$ = The amount of carbon ingested by the *h*'th animal cohort during the time they have spent in the ecosystem [FOOD(H,1)]

Other constituents associated with assimilation, egestion and respiration are calculated.

$$Z_{38} = Z_{36}\ X_{11_{hc}} / X_{11_{h1}} \qquad h \in B \qquad [\text{A1805}] \quad 51$$

$$Z_{38} = Z_{38} / Z_{16} \qquad h \in A \qquad [\text{A1810}] \quad 52$$

$$Z_{19} = Z_{37}\ X_{11_{hc}} / X_{11_{h1}} \qquad [\text{A1815}] \quad 53$$

$$Z_{39} = Z_{9_{hc}} - Z_{19} \qquad [\text{A1825}] \quad 54$$

where:

Z_{38} = The amount of respiration for the animal cohort and constituent currently under consideration [RESPI]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [ASSI]

Z_{39} = The amount of egestion for the animal cohort and constituent currently under consideration [EXCR]

Z_{36} = The amount of carbon respired for the animal cohort currently under consideration [RESPAC]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

$X_{11_{h1}}$ = The carbon content of the *h*'th animal category [CBIOM(H,1)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Z_{37} = The amount of carbon assimilated for the animal cohort currently under consideration [ASSICA]

$Z_{9_{hc}}$ = The total amount of the *c*'th constituent ingested by the *h*'th animal group [FOOD(H,C)]

Part of the egested material goes into solution with the remainder entering the detrital compartments. For the non-planktonic, non-benthic-dwelling animals:

$$Z_{40} = Z_{39}\ P_{34_{h}} / Z_{21} \qquad h \in B \text{ and } K \qquad [\text{A1850}] \quad 55$$

$${}_{G}\dot{X}_{31_{c}} = Z_{40}\ X_{75} \qquad h \in B \text{ and } K \qquad [\text{A1855}] \quad 56$$

$${}_{G}\dot{Y}_{31_{c}} = Z_{40}\ (Z_{21} - X_{75}) \qquad h \in B \text{ and } K \qquad [\text{A1860}] \quad 57$$

$$Z_{39} = Z_{39}\ (1. - P_{34_{h}}) \qquad h \in B \text{ and } K \qquad [\text{A1865}] \quad 58$$

$${}_{G}\dot{X}_{43_{dc}} = Z_{39} \qquad P_{35_{h}} > P_{36} \qquad [\text{A1870}] \quad 59$$

$${}_{G}\dot{Y}_{41_{dc}} = Z_{39}\ Z_{41} \qquad P_{35_{h}} \leq P_{36} \qquad [\text{A1875}] \quad 60$$

$${}_{G}\dot{X}_{41_{dc}} = Z_{39}\ (1. - Z_{41}) \qquad P_{35_{h}} \leq P_{36} \qquad [\text{A1880}] \quad 61$$

where:

Z_{40} = The amount of egesta of the constituent and cohort currently under consideration which goes into solution in a time period [SOLUTE]

$P_{34_{h}}$ = The proportion of egesta of the *h*'th cohort that goes into solution in a time period [XCRSOL(H)]

Z_{21} = The total amount of water in and passing through the system in a day

X_{75} = The amount of water in the ecosystem at any one time in cubic meters [WATSYS]

Z_{41} = $(Z_{16} - 1.)/Z_{16}$

Z_{16} = The number of turnovers of water minus one in a day [CYCLE]

Z_{39} = The amount of egestion for the animal cohort and constituent currently under consideration [EXCR]

P_{35_h} = The fate of excreta of the *h*'th animal cohort [IXFATE(H)]

P_{36} = The number of litter categories in the ecosystem [NOLIT]

${}_G\dot{X}_{31_c}$ = The change in the *c*'th dissolved organic constituent due to egestion [AQUAQQ(C)]

${}_G\dot{Y}_{31_c}$ = The change in the *c*'th dissolved organic constituent leaving the ecosystem due to egestion [COMPIN(C)]

${}_G\dot{X}_{43_{dc}}$ = The change in the *c*'th constituent of the *d*'th detritus type in the benthos [CORGQQ(D,C)]

${}_G\dot{Y}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th detritus type leaving the ecosystem [DETIN(D,C)]

${}_G\dot{X}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th suspended detritus type [CLITQQ(D,C)]

For the non-planktonic, benthic-dwelling animals egested products are calculated.

$Z_{40} = Z_{39}\, P_{34_h}$ $h \in$ B and F [A1890] 62

${}_G\dot{X}_{33_c} = Z_{40}$ $h \in$ B and F [A1895] 63

$Z_{39} = Z_{39}\ (1. - P_{34_h})$ $h \in$ B and F [A1900] 64

${}_G\dot{X}_{43_{dc}} = Z_{39}$ $h \in$ B and F [A1905] 65

where:

${}_G\dot{X}_{33_c}$ = The change in the *c*'th dissolved organic constituent due to egestion [AQUABQ(C)]

Z_{40} = The amount of egesta of the constituent and cohort currently under consideration which goes into solution in a time period [SOLUTE]

Z_{39} = The amount of egestion for the animal cohort and constituent currently under consideration [EXCR]

P_{34_h} = The amount of egesta of the *h*'th cohort that goes into solution in a time period [XCRSOL(H)]

${}_G\dot{X}_{43_{dc}}$ = The change in the *c*'th constituent of the *d*'th detritus type in the benthos [CORGQQ(D,C)]

For the planktonic animals egested products are calculated.

$Z_{40} = Z_{39}\, P_{34_h}$ [A1915] 66

${}_G\dot{X}_{31_c} = Z_{40}$ [A1920] 67

${}_G\dot{Y}_{31_c} = Z_{40}\ (Z_{16} - 1.)$ [A1925] 68

$Z_{39} = Z_{39}\ (1. - P_{34_h})$ [A1930] 69

${}_G\dot{X}_{41_{dc}} = Z_{39}$ [A1935] 70

${}_G\dot{Y}_{41_{dc}} = Z_{39}\ (Z_{16} - 1.)$ [A1940] 71

where:

Z_{40} = The amount of egesta of the constituent and cohort currently under consideration which goes into solution in a time period [SOLUTE]

Z_{39} = The amount of egestion for the animal cohort and constituent currently under consideration [EXCR]

P_{34_h} = The amount of egesta of the *h*'th cohort that goes into solution in a time period [XCRSOL(H)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

${}_G\dot{X}_{31_c}$ = The change in the *c*'th dissolved organic constituent due to egestion [AQUAQQ(C)]

${}_G\dot{Y}_{31_c}$ = The change in the *c*'th dissolved organic constituent leaving the ecosystem due to egestion [COMPIN(C)]

${}_G\dot{X}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th suspended detritus type [CLITQQ(D,C)]

${}_G\dot{Y}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th detritus type leaving the ecosystem [DETIN(D,C)]

Growth (productivity) equals assimilation minus respiration.

$Z_{42} = Z_{19} - Z_{38}$ [A1960] 72

${}_W\dot{Y}_{11_{hc}} = Z_{42}(Z_{16} - 1.)$ $h \in$ A [A1965] 73

${}_W\dot{X}_{11_{hc}} = Z_{42}$ $h \in$ B [A1970] 74

where:

Z_{42} = Growth for the cohort being considered [ASSIT]

${}_W\dot{Y}_{11_{hc}}$ = Growth of the *c*'th constituent of the *h*'th cohort of the animals drifting out of the system [DRIFTA(H,C)]

${}_W\dot{X}_{11_{hc}}$ = Growth of the *c*'th constituent of the *h*'th cohort [CBIOMQ(H,C)]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXCR]

Z_{38} = The amount of respiration for the animal cohort and constituent currently under consideration [RESPI]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Animal productivity (growth) is tracked.

${}_{W}\dot{X}_{16_{hc}} = Z_{42}(Z_{16} - 1.)$ $h \, \epsilon \, A$ [A1975] 75

${}_{W}\dot{X}_{16_{hc}} = Z_{42}$ $h \, \epsilon \, B$ [A1985] 76

where:

Z_{42} = Growth for the cohort being considered [ASSIT]

Z_{16} = The number of turnovers of water minus one [CYCLE]

${}_{W}\dot{X}_{16_{hc}}$ = Productivity of the c'th constituent of the h'th animal cohort [CBIOMP(H,C)]

Respired constituents enter dissolved inorganic compartments, with energy being considered lost to the atmosphere. When the animals being considered are non-planktonic ($h \, \epsilon$ B) the following calculations apply:

$Z_{43} = Z_{38}/Z_{21}$ $h \, \epsilon \, B$ [A1995] 77

${}_{R}\dot{X}_{01_{2,2}} = -Z_{43}\,Z_{21}$ $h \, \epsilon \, B$ and $c = 2$ [A2000] 78

${}_{R}\dot{X}_{01_{13,c}} = -Z_{43}\,Z_{21}$ $h \, \epsilon \, B$ and $c \neq 2$ [A2010] 79

${}_{R}\dot{X}_{03_{13,c}} = Z_{43}\,Z_{21}$ $h \, \epsilon \, B$ and $c \neq 2$ [2015] 80

${}_{R}\dot{X}_{51_{k}} = Z_{43}\,X_{75}$ $h \, \epsilon \, B$ and J and $c \neq 2$ [A2025] 81

${}_{R}\dot{Y}_{51_{k}} = Z_{43}(Z_{21} - X_{75})$ $h \, \epsilon \, B$ and J and $c \neq 2$ [A2030] 82

${}_{R}\dot{X}_{53_{k}} = Z_{43}\,Z_{21}$ $h \, \epsilon \, B$ and K and $c \neq 2$ [A2040] 83

where:

Z_{43} = The amount of a respired product in grams per cubic meter for the constituent and cohort currently under consideration [RESP]

${}_{R}\dot{X}_{01_{2,2}}$ = Loss of energy to the atmosphere due to respiration of the cohort in question [AGAINQ(2,2)]

${}_{R}\dot{X}_{01_{13,c}}$, &

${}_{R}\dot{X}_{03_{13,k}}$ = A change of chemical state for the element in question [DGAINQ(13,K)]

${}_{R}\dot{X}_{51_{k}}$ = The change in the k'th dissolved inorganic constituent in the water column due to respiration [WDINRQ(K)]

Z_{38} = The amount of respiration for the animal cohort and constituent currently under consideration [RESPI]

Z_{21} = The total amount of water in and passing through the system in a day [WATTOT]

X_{75} = The amount of water in the ecosystem at any one time in cubic meters [WATSYS]

${}_{R}\dot{Y}_{51_{k}}$ = The change in the k'th dissolved inorganic constituent in outflowing water [DNORG(K)]

${}_{R}\dot{X}_{53_{k}}$ = The change in the k'th dissolved inorganic constituent in the benthos due to respiration [BDINRQ(K)]

Respiration when the animals being considered are zooplankton ($h \, \epsilon$ A) is calculated by:

$Z_{43} = Z_{38}$ $h \, \epsilon \, A$ [A2060] 84

${}_{R}\dot{X}_{01_{2,2}} = -Z_{43}\,Z_{16}$ $h \, \epsilon \, A$ and $c = 2$ [A2065] 85

${}_{R}\dot{X}_{51_{k}} = Z_{43}$ $h \, \epsilon \, A$ and $c \neq 2$ [A]075] 86

${}_{R}\dot{X}_{01_{13,c}} = -Z_{43}\,Z_{16}$ $h \, \epsilon \, A$ and $c \neq 2$ [A2080] 87

${}_{R}\dot{X}_{03_{13,k}} = Z_{43}\,Z_{16}$ $h \, \epsilon \, A$ and $c \neq 2$ [A2085] 88

${}_{R}\dot{Y}_{51_{k}} = Z_{43}\,(Z_{16} - 1.)$ $h \, \epsilon \, A$ and $c \neq 2$ [A2090] 89

where:

Z_{43} = The amount of a respired product in grams per cubic meter for the constituent and cohort currently under consideration [RESP]

Z_{38} = The amount of respiration for the animal cohort and constituent currently under consideration [RESPI]

Z_{16} = The number of turnovers of water minus one [CYCLE]

${}_{R}\dot{X}_{01_{2,2}}$ = Loss of energy to the atmosphere due to respiration of the cohort in question [AGAINQ(2,2)]

${}_{R}\dot{X}_{51_{k}}$ = The change in the k'th dissolved inorganic constituent in the water column due to respiration [WDINRQ(K)]

${}_{R}\dot{X}_{01_{13,c}}$ = A change of chemical state for the element in question [AGAINQ(13,C)]

${}_{R}\dot{X}_{03_{13,k}}$ = A change of chemical state for the element in question [DGAINQ(13,K)]

${}_{R}\dot{Y}_{51_{k}}$ = The change in the k'th dissolved inorganic constituent in outflowing water [DNORG(K)]

Non-planktonic animals passing through the system respire according to:

$Z_{43} = Z_{38}/(X_{11_{hc}}\,Z_{16})$ [A2100] 90

${}_{R}\dot{Y}_{51_{k}} = Z_{43}\,V_{11_{hc}}$ $c \neq 2$ [2115] 91

${}_{R}\dot{X}_{01_{2,2}} = -Z_{43}\,V_{11_{hc}}$ $c \neq 2$ [A2105] 92

${}_{R}\dot{X}_{01_{13,c}} = -Z_{43}\,V_{11_{hc}}$ $c \neq 2$ [A2120] 93

${}_{R}\dot{X}_{03_{13,k}} = Z_{43}\,V_{11_{hc}}$ $c \neq 2$ [A2125] 94

${}_{R}\dot{Y}_{11_{hc}} = -Z_{43}\,V_{11_{hc}}$ $c \neq 2$ [A2130] 95

where:

Z_{43} = The amount of a respired product in grams per cubic meter for the constituent and cohort currently under consideration [RESP]

Z_{38} = The amount of respiration for the animal cohort and constituent currently under consideration [RESPI]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

$\dot{V}_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system in a time unit [XDRIFA(H,C)]

${}_R\dot{Y}_{51_k}$ = The change in the *k*'th dissolved inorganic constituent in outflowing water [DNORG(K)]

${}_R\dot{X}_{01_{2,2}}$ = Loss of energy to the atmosphere due to respiration of the cohort in question [AGAINQ(2,2)]

${}_R\dot{X}_{01_{13,c}}$ = A change of chemical state for the element in question [AGAINQ(13,C)]

${}_P\dot{X}_{03_{13,k}}$ = A change of chemical state for the element in question [AGAINQ(13,K)]

${}_R\dot{Y}_{11_{hc}}$ = The change of the *c*'th constituent of the *h*'th animal cohort passing through the system due to respiration [DRIFTA(H,C)]

Cohort Transfer

Where an animal population consists of more than one sub-population or cohort at different stages of development, transfer of individuals from one stage to another is determined in various ways, which may be special to each of these cohorts.

The rate of transfer may be a function of accumulated mean daily temperatures in excess of a specified threshold starting when animals entered a particular cohort.

$$Z_{44} = \min[P_{16}, \max \ (P_{42_h} - P_{38_h})/(P_{39_h} - P_{38_h}) \ ] \qquad P_{37_h} \ \varepsilon \ 1 \text{ or } 3 \qquad [A2320] \quad 96$$

where:

Z_{44} = A fraction of the cohort in question leaving that cohort [HATCH]

P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]

P_{38_h} = A threshold for accumulated temperature for the *h*'th cohort at which time cohort transfer begins [THRES(H)]

P_{39_h} = The accumulated temperature for the *h*'th cohort at which the entire population is transferred [AMAX(H)]

P_{42_h} = The accumulated temperature for the *h*'th cohort [ACCUM(H)]

P_{37_h} = A switch controlling mode of cohort transfer of the *h*'th cohort [NTRANS(H)]

The second mode of transfer is an exponential function of the temperature on a particular day.

$$Z_{44} = \min[P_{16}, \max\{P_{40_h} \exp(P_{41_h} X_{72})\}] \qquad P_{37_h} \ \varepsilon \ 2 \qquad [A2335] \quad 97$$

where:

P_{40_h} = The fraction of animals transferred at zero temperature for the *h*'th cohort [HATCON(H)]

P_{41_h} = The coefficient for temperature dependence for the rate of transfer of the *h*'th animal cohort [TEMCON(H)]

Z_{44} = A fraction of the cohort in question leaving that cohort [HATCH]

P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]

X_{72} = The water temperature in degrees centigrade [WTEMP]

P_{37_h} = A switch controlling mode of cohort transfer of the *h*'th cohort [NTRANS(H)]

For $P_{37}h$ = 4 the animals of that cohort are transferred on the last day of the year. Yet another mode of transfer occurs as a function of the average weight of an individual above a certain specified weight.

$$Z_{44} = \min[P_{16}, \max \{(Z_{46_h} - P_{42_h}) \ P_{39_h}/P_{42_h}\}] \qquad P_{37_h} \ \varepsilon \ 5 \qquad [A2370] \quad 98$$

where:

Z_{44} = A fraction of the cohort in question leaving that cohort [HATCH]

P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]

P_{42_h} = The weight of an average individual of the *h*'th cohort above which cohort transfer will commence [ACCUM(H)]

P_{39_h} = A factor regulating the fraction of cohort transfer [AMAX(H)]

and

$Z_{46} = X_{11_{hc}}/X_{12_l}$ = The average weight of an individual in the cohort being considered [ANAVER]

If P_{37} = 6 no transfer of animals for the *h*'th cohort is established. For the plantonic animals,

$$Z_{44} = Z_{44}/Z_{16} \qquad [A2390] \quad 99$$

where:

Z_{44} = A fraction of the cohort in question leaving that cohort [HATCH]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Population transfers are made.

$$Z_{47} = Z_{44} Z_{12_l} \qquad \text{[A2395] 100}$$

$$_T\dot{X}_{12_l} = -Z_{47} \qquad \text{[A2400] 101}$$

$$_T\dot{Y}_{12_l} = -Z_{47}(Z_{16} - 1.) \quad P_{43_h} \; \varepsilon \; 1 \qquad \text{[A2405] 102}$$

$$_T\dot{X}_{12_{l+1}} = Z_{47} \quad P_{37_h} \neq 3 \text{ or } P_{43_h} = 1 \qquad \text{[A2410] 103}$$

$$_T\dot{Y}_{12_{l+1}} = Z_{47}(Z_{16} - 1.) \quad P_{37_h} \neq 3 \text{ or } P_{43_h} = 1 \qquad \text{[A2415] 104}$$

where:

Z_{47} = The total number of animals of the cohort under consideration which leave the cohort [CHANGE)]

Z_{44} = A fraction of the cohort in question leaving that cohort [HATCH]

Z_{16} = The number of turnovers of water minus one [CYCLE]

$_T\dot{X}_{12_l}$ = The change in the *l*'th population due to cohort transfer [POPQQQ(L)]

$_T\dot{Y}_{12_l}$ = The change in the *l*'th population of animals leaving the system due to cohort transfer [DRIFPO(L)]

$_T\dot{X}_{12_{l+1}}$ = The change in the population of the receiving cohort due to cohort transfer [POPQQQ(L+1)]

$_T\dot{Y}_{12_{l+1}}$ = The change in the population of the receiving cohort leaving the ecosystem due to cohort transfer [DRIFPO(L+1)]

Not all of the biomass leaving a cohort during a transfer enters the receiving cohort. Part of it may be lost as cast skins to the appropriate litter compartment.

$$Z_{48} = P_{44} \; Z_{47} \qquad \text{[A2430] 105}$$

where:

Z_{48} = The amount of the constituent in question during a cohort transfer which is cast skin [SHELLS]

P_{44_h} = The fraction of biomass of the *h*'th cohort which is made up of exoskeleton which will be shed[SHELP(H)]

Z_{47} = The total amount of animals of the cohort under consideration which leave the cohort [CHANGE]

Increments and decrements are made for the proper compartment. For the zooplankton ($h \; \varepsilon \, A$).

$$_T\dot{X}_{41_{dc}} = Z_{48} \; X_{11_{hc}} \qquad \text{[A2465] 106}$$

$$_T\dot{Y}_{41_{dc}} = Z_{48} \; X_{11_{hc}}(Z_{16} - 1.) \qquad \text{[A2470] 107}$$

$$_T\dot{X}_{11_{hc}} = -Z_{47} \; X_{11_{hc}} \qquad \text{[A2475] 108}$$

$$_T\dot{X}_{11_{h+1,c}} = (Z_{47} - Z_{48}) \; X_{11_{hc}} \qquad \text{[A2480] 109}$$

$$_T\dot{Y}_{11_{hc}} = -Z_{47} \; X_{11_{hc}}(Z_{16} - 1.) \qquad \text{[A2485] 110}$$

$$_T\dot{Y}_{11_{h+1,c}} = (Z_{47} - Z_{48}) \; X_{11_{hc}}(Z_{16} - 1.) \qquad \text{[A24902 111}$$

where:

Z_{48} = The amount of the constituent in question during a cohort transfer which is cast skins [SHELLS]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Z_{47} = The total numbers of animals of the cohort under consideration which leave the cohort [CHANGE]

$_T\dot{X}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th organic detritus type due to cohort transfer [CLITQQ(D,C)]

$_T\dot{Y}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th organic detritus type leaving the system due to cohort transfer [DETIN(D,C)]

$_T\dot{X}_{11_{hc}}$ & $_T\dot{X}_{11_{h+1,c}}$ = The change in the *c*'th constituent of the *h*'th or *h* + 1'th animal cohort due to cohort transfer [CBIOMQ(H,C), CBIOMQ (H+1,C)]

$_T\dot{Y}_{11_{hc}}$ & $_T\dot{X}_{11_{h+1,c}}$ = The change in the *c*'th constituent of the *h*'th or *h* + 1'th cohort due to cohort transfer [DRIFTA(H,C), DRIFTA(H+1,C)]

$$_T\dot{X}_{43_{dc}} = Z_{48} \, X_{11_{hc}} \quad P_{45_h} > P_{36} \qquad \text{[A2500] 112}$$

$$_T\dot{X}_{41_{dc}} = Z_{48} \, X_{11_{hc}} (1 - Z_{41}) \quad P_{45_h} \leq P_{36} \qquad \text{[A2502] 113}$$

$$_T\dot{Y}_{41_{dc}} = Z_{48} \, X_{11_{hc}} Z_{41} \quad P_{45_h} \leq P_{36} \qquad \text{[A2515] 114}$$

$$_T\dot{X}_{11_{hc}} = -Z_{47} \, X_{11_{hc}} \qquad \text{[A2520] 115}$$

$$_T\dot{X}_{11_{h+1,c}} = (Z_{47} - Z_{48}) \, X_{11_{hc}} \quad P_{37} \neq 3 \qquad \text{[A2525] 116}$$

$$_T\dot{X}_{01_{2c}} = -(Z_{47} - Z_{48}) X_{11_{hc}} \quad P_{37} = 3 \qquad \text{[A2530] 117}$$

where:

Z_{48} = The amount of the constituent in question during a cohort transfer which is cast skin [SHELLS]

$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]

Z_{41} = $(Z_{16}-1.)/Z_{16}$

Z_{47} = The total number of animals of the cohort under consideration which leave the cohort [CHANGE]

Z_{16} = The number of turnovers of water minus one [CYCLE]

$_T\dot{X}_{43_{dc}}$ = The change in the *c*'th constituent of the *d*'th benthic litter type due to cohort transfer [CORGQQ(D,C)]

$_T\dot{X}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th organic detritus type due to cohort transfer [CLITQQ(D,C)]

${}_T\dot{Y}_{41_{dc}}$ = The change in the *c*'th constituent of the *d*'th organic detritus type leaving the system due to cohort transfer [DETIN(D,C)]

${}_T\dot{X}_{11_{hc}}$ = The change in the *c*'th constituent of the *h*'th animal cohort due to cohort transfer [CBIOMQ(H,C)]

${}_T\dot{X}_{11_{h+1,c}}$ = The change in the *c*'th constituent of the *h*+1'th cohort due to cohort transfer [DRIFTA(H+1,C)]

${}_T\dot{X}_{01_{2,c}}$ = The amount of the *c*'th constituent lost to the atmosphere due to cohort transfer [AGAINQ(2,C)]

P_{43_h} = A switch for type of drift for the *h*'th cohort [NDRIFA(H)]

P_{45_h} = A switch for fate of shed skins [ISFATE(H)]

P_{37_h} = A switch for mode of transfer of the *h*'th cohort [NTRANS(H)]

P_{36} = The number of organic litter categories [NOLIT]

Where more than one cohort makes up a species, the first cohort is considered eggs or young and may be incremented from any other cohort of the species. The following modes of transfer exist (as specified by P_{46_h}):

1. Oviposition occurs in a range of temperatures as a function of days of the year. The function is a half circle with P_{47_a} being the apex. When $P_{51_a} \leqslant X_{72} \leqslant P_{52_a}$ and $P_{48_a} < P_{50} < P_{49_a}$

$$Z_{45} = (P_{47_a}^{\,2} - [\{(P_{50} - P_{48_a})\, 2P_{47_a} / (P_{49_a} - P_{48_a})\} - P_{47_a}]^2)^{\frac{1}{2}} \qquad P_{46_h} \in 1 \qquad [A2650]\ 118$$

2. Oviposition is constant between certain temperatures.

$$Z_{45} = P_{53_h} \qquad P_{51_a} \leq X_{72} \leq P_{52_a} \qquad P_{46_h} \in 2 \qquad [A2625]\ 119$$

where:

Z_{45} = A fraction of the weight of the cohort in question which will become offspring [HATCH]

P_{47_a} = The maximum fraction of the *a*'th species biomass which will be oviposited in one day [RCONST(H)]

P_{48_a} = The first Julian day for egg deposition for the for the *a*'th species [NLAY1(H)]

P_{49_a} = The last Julian day for egg deposition for the *a*'th species [NLAY2(H)]

P_{50} = The current Julian day [IYRDAY]

P_{51_a} = Temperature below which no eggs will be laid by the *a*'th species [CONSA(H)]

P_{52_a} = Temperature above which no eggs will be laid by the *a*'th species [UPTHRE(H)]

P_{53_h} = A fraction of the *h*'th cohort which will become offspring [REPROD(H)]

X_{72} = The water column temperature in degrees centigrade [WTEMP]

For these two methods of oviposition, proper variables are incremented or decremented. It will be convenient to designate the first or receiving cohort of a species as *s* (for biomass) and *e* (for population).

$$Z_{49} = Z_{45}\, X_{11_{h1}} \qquad [A2690]\ 120$$

$$Z_{49} = Z_{49}/Z_{16} \qquad P_{43_h} \in 1 \qquad [A2705]\ 121$$

$$Z_{50} = Z_{49}\, P_{54_{ac}} / P_{54_{h1}} \qquad [A2720]\ 122$$

$${}_T\dot{X}_{11_{sc}} = Z_{50} \qquad [A2755,\ A2730]\ 123$$

$${}_T\dot{X}_{11_{hc}} = -Z_{50} \qquad [A2745,\ A2735]\ 124$$

$${}_T\dot{Y}_{11_{hc}} = -Z_{50}(Z_{16} - 1) \qquad P_{43_h} \in 1 \qquad [A2750]\ 125$$

$${}_T\dot{Y}_{11_{sc}} = Z_{50}(Z_{16} - 1) \qquad P_{43_h} \in 1 \qquad [A2760]\ 126$$

$${}_T\dot{X}_{12_e} = Z_{49}/P_{54_{a1}} \qquad [A2770]\ 127$$

$${}_T\dot{Y}_{12_e} = Z_{49}/P_{54_{a1}}\ (Z_{16} - 1) \qquad P_{43_h} \in 1 \qquad [A2775]\ 128$$

where:

Z_{49} = The actual amount of biomass of carbon for species in question which will be transferred to the first cohort of a species [CHANGE]

Z_{50} = The biomass of the constituent and species in question which is to be transferred as eggs [CHELEM]

$P_{54_{ac}}$ = The weight of the *c*'th constituent of one egg for the *a*'th species [EGCOMP(A,C)]

${}_T\dot{X}_{11_{sc}}$ = The change in the *c*'th constituent in the first cohort of the *a*'th species being considered due to oviposition [CBIOMQ(S,C)]

${}_T\dot{X}_{11_{hc}}$ = The change in the *c*'th constituent of the *h*'th cohort due to oviposition [CBIOMQ(H,C)]

${}_T\dot{Y}_{11_{hc}}$ = The change in the *c*'th constituent of the *h*'th cohort leaving the system [DRIFTA(H,C)]

${}_T\dot{Y}_{11_{sc}}$ = The change in the *c*'th constituent of the first cohort of the species being considered [DRIFTA(S,C)]

${}_T\dot{X}_{12_e}$ = The change in population of the first cohort of the species under consideration [POPQQQ(E)]

${}_T\dot{Y}_{12_e}$ = The change in population of the first cohort of the species under consideration [DRIFPO(E)]

Z_{45} = A fraction of the cohort in question which will become offspring [HATCH]

$X_{11_{h1}}$ = The carbon content of the *h*'th animal category [CBIOM(H,1)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

P_{43_h} = [NDRIFA(H)]

3. The last method of transfer (for $P_{46_h} = 3$) is of the type where the ecosystem receives eggs from aerial insects. If Z_{44} was positive for a cohort *h*, a specific number of eggs are laid per surface area.

$${}_{T}\dot{X}_{12_e} = P_{55_a} X_{81} \qquad \text{[A2580] 129}$$

$${}_{T}\dot{X}_{01_{1c}} = P_{55_a} P_{54_{ac}} X_{81} \qquad \text{[A2690, A2595] 130}$$

$${}_{T}\dot{X}_{11_{sc}} = P_{55_a} P_{54_{ac}} X_{81} \qquad \text{[A2600, A2590] 131}$$

where:

P_{55_a} = The number of eggs laid for the a'th species per unit of surface area [EXOGEN(A)]
X_{81} = The surface area of the ecosystem in square meters [AREA]
${}_{T}\dot{X}_{01_{1c}}$ = The biomass of the c'th constituent entering the system from the atmosphere [AGAINQ(1,C)]
$P_{54_{ac}}$ = The weight of the c'th constituent of one egg for the a'th species [EGCOMP(A,C)]
${}_{T}\dot{X}_{12_e}$ = The change in population of the first cohort of the species under consideration [POPQQQ(E)]
${}_{T}\dot{X}_{11_{sc}}$ = The change in the c'th constituent in the first cohort of the a'th species being considered due to oviposition [CBIOMQ(S,C)]

Non-predatory Mortality

Each of the animal groups has a non-predatory mortality which is considered constant for that group, with the dead entering specified litter categories.

$$Z_{51} = P_{56_h}/Z_{16} \qquad \text{[A2835] 132}$$

$${}_{H}\dot{Y}_{12_l} = -Z_{51} V_{12_l} \qquad \text{[A2840] 133}$$

$${}_{H}\dot{Y}_{11_{hc}} = -Z_{51} V_{11_{hc}} \qquad \text{[A2855] 134}$$

$${}_{H}\dot{X}_{43_{dc}} = Z_{51} V_{11_{hc}} \qquad P_{57_h} > P_{36} \qquad \text{[A2860] 135}$$

$${}_{H}\dot{Y}_{41_{dc}} = Z_{51} V_{11_{hc}} \qquad P_{57_h} \le P_{36} \qquad \text{[A2870] 136}$$

$$Z_{51} = P_{56_h} \qquad P_{43_h} = 1 \qquad \text{[A2875] 137}$$

$${}_{H}\dot{X}_{11_{hc}} = -X_{11_{hc}} Z_{51} \qquad \text{[A2880] 138}$$

$${}_{H}\dot{X}_{41_{dc}} = Z_{51} X_{11_{hc}} \qquad P_{43_h} = 1 \text{ and } P_{57_h} \le P_{36} \qquad \text{[A2890] 139}$$

$${}_{H}\dot{X}_{43_{dc}} = Z_{51} X_{11_{hc}} \qquad P_{57_h} > P_{36} \qquad \text{[A2915, A2900] 140}$$

$${}_{H}\dot{Y}_{41_{dc}} = Z_{51} X_{11_{hc}} \{(Z_{16} - 1)/Z_{16}\} \qquad P_{43_h} \neq 1 \text{ and } P_{57_h} \le P_{36} \qquad \text{[A2925] 141}$$

$${}_{H}\dot{X}_{41_{dc}} = Z_{51} X_{11_{hc}} [1 - \{(Z_{16} - 1)/Z_{16}\}] \qquad P_{43_h} \neq 1 \text{ and } P_{57_h} \le P_{36} \qquad \text{[A2935] 142}$$

$${}_{H}\dot{X}_{12_l} = -X_{12_l} Z_{51} \qquad \text{[A2950] 143}$$

where:

Z_{51} = The proportion of animals dying [DEAD]
P_{56_h} = The proportion of animals of the h'th cohort dying in a day [AMORTA(H)]
Z_{16} = The number of turnovers of water minus one [CYCLE]
V_{12_l} = The population of the l'th animal category entering the ecosystem in a time unit [XDRIFO(L)]
$V_{11_{hc}}$ = The amount of the c'th constituent of the h'th animal group entering the system in a time unit [XDRIFA(H,C)]
X_{12_l} = The population of the l'th animal cohort [POP(L)]
$X_{11_{hc}}$ = The amount of the c'th constituent of the h'th animal group [CBIOM(H,C)]
P_{36} = The number of organic litter categories [NOLIT]
P_{43_h} = A switch for the type of drift of the h'th animal cohort [NDRIFA(H)]
P_{57_h} = The fate of the dead of the h'th cohort [IAFATE]

and the fluxes are those due to non-predatory mortality.

${}_{H}\dot{Y}_{12_l}$ = Population change of the l'th cohort leaving the system [DRIFPO(L)]
${}_{H}\dot{Y}_{11_{hc}}$ = Constituent change of the h'th cohort leaving the system [DRIFTA(H,C)]
${}_{H}\dot{Y}_{41_{dc}}$ = Detritus change leaving the system [DETIN(D,C)]
${}_{H}\dot{X}_{43_{dc}}$ = Detritus change in the ecosystem [CORGQQ(D,C)]
${}_{H}\dot{X}_{11_{hc}}$ = Constituent change of the h'th animal cohort [CBIOMQ(H,C)]
${}_{H}\dot{X}_{41_{dc}}$ = Suspended detritus change in the ecosystem [CLITQQ(D,C)]
${}_{H}\dot{X}_{12_l}$ = Population change of the l'th cohort [POPQQQ(L)]

Animal Scouring and Deposition

Animals in the system which are allowed to be scoured or deposited are those specified by NDRIFA = 2 or 3. Scouring and deposition occur as a function of water velocity.

For scouring (when X_{73} is greater than P_{21_h})

$$Z_{33} = \min(P_{16}, \max (0., \{P_{22_h}^{X_{73}} - P_{22_h}^{P_{21_h}}\})] \qquad \text{[A3015] 144}$$

$${}_{S}\dot{X}_{11_{hc}} = -Z_{23} X_{11_{hc}} \qquad \text{[A3035, A3040] 145}$$

$${}_{S}\dot{Y}_{11_{hc}} = Z_{23} X_{11_{hc}} \qquad \text{[A3035, A3045] 146}$$

$${}_{S}\dot{X}_{12_l} = Z_{23} X_{12_l} \qquad \text{[A 3051] 146}$$

$${}_{S}\dot{Y}_{12_l} = Z_{23} X_{12_l} \qquad \text{[A 3052] 146}$$

where:

Z_{23} = The fraction of the group of animals currently under consideration which is scoured [SCOUR]

P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]
P_{22_h} = A quadratic coefficient [ANDRF2(H)]
X_{73} = Water velocity [VELOCT]
P_{21_h} = The water velocity above which the *h*'th category of animals will be scoured [ANIHI(H)]
${}_S\dot{X}_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th category of animals which is scoured [CBIOMQ(H,C)]
$X_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group [CBIOM(H,C)]
${}_S\dot{X}_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal category which is washed out of system [DRIFTA(H,C)]
${}_S\dot{X}_{12_l}$ = The population of the *l*'th cohort removed by scouring
${}_S\dot{Y}_{12_l}$ = The change in the *l*'th population leaving the ecosystem
X_{12_l} = The population of the *l*'th cohort

For settling (when X_{73} is less than P_{23_h})

$$Z_{24} = \min (P_{16}, \max (0., \{P_{24_h}^{X_{73}} - P_{24_h}^{P_{23_h}}\})] \quad [A3060] \quad 147$$

$${}_P\dot{X}_{11_{hc}} = (Z_{24}/Z_{16})V_{11_{hc}} \quad [A3070, A3080] \quad 148$$

$${}_P\dot{Y}_{11_{hc}} = -(Z_{24}/Z_{16})V_{11_{hc}} \quad [A3085, A3070] \quad 149$$

$${}_P\dot{X}_{12_l} = (Z_{24}/Z_{16})\ V_{12_l} \quad [A\ 3086] \quad 149$$

$${}_P\dot{Y}_{12_l} = -\ (Z_{24}/Z_{16})\ V_{12_l} \quad [A\ 3087] \quad 149$$

where:

Z_{24} = The fraction of the normally sessile animals currently in the water column which will be deposited [FALLS]
P_{24_h} = A quadratic coefficient [ANDRF3(H)]
P_{23_h} = The water velocity below which the *h*'th animal category will be deposited [ANILO(H)]
${}_P\dot{X}_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal category being deposited [CBIOMQ(H,C)]
${}_P\dot{Y}_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th group of animals which would have been washed out of the system but instead was deposited [DRIFTA(H,C)]
P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]
X_{73} = Water velocity [VELOCT]
Z_{16} = The number of turnovers of water minus one [CYCLE]
$V_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system in a time unit [XDRIFA(H,C)]
${}_P\dot{X}_{12_l}$ = The population of the *l*'th cohort added by deposition
${}_P\dot{Y}_{12_l}$ = The change in the *l*'th population leaving ecosystem
V_{12_l} = The *l*'th population entering the ecosystem

Behavioral Drift

For the behavioral drifters, when $P_{43_h} = 3$, the amount of animals entering or leaving the drift is predicted on the basis of carrying capacity. This is measured as the difference between the amount an animal wants to eat and the amount it can actually ingest as a function of food quantities available to it.

$$Z_{52} = P_{25_h}/Z_{25_h} \quad [A3170]\ 150$$

$$Z_{53} = \min[P_{16}, \{P_{58_h}\ P_{59_h}^{Z_{52}}\}] \quad [A3200]\ 151$$

$$Z_{54} = (1. - Z_{53})/Z_{16} \quad [A3205]\ 152$$

$${}_B\dot{X}_{11_{hc}} = Z_{54}\ V_{11_{hc}} - (Z_{53}\ X_{11_{hc}}) \quad [A3230]\ 153$$

$${}_B\dot{Y}_{11_{hc}} = Z_{53}\ X_{11_{hc}} - (Z_{54}\ V_{11_{hc}}) \quad [A3235]\ 154$$

$${}_B\dot{X}12_l = Z_{54}\ V_{12_l} - (Z_{53}\ X_{12_l}) \quad [A3250]\ 155$$

$${}_B\dot{Y}12_l = Z_{53}\ X_{12_l} - (Z_{54}\ V_{12_l}) \quad [A3255]\ 156$$

where:

P_{43_h} = A switch for the type of drift of the *h*'th cohort [NDRIFA(H)]
P_{25_h} = The maximum possible intake of the *h*'th animal group in grams per gram animal [TAKE(H)]
Z_{25_h} = The proportion of food ingested by the *h*'th animal cohort [EATS(H)]
P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]
Z_{16} = The number of turnovers of water minus one [CYCLE]
$V_{11_{hc}}$ = The amount of the *c*'th constituent of the *h*'th animal group entering the system in a time unit [XDRIFA(H,C)]
V_{12_l} = The population of the *l*'th animal category entering the ecosystem in a time unit [XDRIFO(L)]
X_{12_l} = The population of the *l*'th animal cohort [POP(L)]
Z_{53} = The fraction of the animal cohort in question leaving the system because of foods available [BEFAC2]
Z_{54} = The fraction of drifting animals of the cohort in question remaining in the system [BEFAC5]
${}_B\dot{X}_{11_{hc}}$ = The change in the *c*'th constituent of the *h*'th cohort due to behavioral drift [CBIOMQ(H,C)]

${}_B\dot{X}_{12_l}$ = The change in population of the l'th cohort due to behavioral drift [POPQQQ(L)]

${}_B\dot{Y}_{11_{hc}}$ = The change in the c'th constituent of the h'th cohort drifting out of the system due to behavior [DRIFTA(H,C)]

${}_B\dot{Y}_{12_l}$ = The change in population for the l'th cohort drifting out of the system due to behavior [DRIFPO(L)]

Heterotrophic Microorganisms

For the heterotrophic microorganisms the following subsets are defined:

$A = (1)$ $D = (3)$

$B = (2)$ $E = (1,2,3)$

$C = (2,3)$ $F = (1,3)$

where 1 = planktonic, 2 = attached and 3 = benthic heterotrophic microorganisms.

Decomposition

The substrate used by the heterotrophic microorganisms is based on the sum of the foods available weighted by preference-availability factors for those foods. Foods for the heterotrophic microorganisms consist of suspended and benthic organic detritus, as well as the dissolved organic matter in the water column and interstitial water.

The maximum possible "intake" from the suspended litter category equals:

$$Z_{11_d} = X_{41_{d1}} \; P_{7_{md}} \qquad m \varepsilon A \qquad [A3385] \quad 157$$

where:

Z_{11_d} = The weighted amount of the d'th category of suspended litter available to the microorganisms [FEEDRF(D)]

$X_{41_{d1}}$ = The amount of carbon in the d'th suspended litter category [CLIT(D,1)]

$P_{7_{md}}$ = The preference-availability factor of the m'th category of microorganisms for the d'th category of detritus [PREFRF(M,D)]

While for benthic litter and the dissolved organic material in the water column and interstitial water the following applies:

$$Z_{12_d} = X_{43_{d1}} \; P_{8_{md}} \qquad m \varepsilon C \qquad [A3405] \quad 158$$

$$Z_{13} = X_{31_1} \; P_{9_m} \qquad m \varepsilon A \qquad [A3435] \quad 159$$

$$Z_{13} = X_{33_1} \; P_{9_m} \qquad m \varepsilon D \qquad [A3460] \quad 160$$

where:

Z_{12_d} = The weighted amount of the d'th category of benthic litter available to the microorganisms [FEEDRB(D)]

$X_{43_{d1}}$ = The amount of carbon in the d'th category of benthic litter [CORG(D,1)]

$P_{8_{md}}$ = The preference-availability factor of the m'th category of microorganisms for the d'th category of benthic detritus [PREFRB(M,D)]

Z_{13} = The weighted amount of dissolved organic material in the water column [FEEDRW]

X_{31_1} = The carbon content of the dissolved material in the water [AQUA(1)]

P_{9_m} = The preference-availability factor of the m'th category of microorganisms for dissolved organic material [PREFRW(M)]

X_{33_1} = The carbon content of the dissolved organic material in interstitial water [AQUAB(1)]

The total possible weighted amounts of substrates available to a group of microorganisms becomes

$$Z_7 = \sum_d Z_{11_d} + \sum_d Z_{12_d} + Z_{13} \qquad 161$$

where:

Z_7 = [SUM]

Z_{11_d} = The weighted amount of the d'th category of suspended litter available to the microorganisms [FEEDRF(D)]

Z_{12_d} = The weighted amount of the d'th category of benthic litter available to the microorganisms [FEEDRB(D)]

Z_{13} = The weighted amount of dissolved organic material in the water column [FEEDRW]

The actual total substrate use per unit biomass of microorganisms per time unit based on carbon becomes

$$Z_{14_{m1}} = Z_{15}/\{1. + P_{10_m}/(Z_7/X_{81})\} \qquad [A3495] \quad 162$$

where:

$$Z_{15} = \exp(P_{11} + P_{12}\,X_{72} - P_{13}\,X_{72}^{\,2}) \qquad [A3490] \quad 163$$

and

$Z_{14_{m1}}$ = Total intake of carbon per time unit for the m'th category of microorganisms [FOOD(M,1)]

Z_{15} = A factor relating food intake to temperature [B]

P_{10_m} = Michaelis constant for rate of substrate use by the m'th type of microorganism [CONS(M)]

Z_7 = The sum of the weighted amounts of substrates [SUM]

P_{11}, P_{12}, P_{13} = Constant, linear and quadratic coefficients for temperature dependence of substrate use [CONTA, CONTB, CONTC]

X_{72} = Water temperature [WTEMP]

X_{81} = Surface area of the ecosystem [AREA]

The substrate use in the eocystem becomes

$$Z_{10} = Z_{14_{m1}} X_{21_{m1}} \qquad m \in C \qquad [A3515] \qquad 164$$

or

$$Z_{10} = (Z_{14_{m1}} / Z_{16}) X_{21_{m1}} \qquad m \in A \qquad [A3510, A3515] \qquad 165$$

where:

Z_{10} = Total amount decomposed [TAKING]

$Z_{14_{m1}}$ = Total intake of carbon per time unit for the m'th category of microorganisms [FOOD(M,1)]

$X_{21_{m1}}$ = Total amount of carbon in the m'th type of microorganism [CBACT(M,1)]

Z_{16} = The proportion of actual time spent in the ecosystem to the time period used [CYCLE]

The suspended litter category is decremented by the amount decomposed.

$$\left.\begin{aligned} {}_D\dot{X}_{41_{dc}} &= -X_{41_{dc}} Z_{10} Z_{11_d} / (Z_7 X_{41_{d1}}) \qquad [A3550, A3560] \quad 166 \\ {}_D\dot{Y}_{41_{dc}} &= -V_{41_{dc}} Z_{10} Z_{11_d} / (Z_7 X_{41_{d1}}) \qquad [A3550, A3565] \quad 167 \end{aligned}\right\} \quad m \in A$$

where:

${}_D\dot{X}_{41_{dc}}$ = The amount of the c'th constituent of the d'th suspended litter category in the ecosystem decomposed [CLITQQ(D,C)]

$X_{41_{dc}}$ = The amount of the c'th constituent of the d'th litter category in the ecosystem [CLIT(D,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{11_d} = The weighted amount of the d'th category of suspended litter available to the microorganism [FEEDRF(D)]

Z_7 = The sum of the weighted foods for the animal group currently being considered [SUM]

$X_{41_{d1}}$ = The carbon content of suspended detritus in the ecosystem [CLIT(D,1)]

${}_D\dot{Y}_{41_{dc}}$ = The amount of the c'th constituent of the d'th suspended litter category which would have been washed out of the system in a time unit but instead has been decomposed [DETIN(D,C)]

$V_{41_{dc}}$ = The amount of the c'th constituent of the d'th suspended litter category entering the ecosystem during a time unit [XDETIN(D,C)]

The benthic litter category is decremented by the amount decomposed.

$${}_D\dot{X}_{43_{dc}} = X_{43_{dc}} Z_{10} Z_{12_d} / (Z_7 X_{43_{d1}}) \qquad m \in C \qquad [A3595, A3605] \qquad 168$$

where:

${}_D\dot{X}_{43_{dc}}$ = The amount of the c'th constituent of the d'th type of benthic detritus which has been decomposed [CORGQQ(D,C)]

$X_{43_{dc}}$ = The amount of the c'th constituent of the d'th type of benthic detritus [CORG(D,C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{12_d} = The weighted amount of the d'th category of benthic litter available to the microorganism [FEEDRB(D)]

Z_7 = The sum of the weighted foods for the animal group currently being considered [SUM]

$X_{43_{d1}}$ = The carbon content of the d'th type of benthic litter [CORG(D,1)]

The dissolved organic material in the water column is decremented by the amount decomposed.

$$\left.\begin{aligned} {}_D\dot{X}_{31_c} &= X_{31_c} Z_{10} Z_{13} / (Z_7 X_{31_1}) \qquad [A3660, A3670] \quad 169 \\ {}_D\dot{Y}_{31_c} &= V_{31_c} Z_{10} Z_{13} / (Z_7 X_{31_1}) \qquad [A3660, A3675] \quad 170 \end{aligned}\right\} \quad m \in A$$

where:

${}_D\dot{X}_{31_c}$ = The amount of the c'th constituent in the ecosystem which is dissolved in the water column and which has been decomposed [AQUAQQ(C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{13} = The weighted amount of dissolved organic material in the water column [FEEDRW]

Z_7 = The sum of the weighted foods for the animal group currently being considered [SUM]

X_{31_1} = The carbon content of the dissolved material in the water [AQUA(1)]

${}_D\dot{Y}_{31_c}$ = The amount of the *c*'th dissolved constituent which would have been washed out of the system but instead was decomposed [COMPIN(C)]

V_{31_c} = The amount of the *c*'th dissolved constituent entering the ecosystem in a time unit [XCOMPN(C)]

The dissolved organic material in the interstitial water is decremented by the amount decomposed.

$$ {}_D\dot{X}_{33_c} = X_{33_c} Z_{10} Z_{13} / (Z_7 X_{33_1}) \qquad m \in D \qquad [A3640, A3630] \qquad 171 $$

where:

${}_D\dot{X}_{33_c}$ = The amount of the *c*'th dissolved organic constituent in the interstitial water which has been decomposed [AQUABQ(C)]

X_{33_c} = The amount of the *c*'th dissolved organic constituent in the interstitial water [AQUAB(C)]

Z_{10} = Total carbon intake for the cohort currently under consideration [TAKING]

Z_{13} = The weighted amount of dissolved organic material in the water column [FEEDRW(D)]

Z_7 = The sum of the weighted foods for the animal group currently being considered [SUM]

X_{33_1} = The carbon content of the dissolved organic material in interstitial water [AQUAB(1)]

The total intake by the microorganisms thus becomes:

$$ Z_{17_{mc}} = -\Sigma_d {}_D\dot{X}_{41_{dc}} - \Sigma_d {}_D\dot{Y}_{41_{dc}} - \Sigma_d {}_D\dot{X}_{43_{dc}} $$

$$ -\Sigma {}_D\dot{X}_{31_c} - \Sigma {}_D\dot{Y}_{31_c} - \Sigma {}_D\dot{X}_{33_c} \qquad 172 $$

where:

$Z_{17_{mc}}$ = The total intake of the *c*'th constituent by the *m*'th detritus category [FOOD(M,C)]

${}_D\dot{X}_{41_{dc}}$ = The amount of the *c*'th constituent of the *d*'th suspended litter category in the ecosystem decomposed [CLITQQ(D,C)] [A3570]

${}_D\dot{Y}_{41_{dc}}$ = The amount of the *c*'th constituent of the *d*'th suspended litter category which would have been washed out of the system in a time unit but instead have been decomposed [DETIN(D,C)] [A3570]

${}_D\dot{X}_{43_{dc}}$ = The amount of the *c*'th constituent of the *d*'th type of benthic detritus which has been decomposed [CORGQQ(D,C)] [A3610]

${}_D\dot{X}_{31_c}$ = The amount of the *c*'th constituent in the ecosystem which is dissolved in the water column and which has been decomposed [AQUAQQ(C)] [A3680]

${}_D\dot{Y}_{31_c}$ = The amount of the *c*'th dissolved constituent which would have been washed out of the system but instead was decomposed [COMPIN(C)] [A3680]

${}_D\dot{X}_{33_c}$ = The amount of the *c*'th dissolved organic constituent in the interstitial water which has been decomposed [AQUABQ(C)] [A3645]

Respiration and assimilation are both calculated as a fraction of the "food" intake with the remainder being added to the dissolved organic category. Respiratory products increment the dissolved inorganic elements with the exception of energy, which is considered lost to the atmposphere. Because the relationship of each type (planktonic, attached and benthic) of microorganism with their environment differs, these processes are calculated separately.

For the planktonic microorganisms, respiration equals

$$ Z_{18} = P_{14_m} Z_{17_{mc}} \qquad m \in A \qquad [A3735] \qquad 173 $$

where:

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

P_{14_m} = The fraction of the "food" which is respired by the *m*'th type of microorganism [RESPM(M)]

$Z_{17_{mc}}$ = The total intake of the *c*'th constituent by the *m*'th detritus category [FOOD(M,C)]

The respired elements enter the dissolved inorganic categories.

$$ {}_R\dot{X}_{51_k} = Z_{18} \qquad m \in A \text{ and } c \neq 2 \qquad [A3750] \qquad 174 $$

$$ {}_R\dot{Y}_{51_k} = Z_{18} Z_{16} - Z_{18} \qquad m \in A \text{ and } c \neq 2 \qquad [A3765] \qquad 175 $$

where:

${}_R\dot{X}_{51_k}$ = The increment of the *k*'th inorganic element in solution in the ecosystem due to respiration [WDINRQ(K)]

${}_R\dot{Y}_{51_k}$ = The increment to the *k*'th inorganic element in solution due to respiration which is being washed out of the system [DNORG(K)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Z_{16} = The number of turnovers of water minus one [CYCLE]

This chemical change is tracked according to:

$${}_{R}\dot{X}01_{13,c} = -Z_{18}Z_{16} \qquad m \in A \text{ and } c \neq 2 \qquad [A3755] \quad 176$$

$${}_{R}\dot{X}03_{13,k} = Z_{18}Z_{16} \qquad m \in A \text{ and } c \neq 2 \qquad [A3760] \quad 177$$

where:

${}_{R}\dot{X}01_{13,c}$ = The amount of the *c*'th organic constituent transformed to the inorganic state as a function of respiration [AGAWQ(13,C)]

${}_{R}\dot{X}03_{13,k}$ = The amount of the *k*'th dissolved element transferred from the organic state as a function of respiration [DGAINQ(13,K)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Energy from respiration is lost to the atmosphere

$${}_{R}\dot{X}01_{2,2} = -Z_{18}Z_{16} \qquad m \in A \qquad [A3740] \quad 178$$

Assimilation is calculated and incrementations added to the microorganisms.

$$Z_{19} = P_{15_m} Z_{17_{mc}} \qquad m \in E \qquad [A3770] \quad 179$$

where:

Z_{19} = The assimilation of the constituent for the cohort under consideration [ASSI]

P_{15_m} = The fractional part of the food for the *m*'th category of microorganism which is assimilated [ASSIMH(M)]

$Z_{17_{mc}}$ = The total intake of the *c*'th constituent by the *m*'th detritus category [FOOD(M,C)]

$${}_{A}\dot{Y}21_{mc} = Z_{19}Z_{16} - Z_{19} \qquad m \in A \qquad [A3775] \quad 180$$

$${}_{A}\dot{X}21_{mc} = Z_{19} \qquad m \in E \qquad [A3780] \quad 181$$

where:

${}_{A}\dot{Y}21_{mc}$ = The change due to assimilation of the *c*'th constituent of the *m*'th type of microorganism which is washed out of the system during a time unit [DRIFTM(M,C)]

${}_{A}\dot{X}21_{mc}$ = The change due to assimilation of the *c*'th constituent of the *m*'th type of microorganism in the ecosystem [CBACTQ(M,C)]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXGR]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Productivity is calculated as the amount of assimilation for a time unit.

$${}_{A}\dot{X}26_{mc} = Z_{19}\,Z_{16} \qquad m \in A \qquad [A3785] \quad 182$$

where:

${}_{A}\dot{X}26_{mc}$ = Bacterial productivity [CBACTP(M,C)]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXGR]

Z_{16} = The number of turnovers of water minus one [CYCLE]

The difference between "food" and the fraction of it assimilated and respired is considered leakage and is added to the dissolved organic compartment.

$$Z_{20} = Z_{17_{mc}} - (Z_{18} + Z_{19}) \qquad m \in F \qquad [A3790] \quad 183$$

where:

Z_{20} = The amount of the constituent for the microorganism category under consideration which will be added to the dissolved organic compartments [AGOORG]

$Z_{17_{mc}}$ = The total intake of the *c*'th constituent by the *m*'th detritus category [FOOD(M,C)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration[RESP]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXGR]

$${}_{L}\dot{X}31_{c} = Z_{20} \qquad m \in A \qquad [A3795] \quad 184$$

$${}_{L}\dot{Y}31_{c} = Z_{20}Z_{16} - Z_{20} \qquad m \quad A \qquad [A3800] \quad 185$$

where:

${}_{L}\dot{X}31_{c}$ = The change in the *c*'th dissolved constituent in the ecosystem due to leakage [AQUAQQ(C)]

${}_{L}\dot{Y}31_{c}$ = The change of the *c*'th dissolved constituent leaving the ecosystem in a time unit [COMPIN(C)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Z_{20} = The amount of the constituent for the microorganism category under consideration which will be added to the dissolved organic compartments [AGOORG]

For the attached microorganisms, respiration equals:

$$Z_{18} = P_{14_m} Z_{17_{mc}} / Z_{21} \qquad m \in B \qquad [A3810] \quad 186$$

where:

Z_{21} = The total amount of water that has flowed through the system in a time unit plus the water in the system [WATTOT]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

P_{14_m} = The fraction of the "food" which is respired by the m'th type of microorganism [RESPM(M)]

$Z_{17_{mc}}$ = The total intake of the c'th constituent by the m'th detritus category [FOOD(M,C)]

The respired elements enter the dissolved inorganic categories.

$${}_{R}\dot{X}_{51_k} = Z_{18} Z_{22} \qquad m \in B \text{ and } c \neq 2 \qquad [A3825] \quad 187$$

$${}_{R}\dot{Y}_{51_k} = Z_{18}(Z_{21} - Z_{22}) \qquad m \in B \text{ and } c \neq 2 \qquad [A3840] \quad 188$$

where:

Z_{22} = The total water in the system during the time unit [WATSYS]

${}_{R}\dot{X}_{51_k}$ = The change in the k'th dissolved inorganic constituent in the water column due to respiration [WDINRQ(K)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideraation [RESP]

${}_{R}\dot{Y}_{51_k}$ = The change in the k'th dissolved inorganic constituent in outflowing water [DNORG(K)]

Z_{21} = The total amount of water in and passing through the system in a day

This chemical change is tracked according to:

$${}_{R}\dot{X}_{01_{13,c}} = -Z_{18} Z_{21} \qquad m \in B \text{ and } c \neq 2 \qquad [A3830] \quad 189$$

$${}_{R}\dot{X}_{03_{13,k}} = Z_{18} Z_{16} \qquad m \in B \text{ and } c \neq 2 \qquad [A3835] \quad 190$$

where:

${}_{R}\dot{X}_{01_{13,c}}$ = A change in the chemical state for the element in question [AGAINQ(13,C)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Z_{21} = The total amount of water in and passing through the system in a day

${}_{R}\dot{X}_{03,k}$ = A change in chemical state for the element in question [DGAIN(13,K)]

Z_{16} = The number of turnovers of water minus one [CYCLE]

Energy from respiration is lost to the atmosphere.

$${}_{R}\dot{X}_{01_{2,2}} = -Z_{18} Z_{21} \qquad m \in B \qquad [A3815] \quad 191$$

where:

${}_{R}\dot{X}_{01_{2,2}}$ = Loss of energy to the atmosphere due to respiration of the cohort in question [AGAINQ(2,2)]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Z_{21} = The total amount of water in and passing through the system in a day

Assimilation is calculated in the same way as in equation 179, with incrementations being the same as in equations 180 and 181.

Productivity is calculated as the amount of assimilation

$${}_{A}\dot{X}_{26_{mc}} = Z_{19} \qquad m \in C \qquad [A3855] \quad 192$$

where:

${}_{A}\dot{X}_{26_{mc}}$ = Microbial productivity [CBACTP(M,C)]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXGR]

The difference between "food" and the fraction of it assimilated and respired is considered leakage and is added to the dissolved organic compartment.

$$Z_{20} = \{Z_{17_{mc}} - [Z_{19} + (Z_{18} Z_{21})]\} / Z_{21} \qquad m \in B \qquad [A3860] \quad 193$$

where:

Z_{20} = The amount of the constituent for the microorganism category under consideration which will be added to the dissolved organic compartments [AGOORG]

$Z_{17_{mc}}$ = The total intake of the c'th constituent by the m'th detritus category [FOOD(M,C)]

Z_{19} = The amount of assimilation for the animal cohort and constituent currently under consideration [EXGR]

Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Z_{21} = The total amount of water in and passing through the system in a day.

${}_L\dot{X}_{31_c} = Z_{20}Z_{22}$ $m \in B$ [A3865] 194

${}_L\dot{Y}_{31_c} = Z_{20}(Z_{21}-Z_{22})$ $m \in B$ [A3870] 195

where:

${}_L\dot{X}_{31_c}$ = The change of the c'th dissolved constituent in the ecosystem due to leakage [AQUAQQ(C)]
Z_{20} = The amount of the constituent for the microorganism category under consideration which will be added to the dissolved organic compartments [AGOORG]
Z_{22} = The total water in the system during the time unit [WATSYS]
${}_L\dot{Y}_{31_c}$ = The change of the c'th dissolved constituent leaving the ecosystem in a time unit [COMPIN(C)]
Z_{21} = The total amount of water in and passing through the system in a day

For the benthic heterotrophic microorganisms, respiration follows the form of equation 173. The respired elements enter the dissolved inorganic category in the interstitial water.

${}_R\dot{X}_{53_k} = Z_{18}$ $m \in D$ and $c \neq 2$ [A3895] 196

where:

${}_R\dot{X}_{53_k}$ = [BDINRQ(K)]
Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

This chemical change is tracked according to

${}_R\dot{X}_{01_{13,c}} = -Z_{18}$ $m \in D$ [A3900] 197

${}_R\dot{X}_{02_{13,k}} = Z_{18}$ $m \in D$ [A3905] 198

where:

${}_R\dot{X}_{01_{13,c}}$ = A change in the chemical state for the element in question [AGAINQ(13,C)]
Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]
${}_R\dot{X}_{03_{13,k}}$ = A change in the chemical state for the element in question [DGAIN(13,K)]

Energy from respiration is lost to the atmosphere.

${}_R\dot{X}_{01_{2,2}} = -Z_{18}$ $m \in D$ [A3865] 199

where:

${}_R\dot{X}_{01_{2,2}}$ = Loss of energy to the atmosphere due to respiration of the cohort in question [AGAINQ(2,2)]
Z_{18} = Respiration for the constituent and microorganism group currently under consideration [RESP]

Assimilation is calculated as in equation 179; incrementation as in equation 181; leakage as in equation 183 and productivity as in equation 192. The products of leakage increment the dissolved organic compartment in the interstitial water.

${}_L\dot{X}_{33_c} = Z_{20}$ $m \in D$ [A3930] 200

where:

${}_L\dot{X}_{33_c}$ = [AQUABQ(C)]
Z_{20} = The amount of the constituent for the microorganism category under consideration which will be added to the dissolved organic compartments [AGOORG]

If attached or benthic heterotrophic microorganisms are included in the simulation [NDRIFM = 2 or 3] they may be scoured and washed out of the system due to high water velocities. For scouring (when X_{73} is greater than P_{18_m})

$Z_{23} = \min[P_{16}, \max(0., \{P_{17_m}{}^{X_{73}} - P_{17_m}{}^{P_{18_m}}\})]$ [A4000] 201

${}_S\dot{X}_{21_{mc}} = -Z_{23}X_{21_{mc}}$ [A4020, A4025] 202

${}_S\dot{Y}_{21_{mc}} = Z_{23}X_{21_{mc}}$ [A4025, A4030] 203

where:

Z_{23} = The fraction of the microorganism category category currently under consideration which is scoured [SCOUR]
P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]
P_{17_m} = A quadratic coefficient [BDRF2(M)]
X_{73} = The water velocity [VELOCT]
P_{18_m} = The water velocity above which the m'th microorganisms will be scoured [BACTHI(M)]
${}_S\dot{X}_{21_{mc}}$ = The amount of the c'th constituent of the m'th category of microorganisms which is scoured [CBACTQ(M,C)]
${}_S\dot{Y}_{21_{mc}}$ = The amount of the c'th constituent of the m'th category of microorganism which is washed out of the system [DRIFTM(M,C)]
$X_{21_{mc}}$ = The amount of the c'th constituent of the m'th type of microorganism present in the system [CBACT(M,C)]

For settling (when Z_{73} is less than P_{19_m})

$$Z_{24} = \min[P_{16}, \max(0., \{P_{20_m}^{X_{73}} - P_{20_m}^{P_{19_m}}\})] \quad [A4045] \quad 204$$

$$_P\dot{X}_{21_{mc}} = (Z_{24}/Z_{16})V_{21_{mc}} \quad [A4055, A4065] \quad 205$$

$$_P\dot{Y}_{21_{mc}} = -(Z_{24}/Z_{16})V_{21_{mc}} \quad [A4055, A4070] \quad 206$$

where:

Z_{24} = The fraction of the normally sessile microorganisms currently in the water column which will be deposited [FALLS]

P_{20_m} = A quadratic coefficient [BDRF3(M)]

P_{19_m} = The water velocity below which the *m*'th type of microorganisms will be deposited [BACTLO(M)]

$_P\dot{X}_{21_{mc}}$ = The amount of the *c*'th constituent of the *m*'th type of microorganisms being deposited [CBACTQ(M,C)]

$_P\dot{Y}_{21_{mc}}$ = The amount of the *c*'th constituent of the *m*'th type of microorganisms which would have washed out of the system but instead was deposited in the ecosystem [DRIFTM(M,C)]

P_{16} = The maximum fraction of a state variable affected by a function [ALLMAX]

X_{73} = Water velocity [VELOCT]

Z_{16} = The number of turnovers of water minus one [CYCLE]

$V_{21_{mc}}$ = The amount of the *c*'th constituent of the *m*'th type of microorganism entering the system in a time period [XDRIFM(M,C)]

TABLE OF SYMBOLS

The following table is supplied as a user's aid. It lists the symbols used in the mathematical description, the FORTRAN equivalent, the equations where the symbol is used, and the units for the symbol. The classification of symbols is explained in the Introduction; listings in the table are alphabetical according to variable type and then numerically according to subscript number. The following abbreviations are used:

C = centigrade
cu = cubic
ecsys = ecosystem
g = gram or grams
hr = hour
kcal = kilocalories
m = meter or meters
mm = millimeters
pop = populations
sq = square

Many of the exogenous variables (V) have for units "variable" for they are first used as grams per cubic meter of water flowing into the system from upstream, and then as grams per ecosystem per day of material entering the system from all sources. Also, Y is used as grams per ecosystem per day leaving the system, or as grams per cubic meter of water leaving the ecosystem as downstream flow.

Symbol	Fortran Equivalent	Equations where used	Units
$P_{1_{hp}}$	PREFV(H,P)	1, 2	dimensionless
$P_{2_{hh}}$	PREFA(H, H)	3, 4, 5, 6	dimensionless
P_{3_h}	FEDFRM(H)	5, 6	dimensionless
$P_{4_{hd}}$	PREFL (H,D)	7, 8	dimensionless
$P_{5_{hd}}$	PREFO(H,D)	9	dimensionless
$P_{6_{hm}}$	PREFM(H,M)	10, 11	dimensionless
$P_{7_{md}}$	PREFRF(M,D)	157	dimensionless
$P_{8_{md}}$	PREFRB(M,D)	158	dimensionless
P_{9_m}	PREFRW(M)	159, 160	dimensionless
P_{10_m}	CONS(M)	162	
P_{11}	CONTA	163	
P_{12}	CONTB	163	
P_{13}	CONTC	163	
P_{14_m}	RESPM(M)	173, 186	$g \cdot g^{-1}$
P_{15_m}	ASSIMH(M)	179	$g \cdot g^{-1}$
P_{16}	ALLMAX	96, 97, 98, 144, 147, 151 201, 204	dimensionless
P_{17_m}	BDRF2(M)	201	dimensionless
P_{18_m}	BACTHI(M)	201	$m \cdot sec^{-1}$
P_{19_m}	BACTLO(M)	204	$m \cdot sec^{-1}$
P_{20_m}	BDRF3(M)	204	dimensionless
P_{21_h}	ANIHI(H)	144	$m \cdot sec^{-1}$
P_{22_h}	ANDRF2(H)	144	dimensionless
P_{23_h}	ANILO(H)	147	$m \cdot sec^{-1}$
P_{24_h}	ANDRF3(H)	147	dimensionless
P_{25_h}	TAKE(H)	12, 15, 20, 150	$g \cdot g^{-1} \cdot day^{-1}$
P_{26_h}	CURVE(H)	12	
P_{27_h}	ASSIM(H)	15, 20, 50	$g \cdot g^{-1}$
P_{28_h}	WMIN(H)	15, 16	g
P_{29_h}	SLOPE(H)	15, 21, 49	
P_{30_h}	CONST(H)	15, 21, 49	
P_{31_h}	TOPT(H)	15, 17, 19, 21	degrees C

Symbol	Fortran Equivalent	Equations were used	Units
P_{32_h}	WMAX(H)	16	g
P_{33_h}	TMAX(H)	17, 19	degrees C
P_{34_h}	XCRSOL(H)	55, 58, 62, 64, 66, 69	g · g · day^{-1}
P_{35_h}	IXFATE(H)	59, 60, 61	
P_{36}	NOLIT	112, 113, 114, 135, 136, 139 140, 141, 142	
P_{37_h}	NTRANS(H)	96, 97, 98, 116, 117	
P_{38_h}	THRESH(H)	96	degrees C
P_{39_h}	AMAX(H)	96, 98	variable
P_{40_h}	HATCON(H)	97	
P_{41_h}	TEMCON(H)	97	
P_{42_h}	ACCUM(H)	96, 98	variable
P_{43_h}	NDRIFA(H)	106, 107, 108, 109, 110, 111, 112 113, 114, 115, 116, 117, 121, 125, 126, 128, 137, 139, 141, 142	
P_{44_h}	SHELP(H)	105	g·g^{-1}
P_{45_h}	ISFATE(H)	112, 113, 114	
P_{46_h}	NTRANE(H)	118, 119	
P_{47_a}	RCONST(A)	118	g · g^{-1}
P_{48_a}	NLAY1(A)	118	
P_{49_a}	NLAY2(A)	118	
P_{50}	IYRDAY	118	
P_{51_a}	CONSA(A)	119	degrees C
P_{52_a}	UPTHRE(A)	119	degrees C
P_{53_h}	REPROD(H)	119	g · g^{-1}· day^{-1}
$P_{54_{ac}}$	EGCOMP(A,C)	122, 127, 128, 130, 131	g · g^{-1}
P_{55_a}	EXOGEN(A)	129, 130, 131	pop · cu m^{-1}
P_{56_h}	AMORTA(H)	132, 137	g · g^{-1}· day^{-1}
P_{57_h}	IAFATE(H)	135, 136, 139, 140, 141, 142	
P_{58_h}	BEFAC3(H)	151	
P_{59_h}	BEFAC4(H)	151	
$V_{1_{p,1,1}}$	XDRIFV(P,1,1)	2, 28	variables
$V_{1_{p,1,c}}$	XDRIFV(P,1,C)	26, 27, 28	variables
$V_{11_{h1}}$	XDRIFA(H,1)	4, 5, 33, 34, 35, 36, 37, 38	variables
$V_{11_{hc}}$	XDRIFA(HC)	31, 35, 37, 91, 92, 93, 94, 95 134, 135, 136, 148, 149, 153, 154	variables
V_{12_l}	XDRIFO(L)	32, 36, 38, 133, 155, 156	variables
$V_{21_{m1}}$	XDRIFM(M,1)	11, 46, 47	variables
$V_{21_{mc}}$	XDRIFM(M,C)	45, 47, 205, 206	variables
V_{31_c}	XCOMPIN(C)	170	variables
$V_{41_{d1}}$	XDETIN(D,1)	8, 41, 42	variables
$V_{41_{dc}}$	XDETIN(D,C)	40, 42, 167	variables
${}_{R}\dot{X}_{01_{2,2}}$	AGAINQ(2,2)	78, 85, 92, 178, 191, 199	g ·ecsys^{-1}.day^{-1}
${}_{R}\dot{X}_{01_{13,c}}$	AGAINQ(13,C)	79, 87, 93, 176, 189, 197	g ·ecys^{-1}.day^{-1}
${}_{T}\dot{X}_{01_{1c}}$	AGAINQ(1,C)	130	g ·ecys^{-1}.day^{-1}
${}_{T}\dot{X}_{01_{1c}}$	AGAINQ(2.C)	117	g ·ecys^{-1}.day^{-1}
${}_{P}\dot{X}_{03_{13,k}}$	DGAINQ(13,K)	80, 88, 94, 177, 190, 198	g ·ecys^{-1}.day^{-1}
$X_{1_{p,1,1}}$	CVEG(P,1,1)	1, 2, 25, 26, 27, 28	g ·ecys^{-1}
${}_{I}\mathrm{I}\dot{X}_{1_{p,1,c}}$	CVEGQQ(P,1,C)	25, 27, 48	g ·ecsys^{-1}.day^{-1}
$X_{11_{h1}}$	CBIOM(H,1)	3, 4, 6, 29, 30, 31, 32, 33, 34, 35, 36, 51, 53, 120	g .ecsys^{-1}
$X_{11_{hc}}$	CBIOM(H,C)	16, 21, 23, 24, 29, 33, 49, 51, 53, 90, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 138, 139, 140, 141, 142, 143, 145, 146, 153, 154	g .ecsys^{-1}
X_{12_l}	POP(L)	16, 21, 30, 34, 49, 100, 155, 156	pop ·ecsys^{-1}
${}_{B}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	153	g ·ecsys^{-1}.day^{-1}
${}_{B}\dot{X}_{12_l}$	POPQQQ(L)	155	pop ·ecsys^{-1}.day^{-1}
${}_{H}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	138	g ·ecsys^{-1}. day^{-1}
${}_{H}\dot{X}_{12_l}$	POPQQQ(L)	143	pop ·ecsys^{-1}.day^{-1}
${}_{I}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	29, 33, 48	g ·ecsys^{-1}.day^{-1}
${}_{I}\dot{X}_{12_l}$	POPQQQ(L)	30, 34	pop ·ecsys^{-1}.day^{-1}
${}_{P}\dot{X}_{11_{hc}}$	CBIOMQ(M,C)	148	g ·ecsys^{-1}.day^{-1}
${}_{S}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	145	g ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{12_l}$	POPQQQ(L)	127, 129	pop ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	108, 115, 124	g ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{11_{h+1}}$	CBIOMQ(H+1,C)	109, 116	g ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{12_l}$	POPQQQ(L)	101	pop ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{12_{l+1}}$	POPQQQ(L+1)	103	pop ·ecsys^{-1}.day^{-1}
${}_{T}\dot{X}_{11_{sc}}$	CBIOMQ(S,C)	123, 131	g ·ecsys^{-1}.day^{-1}
${}_{W}\dot{X}_{11_{hc}}$	CBIOMQ(H,C)	74	g ·ecsys^{-1}.day^{-1}
${}_{W}\dot{X}_{16_{hc}}$	CBIOMP(H,C)	75,76	g ·ecsys^{-1}.day^{-1}
$X_{21_{m1}}$	CBACT(M,1)	10, 11, 44, 45, 46, 47, 164, 165	g ·ecsys^{-1}
$X_{21_{mc}}$	CBACT(M,C)	44, 46, 202, 203	g ·ecsys^{-1}
${}_{A}\dot{X}_{21_{mc}}$	CBACTQ(M,C)	181	g ·ecsys^{-1}.day^{-1}
${}_{I}\dot{X}_{21_{mc}}$	CBACTQ(M,C)	44, 46, 48	g ·ecsys^{-1}.day^{-1}
${}_{P}\dot{X}_{21_{mc}}$	CBACTQ(M,C)	205	g ·ecsys^{-1}.day^{-1}

Symbol	Fortran Equivalent	Equations were used	Units
$S^{\dot{X}}_{21_{mc}}$	CBACTQ(M,C)	202	g ·ecsys^{-1}.day^{-1}
$A^{\dot{X}}_{26_{mc}}$	CBACTP(M,C)	182, 192	g ·ecsys^{-1}.day^{-1}
X_{31_1}	AQUA(1)	159, 169, 170	g ·ecsys^{-1}
X_{31_c}	AQUA(C)	169	g ·ecsys^{-1}
$D^{\dot{X}}_{31_c}$	AQUAQQ(C)	172	g ·ecsys^{-1}.day^{-1}
$G^{\dot{X}}_{31_c}$	AQUAQQ(C)	56, 67, 169	g ·ecsys^{-1}.day^{-1}
$G^{\dot{X}}_{33_c}$	AQUABQ(C)	63	g ·ecsys^{-1}.day^{-1}
$L^{\dot{X}}_{31_c}$	AQUAQQ(C)	184, 194	g ·ecsys^{-1}.day^{-1}
X_{33_1}	AQUAB(1)	160, 171	g ·ecsys^{-1}
X_{33_c}	AQUAB(C)	171	g ·ecsys^{-1}
$D^{\dot{X}}_{33_c}$	AQUABQ(C)	171,172	g ·ecsys^{-1}.day^{-1}
$L^{\dot{X}}_{33_c}$	AQUABQ(C)	200	g ·ecsys^{-1}.day^{-1}
$X_{41_{d1}}$	CLIT(D,1)	7, 8, 39, 40, 41, 42, 157, 166, 167	g ·ecsys^{-1}
$X_{41_{dc}}$	CLIT(D,C)	39, 41, 166	g ·ecsys^{-1}
$D^{\dot{X}}_{41_{dc}}$	CLITQQ(D,C)	166, 172	g ·ecsys^{-1}.day^{-1}
$G^{\dot{X}}_{41_{dc}}$	CLITQQ(D,C)	61, 70	g ·ecsys^{-1}.day^{-1}
$H^{\dot{X}}_{41_{dc}}$	CLITQQ(D,C)	139, 142	g ·ecsys^{-1}.day^{-1}
$I^{\dot{X}}_{41_{dc}}$	CLITQQ(D,C)	39, 41, 48	g ·ecsys^{-1}.day^{-1}
$T^{\dot{X}}_{41_{dc}}$	CLITQQ(D,C)	106, 113	g ·ecsys^{-1}.day^{-1}
$X_{43_{d1}}$	CORG(D,1)	9, 43, 158, 168	g ·ecsys^{-1}
$X_{43_{dc}}$	CORG(D,C)	43, 168	g ·ecsys^{-1}
$D^{\dot{X}}_{43_{dc}}$	CORGQQ(D,C)	168, 172	g ·ecsys^{-1}.day^{-1}
$G^{\dot{X}}_{43_{dc}}$	CORGQQ(D,C)	59, 65	g ·ecsys^{-1}.day^{-1}
$H^{\dot{X}}_{43_{dc}}$	CORGQQ(D,C)	135, 140	g ·ecsys^{-1}.day^{-1}
$I^{\dot{X}}_{43_{dc}}$	CORGQQ(D,C)	43, 48	g ·ecsys^{-1}.day^{-1}
$T^{\dot{X}}_{43_{dc}}$	CORGQQ(D,C)	112	g ·ecsys^{-1}.day^{-1}
$R^{\dot{X}}_{51_k}$	WDINRQ(K)	81, 86, 174, 187	g ·ecsys^{-1}.day^{-1}
$R^{\dot{X}}_{53_k}$	BDINRQ(K)	83, 196	g ·ecsys^{-1}.day^{-1}
X_{72}	WTEMP	17, 18, 49, 97, 163	degrees C
X_{73}	VELOCT	144, 147, 201, 204	m ·second^{-1}
X_{75}	WATSYS	56, 57, 81, 82	cu m ·ecsys^{-1}
X_{81}	AREA	13, 129, 130, 131, 162	sq m ·ecsys^{-1}
$I^{\dot{Y}}_{1_{p,1,c}}$	DRIFTV(P,1,C)	26, 28, 48	g ·ecsys^{-1}.day^{-1}
$B^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	154	g ·ecsys^{-1}.day^{-1}

Symbol	Fortran Equivalent	Equations were used	Units
$B^{\dot{Y}}_{12_l}$	DRIFPO(L)	156	g ·ecsys^{-1}.day^{-1}
$H^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	134	g ·ecsys^{-1}.day^{-1}
$H^{\dot{Y}}_{12_l}$	DRIFPO(L)	133	g ·ecsys^{-1}.day^{-1}
$I^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	31, 35, 37, 48	g ·ecsys^{-1}.day^{-1}
$I^{\dot{Y}}_{12_l}$	DRFIPO(L)	32, 36, 38	g ·ecsys^{-1}. day^{-1}
$P^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	149	g ·ecsys^{-1}.day^{-1}
$R^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	95	g ·ecsys^{-1}.day^{-1}
$S^{\dot{Y}}_{11_{hc}}$	DRFITA(H,C)	146	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{12_l}$	DRIFPO(L)	128	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	110, 125	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{11_{h+1,c}}$	DRFITA(H+1,C)	111	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{12_l}$	DRIFPO(L)	102	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{12_{l+1}}$	DRIFPO(L+1)	104	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{11_{hc}}$	DRIFTA(H C)	126	g ·ecsys^{-1}.day^{-1}
$W^{\dot{Y}}_{11_{hc}}$	DRIFTA(H,C)	73	g ·ecsys^{-1}.day^{-1}
$A^{\dot{Y}}_{21_{mc}}$	DRIFTM(M,C)	180, 181	g ·ecsys^{-1}.day^{-1}
$I^{\dot{Y}}_{21_{mc}}$	DRIFTM(M,C)	45, 47, 48	g ·ecsys^{-1}.day^{-1}
$P^{\dot{Y}}_{21_{mc}}$	DRIFTM(M,C)	206	g ·ecsys^{-1}.day^{-1}
$S^{\dot{Y}}_{21_{mc}}$	DRIFTM(M,C)	203	g ·ecsys^{-1}.day^{-1}
$D^{\dot{Y}}_{31_c}$	COMPIN(C)	170, 172	g ·ecsys^{-1}.day^{-1}
$G^{\dot{Y}}_{31_c}$	COMPIN (C)	57, 68	g ·ecsys^{-1}.day^{-1}
$L^{\dot{Y}}_{31_c}$	COMPIN (C)	185, 195	g ·ecsys^{-1}.day^{-1}
$D^{\dot{Y}}_{41_{dc}}$	DETIN(D,C)	167, 172	g ·ecsys^{-1}.day^{-1}
$G^{\dot{Y}}_{41_{dc}}$	DETIN(D,C)	60, 71	g ·ecsys^{-1}.day^{-1}
$H^{\dot{Y}}_{41_{dc}}$	DETIN(D,C)	136, 141	g ·ecsys^{-1}.day^{-1}
$I^{\dot{Y}}_{41_{dc}}$	DETIN(D,C)	40, 42, 48	g ·ecsys^{-1}.day^{-1}
$T^{\dot{Y}}_{41_{dc}}$	DETIN(D,C)	107, 114	g ·ecsys^{-1}.day^{-1}
$R^{\dot{Y}}_{51_k}$	DNORG(K)	82, 89, 91, 175, 188	g ·ecsys^{-1}.day^{-1}
Z_{1_p}	FEEDV(P)	1, 2, 14, 25, 26, 27, 28	
Z_{2_h}	FEEDA(H)	3, 4, 6, 14, 29, 30, 31, 32, 33, 34, 35, 36	
Z_{3_h}	FEEDAD(H)	5, 14, 37, 38	
Z_{4_d}	FEEDL(D)	7, 8, 14, 39, 40, 41, 42	
Z_{5_d}	FEEDO(D)	9, 14, 43	
Z_{6_m}	FEEDM(M)	10, 11, 14, 44, 45, 46, 47	

Symbol	Fortran Equivalent	Equations were used	Units
Z_7	SUM	13, 14, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 161, 162, 166, 167, 168, 169, 170, 171	
Z_{8_h}	EATS(H)	12, 13	g · g.day^{-1}
$Z_{9_{hc}}$	FOOD(H,C)	48, 54	g · ecsys $^{-1}$.day^{-1}
Z_{10}	TAKING	23, 24,25,26,27,28,29,30,31,32,33,34, 35,36,37,38,39,40,41,42,43,44,45,46 47, 164, 165, 166, 167, 168, 169, 170, 171	
Z_{11_d}	FEEDRF(D)	157, 161, 166, 167	
Z_{12_d}	FEEDRB(D)	158, 161, 168	
Z_{13}	FEEDRW	159, 160, 161, 169, 170, 171	
$Z_{14_{m1}}$	FOOD(M,1)	162, 164, 165	g · day^{-1}
Z_{15}	B	162, 163	
Z_{16}	CYCLE	22,52,68,71,73,75,85,87,88,89,90, 99,102,104,107,110,111,121,125,126, 128, 132, 141, 142, 148, 149, 152, 165, 175, 176, 177, 178, 180, 182, 185, 190, 205, 206	day^{-1}
$Z_{17_{mc}}$	FOOD(M,C)	172, 173, 179, 183, 186, 193	g · ecsys $^{-1}$.day^{-1}
Z_{18}	RESP	173, 174, 175, 176, 177, 178, 183, 186, 187, 188, 189, 190, 191, 193, 196, 197 198, 199	variable
Z_{19}	ASSI	53, 54, 72, 179, 180, 181, 182,183, 192, 193	g · ecsys $^{-1}$.day^{-1}
Z_{20}	AGOORG	183, 184, 185, 193, 194, 195, 200	variable
Z_{21}	WATTOT	55,56,77,78,79,80,82,83,186,188, 189, 191,193,195	cu m · ecsys $^{-1}$ day^{-1} + cu m · ecsys $^{-1}$
Z_{22}	WATSYS	187, 188, 194, 195	cu m · ecsys $^{-1}$
Z_{23}	SCOUR	144, 145, 146, 201, 202, 203	g · g $^{-1}$
Z_{24}	FALLS	147, 148, 149, 204, 205, 206	g · g $^{-1}$
Z_{25_h}	EATS(H)	12, 22, 24	g · g $^{-1}$.day^{-1}
Z_{26}	GMAX	15, 16	
Z_{27}	GPOT	16, 20	
Z_{30}	B	17, 18	
Z_{31}	B	18, 19	
Z_{32}	B	19, 20	
Z_{33}	B	20, 23, 24	
Z_{34}	RESPAC	20, 21	g · ecsys $^{-1}$.day^{-1}
$Z_{35_{h1}}$	FOOD(H,1)	22, 23, 50	g · ecsys $^{-1}$.day^{-1}
Z_{36}	RESPAC	49, 51	g · ecsys^{-1} .day^{-1}
Z_{37}	ASSICA	50, 53	g · ecsys $^{-1}$.day^{-1}
Z_{38}	RESPI	51, 52, 72, 77, 84, 90	g · ecsys $^{-1}$.day^{-1}
Z_{39}	EXCR	54, 55, 58, 59, 60, 61, 62, 64, 65, 66, 69, 70, 71	g · ecsys $^{-1}$.day^{-1}
Z_{40}	SOLUTE	55, 56, 57, 62, 63, 66, 67, 68	g · ecsys $^{-1}$.day^{-1}
Z_{41}	C	60, 61, 113, 114	dimensionless
Z_{42}	ASSIT	72, 73, 74, 75, 76	g · ecsys $^{-1}$.day^{-1}
Z_{43}	RESP	77,78,79,80,81,82,83,84,85,86,87, 88,89,90,91,92,93,94,95	variable

Symbol	Fortran Equivalent	Equations were used	Units
Z_{44}	HATCH	96, 97, 98, 99, 100	g · g $^{-1}$
Z_{45}	HATCH	118, 119, 120	g · g $^{-1}$
Z_{46}	ANAVER	98	g · individual^{-1}
Z_{47}	CHANGE	100,101,102,103,104,105.108,109, 110,111,115,116,117	
Z_{48}	SHELLS	105,106,107,109,111,112,113,114, 116,117	g · ecsys $^{-1}$.day^{-1}
Z_{49}	CHANGE	120, 121, 122, 127, 128	
Z_{50}	CHELEM	122, 123, 124, 125, 126	
Z_{51}	DEAD	132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143	variable
Z_{52}	BEFAC1	150, 151	
Z_{53}	BEFAC2	151, 152, 153, 154, 155, 156	
Z_{54}	BEFAC5	152, 153, 154, 155, 156	

PROCESS DELETION

Just as the animal subroutine acts as a "black box" to other subroutines and the main program, actions within the subroutine act as "black boxes" to each other. The user may elect not to use some of these function, and this may be accomplished in two ways. One, a particular section may be left out of the program during compilation, or two, parameters or switches may be set to skip certain sections, or to predict a change of zero. The latter is by far the most useful, for the user may wish to change particular state variables by a process and not others, and a recompilation would not be necessary. Both methods will be treated. The numbers prefixed with an (A-) refer to the program sequence number (Appendix I).

PROCESS	PROGRAM SECTION
Ingestion Egestion Respiration Growth Assimilation	A0460 to A2145
Cohort transfer	A2150 to A2785
Non-predatory mortality	A2790 to A2955
Scouring and deposition	A2960 to A3095
Behavioral drift(1)	A3100 to A3265
Microbial decomposition	A3285 to A3940
Microbial scouring and deposition	A3945 to A4080

(1) Since behavioral drift depends upon ingestion, the first group must be utilized to have behavioral drift.

Switches and parameters should be set as follows to "set to zero" certain processes

PROCESS	PARAMETER	FORTRAN EQUIVALENT	SETTING
ANIMALS			
Ingestion	P_{25_h}	TAKE(H)	0
Egestion	P_{25_h}	TAKE(H)	0 or
	P_{27_h}	ASSIM(H)	1.
Respiration	P_{30_h}	CONST(H)	0
Assimilation	P_{27_h}	ASSIM(H)	0
Transfer to more mature cohort	P_{37_h}	NTRANS(H)	6
Oviposition	P_{46_h}	NTRANE(H)	4
Non-predatory mortality	P_{56_h}	AMORTA(H)	0
Catastrophic drift			
1. Scouring	P_{22_h}	ANDRF2(H)	1.
2. Deposition	P_{24_h}	ANDRF3(H)	1.
Behavioral drift	P_{43_h}	NDRIFA(H)	2
MICROORGANISMS			
"Ingestion"	$P_{7_{md}}$	PREFRF(M,D)	
	$P_{8_{md}}$	PREFRB(M,D)	0
	$P_{9_{md}}$	PREFQW(M,D)	
Respiration	$P_{14_{md}}$	RESPM(M)	0
Assimilation	$P_{15_{md}}$	ASSIMH(M)	0
Leakage	$P_{14_{md}}+P_{15_{md}}$	RESPM(M) + ASSIMH(M)	1.
Scouring	P_{17_m}	BDRF2(M)	1.
Deposition	P_{20_m}	BDRF3(M)	1.

ARRAY DIMENSIONS

The use of the program is limited by the dimensions allocated to the arrays, and these limitations need discussion so that the user may be in a position to modify them as his particular requirements indicate. Below is a list of arrays peculiar to the ANIMAL submodel, in which the dimensions which may appropriately be varied are indicated by letters.

ACCUM(a)
AMAX(a)
AMORTA(a)
ANDRF2(a)
ANDRF3(a)
ANIHI(a)
ANILO(a)
ASSIMH(d)
BACTHI(d)
BACTLO(d)
BDRF2(d)
BDRF3(d)
BEFAC3(a)
BEFAC4(a)
CONS(d)
CONSA(c)
CONST(a)
CURVE(a)
EGCOMP(c,b)
EXOGEN(c)
FEDFRM(a)
FEEDA(a)
FEEDAD(a)
FEEDL(f)
FEEDM(d)
FEEDO(f)
FEEDRB(d)
FEEDRF(d)
FEEDV(e)
FOOD(a,b)
HATCOB(a)
HATCON(a)
IAFATE(a)
ISFATE(a)
IXFATE(a)
LIVEAN(a)
NLAY1(c)
NLAY2(c)
NTRANE(a)
NTRANS(a)
PREFA(a,a)
PREFL(a,f)
PREFM(a,d)
PREFO(a,f)
PREFRB(d,f)
PREFRF(d,f)
PREFRW(d)
PREFV(a,e)
RCONST(c)
REPROD(a)
RESPM(d)
SHELP(a)
SLOPE(a)
TAKE(a)
TEMCON(a)
THRESH(a)
THRES2(a)
TMAX(a)
TOPT(a)
UPTHRE(c)
WMAX(a)
WMIN(a)
XCRSOL(a)

The dimensions indicated by letters define the maximum values possible for the following quantities.

		FORTRAN NAME
a	Number of animal cohorts or size categories	NCOHOR
b	Number of organic constituents being tracked	NFRELM
c	Number of animal species	NSPECA
d	Number of microorganism categories	MICROB
e	Number of plant species	NSPECV
f	Number of organic litter categories	NOLIT

PARAMETERS AND SWITCHES

A list of all the parameters and switches needed for the ANIMAL subroutine follows. Explanations can be found in the definitions list, Appendix A. Letters used for dimensions are explained above under Array Dimensions

ACCUM(a)
ALLMAC
AMAX(a)
AMORTA(a)
ANDRF2(a)
ANDRF3(a)
ANIHI(a)
ANILO(a)
ASSIM(a)
ASSIMH(d)
BACTHI(d)
BACTLO(d)
BDRF2(d)
BDRF3(d)
BEFAC3(a)
BEFAC4(a)

CONS(d)
CONSA(c)
CONST(a)
CONTA
CONTB
CONTC
CURVE(a)
EGGCOMP(c,b)
EXOGEN(c)
FEDFRM(a)

HATCOB(a)
HATCON(a)

IAFATE(a)
ISFATE(a)
IXFATE(a)
LIVEAN(a)

NDRIFA(a)
NDRIFM(d)
NLAY1 (c)
NLAY2(c)
NTRANE(a)
NTRANS(a)

PREFA(a,a)
PREFL(a,f)
PREFM(a,d)
PREFO(a,f)
PREFRB(d,f)
PREFRF(d,f)
PREFRW(d)
PREFV(a,e)

RCONST(c)
REPROD(a)
RESPM(d)

SHELP(a)
SLOPE(a)

TAKE(a)
TEMCON(a)
THRESH(a)
THRES2(a)
TMAX(a)
TOPT(a)
UPTHRE(c)
WMAX(a)
WMIN(a)
XCRSOL(a)

SUBROUTINE VEGET

INTRODUCTION

All processes concerning a change in the biomass of vegetation are handled by the subprogram VEGET, except herbivory and those changes in phytoplankton due to flow. At present these processes include photosynthesis, respiration, death, leakage, scouring, and colonization. All materials leaving the ecosystem also are tracked.

For a generalized model flow chart of the plant processes, refer to Diagram V1. A listing of this submodel can be found in Appendix J.

VERBAL DESCRIPTION

Photosynthesis depends above all on the radiation reaching the plant. The mean radiation intensity at the water surface for the daylight hours is an exogenous variable, with this intensity being scaled down to the average depth of a particular plant group. Attenuation of the radiation is due to absorption by the water column, dissolved organic and inorganic constitutents, organic and inorganic detritus, and any plant at an average depth shallower than the plant under consideration. Self-shading is also provided for, with half the biomass of the same species (or any other species at the same depth) being included in the shading material. The attenuation occurs as an exponential decay function as shown in Figure V1.

Besides the radiation, photosynthesis also is affected by temperature (an exogenous variable), the amount of space available for a plant group, and by the availability within the plant of nutrients needed to convert photosynthate into new cell materials. The temperature effect is assumed to be parabolic (Figure V2). The internal availability of nutrients is expressed as the ratio of the amount of each nutrient in the plant tissue to its carbon content, and it is assumed that the dependence of photosynthesis on this quantity is exponential (Figure V3). Its dependence on radiation intensity follows the curve shown in Figure V4. The rate of photosynthesis realized is thus calculated by multiplying the product of the quantities indicated in the preceding sentences by the photoperiod, and by subtracting respiration which is exponentially dependent on temperature.

All constants in these expressions are special to each plant group included as a separate entity in the model. Photosynthesis will take place only to the extent that the requisite inorganic constituents are available in the surrounding water (Figures V5 and V6). The rate at which nutrients are taken up to "match" the photosynthesis is proportional to the difference between the internal concentration and that which would be in equilibrium with the existing external concentration; if the external supply is constantly renewed, then the internal concentration will be asymptotic to this equilibrium value.

The demands by the various plant groups for all nutrients from the surroundings are summed, and compared with the amounts available. If any is inadequate, photosynthesis is scaled down by all plants in such proportion as allowed by the limiting nutrient.

Plants dying in the ecosystem do so as a function of temperature (Figure V7) and as a constant for each particular plant group. The dead material increments any of the benthic or suspended litter categories, as specified by the user at execution time. Those plants dying as a function of temperature do so only down to a propagule biomass, which is a proportion of the maximum amount of that plant occurring during the previous year.

Plants also leak organic solutes to the surrounding water, at a rate which is constant for each plant group but may vary from group to group.

Those plants that are considered sessile in the ecosystem, whether they are attached algae or rooted angiosperms, may colonize an area at certain times or may be washed out of an area at other times. Colonization occurs between specified days of the year, but only if the water velocity is below a critical value. On these occasions a set fraction of the plants drifting into the ecosystem are allowed to colonize the area. When the water velocity is above a critical value, plants are "uprooted" and washed out of the system according to Figure V8. If the plants are uprooted between "colonization" days as specified above, then a proportion of the plants leaving the system remain viable (see Figure V9). The rest of the "uprooted" plant enters the suspended detritus and is washed out of the system. Viable plant parts may also leave the system at a constant proportion between specified dates.

Finally, all materials leaving the ecosystem are tracked. This is a bookkeeping step and is in the VEGET submodel only because it is the last submodel referenced for each time period. This step is taken since the model strives to maintain a conservation of matter and energy, and also because the materials leaving through the downstream channel may be saved and used as input for the next simulated stream section.

Water leaving the system does so at present by three different ways: evaporation, which is handled in another subprogram with no loss of any constituents, and by flow either downstream or by way of irrigation. Any dissolved or planktonic materials also leave the ecosystem by these latter two channels, in the same ratio as exiting water. Any suspended particulate material may leave the same way, or at the option of the user may exit completely through one channel or the other.

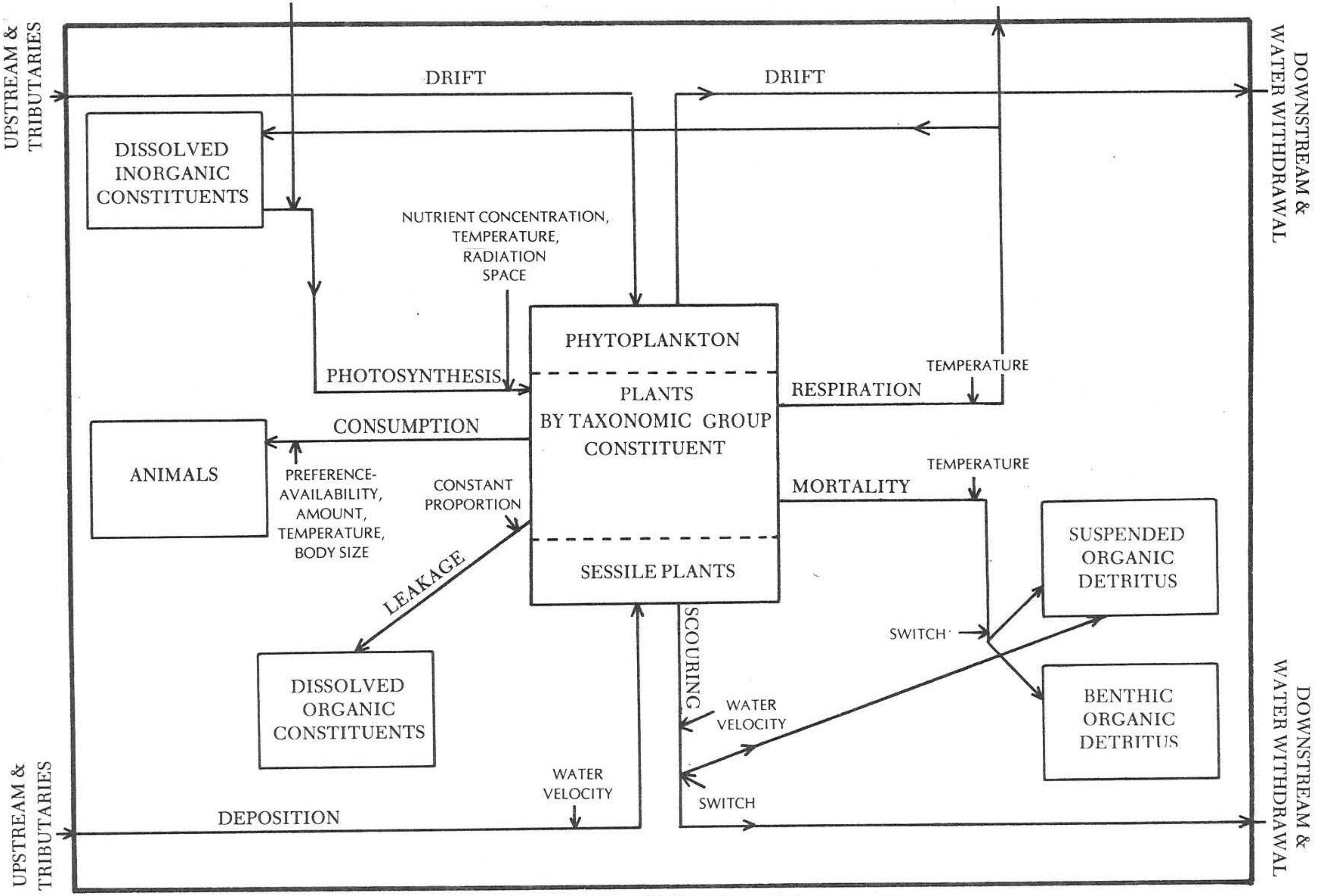

Diagram V 1. Generalized model flow chart of plant processes.

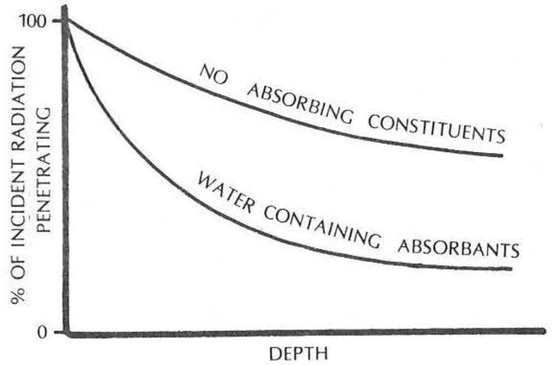

Figure V1. Relation between water column depth and radiation intensity reaching submerged plants.

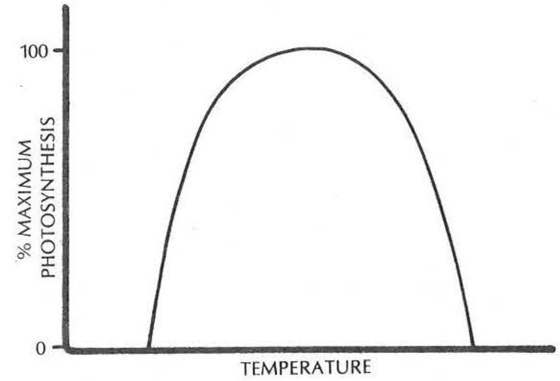

Figure V2. Relation between temperature and photosynthetic rate.

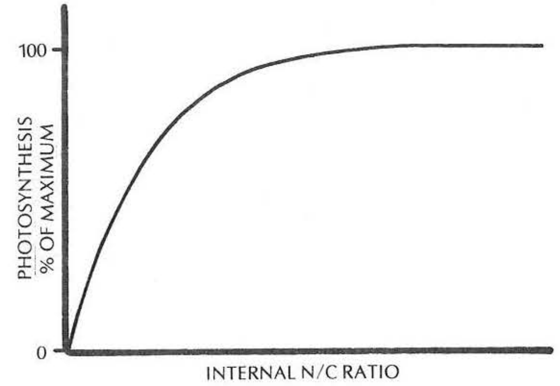

Figure V3. Photosynthetic rate as affected by plant nutrient status.

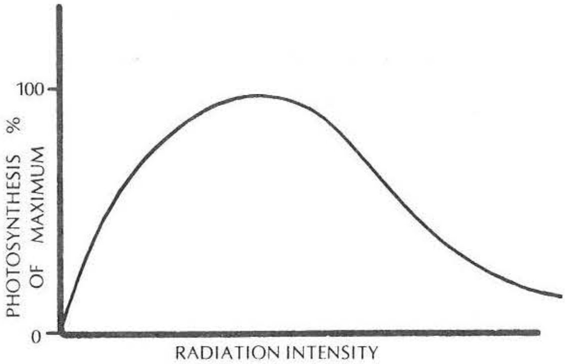

Figure V4. Photosynthetic rate as a function of radiation intensity.

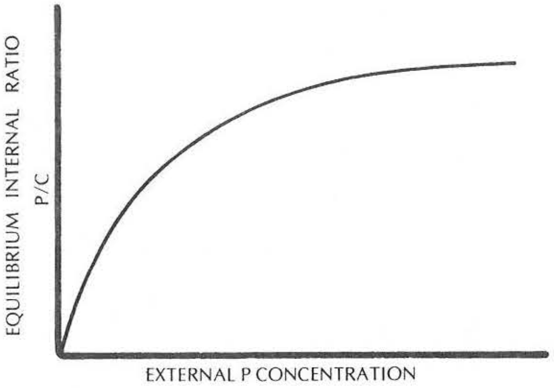

Figure V5. Change in equilibrium of internal phosphorus/carbon ratio as P concentration increases in medium.

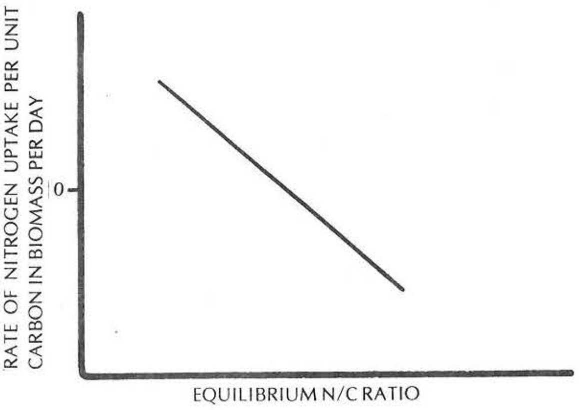

Figure V6. Rate of nitrogen uptake in relation to nitrogen/carbon ratio in the tissue and the medium.

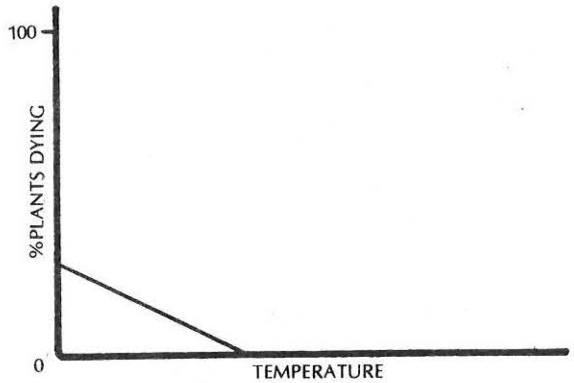

Figure V7. Percent of plants dying as a function of temperature.

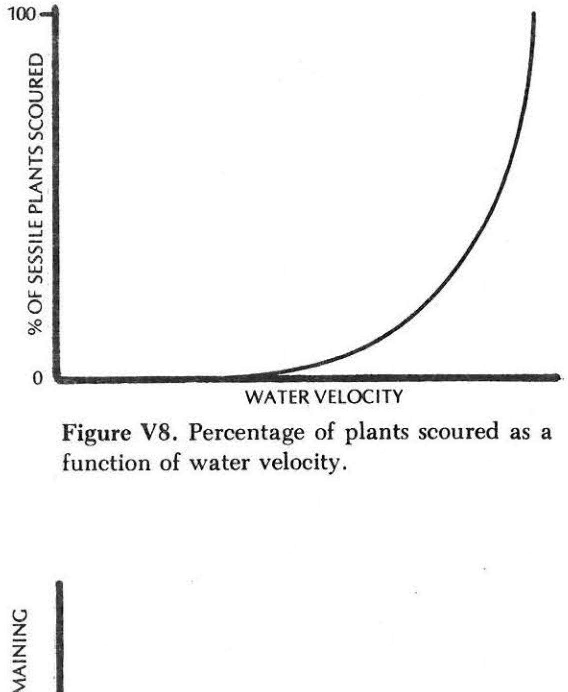

Figure V8. Percentage of plants scoured as a function of water velocity.

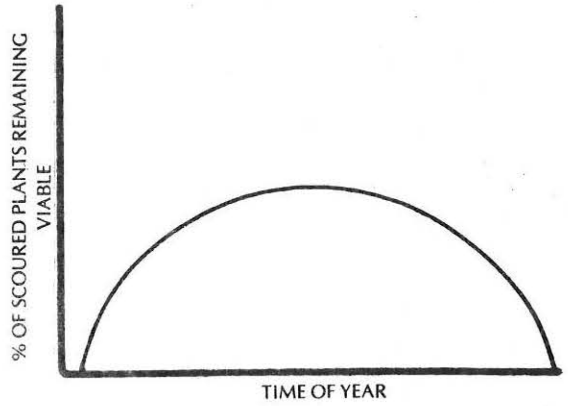

Figure V9. Percentage of scoured plants remaining viable.

MATHEMATICAL DESCRIPTION

The equations described here follow the order in the program itself, except where a particular "thought train" or process is being developed. The equations are numbered at the right side of the page, while the numbers in brackets preceded by a "VE" refer to the actual FORTRAN program equivalent in Appendix J. The names in brackets for the variable explanations are their FORTRAN equivalents. At the end of the mathematical description is a table listing the symbols, their FORTRAN equivalents, all equations where that symbol is used as well as the units for that variable. The classification as to types of symbols used for variables is explained in the MAIN Introduction.

Photosynthesis

Photosynthesis and growth by the various groups of plants are first calculated on the assumption that raw materials in the system are adequate to cover all needs. The total requirements are then compared with supplies, and if necessary, the actual growth and photosynthesis are scaled down from these potential figures.

Photosynthesis is dependent on the amount of light reaching the average depth that a particular plant species occurs. The light incident upon the surface of the water is cut down by organic and inorganic detritus, dissolved material, the water column itself, as well as any plant occurring at the same depth or above the plant in question.

$$Z_1 = \sum_k X_{51_k} + \sum_c X_{31_c} \qquad [VE0425] \quad 1$$

$$Z_2 = \sum_t \sum_n X_{61_{tn}} \qquad [VE0455] \quad 2$$

$$Z_3 = \sum_d X_{41_{d1}} \qquad [VE0470] \quad 3$$

$$Z_4 = \sum_{p \in A} X_{1_{p1,1}} + .5 \sum_{p \in B} X_{1_{p1,1}} \qquad [VE0635] \quad 4$$

$$Z_5 = V_{78} \exp -[(P_1 Z_4 + P_2 Z_2 + P_3 Z_3 + P_4 Z_1 + P_5)P_{6_p} X_{74}] \qquad [VE0685] \quad 5$$

where:

Z_1 = Amount of solutes per cubic meter [DISOLV]
X_{51_k} = The amount of the *k*'th dissolved inorganic constituent in the water column [WDINR(K)]
X_{31_c} = The amount of the *c*'th organic constituent in the water column [AQUA(C)]
Z_2 = Amount of suspended sediments per cubic meter [SED]
$X_{61_{tn}}$ = Amount of the *n*'th inorganic particulate material of the *t*'th type of detritus in the water column [WPINR(T,N)]
Z_3 = Amount of carbon in all organic litter categories per cubic meter [DETRI]
$X_{41_{d1}}$ = The amount of carbon in the *d*'th suspended litter category [CLIT(D,1)]

Z_4 = The amount of carbon in plants occurring at an average depth above the plant in question ($p \varepsilon A$) plus half the carbon in plants at the same average depth ($p \varepsilon B$) [A]
$X_{1_{p1,1}}$ = The carbon content of the *p*'th plant [CVEG(P,1,1)]
Z_5 = The amount of radiation reaching the plant in question [RADIA]
V_{78} = The amount of radiation incident upon the water surface [DAYRAD]
P_1 = Extinction coefficient for plants [EXTINP]
P_2 = Extinction coefficient for sediments [EXTINS]
P_3 = Extinction coefficient for organic detritus [EXTIND]
P_4 = Extinction coefficient for dissolved substances [EXTIND]
P_5 = Extinction coefficient for water [*EXTINW*)
P_{6_p} = The fraction of depth where the average *p*'th plant would be found [PLDEP(P)]
X_{74} = Water depth [DEPTH]

The actual factor used for light dependence of photosynthesis is based on the ratio of the amount of light available to the amount of light for maximum photosynthesis for the plant in question.

$$Z_6 = Z_5/P_{7_p} \qquad \text{[VE0705]} \quad 6$$

where:

Z_6 = A temporary variable for light dependence of photosynthesis [B]
Z_5 = The amount of radiation reaching the plant in question [RADIA]
P_{7_p} = Radiation intensity for maximum photosynthesis of the *p*'th plant [CONRAD(P)]

The ratio of nutrients to carbon also affects the photosynthetic rate. For the plant in question the factor is calculated as

$$Z_7 = \prod_{c \varepsilon D} \{1. - \exp(P_{8_{pc}} - P_{9_{pc}} X_{1_{p1c}} / X_{1_{p1,1}})\}$$

[VE0745, VE0725] 7

where:

Z_7 = Temporary factor of the affect of nutrients to carbon on the photosynthetic rate [A]
D = The set of nutrients affecting photosynthesis (minus carbon)
$P_{8_{pc}}$ = Constant for photosynthesis reduction when the *c*'th constituent is absent for the *p*'th plant [CONNI2(P,C)]
$P_{9_{pc}}$ = Proportionality constant for the effect of the *c*'th constituent on the rate of photosynthesis of the *p*'th plant group [CONNIT(P,C)]
$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group [CVEG(P,1,C)]
$X_{1_{p1,1}}$ = The carbon content of the *p*'th plant [CVEG(P,1,1)]

Light and nutrient factors are then taken into consideration with temperature in calculating a possible maximum gross photosynthesis for the plant group under consideration.

$$Z_8 = Z_6 \exp(1. - Z_6) Z_7 (P_{10} + P_{11} X_{72} + P_{12} X_{72} X_{72})$$

[VE0765] 8

where:

Z_8 = Maximum possible gross photosynthesis as a fraction of the current biomass per hour [A]
Z_6 = A temporary variable for light dependence of photosynthesis [B]
Z_7 = A temporary factor of the effect of nutrients to carbon on the photosynthetic rate [A]
P_{10_p} = Constant term for photosynthesis dependence on temperature [CONTE1(P)]
P_{11_p} = Linear term for photosynthesis dependence on temperature [CONTE2(P)]
P_{12_p} = Quadratic term for photosynthesis dependence on temperature [CONTE3(P)]
X_{72} = Water temperature [WTEMP]

Daily respiration for the plant group under consideration is calculated as a fraction of the current biomass.

$$Z_9 = P_{42_{pt}} P_{13_p} \exp(P_{14_p} X_{72}) \qquad \text{[VE0775]} \quad 9$$

where:

Z_9 = [RESPV]
P_{13_p} = Proportional respiration rate of the *p*'th plant at zero temperature [RESPC(P)]
P_{14_p} = Proportional increase in respiration with an increase in temperature [RESPD(P)]
X_{72} = Water temperature [WTEMP]

Constituent requirements for carbon and energy are calculated, and decreased as a function of the space in which the plants may grow.

$$Z_{10_{p1}} = X_{1_{p,1,1}} V_{77} Z_8 - Z_9 \qquad \text{[VE0780]} \quad 10$$
$$Z_{23} = 1. \exp(P_{41_p} X_{1_{p1,1}} / X_{81}) \qquad \text{[VE0785]} \quad 11$$
$$Z_{10_{p1}} = Z_{10_{p1}} Z_{23} \qquad \text{[VE0790]} \quad 12$$
$$Z_{10_{p2}} = P_{15} Z_{10_{p1}} \qquad \text{[VE0805]} \quad 13$$
$$Z_{11_1} = \sum_p Z_{10_{p1}} \qquad \text{[VE0815]} \quad 14$$

where:

$Z_{10_{p1}}$ = The carbon requirement of the *p*'th plant group [SPREQ((P,1)]
V_{77} = Daily photoperiod in hours [DAPHOT]

$Z_{11_{p2}}$ = The energy requirement of the p'th plant group [SPREQ(P,2)]
P_{15} = The amount of energy captured for each gram of carbon converted during photosynthesis [ENERGY]
Z_{11} = Total carbon requirement for all plants [REQ(1)]
P_{41_p} = A factor used to calculate photosynthesis reduction of the p'th plant due to space limitations [VSPAS(P)]
X_{81} = The surface area of the ecosystem
$X_{1_{p1,1}}$ = The carbon content of the p'th plant [CVEG(P,1,1)]
Z_8 = Maximum possible gross photosynthesis as a fraction of the current biomass per hour [A]
Z_9 = Respiration of the plant in question [RESPV]

If photosynthesis is dependent on other constituents for growth (if NFRELM is greater than 2) requirements for these components are calculated.

$$Z_{12} = X_{1_{p1c}}/(X_{1_{p1,1}} + Z_{10_{p1}}) \qquad \text{[VE0845]} \quad 15$$

$$Z_{13} = P_{16_{pc}}[1. - \exp\{P_{17_{pc}} X_{51_k}/({}_{75} *1000000.)\}] \qquad \text{[VE0850]} \quad 16$$

$$Z_{10_{pc}} = P_{18_{pc}}(X_{1_{p1c}} + Z_{10_{p1}})(Z_{13} - Z_{12}) \qquad \text{[VE0855]} \quad 17$$

$$Z_{11_c} = \sum_p Z_{10_{pc}} \qquad c > 2$$

where:

Z_{12} = The ratio of a constituent to carbon of the plant currently under consideration [AINTER]
Z_{13} = The ratio of an element within the plant to carbon, which would be in equilibrium with the current external concentration of that element [EQVIL]
$X_{1_{p1c}}$ = The amount of the c'th constituent of the p'th plant group [CVEG(P,1,C)]
$X_{1_{p1,1}}$ = The carbon content of the p'th plant [CVEG(P,1,1)]
$Z_{10_{p1}}$ = The carbon requirement of the p'th plant group [SPREQ(P,1)]
$P_{16_{pc}}$ = The maximum value for the ratio of the c'th constituent to carbon for the p'th plant group [UPCON1(P,C)]
$P_{17_{pc}}$ = Factor relating internal to external concentration of the c'th constituent of the p'th plant group [UPCON2(P,C)]
X_{75} = The amount of water in the ecosystem [WATSYS]
$Z_{10_{pc}}$ = Requirement of the c'th constituent for the p'th plant group for photosynthesis [SPREQ(P,C)]
$P_{18_{pc}}$ = Parameter used for nutrient uptake of the c'th constituent by the p'th plant group [UPCON(P,C)]

Z_{11_c} = Total requirement of the c'th constituent by all plants [REQ(C)]
X_{51_k} = The amount of the k'th dissolved inorganic constitutent in the water column [WDINR(K)]
$Z_{10_{p1}}$ = The carbon requirement of the p'th plant group [SPREQ(P,1)]

Total requirement for a particular constituent is then checked against the availability of that constituent and if the supply is found short, all requirements are decreased proportionally.

$$Z_{14} = \min\ (V_{51_k} + X_{51_k})/Z_{11_c} \qquad c \neq 2 \qquad \text{[VE0955]} \quad 19$$

$$Z_{15} = Z_{14}\ Z_{10_{p,c}} \qquad \text{for } Z_{12} < 1 \qquad \text{[VE1025]} \quad 20$$

where:

Z_{14} = The ratio of the element required to that available which is in least supply [AA]
V_{51_k} = The amount of the k'th inorganic element entering the system in a time unit [XDNORG(K)]
Z_{15} = The amount of an element for a plant which are both currently under consideration which is actually used in photosynthesis [B]
X_{51_k} = The amount of the k'th dissolved inorganic constituent in the water column [WOINR(K)]
Z_{11_c} = Total requirement of the c'th constituent by all plants [REQ(C)]
$Z_{10_{pc}}$ = Requirement of the c'th constituent for the p'th plant group for photosynthesis [SPREQ(P,C)]

Appropriate variables are incremented or decremented

$$Z_{24} = (Z_{19} - 1)/Z_{19} \qquad \text{[VE0990]} \quad 21$$

$$_N\dot{X}_{6_{p1c}} = Z_{15} \qquad \text{[VE1045]} \quad 22$$

$$_N\dot{Y}_{51_k} = -Z_{15}\ Z_{24} \qquad c \neq 2 \qquad \text{[VE1060]} \quad 23$$

$$_N\dot{Y}_{1_{p1c}} = Z_{15}\ Z_{24} \qquad P_{25_p} = 1 \qquad \text{[VE1070]} \quad 24$$

$$_N\dot{X}_{1_{p1c}} = B(1-Z_{24}) \qquad P_{25_p} = 1 \qquad \text{[VE1075]} \quad 25$$

$$_N\dot{X}_{1_{p1c}} = Z_{15} \qquad P_{25_p} = 2 \qquad \text{[VE1085]} \quad 26$$

$$_N\dot{X}_{51_k} = -Z_{15}(1-Z_{24}) \qquad c \neq 2 \qquad \text{[VE1090]} \quad 27$$

$$_N\dot{X}_{01_{13,c}} = Z_{15} \qquad c \neq 2 \qquad \text{[VE1095]} \quad 28$$

$$_N\dot{X}_{03_{13K}} = -Z_{15} \qquad c \neq 2 \qquad \text{[VE1100]} \quad 29$$

$$_N\dot{X}_{01_{1,2}} = Z_{15} \qquad \text{for } Z_{15} > 0 \qquad \text{[VE1110]} \quad 30$$

$$_N\dot{X}_{01_{2,2}} = Z_{15} \qquad \text{for } Z_{15} < 0 \qquad \text{[VE1110]} \quad 31$$

where:

Z_{24} = The ratio of water in to that passing through the system [C]

Z_{19} = The number of turnovers of water minus 1 [CYCLE]
${}_{N}\dot{X}_{6_{p1c}}$ = Productivity for the *c*'th constituent for the *p*'th plant species [CVEGP(P,1,C)]

And the fluxes are caused by photosynthesis

${}_{N}\dot{Y}_{51_k}$ = Change in the *k*'th dissolved inorganic constituent leaving the system [DNORG(K)]
${}_{N}\dot{Y}_{1_{p,1,c}}$ = Change in plants drifting out of the system [DRIFTV(P,1,C)]
${}_{N}\dot{X}_{1_{p,1,c}}$ = Change in plants in the system [CVEGQQ(P,1,C)]
${}_{N}\dot{X}_{51_k}$ = Change in the *k*'th dissolved inorganic constituent in the system [WDINRQ(K)]
${}_{N}\dot{X}_{01_{13,c}}$ = Change of state of the *c*'th constituent [AGAINQ(13,C)]
${}_{N}\dot{X}_{03_{13,k}}$ = Change of state of the *k*'th constituent [AGAINQ(13,K)]
${}_{N}\dot{X}_{01_{1,2}}$ = Energy as radiation entering the system and being used in photosynthesis [AGAINQ(1,2)]
${}_{N}\dot{X}_{01_{2,2}}$ = Energy as heat lost to the system [AGAINQ(2,2)]
Z_{15} = The amount of an element actually used in photosynthesis by a plant which is currently under consideration [B]
P_{25_p} = 1 for phytoplankton and 2 for sessile plants [NDRIFV(P)]

Plant Mortality

Each plant species has a daily mortality factor associated with it. In addition, plants may die because of low temperatures, until a "seed" biomass is reached, which is considered to be a specified fraction of the years greatest biomass.

$Z_{16_p} = \max(Z_{16_p}, X_{1_{p1,1}} P_{19_p})$ [VE1175] 32
$Z_{17} = P_{20_p} X_{72} + P_{21_p}$ [VE1225] 33
$Z_{18} = (P_{22_p}/Z_{19}) V_{1_{p1c}} + (Z_{17}/Z_{19}) V_{1_{p1c}}$ [VE1235] 34
${}_{H}\dot{Y}_{1_{p1c}} = -Z_{18}$ [VE1240] 35
${}_{H}\dot{Y}_{41_{dc}} = Z_{18}$ for $P_{23_p} \leq P_{24}$ [VE1245] 36
${}_{H}\dot{X}_{43_{dc}} = Z_{18}$ for $P_{23_p} > P_{24}$ [VE1250] 37
$Z_{20} = P_{22_p}/Z_{19}$ for $P_{25_p} = 1$ [VE1255] 38
$Z_{17} = Z_{17}/Z_{19}$ for $P_{25_p} = 1$ [VE1260] 39
$Z_{18} = Z_{20} X_{1_{p1c}} + Z_{17} X_{1_{p1c}}$ [VE1265] 40
${}_{H}\dot{X}_{1_{p1c}} = -Z_{18}$ [VE1270] 41
${}_{H}\dot{X}_{41_{dc}} = Z_{18}$ for $P_{25_p} = 1$ and $P_{23_p} \leq P_{24}$ [VE1280] 42
${}_{H}\dot{X}_{43_{dc}} = Z_{18}$ for $P_{25_p} = 1$ and $P_{23_p} > P_{24}$ [VE1285] 43
${}_{H}\dot{X}_{43_{dc}} = Z_{18}$ for $P_{25_p} = 1$ and $P_{23_p} > P_{24}$ [VE1295] 44
${}_{H}\dot{Y}_{41_{dc}} = Z_{18}(Z_{19}-1)/Z_{19}$ for $P_{25_p} = 1$ and $P_{23_p} \leq P_{24}$ [VE1300] 45
${}_{H}\dot{X}_{41_{dc}} = Z_{18}\{1-(Z_{19}-1)/Z_{19}\}$ for $P_{25_p} = 2$ and $P_{23_p} \leq P_{24}$ [VE1305] 46

where:

Z_{16_p} = The amount of carbon in the *p*'th plant species that is seed [SEED(P)]
P_{19_p} = The proportion of the *p*'th plant at maximum biomass which overwinters (seed) [PERSED(P)]
Z_{17} = The fraction of the plant in question which dies as a function of temperature [DEADT]
P_{20_p} = The slope of the line predicting the proportion of the *p*'th plant dying as a function of temperature [VTDEDS(P)]
$X_{1_{p1,1}}$ = The carbon content of the *p*'th plant [CVEG(P,1,1)]
P_{21_p} = The proportion of the *p*'th plant species dying at 0 degrees centigrade [VTDEDY(P)]
Z_{18} = Total amount of the plant and constituent in question dying in a time period [ALLDED]
Z_{19} = The number of turnovers of water in the ecosystem in a day [CYCLE]
P_{23_p} = The fate of the *p*'th plant species after death [IVFATE(P)]
P_{24} = The number of litter categories in the system [NOLIT]
P_{25_p} = 1 for phytoplankton and 2 for sessile plants [NDRIFV(P)]

The fluxes are due to plants dying

${}_{H}\dot{Y}_{1_{p1c}}$ = Plants drifting out of the system DRIFTV(P,1,C)]
${}_{H}\dot{Y}_{41_{dc}}$ = Detritus drifting out of the system [DETIN(D,C)]
${}_{H}\dot{X}_{43_{dc}}$ = Benthic detritus in the system [CORGQQ(D,C)]
${}_{H}\dot{X}_{1_{p1c}}$ = Plants in the system [CVEGQQ(P,1,C)]
${}_{H}\dot{X}_{41_{dc}}$ = Suspended detritus in the system [CLITQQ(D,C)]
X_{72} = Water temperature [WTEMP]
$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group [CVEG(P,1,C)]

Leakage

Any of the plants in the ecosystem may leak solutes.

$Z_{21} = P_{26}/Z_{19}$ [VE1355] 47
${}_{L}\dot{Y}_{1_{p1c}} = -Z_{21} V_{1_{p1c}}$ [VE1360] 48
${}_{L}\dot{Y}_{31_c} = Z_{21} V_{1_{p1c}}$ [VE1365] 49
$Z_{21} = P_{26_p}$ for $P_{25_p} = 2$ [VE1370] 50
${}_{L}\dot{X}_{1_{p1c}} = -Z_{21} X_{1_{p1c}}$ [VE1375] 51
${}_{L}\dot{X}_{31_c} = Z_{21} X_{1_{p1c}}$ for $P_{25_p} = 1$ [VE1380] 52
$Z_{21} = Z_{21} X_{1_{p1c}}/Z_{22}$ for $P_{25_p} = 2$ [VE1390] 53
${}_{L}\dot{Y}_{31_c} = Z_{21}(Z_{22} - X_{75})$ for $P_{25_p} = 2$ [VE1395] 54
${}_{L}\dot{X}_{31_c} = Z_{21} X_{75}$ for $P_{25_p} = 2$ [VE1400] 55

where:

Z_{21} = The amount of the constituent in question leaked from the plant in question [ALEAK)]
P_{26_p} = The proportion of the *p*'th plant which is leaked in a time unit [SIEVEG(P)]
$V_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant entering the ecosystem [XDRIFV(P,1,C)]
Z_{22} = The total amount of water in or passing through the ecosystem in a day [WATTOT]

The fluxes may be ascribed to changes to plant leakage

Z_{19} = The number of turnovers of water minus 1 [CYCLE]
$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group [CVEG(P,1,C)]
X_{75} = The amount of water in the ecosystem [WATSYS]
P_{25_p} = 1 for phytoplankton and 2 for sessile plants [NDRIFV(P)]
${}_L\dot{Y}_{1_{p1c}}$ = Plants drifting out of the system [DRIFTV(P,1,C)]
${}_L\dot{Y}_{31_c}$ = Dissolved organics leaving the system [COMPIN(C)]
${}_L\dot{X}_{1_{p1c}}$ = Plants in the system [CVEGQQ(P,1,C)]
${}_L\dot{X}_{31_c}$ = Dissolved organics in the system [AQUAQQ(C)]

Scouring and Colonization

Plants that are normally sessile in the system may be scoured by high water velocities, or they may colonize by seed deposition between specified dates.

$$Z_{25} = \min[1., \max\{0., P_{27_p}{}^{X_{73}} - P_{27_p}{}^{P_{28_p}}\}] \qquad \text{[VE1490]} \quad 56$$

$$Z_{26} = Z_{25}\, X_{1_{p1c}} \qquad \text{[VE1495]} \quad 57$$

$$Z_{27} = P_{31_p}\, X_{1_{p1c}} \quad \text{for } P_{33} \geq P_{29_p} \text{ and } P_{33} \leq P_{30_p} \qquad \text{[VE1500]} \quad 58$$

$$Z_{28} = \{P_{32_p}{}^2 - [\{(P_{33} - P_{34_p})2P_{32_p}/(P_{35_p} - P_{34_p})\} - P_{32_p}]^2\}^{.5} \qquad \text{[VE1515]} \quad 59$$

$$Z_{29} = \min[X_{1_{p1c}}, \{(Z_{26}\, Z_{28}) + Z_{27}\}] \qquad \text{[VE1540]} \quad 60$$

$$Z_{30} = Z_{26} - (Z_{26}\, Z_{28}) \qquad \text{[VE1545]} \quad 61$$

$$Z_{31} = Z_{30}/Z_{22} \qquad \text{[VE1550]} \quad 62$$

$$Z_{32} = P_{36_p}\, V_{1_{p1c}} \quad \text{for } P_{28_p} < X_{73} \qquad \text{[VE1565]} \quad 63$$

$${}_F\dot{Y}_{1_{p1c}} = -Z_{32} + Z_{29} \qquad \text{[VE1570]} \quad 64$$

$${}_F\dot{X}_{1_{p1c}} = -Z_{30} - Z_{29} + Z_{32} \qquad \text{[VE1575]} \quad 65$$

$${}_F\dot{Y}_{41_{dc}} = Z_{31}\,(Z_{22} - X_{75}) \qquad \text{[VE1585]} \quad 66$$

$${}_F\dot{X}_{41_{dc}} = Z_{31}\, X_{75} \qquad \text{[VE1590]} \quad 67$$

where:

Z_{25} = A proportion of the plant in question washed out of the system due to high-water velocity [VDRFI]
X_{73} = The water velocity in meters per second [VELOCT]
P_{28_p} = The water velocity above which the *p*'th plant starts to wash away [VDRF3(P)]
Z_{26} = The actual amount of the constituent in question being washed out of the system due to high water velocities [VDRF4]
P_{33} = The current Julian day [IYRDAY]
P_{29_p} and P_{30_p} = The first and last Julian days for seed dispersal for the *p*'th plant group [NVDAYI(P), NVDAY2(P)]
Z_{27} = The amount of seed washed out of the system for the constituent and plant under consideration [VDRF6]
Z_{30} = The proportion of uprooted plants dying and entering litter compartments [CDRF13]
P_{31_p} = The proportion of the *p*'th plant remaining viable if washed out of the ecosystem [VDRF11(P)]
P_{34_p} and P_{35_p} = The first and last Julian day that parts of plants remain viable if washed out of the system [NVDRF8(P), NVDRF9(P)]
X_{75} = The amount of water in the ecosystem in cubic meters [WATSYS] and the fluxes are ascribed to plant drift
${}_F\dot{X}_{1_{p1c}}$ = Plants in the system [CVEGQQ(P,1,C)]
${}_F\dot{Y}_{1_{p1c}}$ = Plants leaving the system [DRIFTV(P,1,C)]
${}_F\dot{Y}_{41_{dc}}$ = Litter leaving the system [DETIN(D,C)]
${}_F\dot{X}_{41_{dc}}$ = Litter in the system [CLITQQ(D,C)]
Z_{28} = The proportion of uprooted plants remaining viable [VDRF6]
$X_{1_{p1c}}$ = The amount of the *c*'th constituent of the *p*'th plant group [CVEG(P,1,C)]

The following section is in the VEGET subroutine solely because this is the last subroutine entered during a time step. It deals with all materials leaving the ecosystem as downstream drift, or through irrigation. Any dissolved or planktonic material leaves by way of both pathways in the same proportion as flowing water. The user has the option of whether non-planktonic material exits by way of downstream, irrigation withdrawal or both. In addition, values representing downstream flowing materials are converted to grams per cubic meter in preparation for their use if more than one stream section is to be simulated.

$$Z_{33} = Y_{86}/(Y_{86} + Y_{80}) \qquad \text{[VE1625]} \tag{68}$$

$$Z_{34} = Y_{80}/(Y_{86} + Y_{80}) \qquad \text{[VE1630]} \tag{69}$$

$$Z_{35} = Y_{86} + Y_{80} \qquad \text{[VE1635]} \tag{70}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{31_c} Z_{33} \qquad \text{[VE1655]} \tag{71}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{31_c} Z_{34} \qquad \text{[VE1660]} \tag{72}$$

$$Y_{31_c} = Y_{31_c}/Z_{35} \qquad \text{[VE1665]} \tag{73}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{41_{dc}} Z_{33} \qquad \text{for } P_{37_d} = 1 \qquad \text{[VE1690]} \tag{74}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{41_{dc}} Z_{34} \qquad \text{for } P_{37_d} = 1 \qquad \text{[VE1695]} \tag{75}$$

$$Y_{41_{dc}} = Y_{41_{dc}}/Z_{35} \qquad \text{for } P_{37_d} = 1 \qquad \text{[VE1700]} \tag{76}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{41_{dc}} \qquad \text{for } P_{37_d} = 2 \qquad \text{[VE1710]} \tag{77}$$

$$Y_{41_{dc}} = 0 \qquad \text{for } P_{37_d} = 2 \qquad \text{[VE1715]} \tag{78}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{41_{dc}} \qquad \text{for } P_{37_d} = 3 \qquad \text{[VE1725]} \tag{79}$$

$$Y_{41_{dc}} = Y_{41_{dc}}/Y_{80} \qquad \text{for } P_{37_d} = 3 \qquad \text{[VE1730]} \tag{80}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{1_{plc}} Z_{33} \qquad \text{for } P_{38_p} = 1 \qquad \text{[VE1760]} \tag{81}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{1_{plc}} Z_{34} \qquad \text{for } P_{38_p} = 1 \qquad \text{[VE1765]} \tag{82}$$

$$Y_{1_{plc}} = Y_{1_{plc}}/Z_{35} \qquad \text{for } P_{38_p} = 1 \qquad \text{[VE1770]} \tag{83}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{1_{plc}} \qquad \text{for } P_{38_p} = 2 \qquad \text{[VE1780]} \tag{84}$$

$$Y_{1_{plc}} = 0 \qquad \text{for } P_{38_p} = 2 \qquad \text{[VE1785]} \tag{85}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{1_{plc}} \qquad \text{for } P_{38_p} = 3 \qquad \text{[VE1795]} \tag{86}$$

$$Y_{1_{plc}} = Y_{1_{plc}}/Y_{80} \qquad \text{for } P_{38_p} = 3 \qquad \text{[VE1800]} \tag{87}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{11_{hc}} Z_{33} \qquad \text{for } P_{39_h} = 1 \qquad \text{[VE1830]} \tag{88}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{11_{hc}} Z_{34} \qquad \text{for } P_{39_h} = 1 \qquad \text{[VE1835]} \tag{89}$$

$$Y_{11_{hc}} = Y_{11_{hc}}/Z_{35} \qquad \text{for } P_{39_h} = 1 \qquad \text{[VE1840]} \tag{90}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{11_{hc}} \qquad \text{for } P_{39_h} = 2 \qquad \text{[VE1850]} \tag{91}$$

$$Y_{11_{hc}} = 0 \qquad \text{for } P_{39_h} = 2 \qquad \text{[VE1855]} \tag{92}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{11_{hc}} \qquad \text{for } P_{39_h} = 3 \qquad \text{[VE1865]} \tag{93}$$

$$Y_{11_{hc}} = Y_{11_{hc}}/Y_{80} \qquad \text{for } P_{39_h} = 3 \qquad \text{[VE1870]} \tag{94}$$

$${}_{U}\dot{X}_{01_{4c}} = -Y_{21_{mc}} Z_{33} \qquad \text{[VE1890]} \tag{95}$$

$${}_{U}\dot{X}_{01_{8c}} = -Y_{21_{mc}} Z_{34} \qquad \text{[VE1895]} \tag{96}$$

$$Y_{21_{mc}} = Y_{21_{mc}}/Z_{35} \qquad \text{[VE1900]} \tag{97}$$

$$Y_{11_l} = Y_{11_l}/Z_{35} \qquad \text{for } P_{39_h} = 1 \qquad \text{[VE1935]} \tag{98}$$

$$Y_{11_l} = 0 \qquad \text{for } P_{39_h} = 2 \qquad \text{[VE1945]} \tag{99}$$

$$Y_{11_l} = Y_{11_l}/Y_{80} \qquad \text{for } P_{39_h} = 3 \qquad \text{[VE1955]} \tag{100}$$

$${}_{U}\dot{X}_{03_{4k}} = -Y_{51_k} Z_{33} \qquad \text{[VE1985]} \tag{101}$$

$${}_{U}\dot{X}_{03_{8k}} = -Y_{51_k} Z_{34} \qquad \text{[VE1990]} \tag{102}$$

$$Y_{51_k} = Y_{51_k}/Z_{35} \qquad \text{[VE1995]} \tag{103}$$

$${}_{U}\dot{X}_{04_{4n}} = -Y_{61_{tn}} Z_{33} \qquad \text{for } P_{40_t} = 1 \qquad \text{[VE2025]} \tag{104}$$

$${}_{U}\dot{X}_{04_{8n}} = -Y_{61_{tn}} Z_{34} \qquad \text{for } P_{40_t} = 1 \qquad \text{[VE2030]} \tag{105}$$

$$Y_{61_{tn}} = Y_{61_{tn}}/Z_{35} \qquad \text{for } P_{40_t} = 1 \qquad \text{[VE2035]} \tag{106}$$

$${}_{U}\dot{X}_{04_{4n}} = -Y_{61_{tn}} \qquad \text{for } P_{40_t} = 2 \qquad \text{[VE2045]} \tag{107}$$

$$Y_{61_{tn}} = 0 \qquad \text{for } P_{40_t} = 2 \qquad \text{[VE2050]} \tag{108}$$

$${}_{U}\dot{X}_{04_{8n}} = -Y_{61_{tn}} \qquad \text{for } P_{40_t} = 3 \qquad \text{[VE2060]} \tag{109}$$

$$Y_{61_{tn}} = Y_{61_{tn}}/Y_{80} \qquad \text{for } P_{40_t} = 3 \qquad \text{[VE2065]} \tag{110}$$

where:

Z_{33} = The fraction of water leaving by irrigation [GOA]
Z_{34} = The fraction of water going downstream [GOB]
Z_{35} = The total amount of water leaving the ecosystem either through irrigation or downstream [GOC]
P_{37_d} = The path of the *d*'th litter category leaving the ecosystem [NGOL(D)]
P_{38_p} = The path of the *p*'th plant species leaving the ecosystem [NGOV(P)]
P_{39_h} = The path of the *h*'th animal cohort leaving the ecosystem [NGOA(H)]
P_{40_t} = The path of the *t*'th inorganic particulate category leaving the ecosystem [NGONRP(T)] and the fluxes are ascribed to materials leaving the ecosystem either through irrigation or downstream
${}_{U}\dot{X}_{01_{4c}}$ = [AGAINQ(4,C)]
${}_{U}\dot{X}_{01_{8c}}$ = [AGAINQ(8,C)]
${}_{U}\dot{X}_{03_{4k}}$ = [DGAINQ(4,K)]
${}_{U}\dot{X}_{03_{8k}}$ = [DGAINQ(8,K)]
${}_{U}\dot{X}_{04_{4n}}$ = [CGAINQ(4,N)]
${}_{U}\dot{X}_{04_{8n}}$ = [CGAINQ(8N)]

TABLE OF SYMBOLS

The following table is supplied as a user's aid. It lists the symbols used in the mathematical description, the FORTRAN equivalent, the equations where the symbol is used, and the units for the symbol. The classification of symbols is explained in the Introduction; listings in the table are alphabetical according to variable type, and then numerically according to subscript number. The following abbreviations are used:

C = centigrade
cu = cubic
ecsys = ecosystem
g = gram or grams
hr = hour
kcal = kilocalories
m = meters or meter
mm = millimeters
pop = populations
sq = square

Many of the exogenous variables (V) have for units "variable" for they are first used as grams per cubic meter of water flowing into the system from upstream, and then as grams per ecosystem per day of material entering the system from all sources. Also, Y is used as grams per ecosystem per day leaving the system or as grams per cubic meter of water leaving the ecosystem as downstream flow.

Symbol	FORTRAN Equivalent	Equations where used	Units
P_1	EXTINP	5	$g^{-1} \cdot sq\ m^{-1}$
P_2	EXTINS	5	$g^{-1} \cdot sq\ m^{-1}$
P_3	EXTIND	5	$g^{-1} \cdot sq\ m^{-1}$
P_4	EXTINL	5	$g^{-1} \cdot sq\ m^{-1}$

Symbol	FORTRAN Equivalent	Equations Where Used	Units
P_5	EXTINW	5	m^{-1}
P_{6_p}	PLDEP(P)	5	m
P_{7_p}	CONRAD(P)	6	kcal·sq m·hr^{-1}
$P_{8_{pc}}$	CONNI2(P,C)	7	
$P_{9_{pc}}$	CONNIT(P,C)	7	
P_{10_p}	CONTE1(P)	8	
P_{11_p}	CONTE2(P)	8	
P_{12_p}	CONTE3(P)	8	
P_{13_p}	RESPC(P)	9	
P_{14_p}	RESPD(P)	9	
P_{15}	ENERGY	13	kcal·g^{-1}
$P_{16_{pc}}$	UPCON1(P,C)	16	g·g^{-1}
$P_{17_{pc}}$	UPCON2(P,C)	16	
$P_{18_{pc}}$	UPCON(P,C)	17	
P_{19_p}	PERSED(P)	32	g.g^{-1}
P_{20_p}	VTDEDS (P)	33	
P_{21_p}	VTDEDY(P)	33	
P_{22_p}	AMORT(P)	34, 38	g·g^{-1}
P_{23_p}	IVFATE(P)	44, 45, 46	
P_{24}	NOLIT	44, 45, 46	
P_{25_p}	NDRIFV(P)	44, 45, 46, 50, 52, 54, 55	
P_{26_p}	SIEVEG(P)	47, 50	g·g^{-1}
P_{27_p}	VDRF2(P)	56	
P_{28_p}	CDRF3(P)	56, 63	m·second^{-1}
P_{29_p}	NVDAY1(P)	58	
P_{30_p}	NVDAY2(P)	58	
P_{31_p}	VDRFII(P)	58	g·g^{-1}
P_{32_p}	VDRF7(P)	59	g·g^{-1}
P_{33}	IYRDAY	58, 59	
P_{34_p}	NVDRF8(P)	59	
P_{35_p}	NVDRF9(P)	59	
P_{36_p}	VDRF15(P)	63	g·g^{-1}
P_{37_d}	NGOL(D)	74, 75, 76, 77, 78, 79, 80	
P_{38_p}	NGOV(P)	81, 83, 84, 85, 86, 87	
P_{39_h}	NGOA(H)	88, 89, 90, 91, 92, 93, 94, 98, 99, 100	
P_{40_t}	NGONRP(T)	104, 105, 106, 107, 108, 109, 110	
P_{41_p}	VSPAS(P)	11	
P_{42_p}	RESPE(P)	9	
$V_{1_{p1c}}$	XDRIFV(P,1,C)	34, 48, 49, 63	variable
V_{51_k}	XDNORG(K)	19	variable
V_{77}	DAPHOT	10	hr·day^{-1}
V_{78}	DAYRAD	5	kcal·sq m^{-1}·hr^{-1}
${}_N\dot{X}01_{1c}$	AGAINQ(1,C)	30	g·ecsys^{-1}·day^{-1}
${}_N\dot{X}01_{2c}$	AGAINQ(2,C)	31	g·ecsys^{-1}·day^{-1}
${}_N\dot{X}01_{13c}$	AGAINQ(13,C)	28	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}01_{4c}$	AGAINQ(4,C)	71, 74, 77, 81, 84, 88, 91, 95	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}01_{8c}$	AGAINQ(8,C)	72, 75, 79, 82, 86, 89, 93, 96	g·ecsys^{-1}·day^{-1}
${}_N\dot{X}03_{13k}$	DGAINQ(13,K)	29	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}03_{4k}$	DGAINQ(4,K)	101	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}03_{8k}$	DGAINQ(8,K)	102	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}04_{4n}$	CGAINQ(4,N)	104, 107	g·ecsys^{-1}·day^{-1}
${}_U\dot{X}04_{8n}$	CGAINQ(8,N)	105, 109	g·ecsys^{-1}·day^{-1}
$X_{1_{p1,1}}$	CVEG(P,1,1)	4, 7, 10, 11, 15, 32, 40	g·ecsys^{-1}

Symbol	FORTRAN Equivalent	Equations Where Used	Units
$X_{1_{p1c}}$	CVEG(P,1,C)	7, 15, 17, 51, 52, 53, 57, 58, 60	g·ecsys^{-1}
${}_F\dot{X}_{1_{p1c}}$	CVEGQQ(P,1,C)	65	g·ecsys^{-1}·day^{-1}
${}_H\dot{X}_{1_{p1c}}$	CVEGQQ(P,1,C)	41	g·ecsys^{-1}·day^{-1}
${}_L\dot{X}_{1_{p1c}}$	CVEGQQ(P,1,C)	51	g·ecsys^{-1}·day^{-1}
${}_N\dot{X}_{1_{p1c}}$	CVEGQQ(P,1,C)	25, 26	g·ecsys^{-1}·day^{-1}
${}_N\dot{X}_{6_{p1c}}$	CVEGP(P,1,C)	22	g·ecsys^{-1}·day^{-1}
X_{31_c}	AQUA(C)	1	g·ecsys^{-1}
${}_L\dot{X}_{31_c}$	AQUAQQ(C)	52,55	g·ecsys^{-1}·day^{-1}
$X_{41_{d1}}$	CLIT(D,1)	3	g·ecsys^{-1}
${}_H\dot{X}_{41_{dc}}$	CLITQQ(D,C)	42,46	g·ecsys^{-1}·day^{-1}
${}_H\dot{X}_{43_{dc}}$	CORGQQ(D,C)	37, 43, 44	g·ecsys^{-1}·day^{-1}
X_{51_k}	WDINR(K)	1, 16, 19	g·ecsys^{-1}
${}_N\dot{X}_{51_k}$	WDINRQ(K)	23, 27	g·ecsys^{-1}·day^{-1}
$X_{61_{tn}}$	WPINR(T,N)	2	g·ecsys^{-1}
X_{72}	WTEMP	8, 9, 33	degrees c
X_{73}	VELOCT	56, 68	m·second^{-1}
X_{74}	DEPTH	5	m
X_{75}	WATSYS	16, 54, 55, 66, 67	cu m·ecsys^{-1}
X_{81}	AREA	11	sq m·ecsys^{-1}
$Y_{1_{p1c}}$	DRIFTV(P,1,C)	81, 82, 83, 84, 85, 86, 87, 90	variable
${}_F\dot{Y}_{1_{p1c}}$	DRIFTV(P,1,C)	64	g·ecsys^{-1}·day^{-1}
${}_H\dot{Y}_{1_{p1c}}$	DRIFTV(P,1,C)	35	g·ecsys^{-1}·day^{-1}
${}_L\dot{Y}_{1_{p1c}}$	DRIFTV(P,1,C)	48	g·ecsys^{-1}·day^{-1}
${}_N\dot{Y}_{1_{p1c}}$	DRIFTV(P,1,C)	24, 48	g·ecsys^{-1}·day^{-1}
$Y_{11_{hc}}$	DRIFTA(H,C)	88, 89, 91, 92, 93, 94, 98, 99, 100	variable
$Y_{21_{mc}}$	DRIFTM(M,C)	95, 96, 97	variable
Y_{31_c}	COMPIN(C)	71, 72, 73	variable
${}_L\dot{Y}_{31_c}$	COMPIN(C)	49, 54	g·ecsys^{-1}·day^{-1}
$Y_{41_{dc}}$	DETIN(D,C)	74, 75, 76, 77, 78, 79, 80	variable
${}_F\dot{Y}_{41_{dc}}$	DETIN(D,C)	66, 61	g·ecsys^{-1}·day^{-1}
${}_H\dot{Y}_{41_{dc}}$	DETIN(D,C)	36, 45	g·ecsys^{-1}·day^{-1}
Y_{51_k}	DNORG(K)	101, 102, 103	variable
${}_N\dot{Y}_{51_k}$	DNORG(K)	23	g·ecsys^{-1}·day^{-1}
$Y_{61_{tn}}$	PNORG(T,N)	104, 105, 106, 107, 108, 109, 110	variable
Y_{80}	FLOUT	68, 69, 70, 80, 87, 94, 100, 110	cu m·ecsys^{-1}·day^{-1}
Y_{86}	WIRRIG	68, 69, 70	cu m·ecsys^{-1}·day^{-1}
Z_1	DISOLV	1, 5	variable
Z_2	SED	2, 5	variable
Z_3	DETRI	3, 5	variable
Z_4	A	4, 5	variable
Z_5	RADIA	5, 6	kcal·sq m^{-1}·hr^{-1}
Z_6	B	6, 8	
Z_7	A	7, 8	
Z_8	A	8, 10	
Z_9	RESPV	9, 10	
$Z_{10_{p1}}$	SPREQ(P,1)	10, 12, 13, 14, 15, 17	g·ecsys^{-1}·day^{-1}
$Z_{10_{p2}}$	SPREQ(P,2)	13	g·ecsys^{-1}·day^{-1}
Z_{11_1}	REQ(1)	14	g·ecsys^{-1}·day^{-1}
Z_{11_c}	REQ(C)	18, 19	g·ecsys^{-1}·day^{-1}
Z_{12}	AINTER	15, 17	g·g^{-1}
Z_{13}	EQUIL	16, 17	
$Z_{10_{pc}}$	SPREQ(P,C)	17, 18, 20	g·ecsys^{-1}·day^{-1}
Z_{14}	AA	19	

Symbol	FORTRAN Equivalent	Equations where used	Units
Z_{15}	B	20, 22, 23, 24, 26, 27 28, 29, 30 31	$\text{g}\cdot\text{ecsys}^{-1}\cdot\text{day}^{-1}$
Z_{16_p}	SEED(P)	32	$\text{g}\cdot\text{ecsys}^{-1}$
Z_{17}	DEADT	33, 34, 39, 40	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{18}	ALLDED	34, 35, 36, 37, 40, 41, 42, 43, 44, 45, 46	variable
Z_{19}	CYCLE	21, 34, 38, 39, 45, 46, 47	day^{-1}
Z_{20}	DEAD	38, 40	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{21}	ALEAK	47, 48, 49, 50, 51, 52, 53, 54, 55	variable
Z_{22}	WATTOT	53, 54, 62, 66	$\text{cu m}\cdot\text{ecsys}^{-1}\cdot\text{day}^{-1}$ + $\text{cu m}\cdot\text{ecsys}^{-1}$
Z_{23}	SPAS	11, 12	
Z_{24}	C	21, 23, 24, 25, 27	
Z_{25}	VDRF1	56, 57	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{26}	VDRF4	57, 60, 61	$\text{g}\cdot\text{ecsys}^{-1}\cdot\text{day}^{-1}$
Z_{27}	VDRF5	58, 60	$\text{g}\cdot\text{ecsys}^{-1}\cdot\text{day}^{-1}$
Z_{28}	VDRF6	59, 60, 61	$\text{g}\cdot\text{g}^{-1}$
Z_{29}	VDRF10	60, 64, 65	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{30}	VDRF13	61, 62, 65	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{31}	VDRF14	62, 66, 67	
Z_{32}	VSTAYS	63, 64, 65	$\text{g}\cdot\text{g}^{-1}\cdot\text{day}^{-1}$
Z_{33}	GOA	68, 71, 74, 81, 88, 95, 101, 104	dimensionless
Z_{34}	GOB	69, 72, 75, 82, 89, 96, 102, 105	dimensionless
Z_{35}	GOC	70, 73, 76, 83, 90, 97, 98, 103, 106	$\text{cu m}\cdot\text{ecsys}^{-1}\cdot\text{day}^{-1}$

PROCESS DELETION

Just as the VEGET subroutine acts as a "black box" to other subroutines and the main program, sections within the subroutine act as "black boxes" to each other. The user may elect not to use some of these functions, and this may be accomplished in two ways. One, a particular section may be left out of the program during compilation, or two, parameters or switches may be set to skip certain sections, or to predict a change of zero. The latter is by far the most useful, for the user may wish to change particular state variables by a process and not others, and a recompilation would not be necessary. Both methods will be treated. The numbers prefixed with a (V) refer to the program sequence number (Appendix J).

Process	Program section
Net photosynthesis	VE0390 - VE1140
Plant mortality	VE1145 - VE1315
Leakage	VE1320 - VE1410
Scouring and colonization	VE1415 - VE1600

Switches and parameters should be set as follows to "set to zero" certain processes.

Process	Parameter	FORTRAN Equivalent	Setting
Photosynthesis	P_{10_p}	CONTE1(P)	0
	P_{11_p}	CONTE2(P)	
	P_{12_p}	CONTE3(P)	
Respiration	P_{13_p}	RESPC(P)	0
	P_{42_p}	RESPE(P)	
Mortality (constant)	P_{22_p}	AMORT(P)	0
Mortality (ƒ temperature)	P_{20_p}	VTDEDS(P)	0
	P_{21_p}	VTDEDY(P)	
Leakage	P_{26_p}	SIEVEG(P)	0
Scouring	P_{27_p}	VDRF2(P)	1
Colonization	P_{36_p}	VDRF15(P)	0

ARRAY DIMENSIONS

The use of the program is limited by the dimension allotted to the arrays, and these limitations need discussion so that the user may be in a position to modify them as his particular requirements indicate. Below is a list of arrays peculiar to the subroutine VEGET, in which the dimensions which may appropriately be varied are indicated by letters. Dimension limitation of other arrays used in this subprogram can be found in the main program.

AEXT(b)
AINT(b)
AMORT(a)
CONNI2(a,b)
CONNIT(a,b)
CONRAD(a)
CONTE1(a)
CONTE2(a)
CONTE3(a)
IVFATE(a)
NGOA(c)
NGOL(d)
NGONRP(e)
NGOV(a)
NVDAY1(a)
NVDAY2(a)
NVDRF8(a)
NVDRF9(a)
PERSED(a)
PLDEP(a)
REQ(b)
RESFC(a)
RESPD(a)
RESPE(a)
SIEVEG(a)
SPREQ(a,b)
UPCON(a,b)
UPCON1(a,b)
UPCON2(a,b)
VDRF2(a)
VDRF3(a)
VDRF7(a)
VDRF11(a)
VDRF15(a)
VSPAS(a)
VTDEDS(a)
VTDEDY(a)

The dimensions indicated by letters define the maximum values possible for the following quantities:

		FORTRAN NAME
a.	The number of plant species	NSPECV
b.	Number of organic components tracked (including energy)	NFRELM
c.	The number of animal cohorts or size classes	NSPCOH
d.	The Number of types of organic detritus categories	NOLIT
e.	The number of types of inorganic detritus categories	ISTRTM

PARAMETERS AND SWITCHES

A list of all parameters and switches for the VEGET subroutine follows. Explanations can be found in the definitions list, Appendix A. Letters used for dimensions are explained above under Array Dimensions.

AMORT(a)
CONNIT(a,b)
CONNI2(a,b)
CONRAD(a)
CONTE1(a)
CONTE2(a)
CONTE3(a)
ENERGY
EXTIND
EXTINL
EXTINP
EXTINS
EXTINW
IVFATE(a)
NDRF11
NDRIFV
NGOA(c)
NGOL(d)
NGONRP(e)
NGOV(a)
NVDAY1(a)
NVDAY2(a)
NVDRF8(a)
NVDRF9(a)
PERSED(a)
PLDEP(a)
RESPC(a)
RESPD(a)
RESPE(a)
SIEVEG(a)
UPCON(a,b)
UPCON1(a,b)
UPCON2(a,b)
VDRF2(a)
VDRF3(a)
VDRF7(a)
VDRF15(a)
VSPAS(a)
VTDEDY(a)
VTDEDS(a)

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APPENDICES

APPENDIX A

Listing of Definitions used in the General Stream Model Program

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C AAQUA(N)         AQUA (N) CONVERTED TO OUTPUT UNITS.                   D0005
C AAQUAB(N)        AQUAB(N)CONVERTED TO OUTPUT UNITS.                    D0010
C ABPINR(M,N)      BPINR(M,N) CONVERTED TO OUTPUT UNITS.                 D0015
C ABDINR(N)        BDINR(N) CONVERTED TO OUTPUT UNITS.                   D0020
C ACBACT(T,N)      CBACT(T,N) CONVERTED TO OUTPUT UNITS.                 D0025
C ACBIOM(L,N)      CBIOM(L,N) CONVERTED TO OUTPUT UNIT.                  D0030
C ACCUM(L)         THE ACCUMULATED TEMPERATURES FOR CHANGES IN THE       D0035
C                  L'TH ANIMAL COHORT IF NTRANS(L) EQUALS 1 OR 3, OR     D0040
C                  THE AVERAGE WEIGHT OF AN L'TH INDIVIDUAL AT WHICH     D0045
C                  TIME TRANSFER BEGINS IF NTRANS(L) EQUALS 5.           D0050
C ACLIT (M,N)      CLIT (M,N) CONVERTED TO OUTPUT UNITS.                 D0055
C ACORG(M,N)       CORG(M,N) CONVERTED TO OUTPUT UNITS.                  D0060
C ACVEG(I,J,N)     CVEG(I,J,N) CONVERTED TO OUTPUT UNITS.                D0065
C AEXT(N)          THE CONCENTRATION IN WATER (G.PER G.) OF THE N'TH     D0070
C                  CHEMICAL CONSTITUENT.                                 D0075
C AFLOW(D)         RATE OF INFLOW OF WATER FROM UPSTREAM ON THE D'TH     D0080
C                  DAY(CUBIC METERS/SEC.).                               D0085
C AGAIN(P,N)       NET CHANGE IN THE N'TH CONSTITUENT IN THE SYSTEM AS A D0090
C                  WHOLE THROUGH THE P'TH CHANNEL.                       D0095
C AGAINQ(P,N)      CHANGE PER TIME UNIT IN AGAIN(P,N).                   D0100
C AGAINT(N)        NET CHANGE IN THE N'TH CONSTITUENT IN THE SYSTEM AS A D0105
C                  WHOLE.                                                D0110
C ATNT(N)          THE RATIO IN PLANT TISSUE OF THE N'TH CHEMICAL        D0115
C                  CONSTITUENT TO CARBON.                                D0120
C ALINAM(M,A)      NAME OF THE M'TH DETRITUS FRACTION, UP TO 16          D0125
C                  CHARACTERS.                                           D0130
C ALLMAX           THE MAXIMUM TURNOVER RATE OF A STATE VARIABLE OUT TO  D0135
C                  ANY ONE PARTICULA PROCESS                             D0140
C AMAX(L)          VALUE OF ACCUMULATED TEMPERATURES AT WHICH THE        D0160
C                  ALLMAX FRACTION OF THE L'TH ANIMAL COHORT IS          D0165
C                  TRANSFERED IF NTRANS(L) EQUALS 1 OR 3, OR A FACTOR    D0170
C                  USED WHEN NTRANS(L)=5, WHICH REGULATES THE FRACTION   D0175
C                  OF ANIMALS TRANSFERED FROM THE L'TH TO THE (L+1)TH    D0180
C                  COHORT.                                               D0185
C AMICRO           VALUE BELOW WHICH STATE VARIALBES WILL BE TREATED AS  D0190
C                  ZERO.                                                 D0195
C AMINI(I)         MINIMUM VLAUE OF Y AXIS FOR I'TH GRAPH.               D0210
C AMORT(I)         THE PROPORTIONAL MORTALITY PER TIME UNIT OF THE       D0215
C                  I'TH PLANT SPECIES GROUP.                             D0220
C AMORTA(L)        PROPORTION OF INDIVIDUALS OF THE L'TH ANIMAL COHORT   D0225
C                  DYING IN A TIME UNIT.                                 D0230
C ANDRF2(L)        A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0235
C                  PART OF THE L'TH ANIMAL COHORT WASHED AWAY BY FLOW.   D0240
C ANDRF3(L)        A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0245
C                  PART OF THE L'TH ANIMAL COHORT WHICH SETTLES OUT OF   D0250
C                  THE DRIFT IN A TIME UNIT.                             D0255
C ANIHI(L)         THE WATER VELOCITY ABOVE WHICH THE L'TH ANIMAL        D0260
C                  COHORT WILL BE WASHED AWAY(METERS PER SECOND).        D0265
C ANIINC           TIME UNIT FOR SIMULATION IN ANIMAL SUBROUTINE.        D0270
C ANILO(L)         THE WATER VELOCITY BELOW WHICH THE L'TH ANIMAL        D0275
C                  COHORT WILL SETTLE OUT(METERS PER SECOND).            D0280
C ANIM(K,N)        CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN ALL       D0285
C                  COHORTS OF THE K'TH ANIMAL SPECIES GROUP.             D0290
C ANIMCO           TIME FOR ANIMAL SUBROUTINE SINCE COMMENCEMENT OF THE  D0295
C                  TIME UNIT LOOP.                                       D0300
C APBACT(T,N)      OUTPUT UNITS FOR PCBACT(T,N).                         D0305
C APBIOM(L,N)      OUTPUT UNITS FOR PCBIOM(L,N).                         D0310
C APOP(L)          POP (L) CONVERTED TO OUTPUT UNITS.                    D0315
C APVEG(I,J,N)     OUTPUT UNITS FOR PCVEG(I,J,N).                        D0320
C APWIDE           THE APPROXIMATE TOP WIDTH OF THE STREAM. (METERS)     D0325
C AQUA(N)          CONTENT OF THE N'TH ORGANIC CHEMICAL CONSTITUENT      D0330
C                  DISSOLVED IN THE WATER.                               D0335
C AQUAB(N)         CONTENT OF THE N'TH ORGANIC CONSTITUENT DISSOLVED     D0340
C                  IN THE BENTHOS.                                       D0345
C AQUAPQ(N)        CHANGE DURING THE TIME UNIT IN AQUAB(N).              D0350
C AQUACO           TIME FOR MEDIUM SUBROUTINE SINCE COMMENCEMENT OF THE  D0355
C                  TIME UNIT LOOP.                                       D0360
C AQUAQQ(N)        CHANGE PER TIME UNIT IN AQUA (N).                     D0365
C AQUATT(N)        TOTAL N'TH ORGANIC CONSTITUENT DISSOLVED IN THE WATER D0370
C AQUINC           TIME UNIT FOR SIMULATION IN MEDIUM SUBROUTINE.        D0375
C AREA             SURFACE AREA OF THE WATER IN THE SYSTEM (SQ.M.)       D0380
C ASPNAM(K,A)      NAME OF THE K'TH ANIMAL SPECIES (UP TO 28 CHARACTERS) D0385
C ASSI             QUANTITY OF FOOD ASSIMILATED PER UNIT OF CARBON       D0390
C                  PER TIME UNIT BY THE ANIMAL COHORT CURRENTLY UNDER    D0395
C                  CONSIDERATION.                                        D0400
C ASSIM(L)         PROPORTION OF FOOD ASSIMILATED BY THE L'TH ANIMAL     D0405
C                  COHORT.                                               D0410
C ASSIMH(T)        THE PROPORTION OF INTAKE OF THE T'TH TYPE OF HETERO-  D0415
C                  TROPHIC MICROORGANISM WHICH IS ASSIMILATED.           D0420
C AVELIT(M)        THE AVERAGE AMOUNT (GRAMS/CUBIC METER) OF A           D0425
C                  CONSTITUENT OF THE M'TH SUSPENDED DETRITUS CATEGORY   D0430
C                  IN THE SYSTEM IN A DAY.                               D0435
C AVEIND(H)        AVERAGE WEIGHT IN GRAMS CARBON OF THE H'TH COHORT.    D0440
C AVENRP(M)        THE AVERAGE AMOUNT (GRAMS/CUBIC METER) OF INORGANIC   D0445
C                  PARTICULATE MATTER IN THE M'TH DETRITUS SIZE CLASS    D0450
C                  IN THE SYSTEM IN A DAY.                               D0455
C AWPINR(M,N)      WPINR(M,N)CONVERTED TO OUTPUT UNITS.                  D0460
C AWDINR(N)        WDINR(N) CONVERTED TO OUTPUT UNITS.                   D0465
C BACNAM(T,A)      NAME OF THE T'TH BACTERIAL CATEGORY, UP TO 16         D0470
C                  CHARACTERS.                                           D0475
C BACTHI(T)        THE WATER VELOCITY ABOVE WHICH THE T'TH TYPE OF       D0480
C                  BACTERIA WILL BE SCOURED.(METERS PER SECOND)          D0485
C BACTLO(T)        THE WATER VELOCITY BELOW WHICH THE T'TH TYPE OF       D0490
C                  BACTERIA WILL SETTLE OUT (METERS PER SECOND)          D0491
C BDINR(N)         CONTENT OF THE N'TH INORGANIC CONSTITUTENT DISSOLVED  D0495
C                  IN THE BENTHOS.                                       D0500
C BDINRQ(N)        CHANGE DURING THE TIME UNIT IN BDINR(N).              D0505
C BDRF2(T)         A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0510
C                  PART OF THE T'TH TYPE OF DECOMPOSER SCOURED BY FLOW.  D0515
C BDRF3(T)         A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0520
C                  PART OF THE T'TH TYPE OF DECOMPOSER DEPOSITED IN A    D0525
C                  TIME UNIT.                                            D0530
C BEFAC3(H)        LINEAR FACTOR FOR PREDICTING BEHAVIORAL DRIFT OF THE  D0535
C                  H'TH COHORT.                                          D0540
C BEFAC4(H)        QUADRATIC FACTOR FOR PREDICTING BEHAVIORAL DRIFT OF   D0545
C                  THE H'TH COHORT.                                      D0550
C BI(A)            THE BOTTOM WIDTH AT THE A'TH POINT   OF STREAM.       D0555
C                  (METERS)                                              D0560
C BLANK            STORED BLANK FOR HEADINGS.                            D0585
C BPINR(M,N)       CONTENT OF THE N'TH INORGANIC CONSTITUENT OF THE M'TH D0590
C                  TYPE OF BENTHIC PARTICULATE MATTER.                   D0595
C BPINRQ(M,N)      CHANGE DURING THE TIME UNIT IN BPINR(M,N).            D0600
C BPINRT(M)        TOTAL OF THE M'TH TYPE OF INORGANIC BENTHIC           D0605
C                  PARTICULATE MATTER.                                   D0610
C CBACT(T,N)       CONTENT OF THE N'TH CHEMICAL CONSTITUENT OF THE T'TH  D0615
C                  BACTERIAL CATEGORY.                                   D0620
C CBACTP(T,N)      CHANGE DURING THE TIME UNIT IN PCBACT(T,N).           D0625
C CBACTQ(T,N)      CHANGE DURING THE TIME UNIT IN CBACT(T,N).            D0635
C CBACTT(N)        TOTAL N'TH ORGANIC CONSTITUENT IN ALL BACTERIAL       D0640
C                  CATEGORIES.                                           D0645
C CBIOM(L,N)       CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN THE L'TH  D0650
C                  ANIMAL COHORT.                                        D0655
C CBIOMA(N)        CONTENT OF THE N'TH CHEMICAL CONSTITUENT TOTALED      D0660
C                  OVER ALL ANIMAL COHORTS.                              D0665
C CBIOMP(L,N)      CHANGE DURING THE TIME UNIT IN PCBIOM(L,N).           D0670
C CBIOMQ(L,N)      CHANGE DURING THE TIME UNIT IN CBIOM(L,N).            D0675
C CDRF2(M)         A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0680
C                  PART OF THE M'TH BENTHIC LITTER CATEGORY SCOURED BY   D0685
C                  FLOW.                                                 D0690
C CDRF3(M)         A COEFFICIENT USED IN CALCULATING THE FRACTIONAL      D0695
C                  PART OF THE M'TH SUSPENDED ORGANIC LITTER CATEGORY    D0700
C                  DEPOSITED IN A TIME UNIT.                             D0705
C CFAC1            USED TO CALCULATE THE  CURVATURE FACTOR FOR           D0710
C                  PREDICTING MIXING OF DISSOLVED SUBSTANCES BETWEEN     D0715
C                  BENTHOS AND WATER COLUMN.                             D0720
C CFAC2            FACTOR USED TO CALCULATE THE DEPTH OF BENTHOS         D0725
C                  FROM THE WEIGHT OF BENTHOS IN A SQUARE METER.         D0730
C CGAIN(P,N)       NET CHANGE IN THE N'TH INORGANIC PARTICULATE          D0735
C                  CONSTITUENT THRU THE P'TH CHANNEL.                    D0740
C CGAINQ(P,N)      CHANGE PER TIME UNIT IN CGAIN(P,N).                   D0745
C CGAINT(N)        NET CHANGE OF THE N'TH INORGANIC PARTICULATE          D0750
C                  CONSTITUENT.                                          D0755
C CHANGE           NUMBERS  OR PROPORTION OF BIOMASS   TRANSFERRED INTO  D0760
C                  THE ANIMAL COHORT CURRENTLY UNDER CONSIDERATION.      D0765
C CHELEM           QUANTITY  PER UNIT AREA  OF AN ELEMENT TRANSFERRED    D0770
C                  FROM ADULTS TO EGGS DURING REPRODUCTION.              D0775
C CHNG(A)          CHANGE IN A'TH ACCUMULATOR (IN COMMON BLOCK ACCINC)   D0780
C                  (A.LE.LIMACC).                                        D0785
C CLIT(M,N)        CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN THE M'TH  D0790
C                  CATEGORY OF SUSPENDED DETRITUS.                       D0795
C CLITHI(M)        THE WATER VELOCITY ABOVE WHICH THE M'TH ORGANIC       D0800
C                  LITTER CATEGORY WILL BE SCOURED. (METERS PER SECOND)  D0805
C CLITLO(M)        THE WATER VELOCITY BELOW WHICH THE M'TH ORGANIC       D0810
C                  LITTER CATEGORY WILL SETTLE OUT. (METERS PER SECOND)  D0815
C CLITQQ(M,N)      CHANGE DURING THE TIME UNIT IN CLIT(M,N).             D0820
C CLITT(N)         CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN THE       D0825
C                  SUSPENDED DETRITUS.                                   D0830
C COAGUL           THE PROPORTION OF DISSOLVED ORGANIC MATTER COAGULATED D0835
C                  AND HENCE TRANSFERRED TO SUSPENDED DETRITUS IN A      D0840
C                  SINGLE TIME UNIT (FRACTION PER CUBIC M.PER DAY)       D0845
C COHNAM(L,A)      NAME OF THE COHORTS DESIGNATED AS 'L' (UP TO 16       D0850
C                  CHARACTERS).                                          D0855
C COMPIN(N)        CONTENT (IN G. PER CUBIC METER) OF THE N'TH           D0860
C                  CONSTITUENT IN SOLUTION IN THE OUTFLOWING WATER.      D0865
C CONNI2(I,N)      LN (PROPORTIONAL REDUCTION IN RATE OF PHOTOSYNTHESIS) D0870
C                  FOR THE I'TH PLANT SPECIES GROUP WHEN THE N'TH        D0875
C                  CONSTITUENT IS ABSENT.                                D0880
C CONNIT(I,N)      PROPORTIONALITY CONSTANT FOR THE EFFECT OF THE N'TH   D0885
C                  CONSTITUENT ON RATE OF PHOTOSYNTHESIS IN THE I'TH     D0890
C                  PLANT SPECIES GROUP.                                  D0895
C CONRAD(I)        RADIATION INTENSITY FOR MAXIMUM PHOTOSYNTHESIS OF     D0900
C                  THE I'TH PLANT SPECIES GROUP (KCAL./SQM/HOUR).        D0905
C CONS(T)          MICHAELIS CONSTANT FOR RATE OF SUBSTRATE USE BY THE   D0910
C                  T'TH GROUP OF HETEROTROPHIC MICROORGANISMS.           D0915
C CONSA(L)         TEMPERATURE BELOW WHICH NO EGGS WILL BE LAID BY       D0920
C                  THE L'TH COHORT.                                      D0925
C CONST(L)         RESPIRATION (G. OF CARBON) PER TIME UNIT AT ZERO      D0945
C                  TEMPERATURE BY AN INDIVIDUAL OF THE L'TH ANIMAL       D0950
C                  COHORT CONTAINING ONE GRAM OF CARBON.                 D0955
C CONTA            CONSTANT TERM FOR TEMPERATURE DEPENDENCE OF SUBSTRATE D0990
C                  USE BY HETEROTROPHIC MICROORGANISMS (I.E. LOG         D0995
C                  (MAXIMUM RATE) AT ZERO TEMPERATURE).                  D1000
C CONTB            LINEAR COEFFICIENT FOR TEMPERATURE DEPENDENCE OF      D1005
C                  SUBSTRATE USE BY HETEROTROPHIC MICROORGANISMS.        D1010
C CONTC            QUADRATIC COEFFICIENT FOR TEMPERATURE DEPENDENCE OF   D1015
C                  SUBSTRATE USE BY HETEROTROPHIC MICROORGANISMS.        D1020
C CONTE1(I)        PROPORTION OF OPTIMUM PHOTOSYNTHESIS ATTAINABLE AT    D1025
C                  ZERO TEMPERATURE BY THE I'TH PLANT SPECIES GROUP.     D1030
C CONTE2(I)        LINEAR COEFFICIENT IN THE TEMPERATURE DEPENDENCE      D1035
C                  FUNCTION FOR PHOTOSYNTHESIS OF THE I'TH PLANT SPECIES D1040
C                  GROUP. CHANGE IN ABSOLUTE PHOTOSYNTHESIS PER DEGREE.  D1045
C CONTE3(I)        QUADRATIC COEFFICIENT IN THE TEMPERATURE DEPENDENCE   D1050
C                  FUNCTION FOR PHOTOSYNTHESIS OF THE I'TH PLANT SPECIES D1055
C                  GROUP.                                                D1060
C CORG(M,N)        CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN THE M'TH  D1065
C                  CATEGORY OF BOTTOM DETRITUS.                          D1070
C CORGQQ(M,N)      CHANGE DURING THE TIME UNIT IN CORG(M,N).             D1075
C CORGT(N)         TOTAL CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN     D1080
C                  THE BOTTOM DETRITUS.                                  D1085
C CURVE(L)         FACTOR RELATING FOOD INTAKE IN THE L'TH ANIMAL        D1090
C                  COHORT TO THE FOOD SUPPLY AVAILABLE.                  D1095
C CVEG(I,J,N)      CONTENT OF THE N'TH CONSTITUENT IN THE J'TH ORGAN OF  D1100
C                  THE I'TH PLANT SPECIES GROUP.                         D1105
C CVEGP(I,J,N)     CHANGE DURING THE TIME UNIT IN PCVEG(I,J,N).          D1110
C CVEGQQ(I,J,N)    CHANGE DURING THE TIME UNIT IN CVEG(I,J,N).           D1115
C CVEGV(J,N)       CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN THE J'TH  D1120
C                  ORGAN, SUMMED OVER ALL PLANT SPECIES GROUPS.          D1125
C CVEGVO(N)        CONTENT OF THE N'TH CHEMICAL CONSTITUENT, TOTALED     D1130
C                  ALL PLANT SPECIES GROUPS AND ORGANS.                  D1135
C CYCLE            THE NUMBER OF EXCHANGES OF WATER IN THE SYSTEM        D1140
C                  IN A DAY.                                             D1145
C DADUST(M,N)      THE AMOUNT OF THE N'TH ORGANIC CONSTITUENT OF THE     D1150
C                  M'TH TYPE OF DETRITUS ENTERING THE SYSTEM FROM ABOVE  D1150
C                  (G./S.M.).                                            D1160
C DAPHOT           PHOTOPERIOD FOR THE CURRENT DAY (HRS).                D1165
C DARAIN           AMOUNT OF RAINFALL ON THE CURRENT DAY (M.M.).         D1170
C DAYDAY           INTEGRAL PART OF TIME SINCE COMMENCEMENT OF TIME      D1175
C                  UNIT LOOP.                                            D1180
C DAYRAD           RADIATION FOR THE CURRENT DAY (KCAL./M.SQ./HOUR).     D1185
C DAYRUN           THE AMOUNT OF RUNON ON THE CURRENT DAY (CUBIC METERS) D1190
C DECINC(A)        CHANGE IN A'TH STATE VARIABLE (A.LE.LIMIT).           D1195
C DECJAN(E)        ABBREVIATED NAME OF THE E'TH MONTH.                   D1200
C DECP(A)          A'TH VARIABLE IN COMMON/PRODCH/.                      D1205
C DEPTH            THE MEAN DEPTH OF THE SYSTEM IN METERS.               D1210
C DETIN(K,N)       CONTENT OF THE N'TH CONSTITUENT IN THE K'TH CATEGORY  D1215
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C                    OF PLANKTONIC DETRITUS IN THE OUTFLOWING WATER       D1220
C                    (GRAMS/CUBIC METER).                                 D1225
C DGAIN(P,N)         NET CHANGE IN THE N'TH INORGANIC DISSOLVED           D1230
C                    CONSTITUENT THRU THE P'TH CHANNEL.                   D1235
C DGAINQ(P,N)        CHANGE PER TIME UNIT IN DGAIN(P,N).                  D1240
C DGAINT(N)          NET CHANGE OF THE N'TH INORGANIC DISSOLVED           D1245
C                    CONSTITUENT                                          D1250
C DINAM(N,A)         N'TH DISSOLVED INORGANIC NAME, UP TO 12 CHARACTERS.  D1265
C DNORG(N)           THE AMOUNT OF THE N'TH DISSOLVED INORGANIC CONSTITUEN D1270
C                    LEAVING THE SYSTEM (G./C.M.).                        D1275
C DRIFPO(L)          THE POPULATION OF THE L'TH ANIMAL COHORT IN THE      D1280
C                    OUTFLOWING WATER (PER CUBIC METER).                  D1285
C DRIFTA (L,N)       THE AMOUNT OF THE N'TH CONSTITUENT OF THE L'TH       D1290
C                    ANIMAL COHORT IN THE OUTFLOWING WATER (GRAMS/        D1295
C                    CUBIC METER).                                        D1300
C DRIFTM(T,N)        THE AMOUNT OF THE N'TH CONSTITUENT OF THE T'TH TYPE  D1305
C                    OF MICROORGANISM IN THE OUTFLOWING WATER(GRAMS/      D1310
C                    CUBIC METER).                                        D1315
C DRIFTV(I,J,N)      THE AMOUNT OF THE N'TH CONSITUTENT OF THE J'TH       D1320
C                    ORGAN TYPE OF THE I'TH PLANT SPECIES DRIFTING OUT    D1325
C                    OF THE SYSTEM(GRAMS/CUBIC METER).                    D1330
C DUST(I,M,N)        THE AMOUNT OF THE N'TH CONSTITUENT OF THE M'TH       D1335
C                    DETRITUS TYPE ENTERING THE SYSTEM FROM THE ATMOSPHERE D1340
C                    (AN AVERAGE DAILY FALL OF THE I'TH MONTH IN GRAMS PER D1345
C                    SQUARE METER.)                                       D1350
C DUSTIP(M,N)        THE AMOUNT OF THE N'TH INORGANIC PARTICULATE CONSTITU D1355
C                    OF THE M'TH TYPE OF DETRITUS ENTERING THE SYSTEM     D1360
C                    FROM ABOVE (G./S.M.).                                D1365
C EGCOMP(K,N)        THE AMOUNT OF THE N'TH CHEMICAL CONSTITUENT IN AN EGG D1370
C                    OF THE K'TH ANIMAL SPECIES.                          D1375
C ENERGY             FACTOR CONVERTING CARBON ADDITIONS BY PHOTOSYNTHESIS D1380
C                    TO ENERGY TERMS (KCAL. PER G.)                       D1385
C EQUIL              THE RATIO OF AN ELEMENT WITHIN THE PLANT TO CARBON,  D1390
C                    WHICH WOULD BE IN EQUILIBRIUM WITH THE CURRENT       D1395
C                    EXTERNAL CONCENTRATION OF THAT ELEMENT.              D1400
C EVAP               PAN EVAPORATION FOR THE CURRENT DAY (M.M./DAY).      D1405
C EVAPO              EVAPORATION IN THE TOTAL SYSTEM. (CUBIC METERS).     D1410
C EVAPOR(E)          DAILY PAN EVAPORATION AVERAGED OVER THE E'TH MONTH   D1415
C                    (M.M.)                                               D1420
C EVERYZ(A)          THE A'TH TOTAL FOR VALUES NOT CONVERTED TO AVERAGE   D1425
C                    VALUES FOR OUTPUT (A.LE.LIMEVR).                     D1430
C EXCR               RATE OF EXCRETION PER UNIT BIOMASS (OF CARBON) PER   D1435
C                    TIME UNIT FOR THE ANIMAL COHORT CURRENTLY UNDER      D1440
C                    CONSIDERATION.                                       D1445
C EXOGEN(L)          NUMBERS (PER SQ. M.) OF INDIVIDUALS OF THE L'TH      D1450
C                    ANIMAL COHORT ENTERING THE SYSTEM FROM ABOVE (E.G.   D1455
C                    OVIPOSITION).                                        D1460
C EXPLA(P,A)         IN A GRAPH, EXPLANATION OF THE A'TH VARIABLE - UP TO D1465
C                    20 CHARACTERS.                                       D1470
C EXPLAN(B,A)        EXPLANATION (UP TO 20 CHARACTERS) OF A'TH LINE IN    D1475
C                    MULTIPLE-LINE GRAPHS, TAKEN TOGETHER.                D1480
C EXTIND             EXTINCTION COEFFICIENT FOR LIGHT INTERCEPTED BY      D1485
C                    ORGANIC DETRITUS (PER G. PER SQ. M.).                D1490
C EXTINL             EXTINCTION COEFFICIENT FOR LIGHT INTERCEPTED BY      D1492
C                    DISSOLVED MATERIALS.(PER GRAM PER SQUARE METER)      D1493
C EXTINP             EXTINCTION COEFFICIENT FOR LIGHT INTERCEPTED BY      D1495
C                    PLANT MATERIAL (PER G. PER SQ. M.).                  D1500
C EXTINS             EXTINCTION COEFFICIENT FOR LIGHT INTERCEPTED BY      D1505
C                    SUSPENDED INORGANIC MATERIAL (PER G. PER SQ. M.).    D1510
C EXTINW             EXTINCTION COEFFICIENT FOR LIGHT PASSING THROUGH     D1515
C                    WATER (PER M.).                                      D1520
C FACTC              PROPORTION OF TIME UNIT STILL TO BE COMPLETED.       D1525
C FACTOR             PROPORTION OF A PARTICULAR FOOD TYPE TO BE CONSUMED  D1530
C                    BY THE ANIMAL COHORT CURRENTLY UNDER CONSIDERATION   D1535
C                    OR THE PROPORTION OF TIME UNIT COMPLETED IN ONE CYCLE D1540
C                    OF THE TIME UNIT LOOP IN THE MAIN PROGRAM.           D1545
C FACTR1             FACTOR CONVERTING STATE VARIABLES TO OUTPUT UNITS.   D1550
C FALL(M)            THE PROPORTION OF THE M'TH CATEGORY OF SUSPENDED     D1555
C                    DETRITUS REACHING THE BOTTOM IN A SINGLE TIME UNIT   D1560
C                    (PROPORTION PER CUBIC METER PER DAY).                D1565
C FEEDA(L)           QUANTITY OF THE L'TH ANIMAL COHORT WEIGHTED BY THE   D1570
C                    DIETARY PREFERANCE AND AVAILABILITY OF THE ANIMAL    D1575
C                    COHORT CURRENTLY UNDER CONSIDERATION.                D1580
C FEDERM(L)          THE PROPORTION OF ANIMAL FOOD OF THE L'TH ANIMAL     D1585
C                    COHORT  WHICH IS REMOVED FROM THE DRIFT.(NDRIFA(L)   D1590
C                    MUST BE 4 AND FOOD 2 OR 3).                          D1595
C FEEDL(M)           QUANTITY OF THE M'TH TYPE OF SUSPENDED DETRITUS      D1600
C                    WEIGHTED BY THE DIETARY PREFERANCE AND AVAILABILITY  D1605
C                    OF THE ANIMAL SPECIES GROUP CURRENTLY UNDER          D1610
C                    CONSICERATION                                        D1611
C FEEDM(T)           QUANTITY OF THE T'TH TYPE OF HETEROTROPHIC           D1615
C                    MICROORGANISMS, WEIGHTED BY THE DIETARY PREFERANCE   D1620
C                    AND AVAILABILITY OF THE ANIMAL SPECIOS GROUP         D1625
C                    CURRENTLY UNDER                                      D1626
C                    CONSIDERATION.                                       D1630
C FEEDO(M)           QUANTITY OF THE M'TH TYPE OF BOTTOM DETRITUS,        D1635
C                    WEIGHTED BY THE DIETARY PREFERANCE AND AVAILABILITY  D1640
C                    OF THE ANIMAL SPECIES GROUP CURRENTLY UNDER          D1645
C                    CONSIDERATION                                        D1646
C FEEDV(I)           QUANTITY OF THE I'TH PLANT SPECIES GROUP, WEIGHTED BY D1650
C                    THE DIETARY PREFERANCE AND AVAILABILITY OF THE ANIMAL D1655
C                    SPECIES GROUP CURRENTLY UNDER CONSIDERATION.         D1660
C FIG(A,B)           IN A GRAPH, VALUE OF THE A'TH VARIABLE FOR THE B'TH  D1565
C                    COLUMN.                                              D1670
C FIGS(A,B)          VALUES OF A'TH VARIABLE FOR 70 SUCCESSIVE COLUMNS OF D1675
C                    ALL GRAPHS, TAKEN TOGETHER.                          D1680
C FINDAY             A QUANTITY FRACTIONALLY LESS THAN THE TIME AT THE END D1685
C                    OF THE CURRENT TIME STEP.                            D1690
C FLOGO(A)           THE AMOUNT OF THE A'TH MATERIAL FLOWING OUT OF THE   D1695
C                    SYSTEM (G./C.M).                                     D1700
C FLOSEC             FLOW LEAVING THE SYSTEM (C.M./SEC.).                 D1705
C FLOUT              THE AMOUNT OF WATER LEAVING THE SYSTEM AS DOWNSTREAM D1710
C                    FLOW. (CUBIC METERS).                                D1715
C FLOW               TOTAL INFLOW OF WATER(CUBIC METERS/SEC).             D1720
C FLOWIN             RATE OF INFLOW OF WATER (CUBIC METERS/SECOND) FROM   D1725
C                    UPSTREAM ON THE DAY BEING SIMULATED.                 D1730
C FLOWS              THE AMOUNT OF WATER FLOWING INTO THE ECOSYSTEM PER   D1735
C                    DAY.(CUBIC METERS)                                   D1740
C FLOWTR             AMOUNT OF WATER ADDED TO THE ECOSYSTEM FROM          D1745
C                    TRIBUTARIES (CUBIC METERS/DAY).                      D1750
C FMI(A)             SLOPE OF THE CHANNEL SIDES AT THE A'TH   POINT OF    D1755
C                    STREAM.                                              D1760
C FNI(A)             MANNINGS N FOR THE A'TH  POINT  OF STREAM.           D1765
C FOOD(K,N)          TOTAL FOOD INTAKE OF THE N'TH CONSTITUENT BY THE K'TH D1770
C                    ANIMAL SPECIES GROUP.                                D1775
C FRAC               FRACTIONAL PART OF DAY AT POINT OF TIME REACHED BY   D1780
C                    SIMULATION.                                          D1785
C FRANAM(N,A)        NAME OF THE N'TH CONSTITUENT, UP TO 15 CHARACTERS.   D1790
C H2O(P)             NET GAIN OR LOSS OF WATER THROUGH THE P'TH CHANNEL   D1795
C                    (CUBIC METERS).                                      D1800
C H2OQQQ(P)          CHANGE PER TIME UNIT IN H2O(P).                      D1805
C H2OTOT             NET CHANGE OF WATER IN THE SYSTEM (CUBIC METERS).    D1810
C HATCH              PROPORTION OF BIOMASS OR INDIVIDUALS                 D1815
C                    TO BE TRANSTERRED INTO THE NEXT ANIMAL COHORT.       D1820
C HATCOB(L)          CONSTANT TERM IN EXPRESSION FOR RATE OF TRANSFER     D1830
C                    INTO THE (L+1)'TH ANIMAL COHORT.                     D1835
C HATCON(L)          MULTIPLIER FOR TEMPERATURE DEPENDENCE OF RATE OF     D1840
C                    TRANSTER INTO THE (L+1)'TH ANIMAL COHORT.            D1845
C HIGH               ARBITRARILY HIGH VALUE TO INITIALIZE MINIMIZATIONS.  D1850
C IAFATE(L)          THE FATE OF DEAD BODIES OF THE L'TH ANIMAL COHORT.   D1855
C                    EQUALS THE LITTER CATEGORY NUMBER IF SUSPENDED OR IF D1860
C                    BENTHIC EQUALS THE LITTER CATEGORY NUMBER PLUS NOLIT. D1865
C IDAY               THE NUMBER OF THE CURRENT TIME UNIT.                 D1870
C IDAY1              INTEGRAL PART (DAYS) IN TIME AT COMMENCMENT OF THE   D1875
C                    TIME UNIT LOOP.                                      D1880
C IDAY2              INTEGRAL PART (DAY) IN THE TIME AT COMPLETION OF THE D1885
C                    TIME UNIT LOOP.                                      D1890
C IDUMP(II)          THE VALUE OF IDAY AT WHICH THE NEXT DUMP OF STATE    D1895
C                    VARIABLES IS TO BE MADE.                             D1900
C IMIN               ADDRESS OF A STATE VARIABLE WHICH IS INADEQUATE      D1905
C                    TO MEET A PROPOSED DECREMENT.                        D1910
C INFLOW             EQUALS 1 FOR SEEPAGE INFLOW AND 2 FOR NO SEEPAGE.    D1915
C INITYR             STARTING YEAR OF SIMULATION.                         D1920
C INORGD             THE NUMBER OF DISSOLVED INORGANIC CONSTITUENTS IN    D1925
C                    THE SYSTEM.                                          D1930
C INORGP             THE NUMBER OF PARTICULATE INORGANIC CONSTITUENTS IN  D1935
C                    THE SYSTEM.                                          D1940
C INSTRU(A)          SWITCH FOR THE A'TH INSTRUCTION TO BE TRANSFERRED TO D1945
C                    SUBROUTINES.                                         D1950
C IOUNIT             THE LOGICAL UNIT FOR THE NEXT DUMP OF                D1955
C                    STATE VARIALBES.                                     D1960
C IPARAM             THE ADDRESS IN THE COMMON BLOCK /PARAM/ FROM WHICH A D1965
C                    PRINT-OUT IS TO START.                               D1970
C IREP               THE SERIAL NUMBER OF THE NEXT TABULATED REPORT       D1975
C                    TO BE PRINTED.                                       D1980
C IRUN               RUN COUNTER FOR SENSITIVITY TESTS.                   D1985
C ISENSE             SWITCH, POSITIVE FOR SENSITIVITY TESTS.              D1990
C ISFATE(L)          THE FATE OF DEAD BODIES OF THE L'TH ANIMAL COHORT.   D1995
C                    EQUALS THE LITTER CATEGORY NUMBER IF SUSPENDED OR IF D2000
C                    BENTHIC EQUALS THE LITTER CATEGORY NUMBER PLUS NOLIT. D2005
C ISTRTM             THE NUMBER OF CATEGORIES OF INORGANIC MATERIAL.      D2010
C ISW                SWITCH FOR SENOUT SUBROUTINE.                        D2015
C IVFATE(I)          THE FATE OF DEAD BODIES OF THE I'TH ANIMAL COHORT.   D2020
C                    EQUALS THE LITTER CATEGORY NUMBER IF SUSPENDED OR IF D2025
C                    BENTHIC EQUALS THE LITTER CATEGORY NUMBER PLUS NOLIT. D2030
C IXFATE(L)          THE FATE OF DEAD BODIES OF THE L'TH ANIMAL COHORT.   D2035
C                    EQUALS THE LITTER CATEGORY NUMBER IF SUSPENDED OR IF D2040
C                    BENTHIC EQUALS THE LITTER CATEGORY NUMBER PLUS NOLIT. D2045
C IYR                STARTING YEAR.                                       D2050
C IYRDAY             CURRENT TIME UNIT, COUNTING FROM JANUARY 1.          D2055
C IYRDAZ             TEMPORARY STORAGE OF IYRDAY DURING TIME UNIT LOOP.   D2060
C JDAY               INITIAL DAY OF SIMULATION.                           D2065
C JDUMP              THE CURRENT ADDRESS IN IDUMP.                        D2070
C JFR                TEMPORARY STORAGE FOR JFROM.                         D2075
C JFROM              THE NUMBER OF DAYS A BLOCK OF INFLOWING              D2080
C                    CONSTITUENTS IS TO BE USED.                          D2085
C JKFROM             A SWITCH WHICH INDICATES THE USE OF A BLOCK OF       D2090
C                    INFLOWING CONSTITUENTS. 1=NO EXTRAPOLATION, 2=       D2095
C                    EXTRAPOLATION WITH THE NEXT DATA SET, 3=             D2100
C                    EXTRAPOLATION WITH THE PREVIOUS DATA SET, 4=         D2105
C                    EXTRAPOLATION WITH THE PREVIOUS AS WELL AS THE NEXT  D2110
C                    DATA SET.                                            D2115
C JPARAM             THE ADDRESS IN THE COMMON BLOCK /PARAM/ AT WHICH A   D2120
C                    PRINTOUT IS TO END.                                  D2125
C JSAVE              EQUALS ZERO IF VARIABLES FLOWING OUT OF THE SYSTEM   D2130
C                    ARE NOT TO BE SAVED, OR EQUALS THE LOGICAL UNIT      D2135
C                    NUMBER WHERE THE VALUES ARE TO BE STORED.            D2140
C KDAY               THE DAY ON WHICH THE SUBROUTINE WAS LAST CALLED.     D2145
C KDUMP              THE FINAL ADDRESS IN IDUMP.                          D2150
C KINRGD(A,N)        A'TH SWITCH WHEN ONE WHICH ALLOWS USE OF THE N'TH    D2155
C                    DISSOLVED INORGANIC CONSTITUENT.                     D2160
C KINRGP(A,N)        A'TH SWITCH WHEN ONE WHICH ALLOWS USE OF THE N'TH    D2165
C                    PARTICULATE INORGANIC CONSTITUENT.                   D2170
C KORGSW(A,N)        A'TH SWITCH WHEN ONE WHICH ALLOWS USE OF THE N'TH    D2175
C                    ORGANIC CONSTITUENT.                                 D2180
C LDEBUG             VALUE OF IDAY AT WHICH EXTRA OUTPUT IS TO CONCLUDE.  D2185
C LIGRAF(A)          DESIGNATION NUMBER OF THE A'TH VARIABLE TO BE GRAPHED D2190
C LIMACC             SIZE OF ARRAYS STNG,CHNG.                            D2195
C LIMEVR             SIZE OF ARRAY EVERY2.                                D2200
C LIMEXO             THE LAST WORD IN THE METEOR COMMON BLOCK REQUIRING   D2205
C                    REINITIALIZATION EVERY TIME EXTERN IS CALLED.        D2210
C LIMIT              SIZE OF ARRAYS STATE, DECINC.                        D2215
C LIMPRO             SIZE OF COMMON BLOCKS PRODUC,PRODCH,PRINTP.          D2220
C LIMSUM             SIZE OF COMMON BLOCK PVTOT.                          D2225
C LIMTOT             SIZE OF ARRAY SUMS.                                  D2230
C LISCOH(L)          THE NUMERICAL DESIGNATION OF THE L'TH ANIMAL COHORT. D2235
C LIVEAN(L)          THE HABITAT OF THE L'TH ANIMAL COHORT. 1=THE WATER   D2240
C                    COLUMN , 2=THE GRASS COMMUNITY, 3=THE BENTHOS.       D2245
C LISTER(A)          NUMBER OF CURVES TO BE INCLUDED IN THE A'TH GRAPH.   D2250
C LOOP               THE NUMBER OF TIMES THAT THE TIME UNIT LOOP          D2255
C                    HAS BEEN ATEMPTED WITHOUT BEING COMPLETED.           D2260
C MDEBUG             VALUE OF IDAY FROM WHICH EXTRA OUTPUT IS TO BEGIN.   D2265
C MGRA(A)            THE ADDRESS OF THE A'TH VARIABLE TO BE GRAPHED.      D2270
C MICROB             THE NUMBER OF MICROBIAL CATEGORIES IN THE SYSTEM.    D2275
C MIRRIG(D)          THE DATE OF THE D'TH WATER REMOVAL  EVENT.           D2280
C MONDAY(E)          THE NUMBER OF DAYS IN THE E'TH MONTH.                D2285
C MONEN2             TEMPORARY STORAGE OF MONTH DURING THE TIME UNIT LOOP. D2290
C MONEND             THE NUMBER OF DAYS FROM JAN.1 TO THE END OF          D2295
C                    THE CURRENT MONTH.                                   D2300
C MONTH              THE CURRENT MONTH OF THE YEAR.                       D2305
C MRAIN(D)           THE DATE OF THE D'TH RAIN EVENT (STARTING FROM THE   D2310
C                    BEGINNING OF THE FIRST YEAR).                        D2315
C MRAIN(I)           TIME UNITS (FROM BEGINNING OF FIRST YEAR) ON WHICH   D2320
C                    RAIN FALLS.                                          D2325
C MREP(A)            DATE OF A'TH REPORT.                                 D2330
C MRUNON(D)          THE DATE OF THE D'TH RUNON EVENT. (SURFACE FLOW).    D2335
C NCHAN              NUMBER OF CHANNELS FOR EXCHANGE WITH SURROUNDINGS.   D2340
C NCHECK             SWITCH TO INDICATE FIRST USE OF SUBROUTINES.         D2345
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C NCHOH(K)          NUMBER OF DEVELOPMENTAL CATEGORIES (COHORTS) OF THE       D2350
C                   K'TH ANIMAL SPECIES.                                      D2355
C NCOH(L)           NUMBER OF COHORTS IN THE L'TH ANIMAL SPECIES.             D2360
C NCOHCU(K)         THE STARTING ADDRESS IN LISCOH FOR THE K'TH ANIMAL        D2365
C                   SPECIES.                                                  D2370
C NCOHOR            NUMBER OF COHORT NAMES.                                   D2375
C NDATSZ            EQUALS ZERO IF INITIAL STATE VARIABLE DATA IS THE         D2380
C                   AMOUNT IN THE TOTAL ECOSYSTEM, OR ONE IF DATA IS          D2385
C                   AVERAGED TO A SQUARE METER.                               D2390
C NDAY              FINAL DAY OF SIMULATION.                                  D2395
C NDEBUG            SWITCH WHICH ALLOWS FOR EXTRA OUTPUT.                     D2400
C NDRIFA(L)         A SWITCH FOR THE L'TH ANIMAL COHORT. 1=PLANKTONIC         D2410
C                   LIKE ANIMAL, 2=AN ANIMAL THAT DRIFTS ONLY AS A            D2415
C                   FUNCTION OF SCOURING, 3=THE SAME AS 2 PLUS BEHAV-         D2420
C                   IORAL DRIFT, 4=A FREE SWIMMING ANIMAL.                    D2425
C NDRIFM(T)         A SWITCH FOR THE T'TH HETEROTROPHIC MICROORGANISM.        D2430
C                   1=PLANKTONIC, 2=ATTACHED, 3=BENTHIC.                      D2435
C NDRIFV(I)         A SWITCH FOR THE I'TH PLANT GROUP. 1=A PLANKTONIC         D2440
C                   LIKE PLANT, 2=A SESSILE PLANT.                            D2445
C NEWBEG            A SWITCH, A POSITIVE VALUE OF WHICH PERMITS THE STATE     D2450
C                   VARIABLES TO BE READ FROM LOGICAL UNIT 9 RATHER THAN      D2455
C                   FROM CARDS.                                               D2460
C NFRELM            NUMBER OF ORGANIC CONSTITUENTS CONSIDERED                 D2465
C                   (INCLUDES ENERGY).                                        D2470
C NGOA(L)           A SWITCH WHICH ALLOWS THE L'TH ANIMAL COHORT TO GO        D2475
C                   BOTH DOWNSTREAM + THROUGH IRRIGATION OUTLETS (IF 1),      D2480
C                   OR TO GO ONLY THROUGH OUTLETS (IF 2), OR TO GO ONLY       D2485
C                   DOWNSTREAM (IF 3).                                        D2490
C NGOL(M)           A SWITCH WHICH ALLOWS THE M'TH DETRITUS CATEGORY TO       D2495
C                   GO BOTH DOWNSTREAM + THROUGH IRRIGATION OUTLETS           D2500
C                   (IF 1), OR TO GO ONLY THROUGH OUTLETS (IF 2), OR TO       D2505
C                   GO ONLY DOWNSTREAM (IF 3).                                D2510
C NGONRP(M)         A SWITCH WHICH ALLOWS THE M'TH INORGANIC PARTICULATE      D2515
C                   DETRITUS CATEGORY TO GO BOTH DOWNSTREAM + THROUGH         D2520
C                   IRRIGATION OUTLETS (IF 1), OR GO ONLY THROUGH             D2525
C                   OUTLETS (IF 2), OR TO GO ONLY DOWNSTREAM (IF 3).          D2530
C NGOV(I)           A SWITCH WHICH ALLOWS THE I'TH PLANT CATEGORY TO GO       D2535
C                   BOTH DOWNSTREAM + THROUGH IRRIGATION OUTLETS (IF 1),      D2540
C                   OR TO GO ONLY THROUGH OUTLETS (IF 2), OR TO GO ONLY       D2545
C                   DOWNSTREAM (IF 3).                                        D2550
C NIRRIG            NUMBER OF DAYS ON WHICH WATER IS WITHDRAWN.               D2555
C NOCOL             NUMBER OF COLUMNS IN A HISTOGRAM.                         D2560
C NOGRAF            NUMBER OF LINE GRAPHS REQUIRED.                           D2565
C NOHIST            NUMBER OF BLOCK GRAPHS REQUIRED.                          D2570
C NOHISU            TOTAL NUMBER OF GRAPHS REQUIRED.                          D2575
C NOINST            NUMBER OF INSTRUCTIONS TO BE TRANSFERRED TO               D2580
C                   SUBROUTINES.                                              D2585
C NOLIT             NUMBER OF DETRITUS CATEGORIES.                            D2590
C NOLIT1            NOLIT + 1.                                                D2595
C NOREP             SWITCH FOR TABULATED REPORTS; 1 FOR OMISSION OF ALL       D2600
C                   BUT INITIAL REPORTS, 2 FOR OMISSION OF ALL, 3 FOR         D2605
C                   OMISSION OF THE INITIAL REPORT ONLY.                      D2610
C NORGAN            NUMBER OF ORGANS FOR EACH PLANT SPECIES.                  D2615
C NOSECS            A SWITCH WHICH PROVIDES FOR TIMING OF OUTPUT.             D2620
C                   OPERATIONS AND INCREMENTATIONS OF STATE VARIABLES.        D2625
C                   (0 CAUSES NO TIMING; 1 CAUSES TIMING OF OUTPUT            D2630
C                   OPERATIONS; 2 CAUSES TIMING OF OUTPUT OPERATIONS AND      D2635
C                   INCREMENTATION OPERATIONS).                               D2640
C NOSYM             NUMBER OF VARIABLES IN A SINGLE GRAPH.                    D2645
C NOTIME            NUMBER OF SUBROUTINES WITHIN DO-LOOPS.                    D2650
C NPORT             A SWITCH WHICH ALLOWS OUTPUT TO BE AVERAGED PER           D2655
C                   SQUARE METER (2) OR CUBIC METER (3).                      D2660
C NPOPTI            THE NUMERICAL DESIGNATION OF THE ORGANIC ELEMENT          D2665
C                   WHICH IS TO BE REPORTED AS MATERIALS ENTERING AND         D2670
C                   LEAVING THE ECOSYSTEM.                                    D2675
C NPRT(A)           SWITCH, WHEN 1, ALLOWS FOR PRINTING OF THE A'TH AREA      D2680
C                   OF OUTPUT.                                                D2685
C NRA               NUMBER OF RUNS FOR SENSITIVITY TESTS.                     D2690
C NRAIN             NUMBER OF DAYS ON WHICH PRECIPITATION IS RECORDED.        D2695
C NREP              NUMBER OF TABULATED REPORTS.                              D2700
C NREPET(A)         NUMBER OF REPETITIONS FOR THE A'TH SUBROUTINE.            D2705
C NRUNON            NUMBER OF DAYS ON WHICH SURFACE FLOW IS RECORDED.         D2710
C NSHORT            SWITCH TO INDICATE PROGRAM IS HALTED BY A FAILURE OF      D2715
C                   DECREMENTATION.                                           D2720
C NSI               THE NUMBER OF STREAM  POINT  FOR WHICH INPUT DATA         D2725
C                   IS READ. (MUST BE AT LEAST THREE).                        D2730
C NSO               THE NUMBER OF STREAM  POINT  USED IN ECOSYSTEM.           D2735
C NSPCOH            TOTAL NUMBER OF DEVELOPMENTAL CATEGORIES (COHORTS)        D2740
C                   OF ANIMAL SPECIES.                                        D2745
C NSPECA            NUMBER OF ANIMAL SPECIES CATEGORIES.                      D2750
C NSECB             THE NUMBER OF THE STREAM  POINT  WHICH STARTS THE         D2755
C                   ECOSYSTEM.                                                D2760
C NSECE             THE NUMBER OF THE STREAM  POINT  WHICH ENDS THE           D2765
C                   ECOSYSTEM.                                                D2770
C NSPECV            NUMBER OF PLANT SPECIES CATEGORIES.                       D2775
C NSTRCH            THE SECTION OF STREAM BEING SIMULATED.                    D2780
C NSUBST            EQUALS 1 PLUS 2 TIMES NOLIT.                              D2785
C NTRANE(H)         A SWITCH WHICH REGULATES EGG DEPOSITION 1= AS A           D2790
C                   FUNCTION OF TIME AND TEMPERATURE 2= A CONSTANT ABOVE      D2795
C                   A THRESHOLD TEMPERATURE 3= EGGS LAID ON THE WATER         D2800
C                   SURFACE. 4= NO EGGS LAID BY GROUP                         D2805
C NTRANS(H)         A SWITCH WHICH REGULATES THE TRANSFER OF THE H'TH         D2810
C                   ANIMAL COHORT 1=FRACTIONAL HATCHING DEPENDENT ON          D2815
C                   ACCUMULATED TEMPERATURES. 2= HATCHING AS A FUNCTION       D2820
C                   OF TEMPERATURE 3= SAME AS 1 WITH THE ANIMALS LEAVING      D2825
C                   THE SYSTEM 4= CHANGE AT THE END OF THE YEAR               D2830
C                   5= HATCHING AS A FUNCTION OF SIZE 6= NO TRANSFER          D2835
C                   FOR THE H'TH COHORT                                       D2840
C NTRIB             A SWITCH,ZERO FOR NO TRIBUTARIES, ONE IF INFLOW           D2845
C                   MATERIAL IS TO BE READ, TWO IF INFLOW MATERIAL FROM       D2850
C                   TRIBUTARIES IS TO BE CALCULATED AS A PERCENTAGE OF        D2855
C                   DOWNSTREAM FLOW.                                          D2860
C NUMMON            THE DATE WITHIN THE CURRENT MONTH.                        D2865
C NUMMO7            TEMPORARY STORAGE OF NUMMON DURING THE TIME UNIT LOOP     D2870
C NUNIT             TIME UNIT FOR SIMULATION IN THOUSANDTHS OF A DAY.         D2875
C NVDAY1(I)         THE FIRST JULIAN DAY OF SEED DISPERSAL OF THE             D2880
C                   I'TH SPECIES.                                             D2885
C NVDAY2(I)         THE LAST JULIAN DAY OF SEED DISPERSAL OF THE              D2890
C                   I'TH SPECIES.                                             D2895
C NVDRF8(I)         THE FIRST JULIAN DAY ON WHICH UPROOTED PARTS OF           D2900
C                   THE I'TH PLANT REMAIN VIABLE.                             D2905
C NVDRF9(I)         THE LAST JULIAN DAY ON WHICH UPROOTED PARTS OF THE        D2910
C                   I'TH PLANT REMAINS VIABLE.                                D2915
C NYRDAY            NUMBER OF TIME UNITS IN A YEAR.                           D2920
C NYRDAZ            TEMPORARY STORAGE OF NYRDAY DURING THE TIME UNIT LOOP     D2925
C OMORE(A)          VARIABLE EQUIVALENCED WITH COMMON/OTHER/.                 D2930
C ORGNAM(J,A)       NAME OF THE J'TH PLANT ORGAN (UP TO 24 CHARACTERS).       D2935
C ORIG              STARTING POINT FOR TIME UNIT OF SIMULATION.               D2940
C ORIGIN(B)         A SWITCH TO ALLOW THE B'TH GRAPH TO INCLUDE ZERO.         D2945
C PASUMA(N)         NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D2960
C                   CONSTITUENT FOR ALL ANIMAL COHORTS FROM THE               D2965
C                   BEGINNING OF THE SIMULATION.                              D2970
C PASUMS(K,N)       NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D2975
C                   CONSTITUENT FOR THE K'TH ANIMAL SPECIES FROM THE          D2980
C                   BEGINNING OF THE SIMULATION.                              D2985
C PATOTA(N)         NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D2990
C                   CONSTITUENT FOR ALL ANIMAL COHORTS FOR A TIME UNIT.       D2995
C PATOTS(K,N)       NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D3000
C                   CONSTITUENT FOR THE K'TH ANIMAL SPECIES FOR A TIME        D3005
C                   UNIT.                                                     D3010
C PBSUM(N)          NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D3015
C                   CONSTITUENT FOR ALL MICROORGANISMS FROM THE               D3020
C                   BEGINNING OF THE SIMULATION.                              D3025
C PBTOT(N)          NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D3030
C                   CONSTITUENT FOR ALL MICROORGANISMS FOR A TIME UNIT        D3035
C PCBACT(T,N)       NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D3040
C                   CONSTITUENT OF THE L'TH CATEGORY OF MICR-ORGANISMS        D3045
C                   FROM THE BEGINNING OF THE SIMULATION.                     D3050
C PCBIOM(L,N)       NET PRODUCTIVITY(GROWTH) OF THE N'TH CHEMICAL             D3055
C                   CONSTITUENT OF THE L'TH ANIMAL COHORT FROM THE            D3060
C                   BEGINNING OF THE SIMULATION.                              D3065
C PCVEG(I,J,N)      NET PRODUCTIVITY OF THE N'TH CHEMICAL CONSTITUENT OF      D3070
C                   THE J'TH ORGAN OF THE I'TH PLANT FROM THE BEGINNING       D3075
C                   OF THE SIMULATION.                                        D3080
C PERIM             WETTED STREAM PERIMETER.                                  D3085
C PERIOD            TIME INTERVAL PER COLUMN OF GRAPHS.                       D3090
C PERSED(P)         THE FRACTION OF THE P'TH PLANT SPECIES WHICH              D3095
C                   OVERWINTERS.                                              D3100
C PH                THE PH OF WATER IN THE ECOSYSTEM.                         D3105
C PHB               HYDROGEN ION CONCENTRATION IN THE BENTHOS.                D3110
C PHOTOP(E)         DAILY PHOTOPERIOD AVERAGED OVER THE E'TH MONTH            D3115
C                   (HOURS).                                                  D3120
C PHW               HYDROGEN ION CONCENTRATION IN THE WATER COLUMN.           D3125
C PINAM(M,A)        M'TH INORGANIC PARTICULATE NAME, UP TO 12 CHARACTERS.     D3130
C PINRTT(N)         N'TH TOTAL OF INORGANIC MATERIAL SUMMED OVER              D3135
C                   ALL PARTICULATE CATEGORIES.                               D3140
C PLACE(A)          HEADING FOR ALL OUTPUT.                                   D3145
C PLDEP(I)          THE MEAN PERCENTAGE OF DEPTH IN THE WATER OF THE          D3150
C                   I'TH PLANT SPECIES GROUP.                                 D3155
C PNORG(M,N)        THE AMOUNT OF THE N'TH INORGANIC CONSTITUENT IN THE       D3160
C                   M'TH PARTICULATE TYPE OF DETRITUS LEAVING THE SYSTEM      D3165
C                   (G./C.M.).                                                D3170
C POP(L)            POPULATION OF THE L'TH ANIMAL COHORT.                     D3175
C POPQQQ(L)         CHANGE DURING THE TIME UNIT IN POP(L).                    D3190
C POPSP(K)          POPULATION OF ALL COHORTS OF THE K'TH ANIMAL SPECIES      D3195
C                   GROUP (NUMBER PER SQ.M.).                                 D3200
C PRECIP            TOTAL PRECIPITATION ON THE SYSTEM. (CUBIC METERS).        D3205
C PREFA(L,LL)       PREFERENCE AND AVAILABILITY FACTOR FOR CONSUMPTION        D3210
C                   OF THE LL'TH ANIMAL                                       D3215
C                   SPECIES GROUP BY THE L'TH ANIMAL SPECIES GROUP.           D3220
C PREFL(K,M)        PREFERENCE AND AVAILABILITYFACTOR FOR CONSUMPTION OF      D3225
C                   THE M'TH TYPE                                             D3230
C                   OF SUSPENDED DETRITUS BY THE K'TH ANIMAL SPECIES          D3235
C                   GROUP.                                                    D3240
C PREFM(K,T)        PREFERENCE AND AVAILABILITY FACTOR FOR CONSUMPTION        D3245
C                   OF THE T'TH TYPE OF                                       D3250
C                   HETEROTROPHIC MICROORGANISMS BY THE K'TH ANIMAL           D3255
C                   SPECIES GROUP.                                            D3260
C PREFO(K,M)        PREFERENCE AND AVAILABILITY FACTOR FOR CONSUMPTION        D3265
C                   OF THE M'TH TYPE                                          D3270
C                   OF BOTTOM DETRITUS BY THE K'TH ANIMAL SPECIES GROUP.      D3275
C PREFRB(T,M)       PREFERENCE AND AVAILABILITY FACTOR BY THE T'TH TYPE       D3280
C                   OF HETEROTROPHIC MICROORGANISM FOR THE M'TH TYPE OF       D3285
C                   BENTHIC DETRITUS.                                         D3290
C PREFRF(T,M)       PREFERENCE AND AVAILABILITY FACTOR BY THE T'TH TYPE       D3295
C                   OF HETEROTROPHIC MICROORGANISM FOR THE M'TH TYPE OF       D3300
C                   SUSPENDED DETRITUS.                                       D3305
C PREFRW(T)         PREFERENCE AND AVAILABILITY FACTOR BY THE T'TH TYPE       D3310
C                   OF HETEROTROPHIC MICROORGANISM FOR DISSOLVED ORGANIC      D3315
C                   MATERIAL.                                                 D3320
C PREFV(K,I)        PREFERENCE AND AVAILABILITY FACTOR FOR CONSUMPTION        D3325
C                   OF THE I'TH PLANT                                         D3330
C                   SPECIES GROUP BY THE K'TH ANIMAL SPECIES GROUP.           D3335
C PRTOUT(A)         THE AMOUNT OF THE A'TH STATE VARIABLE FOR OUTPUT.         D3340
C PVSUM(N)          NET PRODUCTIVITY OF THE N'TH CHEMICAL CONSTITUENT         D3345
C                   FOR ALL PLANTS FROM THE BEGINNING OF THE SIMULATION.      D3350
C PRTP(A)           A'TH VARIABLE IN COMMON/PRINTP/.                          D3355
C PSTAT(A)          A'TH VARIABLE IN COMMON/PRODUC/.                          D3360
C PVTOT(N)          NET PRODUCTIVITY OF THE N'TH CHEMICAL CONSTITUENT         D3365
C                   FOR ALL PLANTS FOR A TIME UNIT.                           D3370
C Q7(A)             SEEPAGE LOSS OR INFLOW AT THE A'TH  POINT  OF             D3375
C                   STREAM. (CUBIC METERS)                                    D3380
C RADIA(E)          DAILY RADIATION INTENSITY AVERAGED OVER THE E'TH          D3385
C                   MONTH (KCAL./SQ.M./HR.).                                  D3390
C RAIN(A)           AMOUNT OF RAIN (IN MM.) ON THE A'TH TIME UNIT ON          D3395
C                   WHICH RAIN FALLS.                                         D3400
C RAIN(D)           THE AMOUNT (M.M.) OF RAIN ON THE D'TH RAIN EVENT.         D3405
C RAINCO(N)         THE MEAN ELEMENTAL COMPOSITION OF PRECIPITATION           D3410
C                   (GRAMS/CUBIC METER).                                      D3415
C RAINDI(N)         THE AMOUNT OF THE N'TH DISSOLVED INORGANIC                D3420
C                   CONSTITUENT ENTERING THE SYSTEM IN RAIN (GRAMS/CUBIC      D3425
C                   METER).                                                   D3430
C RCONST(M)         MAXIMUM FRACTION OF ANIMAL BIOMASS OF THE M'TH            D3435
C                   SPECIES OF ANIMALS WHICH IS EGGS.                         D3440
C REACH             THE LENGTH (METERS) OF THE SIMULATED STREAM SECTION.      D3445
C REPROD(L)         THE PROPORTION OF ADULT BIOMASS TRANSFERRED TO EGGS       D3450
C                   PER TIME UNIT IN THE L'TH AINMAL COHORT.                  D3455
C REQ(N)            TOTAL REQUIREMENT FOR THE N'TH CHEMICAL CONSTITUENT       D3460
C                   FOR PLANT GROWTH (G.PER DAY).                             D3465
C RESP              RATE OF RESPIRATION PER UNIT BIOMASS PER TIME UNIT        D3470
C                   FOR THE ANIMAL COHORT CURRENTLY UNDER CONSIDERATION.      D3475
C RESPC(I)          RESPIRATION RATE OF THE I'TH PLANT SPECIES GROUP AT       D3480
C                   ZERO TEMPERATURE. PROPORTION PER DAY.                     D3485
C RESPD(I)          LN (PROPORTIONAL INCREASE IN RESPIRATION RATE)            D3490
C                   PER DEGREE RISE IN TEMPERATURE OF THE I'TH PLANT          D3495
C                   SPECIES GROUP.                                            D3500
C RESPE(I)          DISPLACEMENT COEFFICIENT FOR RESPIRATION OF  THE          D3502
C                   I'TH PLANT SPECIES.                                       D3503
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C RESPI           RESPIRATION OF AN ANIMAL COHORT (G. CARBON. PER GRAM    D3505
C                 COHORT PER PROPORTION OF TIME WITHIN ECOSYSTEM IN A     D3510
C                 TIME UNIT).                                             D3515
C RESPM(T)        THE PROPORTION OF INTAKE OF THE T'TH TYPE OF HETERO-    D3520
C                 TROPHIC MICROORGANISM WHICH IS USED AS RESPIRATION.     D3525
C RESPV           CURRENT RESPIRATION RATE (PER DAY) OF THE PLANT         D3530
C                 SPECIES GROUP UNDER CONSIDERATION.                      D3535
C RUNDEB(K,N)     THE AMOUNT OF THE N'TH CHEMICAL CONSTITUENT IN THE      D3540
C                 K'TH DETRITUS TYPE IMPORTED WITH THE SURFACE FLOW.      D3545
C                 (GRAMS/CUBIC METER).                                    D3550
C RUNDIN(A,N)     N'TH DISSOLVED INORGANIC CONSTITUENT ENTERING THE       D3555
C                 SYSTEM ON THE A'TH RUN-ON EVENT.                        D3560
C RUNDNP(N)       THE AMOUNT OF THE N'TH DISSOLVED INORGANIC              D3565
C                 CONSTITUENT IMPORTED WITH SURFACE FLOW (GRAMS/CUBIC     D3570
C                 METER).                                                 D3575
C RUNMIN(D,N)     THE AMOUNT (GRAMS PER CUBIC METER) OF THE N'TH          D3580
C                 CONSTITUENT IN SOLUTION IMPORTED ON THE D'TH FLOW       D3585
C                 EVENT.                                                  D3590
C RUNON(D)        THE AMOUNT (GRAMS PER CUBIC METER) OF SURFACE FLOW      D3595
C                 ON THE D'TH EVENT.                                      D3600
C RUNORG(D,M,N)   THE AMOUNT OF THE N'TH CONSTITUENT (GRAMS PER CUBIC     D3605
C                 METER) IN THE M'TH DETRITUS TYPE ENTERING THE SYSTEM    D3610
C                 ON THE D'TH FLOW EVENT.                                 D3615
C RUNPIN(A,M,N)   N'TH INORGANIC CONSTITUENT OF THE M'TH PARTICULATE      D3620
C                 DETRITUS TYPE ENTERING THE SYSTEM ON THE A'TH           D3625
C                 RUN-ON EVENT.                                           D3630
C RUNPNR(A,N)     THE AMOUNT OF THE N'TH INORGANIC PARTICULATE            D3635
C                 CONSTITUENT IN THE A'TH DETRITUS SIZE CLASS IMPORTED    D3640
C                 WITH THE SURFACE FLOW (GRAMS/CUBIC METER).              D3645
C RUNSOL(K)       THE AMOUNT OF THE K'TH CHEMICAL CONSTITUENT IN          D3650
C                 SOLUTION IMPORTED WITH THE SURFACE FLOW                 D3655
C                 (GRAMS/CUBIC METER).                                    D3660
C SDRF2(M)        A COEFFICIENT USED IN CALCULATING THE FRACTIONAL        D3665
C                 PART OF THE M'TH INORGANIC PARTICULATE CATEGORY         D3670
C                 SCOURED BY FLOW.                                        D3675
C SDRF3(M)        A COEFFICIENT USED IN CALCULATING THE FRACTIONAL        D3680
C                 PART OF THE M'TH SUSPENDED INORGANIC PARTICULATE        D3685
C                 CATEGORY DEPOSITED IN A TIME UNIT.                      D3690
C SED             THE SUM OF CHEMICAL CONSTITUENTS IN SUSPENDED           D3695
C                 INORGANIC MATERIAL (USED TO CLACULATE LIGHT             D3700
C                 INTERCEPTION).                                          D3705
C SHELLS          PROPORTION OF BIOMASS TRANSFERRED TO DETRITUS AS        D3710
C                 CAST SKINS DURING A TRANSFER BETWEEN ANIMAL COHORTS.    D3715
C SHELP(L)        PROPORTION OF BIOMASS OF THE L'TH ANIMAL COHORT IN      D3720
C                 A TRANSFER BETWEEN ANIMAL                               D3725
C                 COHORTS WHICH CONSISTS OF CAST SKINS.                   D3730
C SI(A)           SLOPE OF CHANNEL AT THE A'TH  POINT  OF STREAM.         D3735
C STIEVEG(I,N)    THE RATE OF LEAKAGE OF THE N'TH                         D3740
C                 CHEMICAL CONSTITUENT IN THE I'TH PLANT SPECIES GROUP    D3745
C                 (PER DAY).                                              D3750
C SLOPE(L)        RATE OF INCREASE OF LOG (RESPIRATION RATE) WITH LOG     D3760
C                 (INDIVIDUAL BIOMASS) OF THE L'TH ANIMAL COHORT.         D3765
C SOLAVE          THE AVERAGE AMOUNT (GRAMS/CUBIC METER)OF A DISSOLVED    D3770
C                 CONSTITUENT IN THE SYSTEM IN A DAY.                     D3775
C SOURCE(J,P)     NAME OF THE P'TH CHANNEL (SEE 'AGAIN' ABOVE) FOR        D3780
C                 GAIN OR LOSS TO THE SYSTEM, UP TO 24 CHARACTERS.        D3785
C SPREQ(I,N)      REQUIREMENT FOR THE N'TH CHEMICAL CONSTITUENT FOR       D3790
C                 GROWTH BY THE I'TH PLANT SPECIES GROUP (G.PER DAY).     D3795
C STATE(A)        A'TH STATE VARIABLE (A.LE.LIMIT).                       D3800
C STNG(A)         A'TH ACCUMULATOR  IN COMMON BLOCK ACC   A.LE.LIMACC.    D3805
C STRHI(M)        THE WATER VELOCITY ABOVE WHICH THE M'TH INORGANIC       D3810
C                 PARTICULATE CATEGORY WILL BE SCOURED. (METERS PER       D3815
C                 SECOND)                                                 D3820
C STRLO(M)        THE WATER VELOCITY BELOW WHICH THE M'TH INORGANIC       D3825
C                 PARTICULATE CATEGORY WILL SETTLE OUT. (METERS PER       D3830
C                 SECOND)                                                 D3835
C STRNAM(M,A)     M'TH INORGANIC LITTER NAME, UP TO 12 CHARACTERS.        D3840
C SUM             WEIGHTED TOTAL OF FOODS AVAILABLE TO THE ANIMAL         D3845
C                 SPECIES GROUP CURRENTLY UNDER CONSIDERATION.            D3850
C SUMPR(A)        A'TH VARIABLE IN COMMON/LIMSUM/.                        D3855
C SUMS(A)         A'TH TOTAL (A.LE.LIMTOT).                               D3865
C TAKE(K)         MAXIMUM INTAKE OF CARBON PER UNIT BIOMASS CARBON        D3870
C                 PER TIME UNIT IN THE K'TH ANIMAL SPECIES GROUP,         D3875
C                 WHEN FOOD SUPPLY IS UNLIMITED.                          D3880
C TAKING          TOTAL FOOD INTAKE BY THE ANIMAL SPECIES GROUP           D3885
C                 CURRENTLY UNDER CONSIDERATION.                          D3890
C TCOMPN(N)       CONCENTRATION OF THE N'TH DISSOLVED ORGANIC             D3895
C                 CONSTITUENT BEING ADDED TO THE SYSTEM FROM              D3900
C                 TRIBUTARY INFLOW (GRAMS/CUBIC METER).                   D3905
C TDETIN(K,N)     CONTENT(GRAMS/CUBIC METER) OF THE N'TH ORGANIC          D3910
C                 CONSTITUENT IN THE K'TH CATEGORY OF DETRITUS BEING      D3915
C                 ADDED TO THE SYSTEM FROM TRIBUTARY INFLOW.              D3920
C TDNORG(N)       THE AMOUNT OF THE N'TH INORGANIC DISSOLVED              D3925
C                 CONSTITUENT ENTERING THE SYSTEM FROM TRIBUTARY INFLOW   D3930
C                 (GRAMS/CUBIC METER).                                    D3935
C TDRIFA(L,N)     THE AMOUNT OF THE N'TH CONSTITUENT OF THE L'TH ANIMAL   D3940
C                 COHORT ENTERING THE ECOSYSTEM FROM THE TRIBUTARY        D3945
C                 INFLOW (GRAMS/CUBIC METER).                             D3950
C TDRIFM(I,N)     THE AMOUNT OF THE N'TH CONSTITUENT IN THE I'TH TYPE     D3955
C                 OF MICROORGANISM ENTERING THE SYSTEM FROM TRIBUTARY     D3960
C                 INFLOW (GRAMS/CUBIC METER).                             D3965
C TDRIFO(L)       THE NUMBER OF THE L'TH ANIMAL COHORT IN THE INFLOWING   D3970
C                 WATER (PER CUBIC METER).                                D3975
C TDRIFV(I,J,N)   THE AMOUNT OF THE N'TH CONSTITUENT OF THE I'TH PLANT    D3980
C                 GROUP AND THE J'TH ORGAN TYPE ENTERING THE ECOSYSTEM    D3985
C                 FROM THE TRIBUTARY INFLOW (GRAMS/CUBIC METER).          D3990
C TEMPB           TEMPERATURE OF THE BENTHOS.(DEGREES CENTIGRADE)         D3995
C TEMCON(L)       COEFFICIENT FOR TEMPERATURE DEPENDENCE OF TRANSFER      D4000
C                 INTO THE (L+1)'TH ANIMAL COHORT.                        D4005
C TEMPW           TEMPERATURE OF THE WATER COLUMN.(DEGREES CENTIGRADE)    D4010
C TFLOW           THE AMOUNT OF WATER ENTERING THE SYSTEM FROM            D4015
C                 TRIBUTARIES (CUBIC METERS/DAY).                         D4020
C THRESH(L)       THE LOWER THRESHOLD VALUE OF TEMPERATURE OR             D4025
C                 ACCUMULATED TEMPERATURES FOR TRANSFER INTO THE          D4030
C                 (L+1)'TH ANIMAL COHORT.                                 D4035
C TIME            TIME EXPIRED SINCE LAST INQUIRY.                        D4040
C TIMER           TIME EXPIRED SINCE LAST INQUIRY.                        D4045
C TITLE (A)       TITLE OF A GRAPH - (UP TO 80 CHARACTERS).               D4050
C TITLES (A,B)    TITLE OF THE A'TH GRAPH, UP TO 80 CHARACTERS            D4055
C                 (A.LE.20).                                              D4060
C TMAX(H)         TEMPERATURE AT MAXIMUM INGESTION FOR THE H'TH ANIMAL    D4065
C                 COHORT.                                                 D4070
C TOPT(H)         TEMPERATURE AT MAXIMUM GROWTH FOR THE H'TH ANIMAL       D4075
C                 COHORT.                                                 D4080
C TOT(N)          CONTENT OF THE N'TH CHEMICAL CONSTITUENT IN ALL         D4090
C                 DETRITUS.                                               D4095
C TOTAL(N)        TOTAL OF N'TH CONSTITUENT IN WHOLE ECOSYSTEM.           D4100
C TOTLIT(M)       TOTAL AMOUNT OF A CONSTITUENT OF THE M'TH SUSPENDED     D4105
C                 DETRITUS CATEGORY IN THE SYSTEM IN A DAY(GRAMS).        D4110
C TOTNAM          HEADING FOR TOTAL COLUMNS.                              D4115
C TOTNRP(M)       TOTAL AMOUNT OF INORGANIC PARTICULATE MATTER IN THE     D4120
C                 N'TH DETRITUS SIZE CLASS IN THE SYSTEM IN A DAY         D4125
C                 (GRAMS).                                                D4130
C TOTSOL          TOTAL AMOUNT OF A DISSOLVED CONSTITUENT IN THE          D4135
C                 SYSTEM IN A DAY (GRAMS).                                D4140
C TPNORG(M,N)     THE AMOUNT OF THE N'TH INORGANIC CONSTITUENT IN THE     D4145
C                 N'TH PARTICULATE TYPE ENTERING THE SYSTEM FROM          D4150
C                 TRIBUTARY INFLOW (GRAMS/CUBIC METER).                   D4155
C TRBFAC          FACTOR RELATING    THE AMOUNT OF STATE VARIABLES        D4160
C                 ENTERING THE SYSTEM FROM TRIBUTARY INFLOW TO THOSE      D4165
C                 ENTERING AS DOWNSTREAM FLOW.                            D4170
C TRFLOW          AMOUNT OF WATER ADDED TO THE ECOSYSTEM FROM             D4175
C                 TRIBUTARIES (CUBIC METERS/SEC).                         D4180
C UNIT            TIME UNIT FOR SIMULATION IN DAYS.                       D4185
C UPCON(I,N)      UPTAKE OF THE N'TH CONSTITUENT BY THE I'TH PLANT        D4190
C                 SPECIES GROUP, PER UNIT BIOMASS CARBON, PER TIME        D4195
C                 UNIT, AND PER UNIT BY WHICH THE INTERNAL RATIO OF       D4200
C                 THIS CONSTITUENT FALLS BELOW THAT WHICH WOULD BE IN     D4205
C                 EQUILIBRIUM WITH THE EXTERIOR.                          D4210
C UPCON1(I,N)     MAXIMUM VALUE FOR RATIO OF THE N'TH CONSTITUENT TO      D4215
C                 CARBON IN THE I'TH PLANT SPECIES  GROUP                 D4220
C UPCON2(I,N)     CURVATURE FACTOR FOR RELATION OF INTERNAL TO            D4225
C                 EXTERNAL CONCENTRATION, FOR THE N'TH CONSTITUENT IN     D4230
C                 THE I'TH PLANT SPECIES GROUP.                           D4235
C UPTHRE(L)       UPPER TRHESHOLD VALUE OF TEMPERATURE FOR TRANSFER       D4240
C                 INTO THE L'TH ANIMAL COHORT.                            D4245
C VDRF1           THE PERCENTAGE OF THE PLANT SPECIES IN QUESTION         D4250
C                 WHICH IS UPROOTED AS A FUNCTION OF VELOCITY.            D4255
C VDRF2(I)        A COEFFICIENT USED IN CALCULATING THE AMOUNT OF         D4260
C                 SESSILE PLANTS OF THE I'TH SPECIES UPROOTED AS A        D4265
C                 FUNCITON OF VELOCITY.                                   D4270
C VDRF3(I)        THE FLOW BELOW WHICH NONE OF THE I'TH PLANT SPECIES     D4275
C                 WILL BE UPROOTED.                                       D4280
C VDRF4           THE AMOUNT(GRAMS) OF THE PLANT SPECIES IN QUESTION      D4285
C                 WHICH IS UPROOTED.                                      D4290
C VDRF5           THE AMOUNT OF SEEDS WASHED OUT OF THE SYSTEM.           D4295
C VDRF6           THE PERCENTAGE OF UPROOTED VEGETATION WHICH REMAINS     D4300
C                 VIABLE.                                                 D4305
C VDRF7(I)        THE MAXIMUM PERCENTAGE OF THE I'TH UPROOTED PLANT       D4310
C                 WHICH REMAINS VIABLE.                                   D4315
C VDRF10          THE AMOUNT OF UPROOTED VEGETATION REMAINING             D4320
C                 VIABLE (INCLUDES SEED DISPERSAL).                       D4325
C VDRF11(I)       THE PERCENTAGE OF THE I'TH PLANT WASHED OUT OF THE      D4330
C                 SYSTEM AS SEEDS OR VIABLE PLANT PARTS (BETWEEN          D4335
C                 NVDAY1 AND NVDAY2).                                     D4340
C VDRF13          UPROOTED PLANTS DYING AND ENTERING THE LITTER (TOTAL)   D4345
C VDRF14          UPROOTED PLANTS DYING AND ENTERING THE LITTER           D4350
C                 (G./CUBIC METER).                                       D4355
C VDRF15(I)       THE PERCENTAGE OF VIABLE PLANTS DRIFTING THRU THE       D4360
C                 SYSTEM WHICH REMAIN IN THE SYSTEM.                      D4365
C VEGCO           TIME FOR VEGET SUBROUTINE SINCE COMMENCEMENT OF THE     D4370
C                 TIME UNIT LOOP.                                         D4375
C VEGINC          TIME UNIT FOR SIMULATION IN VEGET SUBROUTINE.           D4380
C VELOCT          WATER VELOCITY (METERS/SEC).                            D4385
C VSPAS(I)        COEFFICIENT FOR THE I'TH PLANT SPECIES FOR GROWTH       D4387
C                 DEPENDENCE ON SPACE.                                    D4388
C VSPNAM(I,A)     NAME OF THE I'TH PLANT SPECIES (UP TO 28 CHARACTERS).   D4390
C VTDEDS(P)       SLOPE FOR CALCULATING PLANT DEATH AS A FUNCTION OF      D4395
C                 TEMPERATURE.                                            D4400
C VTDEDY(P)       THE FRACTION OF THE P'TH PLANT SPECIES WHICH DIES AT    D4405
C                 ZERO DEGREES CENTIGRADE.                                D4410
C WATDAY          THE AMOUNT OF WATER IN THE SYSTEM ON THE IYRDAY-1       D4415
C                 DAY.                                                    D4420
C WATIRR(D)       THE QUANTITIES OF WATER WITHDRAWN (CUBIC METERS)        D4425
C                 ON THE D'TH EVENT.                                      D4430
C WATSYS          THE AMOUNT OF WATER IN THE SYSTEM (CUBIC METERS).       D4435
C WATTOT          TOTAL AMOUNT OF WATER IN THE SYSTEM IN A DAY            D4445
C                 (CUBIC METERS).                                         D4450
C WDINR(N)        CONTENT OF THE N'TH INORGANIC CONSTITUENT DISSOLVED     D4455
C                 IN THE WATER COLUMN.                                    D4460
C WDINRQ(N)       CHANGE DURING THE TIME UNIT IN WDINR(N).                D4465
C WDINRT(K)       TOTAL FOR THE K'TH DISSOLVED INORGANIC CONSTITUENT.     D4470
C WETFAC          A FACTOR USED TO CALCULATE WET WEIGHT OF LITTER         D4475
C                 FROM LITTER CARBON                                      D4480
C WIDTH           MEAN WIDTH OF SIMULATED STREAM SECTION.                 D4485
C WIRRIG          THE AMOUNT OF WATER WITHDRAWN ON THE CURRENT DAY        D4490
C                 (CUBIC METERS).                                         D4495
C WMAX(H)         THE MAXIMUM WEIGHT(GRAMS CARBON)OF THE H'TH ANIMAL      D4500
C                 COHORT.                                                 D4505
C WMIN(H)         THE MINIMUM WEIGHT(GRAMS CARBON)OF THE H'TH ANIMAL      D4510
C                 COHORT.                                                 D4515
C WPINR(M,N)      CONTENT OF THE N'TH INORGANIC CONSTITUENT OF THE        D4520
C                 M'TH TYPE OF SUSPENDED PARTICULATE MATTER.              D4525
C WPINRQ(M,N)     CHANGE DURING THE TIME UNIT IN WPINR(M,N).              D4530
C WPINRT(N)       TOTAL AMOUNT OF THE N'TH PARTICULATE INORGANIC          D4535
C                 CONSTITUENT.                                            D4540
C XBEG            THE DISTANCE, IN METERS, FROM AN ARBITRARY POINT        D4545
C                 UPSTREAM TO THE BEGINNING OF THE FIRST SECTION.         D4550
C XCOMPN(N)       THE MEAN CONCENTRATION OF THE N'TH DISSOLVED CHEMICAL   D4555
C                 CONSTITUENT IN THE INFLOWING WATER. (GRAMS/CUBIC        D4560
C                 METER)                                                  D4561
C XCRSOL(L)       THE PROPORTION OF THE L'TH ANIMAL COHORTS EXCRETION     D4565
C                 GOING INTO THE WATER COLUMN AS DISSOLVED CONSTITUENTS   D4570
C XDETIN(K,N)     CONTENT (IN G. PER CUBIC METER) OF THE N'TH             D4575
C                 CONSTITUENT IN THE K'TH CATEGORY OF FLOATING            D4580
C                 DETRITUS IN THE INFLOWING WATER.                        D4585
C XDNORG(N)       THE AMOUNT OF THE N'TH DISSOLVED INORGANIC              D4590
C                 CONSTITUENT ENTERING THE SYSTEM AS DRIFT (G./C.M.).     D4595
C XDOT(A)         IN A BLOCK GRAPH, VALUE FOR THE A'TH COLUMN.            D4600
C XDRIFA(L,N)     THE AMOUNT OF THE N'TH CONSTITUENT OF THE L'TH          D4605
C                 ANIMAL COHORT ENTERING (G./CUBIC METER) THE             D4610
C                 ECOSYSTEM BY DRIFT.                                     D4615
C XDRIFM(I,N)     THE AMOUNT OF THE N'TH CONSTITUENT IN THE I'TH          D4620
C                 TYPE OF MICROORGANISM ENTERING (G./CUBIC METER)         D4625
C                 THE ECOSYSTEM BY DRIFT.                                 D4630
C XDRIFO(L)       THE NUMBERS OF THE L'TH ANIMAL COHORT IN THE            D4635
C                 INFLOWING WATER (PER CUBIC METER).                      D4640
C XDRIFV(I,J,N)   THE AMOUNT OF THE N'TH CONSTITUENT OF THE I'TH          D4645
C                 PLANT SPECIES GROUP AND THE J'TH ORGAN TYPE             D4650
C                 ENTERING (G./CUBIC METER) THE ECOSYSTEM BY DRIFT.       D4655
C XI(A)           THE X COORDINATE FOR THE A'TH SET OF DATA.              D4660
C XINC            DISTANCE BETWEEN STREAM SECTIONS. (IN METERS).          D4665
C XMAX            MAXIMUM VALUE FOR X AXIS IN A GRAPH.                    D4670
C XMIN            MINIMUM VALUE FOR X AXIS IN A GRAPH.                    D4675
C XPH             HYDROGEN ION CONCENTRATION OF THE WATER ENTERING        D4680
C                 THE SYSTEM.                                             D4685
C XPNORG(M,N)     THE AMOUNT OF THE N'TH INORGANIC CONSTITUENT            D4690
C                 IN THE M'TH PARTICULATE TYPE OF DETRITUS ENTERING       D4695
C                 THE SYSTEM AS DRIFT (G./C.M.).                          D4700
C XTITLE(J)       TITLE FOR THE X AXIS OF A GRAPH, UP TO 40 CHARACTERS.   D4705
C XWTEMP          WATER TEMPERATURE OF INCOMING WATER.                    D4710
C YAXISS(I,J)     TITLE OF THE Y AXIS IN THE I'TH GRAPH (UP TO 40         D4715
C                 CHARACTERS).                                            D4720
C YDOT            NOT USED.                                               D4725
C YMAX            MAXIMUM VALUE FOR Y AXIS IN A GRAPH.                    D4730
C YMIN            MINIMUM VALUE FOR Y AXIS IN A GRAPH.                    D4735
C YSTART          THE CONTROL DEPTH AT THE LAST SECTION OF STREAM.        D4740
C YTITLE(A)       TITLE FOR THE Y AXIS OF A GRAPH, - UP TO 40             D4745
C                 CHARACTERS.                                             D4750
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APPENDIX B

Listing of the MAIN Program

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C     AQUATIC     MAIN
      DIMENSION NEGATE(20),PLACE(20),DECJAN(12),LIGRAF(80)
      DIMENSION AMAXI(40),AMINI(40),FIGS(80,70),EXPLAN(5,80)
      DIMENSION STATE(354),DECINC(354),SUMS(167),PRTOUT(354)
      DIMENSION MREP(20)            ,ORIGIN(40),EVERY2(17)
      DIMENSION TITLES(40,20),YAXISS(40,10),LISTER(40),IDUMP(5)
      DIMENSION MGRA(8),FLOGO(307),STNG(221),CHNG(221)
      DIMENSION PSTAT(204),DECP(204),PRTP(204),SUMPP(144),OMORE(40)
C-----------------------------------------------------------------
C     COMMON BLOCK /TOTALS/ CONTAINS SUMS OF THE STATE VARIABLES,
C     TOGETHER WITH CERTAIN OTHER VARIABLES REQUIRING INITIALIZATION
C     BUT NOT INCREMENTATION AT EACH TIME UNIT.
C-----------------------------------------------------------------
      COMMON/TOTALS/CVEGV(1,4),CVEGO( 8,4),CVEGVO(4),BPTNRT( 6),
     1WPINRT( 6),PINRTT( 6),AQUATT(4),WDTNRT( 6),
     2                  CBIOMA(4),CLITT(4),CORGT(4),
     3TOT(4), POPSP(15),ANIM(15,4),CBACTT(4),TOTAL(4)
C-----------------------------------------------------------------
C     COMMON BLOCKS/PROSUM/,/PRODUC/,/PRODCH/ DEAL WITH PRODUCTIVITY
C     IN THE SYSTEM.
C-----------------------------------------------------------------
      COMMON/PROSUM/PVTOT(4),PBTOT(4),PATOTS(15,4),PATOTA(4),PVSUM(4),
     1PBSUM(4),PASUMS(15,4),PASUMA(4)
      COMMON/PRODUC/PCVEG( 8,1,4),PCBIOM(40,4),PCBACT(3,4)
      COMMON/PRODCH/CVEGP( 8,1,4), CBIOMP(40,4),CBACTP(3,4)
C-----------------------------------------------------------------
C     COMMON BLOCKS/PRINTS/ AND /PRINTP/ ARE STATE VARIABLES CONVERTED
C     TO OUTPUT UNITS.
C-----------------------------------------------------------------
      COMMON/PRINTP/APVEG( 8,1,4),APBIOM(40,4),APBACT(3,4)
      COMMON/PRINTS/ACVEG( 8,1,4),ACORG(5,4),APOP(40),ACBIOM(40,4),
     1AAQUA(4),ACLIT(5,4),ACBACT(3,4),AAQUAB(4),
     2AWDINR( 5),AWPINR(5, 6),ABDINR( 6),ABPINR(5, 6)
      COMMON/EVERY1/AGAINT(4),H2OTOT,CGAINT( 6),DGAINT( 6)
      COMMON/OTHER/AVEIND(40)
C-----------------------------------------------------------------
C     THE COMMON BLOCK /NAMES/ CONTAINS THE NAMES REQUIRED FOR
C     TABULATED OUTPUT
C-----------------------------------------------------------------
      COMMON/NAMES/COHNAM(26,4),BACNAM(3,4),VSPNAM( 8,7),ASPNAM(15,7),
     1ORGNAM(1,6),FRANAM( 4,3),ALINAM(5,4),DINAM( 6,3),PINAM( 6,3)
     2,STRNAM(5,3)
C-----------------------------------------------------------------
C     COMMON BLOCK /ACC/ CONTAINS ACCUMULATED CHANGES, WHICH MAY BE
C     NEGATIVE.  COMMON BLOCK /ACCINC/ CONTAINS THE INCREMENTS TO THE
C     ARRAYS IN /ACC/ FOR A SINGLE TIME UNIT.
C-----------------------------------------------------------------
      COMMON/ACC/AGAIN(13,4),H2O(13),CGAIN(13, 6),DGAIN(13, 6)
      COMMON/ACCINC/AGAINQ(13,4),H2OQQQ(13),CGAINQ(13, 6),DGAINQ(13, 6)
C-----------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------
      COMMON/SPEC/         NCHAN,INSTRU(20),    WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,IDAY, ATOT, ATOTO,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR                 ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,               MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST, CYCLE,                NOLIT1,LOOP,         IRUN,SOURCE(5,13)
     5,IDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C-----------------------------------------------------------------
C     COMMON BLOCK /STAT/ CONTAINS THE STATE VARIABLES, AND /CHANGE/
C     THEIR INCREMENTS OR DECREMENTS FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------
      COMMON/STAT/CVEG( 8,1,4),CORG(5,4),POP(40),CBIOM(40,4),AQUA(4),
     1CLIT(5,4),CBACT(3,4),AQUAB(4),WDINR( 6),WPINR(5, 6),BDINR( 6)
     2,BPINR(5, 6)
      COMMON/CHANGE/CVEGQQ( 8,1,4),CORGQQ(5,4),POPQQQ(40),CBIOMQ(40,4)
     1,AQUAQQ(4),CLITQQ(5,4),CBACTQ(3,4),AQUABQ(4),
     2WDINRQ( 6),WPINRQ(5, 6),BDINRQ( 6),BPINRQ(5, 6)
C-----------------------------------------------------------------
C     COMMON BLOCK /DIAGR/ CONTAINS INFORMATION REQUIRED FOR GRAPHS.
C-----------------------------------------------------------------
      COMMON/DIAGR/FIG(8,70),EXPLA(5,8),TITLE(20),YTITLE(10),
     1 XDOT(71), XMAX, XMIN, YMAX, YMIN, NOSYM, INITYR
C-----------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------
      COMMON/METEOR/WIRRIG,     PUNSOL(4),PUNDER(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4),TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6),TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RAINCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)    ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4) ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP,
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
C-----------------------------------------------------------------
C     COMMON BLOCK /PARAM/ CONTAINS THE VALUES OF PARAMETERS USED BY THE
C     PROCESS SUBROUTINES.
C-----------------------------------------------------------------
      COMMON/PARAM/P(4147)
      EQUIVALENCE (STNG,AGAIN),(CHNG,AGAINQ),(PRTOUT,ACVEG)
      EQUIVALENCE (STATE, CVEG), (DECINC, CVEGQQ) , (SUMS,CVEGV)
      EQUIVALENCE(FLOSEC,FLOGO) ,(AGAINT,EVERY2)
      EQUIVALENCE(PRTP,APVEG),(PSTAT,PCVEG),(OMORE,AVEIND),(DECP,CVEGP)
      EQUIVALENCE (SUMPP,PVTOT)
      DATA DECJAN/'JAN','FEB','MAR','APR','MAY','JUNE','JULY','AUG',
     1 'SEPT','OCT','NOV','DEC'/,ZERO/'ZERO'/,ORIGIN/40*' '/
      DATA BLANK/' '/,NREPET/20*1/,NPASS/307/
      DATA/AMTCRO/.000000001/,NOCOL/70/,HIGH/1.E20/,LIMIT/354/
      DATA LIMTOT/167/,LIMACC/221/ ,LIMEVR/17/
      DATA MONDAY/31,28,31,30,31,30,31,31,30,31,30,31/
      DATA NYRDAY/365/              ,IRUN/1/,LIMPRO/204/,LIMSUM/144/
      DATA NCHAN/13/,MA/0/,[illegible],JY/2/,NCHECK/0/,LIMGRA/80/
      TIME = EXTIME(0)
   10 FORMAT (////)
      WRITE (6,10)
   20 READ (5,250) (STATE(I), I=1,20)
      WRITE(6,260) (STATE(I),I = 1,20)
      DO 30 I = 1, 20
      IF (STATE(I).NE.BLANK) GO TO 20
   30 CONTINUE
      DO 40 I=1,LIMPRO
   40 DECP(I)=0.
      DO 50 I = 1, LIMIT
   50 DECINC(I) = 0.
      DO 60 I=1,LIMACC
      STNG(I)=0.
   60 CHNG(I) = 0.
C-----------------------------------------------------------------
C     A HEADING IS READ IN FOR TABULAR OUTPUT
C-----------------------------------------------------------------
      READ(5,250)  (PLACE(I), I=1,20)
C-----------------------------------------------------------------
C     SPECIFICATIONS, SWITCHES AND INSTRUCTIONS ARE READ IN
C-----------------------------------------------------------------
      READ (5,220) NSPECV,NSPECA,NORGAN,INORGP,INORGD,NOLIT,NCOHOR,
     1        MICRO8,NUNIT,NOINST,NOTIME,ISTRTM,NSTRCH,JSAVE,NFRELM
     2 ,NTRIB
      READ (5,220) JDAY, IYR, NDAY, NREP, NOGRAF, NOHIST,NPORT,NDAISZ
     1 ,NPORTI
      READ(5,220) MDEBUG,LDEBUG,NOSECS,ISENSE,NOREP,JSTATE,IPARAM,JPARAM
     1 ,NEWBEG,KDUMP,(IDUMP(I), I=1,KDUMP)
      NOHISU = NOGRAF + NOHIST
      IDAY = JDAY
      IDAYPR = JDAY - 1
      IF (NREP.GT.0) GO TO 70
      NREP = 1
      MREP(1) = NDAY
      GO TO 80
   70 READ (5,220) (MREP(I), I = 1, NREP)
   80 CONTINUE
      IF ((MDEBUG.GT.0).AND.(MDEBUG.LE.JDAY)) NDEBUG = 1
      IF (LDEBUG.LT.MDEBUG) LDEBUG = NDAY
      NSUBST = 1 + (2*NOLIT)
      NOLIT1 = NOLIT + 1
      IF (NUNIT.LE.0) NUNIT = 1000
      UNIT = FLOAT(NUNIT) * .001
      IF (NORGAN.LE.0)  NORGAN= 1

C.........INSTRUCTIONS TO PROCESS SUBROUTINES ARE PROVIDED
      IF (NOINST.GT.0) READ(5,220) (INSTRU(I),I=1,NOINST)
      IF (NOTIME.LE.0) GO TO 100

C.........FREQUENCY OF REPETITION OF PROCESS SUBROUTINES WITHIN A
C.........TIME UNIT IS SPECIFIED
      DO 90 I = 1, NOTIME
   90 READ (5,220) J, NREPET(J)
  100 VEGINC = UNIT/FLOAT(NREPET(1)) - .00001
      ANITNC = UNIT/FLOAT(NREPET(2)) - .00001
      AQUINC = UNIT/FLOAT(NREPET(3)) - .00001
      DO 110 I=1,5
  110 READ(5,220)(KORGSW(I,J),J=1,NFRELM)
      DO 120 I=1,5
  120 READ(5,220) (KINRGP(I,J),J=1,INORGP)
      DO 130 I=1,5
  130 READ(5,220) (KINRGD(I,J),J=1,INORGD)
      READ(5,230)(NPRT(I),I=1,26)
      READ(5,240) REACH
C-----------------------------------------------------------------
C     THE STAGES OF DEVELOPMENT FOR THE DIFFERENT ANIMAL SPECIES
C     GROUPS ARE SPECIFIED.
C-----------------------------------------------------------------
  140 IF (NSPECA.LE.0) GO TO 270
      IF (NCOHOR.GT.1) GO TO 160
      DO150 I = 1, NSPECA
      NCOHCU(I) = I
  150 NCOH(I) = 1
      GO TO 270

C.........THE NUMBER OF STAGES OF DEVELOPMENT FOR EACH ANIMAL GROUP
C.........ARE READ.
  160 READ(5,220)(NCOH(I),I=1,NSPECA)
      NCOHCU(1) = NCOH(1)
      K1=0
      DO 210 I = 1, NSPECA
      J=NCOH(I)
      IF (I.GT.1) NCOHCU(I) = NCOHCU(I-1) + J
      IF(J.LE.0) J=1
      IF(J.LE.NCOHOR)GO TO 180
      WRITE (6,170)I,NCOHOR
  170 FORMAT('ONUMBER OF COHORTS FOR SPECIES',I3,' EXCEEDS',I3)
      STOP
  180 K=K1+1
      K1=K1+J
      IF(J.LE.1) GO TO 210
      IF (J.LT.NCOHOR)GO TO 200

C.........IF THE NUMBER OF STAGES OF DEVELOPMENT FOR THIS SPECIES
C.........GROUP IS MORE THAN ONE AND LESS THAN THE MAXIMUM, THEY ARE
C.........SPECIFIED.
      DO 190 L=K,K1
  190 LISCOH(L)=L-K+1
      GO TO 210
  200 READ(5,220)(LISCOH(L),L=K,K1)
  210 CONTINUE
  220 FORMAT (16I5)
  230 FORMAT(80I1)
  240 FORMAT ( 8F10.2)
  250 FORMAT (20A4)
  260 FORMAT (1X, 20A4)
C-----------------------------------------------------------------
C     THE NAMES OF THE VARIOUS ECOSYSTEM COMPONENTS ARE READ IN.
C-----------------------------------------------------------------
  270 IF (NSPECV.GT.0)READ(5,280)((VSPNAM(I,J),J=1,7),I=1,NSPECV)
  280 FORMAT (19A4)
      IF (NSPECA.GT.0)READ(5,280)((ASPNAM(I,J),J=1,7),I=1,NSPECA)
      IF (NORGAN.LE.1) GO TO 300
      READ(5,290)((ORGNAM(I,J), J = 1, 6), I=1,NORGAN)
  290 FORMAT (18A4)
```

```
  300 READ (5,290)((FRANAM(I,J), J = 1,3), I=1,NFRELM)
      IF   (NCOHOR.GT.1) READ(5,250) ((COHNAM(I,J),J=1,4),I=1,NCOHOR)
      IF(NOLIT.GT.0)READ(5,250)((ALINAM(I,J),J=1,4),I=1,NOLIT)
      IF(MICROB.GT.0.0)
     1READ(5,250)((BACNAM(I,J),J=1,4),I=1,MICROB)
      IF(INORGP.GT.0) READ(5,290)((PINAM(I,J),J=1,3),I=1,INORGP)
      IF(INORGD.GT.0) READ(5,290)((DINAM(I,J),J=1,3),I=1,INORGD)
      IF (ISTRTM.GT.0)READ(5,290)((STRNAM(I,J),J=1,3),I=1,ISTRTM)
C-------------------------------------------------------------------
C     INITIAL VALUES FOR THE STATE VARIABLES ARE READ IN, FROM AN
C     INPUT FILE IF THE SWITCH NEWBEC IS POSITIVE, OTHERWISE FROM CARD
C     INPUT.
C-------------------------------------------------------------------
      IF   (NEWPEG.LE.0) GO TO 310
      REWIND 9
      READ (9) STATE
      GO TO 440
  310 IF (NSPECV.LE.0) GO TO 330

C..........PLANT CONSTITUENTS
      DO 320 I = 1, NSPECV
      DO 320 J = 1, NORGAN
      READ (5,240) (CVEG(I,J,K), K = 1, NFRELM)
  320 CONTINUE

  330 IF (NSPECA.LE.0) GO TO 350
      DO 340 K = 1, NSPECA
      K1=1
      IF(K.GT.1) K1=NCOHCU(K-1)+1
      K2=NCOHCU(K)

C..........ANIMAL POPULATIONS
      READ(5,240) (POP(J), J=K1,K2)
      DO340J=K1,K2

C..........ANIMAL CONSTITUENTS
  340 READ (5,240)(CBIOM(J,I), I = 1, NFRELM)
      NSPCOH=NCOHCU(NSPECA)
  350 IF(MICROB.LE.0.) GO TO 370
      DO 360 I=1,MICROB
  360 READ(5,240)(CBACT(I,K),K=1,NFRELM)
  370 IF (NOLIT.LE.0) GO TO 400

C..........CONSTITUENTS OF DEAD MATERIAL
      DO 380 I = 1, NOLIT
  380 READ (5,240) (CLIT(I,K), K = 1, NFRELM)
      DO 390 I=1,NOLIT
  390 READ (5,240) (CORG(I,K), K = 1, NFRELM)
  400 READ(5,240)(AQUA(K),K=1,NFRELM)
      READ(5,240)(AQUAB(K),K=1,NFRELM)
      IF(INORGP.LE.0)GO TO 430
      DO 410 I=1,ISTRTM
  410 READ(5,240)(WPINR(I,J),J=1,INORGP)
      DO 420 I=1,ISTRTM
  420 READ(5,240)(BPINR(I,J),J=1,INORGP)
  430 READ(5,240)(WDINR(I),I=1,INORGD)
      READ(5,240)(BDINR(I),I=1,INORGD)
C-------------------------------------------------------------------
C     PARAMETERS FOR THE BIOLOGICAL SUBROUTINES ARE READ.
C-------------------------------------------------------------------
  440 CALL EINPUT
      CALL PINPUT
      CALL MINPUT
      CALL AINPUT
      CALL VINPUT
      IF (NCHECK.EQ.0) GO TO 940
  450 IF (LOOP.LE.1) GO TO 470
      LOOP1 = LOOP - 1
      DO 460 I = 1, LOOP1
      IMIN = NEGATE(I)
      STATE(IMIN) = -STATE(IMIN) - AMICRO
  460 IF (ABS(STATE(IMIN)).LE.AMICRO) STATE(IMIN) = 0.
      IMIN = 0
  470 CONTINUE
      IF(NPORT.EQ.3) GO TO 480
      FACTR1=1./AREA
      GO TO 490
  480 FACTR1=1./WATSYS
C-------------------------------------------------------------------
C     THE STATE VARIABLES ARE TOTALLED
C-------------------------------------------------------------------

C..........THE TOTAL ARRAYS ARE INITIALIZED
  490 IF(NCHECK.EQ.0) GO TO 500
      IF((NOHISU.EQ.0).AND.(IDAY.NE.MREP(IREP)))GO TO 790
  500 DO 510 I = 1, LIMTOT
  510 SUMS(I) = 0.
      DO 520 I=1,LIMSUM
  520 SUMPR(I)=0
      DO 530 I=1,LIMEVR
  530 EVERY2(I)=0.
  540 IF (NSPECV.LE.0) GO TO 590

C..........PLANT STATE VARIABLES ARE TOTALLED
  550 DO 570 K = 1, NFRELM
      DO 570 I = 1, NSPECV
      DO 560 J = 1, NORGAN
      A = CVEG(I,J,K)
      CVEGO(I,K) = CVEGO(I,K) + A
  560 CONTINUE
      PVTOT(K)=PVTOT(K)+CVEGP(I,1,K)
      PVSUM(K)=PVSUM(K)+PCVEG(I,1,K)
  570 CVEGVO(K) = CVEGVO(K)+CVEGO(I,K)
      DO 580 J=1,NORGAN
      DO 580 K = 1, NFRELM
      DO 580 I = 1, NSPECV
  580 IF (CVEG(I,J,K).GT.0.) CVEGV(J,K) = CVEGV(J,K) + CVEG(I,J,K)

C..........DETRITUS CATEGORIES ARE TOTALLED
  590 DO 600 I = 1, NOLIT
      DO 600 K1 = 1, NFRELM
      CORGT(K1) = CORGT(K1) + CORG(I,K1)
  600 CLITT(K1) = CLITT(K1) + CLIT(I,K1)
      DO610 K = 1,NFRELM
  610 TOT(K) = CORGT(K)+ CLITT(K)

C..........MICROBIAL CATEGORIES ARE TOTALLED
  620 IF (MICROB.LE.0) GO TO 640
      DO 630 I=1,MICROB
      DO 630 K=1,NFRELM
      CBACTT(K) = CBACTT(K) + CBACT(I,K)
      PBTOT(K)=PBTOT(K)+CBACTP(I,K)
      PBSUM(K)=PBSUM(K)+PCBACT(I,K)
  630 CONTINUE
  640 IF (NSPECA.LE.0) GO TO 680

C..........ANIMAL STATE VARIABLES ARE TOTALLED
      DO 670 I = 1, NSPECA
      K1=1
      IF(I.GT.1) K1 = NCOHCU(I-1)+1
      K2 = NCOHCU(I)
      DO 670 J = K1, K2
      DO 660 K = 1, NFRELM
      A = CBIOM(J,K)
      C=PCBIOM(J,K)
      B=CBIOMP(J,K)
  650 ANIM(I,K)=ANIM(I,K)+ A
      PASUMS(I,K)=PASUMS(I,K)+C
      PATOTS(I,K)=PATOTS(I,K)+B
      CBIOMA(K) = CBIOMA(K) + A
      PATOTA(K)=PATOTA(K)+B
      PASUMA(K)=PASUMA(K)+C
  660 CONTINUE
      IF (POP(J).GT.0.) POPSP(I) = POPSP(I) + POP(J)
  670 CONTINUE
  680 CONTINUE
  690 CONTINUE

C..........INORGANIC CONSTITUENTS ARE TOTALLED
       DO 710 I=1, INORGP
      DO 700 J=1, ISTRTM
      BPINRT(I)=BPINRT(I)+BPINR(J,I)
  700 WPINRT(I)=WPINRT(I)+WPINR(J,I)
  710 PINRTT(I)=BPINRT(I)+WPINRT(I)+PINRTT(I)
      DO 720 I=1,NFRELM
  720 AQUATT(I)=AQUA(I)+AQUAB(I)
       DO 730 I=1, INORGD
  730 WDINRT(I)=WDINR(I)+BDINR(I)

C..........TOTALS FOR THE WHOLE SYSTEM ARE CALCULATED
      DO 740 K = 1, NFRELM
  740 TOTAL(K) = CBIOMA(K) + CVEGVO(K) + CBACTT(K) + TOT(K)+ AQUATT(K)
      DO 780 I=1,NCHAN
      H2OTOT=H2OTOT+H2O(I)
      DO 750 K=1,NFRELM
  750 AGAINT(K)=AGAINT(K)+AGAIN(I,K)
      DO 760 K=1,INORGP
  760 CGAINT(K)=CGAINT(K)+CGAIN(I,K)
      DO 770 K=1,INORGD
  770 DGAINT(K)=DGAINT(K)+DGAIN(I,K)
  780 CONTINUE
  790 CONTINUE
      IF((ISENSE.GT.0).AND.(IRUN.EQ.1))CALL SENSIT(IRUN,1,NRUN)
      IF(NCHECK.EQ.0) GO TO 800
      IF((NOHISU.EQ.0).AND.(IDAY.NE.MREP(IREP)))GO TO 940
C-------------------------------------------------------------------
C     OUTPUT VARIABLES ARE CALCULATED FROM STATE
C-------------------------------------------------------------------
  800 DO 810 I=1, LIMTOT
      SUMS(I)=SUMS(I)*FACTR1
  810 CONTINUE
      DO 820 I=1,LIMPRO
  820 DECP(I)=DECP(I)*FACTR1
      DO 830 I=1,LIMSUM
  830 SUMPR(I)=SUMPR(I)*FACTR1
      DO 840 I=1,NSPECV
      DO 840 J=1,NORGAN
      DO 840 K=1,NFRELM
      ACVEG(I,J,K)=CVEG(I,J,K)*FACTR1
      APVEG(I,J,K)=PCVEG(I,J,K)*FACTR1
  840 CONTINUE
      DO 850 I=1,NSPCOH
      DO 850 J=1, NFRELM
      ACBIOM(I,J)=CBIOM(I,J)*FACTR1
      APBIOM(I,J)=PCBIOM(I,J)*FACTR1
  850 CONTINUE
      DO 860 I=1,NSPCOH
      APOP(I)=POP(I)*FACTR1
  860 CONTINUE
      DO 870 I=1,MICROB
      DO 870 J=1,NFRELM
      ACBACT(I,J)=CBACT(I,J)*FACTR1
      APBACT(I,J)=PCBACT(I,J)*FACTR1
  870 CONTINUE
      DO 880 I=1,NOLIT
      DO 880 J=1,NFRELM
      ACLIT(I,J)=CLIT(I,J)*FACTR1
      ACORG(I,J)=CORG(I,J)*FACTR1
  880 CONTINUE
      DO 890 I=1,NFRELM
      AAQUA(I)=AQUA(I)*FACTR1
      AAQUAB(I)=AQUAB(I)*FACTR1
  890 CONTINUE
      DO 900 I=1,ISTRTM
      DO 900 J=1,INORGP
      AWPINR(I,J)=WPINR(I,J)*FACTR1
  900 ABPINR(I,J)=BPINR(I,J)*FACTR1
      DO 910 I=1, INORGD
      AWDINR(I)=WDINR(I)*FACTR1
  910 ABDINR(I)=BDINR(I)*FACTR1
      DO920 I=1,NSPCOH
      IF(APOP(I).LE.0.)AVEIND(I)=0.
      IF(APOP(I).LE.0.)GOTO920
      AVEIND(I)=ACBIOM(I,1)/APOP(I)
  920 CONTINUE
  930 IF(NCHECK.EQ.0) GO TO 1220
  940 IF(NSHORT.EQ.1)GO TO 1950
      IF (IMIN.GT.0) GO TO 1720
```

```
      IF (NCHECK.NE.0) GO TO 1740
C-----------------------------------------------------------------
C     THE DATE IS INITIALIZED
C-----------------------------------------------------------------
      INITYR = IYR
      IF (MOD(IYR,4).GT.0) GO TO 950
      MONDAY(2) = 29
      NYRDAY = 366
  950 IF (JDAY.LE.0) JDAY = 1
      IF (NDAY.LE.JDAY) NDAY = JDAY + 1
      K = 0
C-----------------------------------------------------------------
C     GRAPHING INSTRUCTIONS ARE READ
C-----------------------------------------------------------------
      NOHIS = NOGRAF+1
  960 IF (NOGRAF.LE.0) GO TO 1040

C..........INSTRUCTIONS FOR LINE GRAPHS
      DO 1030 I = 1, NOGRAF
      I1 = K + 1
      READ(5,220) (MGRA(J),J=1,8)
      DO 970 J = 1, 8
      IF (MGRA(J).LE.0) GO TO 980
      K = K + 1
      LIGRAF(K) = MGRA(J)
  970 CONTINUE
  980 LISTER(I) = K
      READ (5,250) (TITLES(I,J) , J = 1, 20)
      READ (5, 250) (YAXISS(I,J),J=1,10), ORIGIN(I)
      IF (K.LE.I1) GO TO 1010
      DO 1000 J = I1 ,K
      IF(J.LE.LIMGRA) GO TO 1000
      WRITE(6,990)
  990 FORMAT('0 CURVE EXPLANATIONS EXCEED DIMENSIONS ')
      STOP
 1000 READ (5,250) (EXPLAN(L,J), L = 1,5)
      GO TO 1030
 1010 DO 1020 J = 1,5
 1020 EXPLAN(J,I1) = BLANK
 1030 CONTINUE
 1040 IF (NOHIST.LE.0) GO TO 1070

C..........INSTRUCTIONS FOR BLOCK GRAPHS
      K1 = K + 1
      K2 = K + NOHIST
      READ (5,220) (LIGRAF(I), I = K1, K2)
      DO 1050 I = NOHIS,NOHISU
      READ (5,250) (TITLES(I,J), J = 1, 20)
 1050 READ (5,250) (YAXISS(I,J),J=1,10), ORIGIN(I)
 1060 FORMAT (' ',20A4)
C-----------------------------------------------------------------
C     SPECIFICATIONS OF TABULAR OUTPUT ARE INITIALIZED
C-----------------------------------------------------------------
 1070 J = 0
      DO 1080 I = 1, NREP
      IF ((MREP(I).LE.0).OR.(MREP(I).GT.NDAY)) GO TO 1080
      IF((I.GT.1).AND.(MREP(I).LE.MREP(I-1)))GO TO 1080
      J = J + 1
      MREP(J) = MREP(I)
 1080 CONTINUE
      NREP = J
      IF (J.EQ.0) GO TO 1090
      IF (MREP(J).EQ.NDAY) GO TO 1100
 1090 NREP = NREP + 1
      MREP(NREP) = NDAY
 1100 IREP = 1
      IF (NOHISU.LE.0) GO TO 1110
      XMIN = JDAY
      XMAX = NDAY
      PERIOD = (XMAX - XMIN)/69.
 1110 IDAY=JDAY
      IYRDAY = IDAY
C-----------------------------------------------------------------
C     IF REQUIRED, PART OF THE COMMON BLOCK /PARAM/ IS PRINTED OUT.
C-----------------------------------------------------------------
      IF (IPARAM.LE.0) GO TO 1140
      WRITE (6,1120) IPARAM, JPARAM
 1120 FORMAT('0COMMON BLOCK /PARAM/ FROM ADDRESS', I6,' TO ADDRESS',I6/)
      WRITE (6,1130) (P(I), I = IPARAM, JPARAM)
 1130 FORMAT (1X, 10G12.5)
 1140 IRUN = 1
      IF (ISENSE.EQ.0) GO TO 1160
C-----------------------------------------------------------------
C     IF SENSITIVITY TESTS ARE BEING PERFORMED, THE SUBROUTINE SENSIT
C     IS CALLED TO SET THE INITIAL CONDITIONS
C-----------------------------------------------------------------
 1150 IF(IRUN.EQ.1) GO TO 1160
      IDAYPR = JDAY - 1
      FRAC = 0.
      IMIN = 0
      IREP = 1
      CALL SENSIT(IRUN,NRA,NRUN)
      IDAY = JDAY
      IYRDAY = JDAY
      NCHECK = 0
 1160 CONTINUE
      NSHORT = 0
      LOOPER = -1
      IF (NOHISU.LE.0) GO TO 1180
C-----------------------------------------------------------------
C     LIMITS FOR THE GRAPHS ARE INITIALIZED
C-----------------------------------------------------------------
      DO 1170 I = 1, NOHISU
      AMINI(I) = HIGH
 1170 AMAXI(I) = -HIGH
 1180 FRAC = 0.
C-----------------------------------------------------------------
C     THE CALENDAR MONTH IS DETERMINED
C-----------------------------------------------------------------
      MONEND = 0
      MONTH = 0
      NUMMON = JDAY
 1190 MONTH = MONTH + 1
      MONEND = MONEND + MONDAY(MONTH)
```

```
      IF (MONTH.GT.1) NUMMON = NUMMON - MONDAY(MONTH-1)
      IF ( IYRDAY.GT.MONEND) GO TO 1190
      IF (IRUN.GT.1) GO TO 2030
C-----------------------------------------------------------------
C     THE SUBROUTINE EXTERN IS CALLED TO RECEIVE INPUT OF
C     EXOGENOUS VARIABLES, AND PHYSIC FOR STREAM CHARACTERISTICS
C-----------------------------------------------------------------
      CALL EXTERN
      CALL PHYSIC
      IF (NDATSZ.EQ.0)GO TO 1210
      DO 1200 I=1, LIMIT
 1200 STATE (I)=STATE(I)*AREA
 1210 IF (NCHECK.EQ.0) GO TO 470
 1220 IF(NOREP.GE.2)GO TO 1250
C-----------------------------------------------------------------
C     A HEADING IS PRINTED FOR THE INITIAL REPORT
C-----------------------------------------------------------------
      WRITE(6,1230)  (PLACE(I),I=1,20)
 1230 FORMAT ('1', 20A4)
      WRITE (6,1240) DECJAN(MONTH), NUMMON, IYR
 1240 FORMAT('0INITIAL REPORT ON ', A4, I3, I5)
 1250 IF (NOHISU.LE.0) GO TO 1450
C-----------------------------------------------------------------
C     THE GRAF SUBROUTINE IS SUPPLIED WITH CURRENT VALUES FOR THE
C     VARIABLES TO BE GRAPHED
C-----------------------------------------------------------------
      I2 = 0
      IF (NOGRAF.LE.0) GO TO 1350
      DO 1340 I = 1, NOGRAF
      I1 = I2 + 1
      I2 = LISTER(I)
      DO 1340 J =I1, I2
      I3 = LIGRAF(J)
      I4 = I3/10000
      I3 = I3 - I4*10000
      I4 = I4 + 1
      GO TO(1320,1260,1280,1270,1290,1300,1310), I4
 1260 A =SUMS(I3)
      GO TO 1330
 1270 A=SUMPR(I3)
      GO TO 1330
 1280 A = STNG(I3)
      GO TO 1330
 1290 A=DECP(I3)
      GO TO 1330
 1300 A=PRTP(I3)
      GO TO 1330
 1310 A=OMORE(I3)
      GO TO 1330
 1320 A = PRTOUT(I3)
 1330 AMINI(I) = AMIN1(AMINI(I),A)
      AMAXI(I) = AMAX1(AMAXI(I),A)
 1340 FIGS (J,1) = A
 1350 IF(NOHIST.LE.0) GO TO 1450
      I1= LISTER(NOGRAF)
      I2 = I1 + NOHIST
      I1 = I1 + 1
      I = NOGRAF
      DO 1440 J =I1, I2
      I = I + 1
      I3 = LIGRAF(J)
      I4 = I3/10000
      I3 = I3 - I4*10000
      I4 = I4 + 1
      GO TO(1420,1360,1410,1370,1380,1390,1400), I4
 1360 A = SUMS(I3)
      GO TO 1430
 1370 A=SUMPR(I3)
      GO TO 1430
 1380 A=DECP(I3)
      GO TO 1430
 1390 A=PRTP(I3)
      GO TO 1430
 1400 A=OMORE(I3)
      GO TO 1430
 1410 A = STNG(I3)
      GO TO 1430
 1420 A = PRTOUT(I3)
 1430 AMINI(I) = A
      AMAXI(I) = A
 1440 FIGS(J,1) = A
 1450 IF (NOREP.GE.2) GO TO 1460
      GO TO 2010
 1460 IF (NOSECS.LE.1) GO TO 1470
C-----------------------------------------------------------------
C     THE CPU TIMER IS REPORTED AND RE-SET
C-----------------------------------------------------------------
      TIMER = EXTIME(0)
      WRITE (6,1530) TIMER
C-----------------------------------------------------------------
C     THE FOLLOWING SECTION ACTUALLY PERFORMS THE SIMULATION OVER A
C     SINGLE TIME UNIT
C-----------------------------------------------------------------

C..........THE LIMITS FOR THE TIME UNIT OF SIMULATION ARE SET AND THE
C..........TIME-UNIT LOOP IS INITIALIZED
 1470 ORIG = FLOAT(IDAY) + FRAC
      FRAC = AMOD((UNIT + FRAC ),1.)
      IDAY1 = IDAY
      FINDAY = ORIG + UNIT - .000001
      IDAY2 = ORIG + UNIT
      IYRDAZ = IYRDAY
      MONTHZ = MONTH
      NUMMOZ = NUMMON
      MONENZ = MONEND
      NYRDAZ = NYRDAY
      IYRZ = IYR
      LOOP = 0
      FACTO = 1.
      FACTOR = 0.
      LOOPER = -1

C..........INITIALIZATION FOR THE CURRENT REPETITION OF THE TIME-UNIT
C..........LOOP IS PERFORMED
```

```fortran
 1480 VEGCO = 0.
      AQUACO=0.
      ANIMCO= 0.
      FACTOR = FACTO
      IDAY = ORIG
      LOOP = LOOP + 1
      IF (LOOP.GT.1) LOOPER = 1
      IF (LOOP.LE.20) GO TO 1500
      WRITE (6,1490) IDAY
 1490 FORMAT (' TIME LOOP ATTEMPTED TWENTY TIMES  AT DAY', I4)
      STOP
 1500 IMIN = 0
      IYRDAY = IYRDAZ
      MONTH = MONTHZ
      NUMMON = NUMMOZ
      MONEND = MONENZ
      NYRDAY = NYRDAZ
      IYR = IYRZ
      DO 1600 IDAY = IDAY1, IDAY2
      IF (IDAY.LE.IDAY1) GO TO 1520
      NUMMON = NUMMON + 1
      IYRDAY = IYRDAY + 1
      IF (IYRDAY.LE.NYRDAY) GO TO 1510
      MONTH = 1
      MONEND = MONDAY(1)
      IYRDAY = IYRDAY - NYRDAY
      NUMMON = IYRDAY
      IYR = IYR + 1
      NYRDAY = 365
      MONDAY(2) = 28
      IF (MOD(IYR,4).GT.0) GO TO 1510
      MONDAY(2) = 29
      NYRDAY = 366
 1510 IF (IYRDAY.LE.MONEND) GO TO 1520
      NUMMON = IYRDAY - MONEND
      MONTH = MONTH + 1
      MONEND = MONEND + MONDAY(MONTH)
      IF (FLOAT(IDAY).GE.FINDAY) GO TO 1600

C..........THE SUBROUTINE EXOGEN IS CALLED FOR CURRENT VALUES OF
C..........THE EXOGENOUS VARIABLES
 1520 CALL EXOGE2
      CALL PHYSIC
      LOOPER = 0
 1530 FORMAT ( 104X, F10.3, ' SECONDS ELAPSED')
 1540 DAYDAY = AMIN1 (UNIT, FLOAT(IDAY-IDAY1+1))

C..........THE PROCESS SUBROUTINES ARE CALLED AS FREQUENTLY
C..........AS NECESSARY WITHIN EACH DAY OF THE TIME UNIT.
 1550 IF((AQUACO + AQUINC).GT.DAYDAY)  GO TO 1560
      AQUACO = AQUACO + AQUINC
      CALL MEDIUM
      GO TO 1550
 1560 IF (NSPECA.LE.0) GO TO 1580
 1570 IF ((ANIMCO + ANIINC).GT.DAYDAY) GO TO 1580
      ANIMCO = ANIMCO + ANIINC
      CALL ANIMAL
      GO TO    1570
 1580 IF (NSPECV.LE.0) GO TO 1600
 1590 IF ((VEGCO + VEGINC).GT.DAYDAY) GO TO 1600
      VEGCO = VEGCO + VEGINC
      CALL VEGET
      GO TO 1590
 1600 NCHECK = 1

C..........PROPOSED DECREMENTS ARE TESTED TO ENSURE THAT STATE
C..........VARIABLES ARE ADEQUATE TO MEET THEM.  OTHERWISE, THE
C..........TIME UNIT IS REDUCED
      DO 1630 I = 1, LIMIT
      IF (DECINC(I).GE.0.) GO TO 1630
      IF ((DECINC(I)+STATE(I)).GE.0.)GO TO 1630
         IF (STATE(I).GT.0.) GO TO 1620
      IDAY = ORIG
       WRITE (6,1610 ) I, DECINC(I), IDAY
 1610 FORMAT (' STATE(',I4,') IS ZERO, SO PROPOSED DECREMENT OF',E15.8 ,
     1' PER TIME STEP AT DAY', I5,' IS IMPOSSIBLE')
      NDAY = IDAY
      NSHORT = 1
      MREP(IREP)=IDAY
      GO TO 470
 1620 A = -STATE(I)/DECINC(I)
      IF (A.GE.FACTOR) GO TO 1630
      FACTOR = A
      IMIN = I
 1630 CONTINUE

C..........INCREMENTS ARE APPLIED, TO THE STATE VARIABLES AND
C..........ACCUMULATORS, AND THE INCREMENT ARRAYS ARE RE-INITIALIZED
      DO 1650 I = 1, LIMIT
      A = DECINC(I)
      IF (A.EQ.0.) GO TO 1640
      IF (STATE(I).LT.0) A = AMIN1(0., -A)
      IF (FACTOR.LT.1.) A = A * FACTOR
      STATE(I) = STATE(I) + A
 1640 IF (ABS(STATE(I)).LT.AMICRO) STATE(I) = 0.
      DECINC(I) = 0.
 1650 CONTINUE
      DO 1660 I = 1, LIMACC
      STNG (I) = STNG(I) + CHNG(I) * FACTOR
 1660 CHNG(I) = 0.
      DO 1670 I=1,LIMPRO
      PSTAT(I)=PSTAT(I)+DECP(I)*FACTOR
 1670 DECP(I)=0
      DO 1695 I=1,NSPCOH
      DO 1692 J=1,NFRELM
      IF(POP(I).LE.AMICRO)GO TO 1680
      IF(CBIOM(I,J).GT. AMICRO) GO TO 1692
 1680 DO 1690 K=1,NFRELM
 1690 CBIOM(I,K)=0.
      POP(I)=0.
      GO TO 1695
 1692 CONTINUE
 1695 CONTINUE
      DO 1703 I=1,NSPECV
      DO 1702 J=1,NFRELM
      IF(CVEG(I,1,J).GT.AMICRO) GO TO 1702
      DO 1701 K=1,NFRELM
 1701 CVEG(I,1,K)=0.
      GO TO 1703
 1702 CONTINUE
 1703 CONTINUE
      DO 1706 I=1,MICROB
      DO 1705 J=1,NFRELM
      IF(CBACT(I,J).GT.AMICRO)GO TO 1705
      DO 1704 K=1,NFRELM
 1704 CBACT(I,K)=0.
      GO TO 1705
 1705 CONTINUE
 1706 CONTINUE
      IF (IMIN) 450,450,470

C..........IF ANY STATE VARIABLES HAVE BEEN INADEQUATE TO MEET
C..........THE PROPOSED DECREMENTS, THE TIME-UNIT LOOP IS RE-ENTERED
 1720 FACTO = FACTO - FACTOR
      STATE(IMIN) = - AMICRO
      NEGATE(LOOP) = IMIN
      WRITE (6,1730) IMIN, FACTOR, IDAY, FRAC
 1730 FORMAT(' STATE(',I5,') PERMITS ONLY',F13.10,' OF THE PROPOSED UNIT
     1 CHANGE AT',I4,' + ',F5.3,' DAYS')
      GO TO 1480
 1740 IDAY = IDAY2
      IF (IDAY.LE.IDAY1) GO TO 1460
      IF (NOHISU.LE.0) GO TO 1900
C-----------------------------------------------------------------------
C     IF GRAPHS ARE REQUIRED, THE CURRENT VALUES OF VARIABLES
C     FOR GRAPHING ARE RECORDED
C-----------------------------------------------------------------------
      JY = (FRAC + FLOAT(IDAY-JDAY))/PERIOD + 1.
      IF (IDAY.EQ.NDAY) JX = 70
      IF (JX.EQ.JXXX) GO TO 1900
      JXXX = JX
      I2 = 0
      I = 0
 1750 I = I + 1
      IF (I.GT.NOHISU) GO TO 1890
      I1 = I2 + 1
      I2 = I1
      IF (I.LE.NOGRAF) I2 = LISTER(I)
      DO 1880 J = I1, I2
      I3 = LIGRAF(J)
      I4 = I3/10000
      I3 = I3 - I4*10000
      I4 = I4 + 1
      GO TO (1820,1760,1780,1770,1790,1800,1810),I4
 1760 A =SUMS(I3)
      GO TO 1840
 1770 A=SUMPR(I3)
      GO TO 1830
 1780 A = STNG(I3)
      GO TO 1840
 1790 A=DECP(I3)
      GO TO 1830
 1800 A=PRTP(I3)
      GO TO 1840
 1810 A=OMORE(I3)
      GO TO 1840
 1820 A = PRTOUT(I3)
      GO TO 1840
 1830 IF(MA.GT.0) GO TO 1840
      AMAXI(I)=A
      AMINI(I)=A
      FIGS(J,1)=A
      MA =MA+1
 1840 FIGS(J,JX) = A
      IF (JX.LE.JY) GO TO 1860
      JX1 = JX - 1
      ADD = (     A      - FIGS(J,JY-1))/FLOAT(JX - JY + 1)
      BADD = FIGS(J,JY-1)
      DO 1850 K = JY, JX1
      BADD = BADD + ADD
 1850 FIGS(J,K) =                BADD
 1860 CONTINUE
 1870 AMAXI(I)=AMAX1(AMAXI(I),A)
 1880 AMINI(I) = AMIN1(AMINI(I), A)
      GO TO 1750
 1890 JY = JX + 1
 1900 CONTINUE
      DO 1910 I=1,LIMPRO
 1910 DECP(I)=0
      IF(MDEBUG.LE.0)GO TO 1920
      NDEBUG = 0
      IF ((IDAY.GE.MDEBUG).AND.(IDAY.LE.LDEBUG)) NDEBUG = 1
C-----------------------------------------------------------------------
C     STATE VARIABLES MAY BE DUMPED ON LOGICAL UNITS 10 ETC. IF NEEDED.
C-----------------------------------------------------------------------
 1920 IF (KDUMP.LE.0) GO TO 1940
      IF (IDUMP(JDUMP).GT.IDAY) GO TO 1940
      REWIND IOUNIT
      WRITE (IOUNIT) STATE
      END FILE IOUNIT
      WRITE (6,1930) IDAY, IOUNIT
 1930 FORMAT ('1STATE VARIABLES DUMPED AT DAY', I5,' ON UNIT', I3)
      JDUMP = JDUMP + 1
      IF (JDUMP.GT.KDUMP) KDUMP = 0
      IOUNIT = IOUNIT + 1
C-----------------------------------------------------------------------
C     IF OTHER SECTIONS OF STREAM  ARE TO BE SIMULATED, DOWNSTREAM
C     FLOWING STATE VARIABLE ARE SAVED ON TAPE
C-----------------------------------------------------------------------
 1940 IF(JSAVE.LE.0) GO TO 1950
      CALL INOUT(0,8,FLOGO(1),NPASS)
      IF(IDAY.EQ.NDAY) CALL REWND(8,1)
 1950 IF(ISENSE.EQ.0) GO TO 1960
C-----------------------------------------------------------------------
C     IF SENSITIVITY TESTS ARE TO BE PERFORMED, THE CURRENT VALUES
C     OF THE VARIABLES REQUIRED ARE RECORDED
C-----------------------------------------------------------------------
      ISW = 1
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      DO 1952 I=1,LIMTOT                                                MA4471
 1952 SUMS(I)=SUMS(I)/FACTP1                                            MA4472
      CALL SENOUT (ISW,IDAY,IRUN)                                       MA4475
      DO 1954 I=1,LIMTOT                                                MA4476
 1954 SUMS(I)=SUMS(I)*FACTP1                                            MA4477
 1960 IF ((IDAY.LT.MREP(IREP)).AND.(IDAY.LT.NDAY)) GO TO 1460           MA4480
C-------------------------------------------------------------------    MA4485
C     IF A TABULAR REPORT IS REQUIRED AT THIS STAGE OF THE              MA4490
C     SIMULATION, IT IS PRODUCED.                                       MA4495
C-------------------------------------------------------------------    MA4500
      IF ((NOREP.EQ.1).OR.(NOREP.EQ.2)) GO TO 2030                      MA4505
      WRITE (6,1230) (PLACE(I), I=1,20)                                 MA4510
      KDAY = IDAY - JDAY                                                MA4515
      IF (NSHORT.EQ.0) GO TO 1980                                       MA4520
      WRITE (6,1970 ) KDAY, DECJAN(MONTH), NUMMON, IYR                  MA4525
 1970 FORMAT(' REPORT WHEN SIMULATION ENDED AFTER',I5,' DAYS, I.E. JUST MA4530
     1PRIOR TO ',A4, I3, I5)                                            MA4535
      GO TO 2010                                                        MA4540
 1980 WRITE(6,1990 ) IREP,DECJAN(MONTH),NUMMON,IYR,KDAY                 MA4545
 1990 FORMAT ('0REPORT NO.', I3, ' ON ', A4, I3, I5,' (I.E., AFTER',I4, MA4550
     1' DAYS OF SIMULATION)')                                           MA4555
      IF (FRAC.GT.0.0005) WRITE (6,2000) FRAC                           MA4560
 2000 FORMAT ('+', 66X,' + ',F5.3,' DAY')                               MA4565
      IREP = IREP + 1                                                   MA4570
 2010 CALL REPORT                                                       MA4575
      IF (NOSECS.LE.0) GO TO 2030                                       MA4580
C-------------------------------------------------------------------    MA4585
C     THE CPU TIMER IS REPORTED AND RE-SET, AND                         MA4590
C     THE SIMULATION IS CONTINUED UNLESS COMPLETE                       MA4595
C-------------------------------------------------------------------    MA4600
 2020 FORMAT   ('+',103X,F10.3,' SECONDS ELAPSED')                      MA4605
      TIMER= EXTIME(Q)                                                  MA4610
      WRITE (6,2020) TIMER                                              MA4615
 2030 IF (IDAY.LT.NDAY) GO TO 1460                                      MA4620
C-------------------------------------------------------------------    MA4625
C     IF SIMULATION IS COMPLETE, ANY GRAPHS REQUIRED ARE PRINTED        MA4630
C-------------------------------------------------------------------    MA4635
      I2 = 0                                                            MA4640
      IF (NOGRAF.LE.0) GO TO 2120                                       MA4645
                                                                        MA4650
C..........LINE GRAPHS                                                  MA4655
      DO 2110 I = 1, NOGRAF                                             MA4660
      I1 = I2 + 1                                                       MA4665
      I2 = LISTER(I)                                                    MA4670
      I3 = 0                                                            MA4675
      DO 2080 K = I1, I2                                                MA4680
      I3 = I3 + 1                                                       MA4685
      DO 2040 J = 1,5                                                   MA4690
 2040 EXPLA(J,I3) = EXPLAN(J,K)                                         MA4695
      YMAX = AMAXI(I)                                                   MA4700
      YMIN = AMINI(I)                                                   MA4705
      IF((ORIGIN(I).NE.ZERO).OR.((YMAX.GT.0.).AND.(YMIN.LT.0.)))GO TO   MA4710
     1 2070                                                             MA4715
      IF (YMAX) 2050,2070,2060                                          MA4720
 2050 YMAX = 0.                                                         MA4725
      GO TO 2070                                                        MA4730
 2060 YMIN = 0.                                                         MA4735
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 2070 DO 2080 J = 1, 70                                                 MA4740
 2080 FIG(I3,J) = FIGS(K,J)                                             MA4745
      DO 2090 J = 1, 20                                                 MA4750
 2090 TITLE(J) = TITLES(I,J)                                            MA4755
      DO 2100 J = 1, 10                                                 MA4760
 2100 YTITLE(J) = YAXISS(I,J)                                           MA4765
      NOSYM = I3                                                        MA4770
      CALL GRAF                                                         MA4775
      IF (NOSECS.LE.0) GO TO 2110                                       MA4780
      TIMER=  EXTIME(Q)                                                 MA4785
      WRITE(6,2020)TIMER                                                MA4790
 2110 CONTINUE                                                          MA4795
 2120 IF (NOHIST.LE.NOGRAF) GO TO 2210                                  MA4800
                                                                        MA4805
C..........BLOCK GRAPHS                                                 MA4810
      I1 = I2 + NOHIST                                                  MA4815
      I2 = I2 + 1                                                       MA4820
      K = NOGRAF                                                        MA4825
 2130 DO 2200 I = I2, I1                                                MA4830
      K = K + 1                                                         MA4835
      YMAX = AMAXI(K)                                                   MA4840
      YMIN = AMINI(K)                                                   MA4845
      IF((ORIGIN(I).NE.ZERO).OR.((YMAX.GT.0.).AND.(YMIN.LT.0.)))GO TO   MA4850
     1 2160                                                             MA4855
      IF (YMAX) 2140,2160,2150                                          MA4860
 2140 YMAX = 0.                                                         MA4865
      GO TO 2160                                                        MA4870
 2150 YMIN = 0.                                                         MA4875
 2160 DO 2170 J = 1, 70                                                 MA4880
 2170 YDOT(J) = FIGS(I,J)                                               MA4985
      DO 2180 J = 1, 20                                                 MA4890
 2180 TITLE(J) = TITLES(K,J)                                            MA4895
      DO 2190 J = 1,10                                                  MA4900
 2190 YTITLE(J) = YAXISS(K,J)                                           MA4905
      CALL HIST                                                         MA4910
C-------------------------------------------------------------------    MA4915
C     THE CPU TIMER IS REPORTED AND RE-SET                              MA4920
C-------------------------------------------------------------------    MA4925
      TIMER= EXTIME(Q)                                                  MA4930
      WRITE (6,2020) TIMER                                              MA4935
 2200 CONTINUE                                                          MA4940
 2210 CONTINUE                                                          MA4945
      IF (ISENSE.EQ.0) STOP                                             MA4950
C-------------------------------------------------------------------    MA4955
C     IF SENSITIVITY TESTS ARE REQUIRED, THE SUBROUTINE SENOUT          MA4960
C     IS CALLED TO RECORD FINAL VALUES OF THE VARIABLES, AND, IF THE    MA4965
C     LAST RUN HAS BEEN COMPLETED, TO PRINT OUT THE RESULTS.            MA4970
C-------------------------------------------------------------------    MA4975
      ISW = 2                                                           MA4980
      DO 2220 I=1,LIMTOT                                                MA4981
 2220 SUMS(I)=SUMS(I)/FACTP1                                            MA4982
      CALL SENOUT (ISW,IDAY,IRUN)                                       MA4985
      IRUN = IRUN + 1                                                   MA4990
      IF (IRUN.LE.30) GO TO 1150                                        MA4995
      STOP                                                              MA5000
      END                                                               MA5005
```

APPENDIX C

Listing of the Subroutine REPORT

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      SUBROUTINE REPORT
C-----------------------------------------------------------------------
C     COMMON BLOCKS/PROSUM/,/PRODUC/,/PRODCH/ DEAL WITH PRODUCTIVITY
C     IN THE SYSTEM.
C-----------------------------------------------------------------------
      COMMON/PROSUM/PVTOT(4),PBTOT(4),PATOTS(15,4),PATOTA(4),PVSUM(4),
     1PBSUM(4),PASUMS(15,4),PASUMA(4)
      COMMON/PRODUC/PCVEG( 9,1,4),PCBIOM(40,4),PCBACT(3,4)
      COMMON/PRODCH/CVEGP( 8,1,4), CBIOMP(40,4),CBACTP(3,4)
      COMMON/OTHER/AVEIND(40)
C-----------------------------------------------------------------------
C     COMMON BLOCK /TOTALS/ CONTAINS SUMS OF THE STATE VARIABLES,
C     TOGETHER WITH CERTAIN OTHER VARIABLES REQUIRING INITIALIZATION
C     BUT NOT INCREMENTATION AT EACH TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/TOTALS/CVEGV(1,4),CVEGO( 8,4),CVEGVO(4),BPINRT( 6),
     1WPINRT( 6),PINRTT( 6),AQUATT(4),WDINRT( 6),
     2                     CBIOMA(4),CLITT(4),CORGT(4),
     3TOT(4), POPSP(15),ANIM(15,4),CBACTT(4),TOTAL(4)
C-----------------------------------------------------------------------
C     COMMON BLOCKS/PRINTS/ AND /PRINTP/ ARE STATE VARIABLES CONVERTED
C     TO OUTPUT UNITS.
C-----------------------------------------------------------------------
      COMMON/PRINTP/APVEG( 8,1,4),APBIOM(40,4),APBACT(3,4)
      COMMON/PRINTS/ACVEG( 8,1,4),ACORG(5,4),APOP(40),ACBIOM(40,4),
     1AAQUA(4),ACLIT(5,4),ACBACT(3,4),AAQUAB(4),
     2AWDINR( 6),AWPINR(5, 6),ABDINR( 6),ABPINR(5, 6)
      COMMON/EVERY1/AGAINT(4),H2OTOT,CGAINT( 6),DGAINT( 6)
C-----------------------------------------------------------------------
C     THE COMMON BLOCK /NAMES/ CONTAINS THE NAMES REQUIRED FOR
C     TABULATED OUTPUT
C-----------------------------------------------------------------------
      COMMON/NAMES/COHNAM(26,4),BACNAM(3,4),VSPNAM( 8,7),ASPNAM(15,7),
     1ORGNAM(1,6),FRANAM( 4,3),ALINAM(5,4),DINAM( 6,3),PINAM( 6,3)
     2,STRNAM(5,3)
C-----------------------------------------------------------------------
C     COMMON BLOCK /ACC/ CONTAINS ACCUMULATED CHANGES, WHICH MAY BE
C     NEGATIVE.  COMMON BLOCK /ACCINC/ CONTAINS THE INCREMENTS TO THE
C     ARRAYS IN /ACC/ FOR A SINGLE TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/ACC/AGAIN(13,4),H2O(13),CGAIN(13, 6),DGAIN(13, 6)
      COMMON/ACCINC/AGAINQ(13,4),H2OQQQ(13),CGAINQ(13, 6),DGAINQ(13, 6)
C-----------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------------
      COMMON/SPEC/        NCHAN,INSTRU(20),     WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,      NOLIT ,NCHECK,IDAY, ATOT, ATOTO,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR                ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,                    MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                     NOLIT1,LOOP,           IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C-----------------------------------------------------------------------
C     COMMON BLOCK /STAT/ CONTAINS THE STATE VARIABLES, AND /CHANGE/
C     THEIR INCREMENTS OR DECREMENTS FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/STAT/CVEG( 8,1,4),CORG(5,4),POP(40),CBIOM(40,4),AQUA(4),
     1CLIT(5,4),CBACT(3,4),AQUAB(4),WDINR( 6),WPINR(5, 6),BDINR( 6)
     2,BPINR(5, 6)
      COMMON/CHANGE/CVEGQQ( 8,1,4),CORGQQ(5,4),POPQQQ(40),CBIOMQ(40,4)
     1,AQUAQQ(4),CLITQQ(5,4),CBACTQ(3,4),AQUABQ(4),
     2WDINRQ( 6),WPINRQ(5, 6),BDINRQ( 6),BPINRQ(5, 6)
C-----------------------------------------------------------------------
C     COMMON BLOCK /DIAGR/ CONTAINS INFORMATION REQUIRED FOR GRAPHS.
C-----------------------------------------------------------------------
      COMMON/DIAGR/FIG(8,70),EXPLA(5,8),TITLE(20),YTITLE(10),
     1 XDOT(71), XMAX, XMIN, YMAX, YMIN, NOSYM, INITYR
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
C-----------------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/METEOR/WIRRIG,      RUNSOL(4),RUNDEB(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4),TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6),TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RATNCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)   ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4)  ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP
C-----------------------------------------------------------------------
C     COMMON BLOCK /PARAM/ CONTAINS THE VALUES OF PARAMETERS USED BY THE
C     PROCESS SUBROUTINES.
C-----------------------------------------------------------------------
      DATA BLANK/' '/
      DATA SOURCE/   'FROM',' THE',' ATM','OSPH','ERE ',
     1 'TO T','HE A','TMOS','PHER','E   ',
     2 'FROM',' OVE','RLAN','D FL','OW  ',
     3 'BY W','ATER',' REM','OVAL','    ',
     4 'FROM',' UPS','TREA','M   ','    ',
     5 'TO U','PSTR','EAM ','    ','    ',
     6 'FROM',' DOW','NSTR','EAM ','    ',
     7 'TO D','OWNS','TREA','M   ','    ',
     8 'FROM',' THE',' STR','EAM ','BED ',
     9 'TO T','HE S','TREA','M BE','D   ',
     A'FROM',' TRI','BUTA','RIES','    ',
     B'TO  ','TRIB','UTAR','IES ','    ',
     C'CHEM','ICAL',' CHA','NGES','    '/
   10 IF (NOSECS.LE.0) GO TO 30
      TIME =   EXTIME(0)
      WRITE (6,20) TIME
   20 FORMAT (' ', 103X, F10.3, ' SECONDS ELAPSED')
C-----------------------------------------------------------------------
C     THE STATE VARIABLES ARE PRINTED.
C-----------------------------------------------------------------------
   30 IF (NPRT(1).EQ.0) GO TO 60
      WRITE(6,40)
   40 FORMAT(3X,'MEAN DEPTH'6X'MEAN FLOW'6X'MEAN WIDTH'6X'MEAN VELOCITY'
     16X'TOTAL VOLUME'7X'AREA')
      WRITE(6,50)DEPTH,FLOWIN,WIDTH,VELOCT,WATSYS,AREA
   50 FORMAT(1X,F6.2,' METERS',3X,F6.3,' CUM/S',5X,F5.2,' METERS',
     15X,F6.3,' MPS',5X,F10.2,'CU.M',3X,F10.2,' SQ. M.')
   60 CONTINUE
      NTOTPR=0
      DO70 I=2,10
   70 NTOTPR=NTOTPR+NPRT(I)
      IF(NTOTPR.LE.0)GOTO780
      IF(NPORT.EQ.3) GO TO 90
      WRITE (6,80) REACH
   80 FORMAT('0THE FOLLOWING CONSTITUENTS ARE ORGANIC AND ARE PRINTED IN
     1 GRAMS (OR KCAL.) PER SQ. METER, AVERAGED OVER ',F6.1,' METERS OF
     2STREAM.')
      GO TO 110
   90 WRITE (6,100)REACH
  100 FORMAT('0THE FOLLOWING CONSTITUENTS ARE ORGANIC AND ARE PRINTED IN
     1GRAMS(OR KCAL.) PER CUBIC METER,AVERAGED OVER',F6.1,' METERS OF S
     2TREAM.')
  110 CONTINUE

C...........PLANT CONSTITUENTS
  120 IF (NSPECV.LE.0) GO TO 240
      IF(NPRT(2).EQ.0)GO TO 240
      WRITE (6,130)
  130 FORMAT('0CONSTITUENTS OF PRIMARY PRODUCERS')
      WRITE (6,260) ((FRANAM(I,J), J = 1,3), I = 1,NFRELM)
      DO 190 I = 1, NSPECV
      WRITE (6,140) (VSPNAM(I,J), J = 1, 7)
  140 FORMAT(1X,30A4)
      IF (NORGAN.GT.1) GO TO 160
      WRITE (6,150) (ACVEG(I,1,K), K=1,NFRELM)
      GO TO 190
  150 FORMAT ('+', 26X, 8F12.5)
  160 DO 170 J = 1, NORGAN
  170 WRITE (6,180) (ORGNAM(J,K), K = 1,6), (ACVEG (I,J,K),K=1,NFRELM)
  180 FORMAT(3X, 6A4,     8F12.5)
      WRITE (6,200) (CVEGO(I,K), K=1,NFRELM)
  190 CONTINUE
  200 FORMAT ( 12X, 'TOTAL ', 10X,8F12.5)
      WRITE (6,210)
  210 FORMAT ('0ALL SPECIES')
      IF(NORGAN.LE.1) GO TO 230
      DO 220 J=1,NORGAN
      WRITE(6,180)(ORGNAM(J,K),K=1,6),(CVEGV(J,K),K=1,NFRELM)
  220 CONTINUE
  230 WRITE (6,200) (CVEGVO(K), K = 1,NFRELM)

C...........ANIMAL CONSTITUENTS BY SPECIES AND COHORT.
  240 IF (NSPECA.LE.0) GO TO 500
      IF(NPRT(3).EQ.0) GO TO 380
      WRITE (6,250)
  250 FORMAT ('0CONSTITUENTS OF ANIMAL BIOMASS')
      WRITE (6,260) ((FRANAM(I,J), J = 1,3), I = 1,NFRELM)
  260 FORMAT ( 30X, 24A4)
      DO 340 I = 1, NSPECA
      K1=1
      IF(I.GT.1) K1=NCOHCU(I-1)+1
      K2=NCOHCU(I)
      WRITE(6,270) (ASPNAM(I,J), J=1,7)
  270 FORMAT(' ',7A4)
  280 FORMAT(5X,7A4)
      IF(K2.GT.K1) GO TO 300
      WRITE (6,290) (ACBIOM(K1,J), J=1,NFRELM)
  290 FORMAT ('+', 26X, 8F12.6)
      GO TO 340
  300 DO 310 K = K1, K2
      L=LISCOH(K)
      WRITE(6,320)(COHNAM(L,J),J=1,4),(ACBIOM(K,J),J=1,NFRELM)
  310 CONTINUE
  320 FORMAT ( 5X, 4A4, 6X, 8F12.6)
      WRITE (6,370) (ANIM(I,K),K=1,NFRELM)
  330 WRITE (6,350)
  340 CONTINUE
  350 FORMAT (1H )
      WRITE (6,360) (CBIOMA(K), K = 1, NFRELM)
  360 FORMAT ('0TOTAL, ALL SPECIES', 8X, 8F12.6)
  370 FORMAT ( 10X, 'TOTAL',12X,8F12.6)

C...........ANIMAL NUMBERS BY SPECIES AND COHORT.
  380 IF(NPRT(4).EQ.0)GO TO 500
      IF(NPORT.EQ.3) GO TO 400
      WRITE (6,390) REACH
  390 FORMAT('0POPULATIONS ARE PRINTED IN NUMBERS PER SQ. METER,'
     1,'AVERAGED OVER', F6.1,' METERS OF STREAM.',/,' AVERAGE WEIGHTS AR
     2E EXPRESSED AS GRAMS OF CARBON (DRY WT.).')
      GO TO 420
  400 WRITE (6,410)REACH
  410 FORMAT('0POPULATIONS ARE PRINTED IN NUMBERS PER CUBIC METER, '
     1,'AVERAGED OVER', F6.1,' METERS OF STREAM.',/,' AVERAGE WEIGHTS AR
     2E EXPRESSED AS GRAMS OF CARBON (DRY WT.).')
  420 WRITE(6,430)
  430 FORMAT(30X'POPULATIONS'12X'WT. OF AVE. IND.')
      DO 490 I = 1, NSPECA
      K1 = 1
      IF (I.GT.1) K1 = NCOHCU(I-1) + 1
      K2 = NCOHCU(I)
      WRITE(6,270) (ASPNAM(I,J), J=1,7)
      IF(K2.GT.K1) GO TO450
      WRITE (6,440)APOP(K1),AVEIND(K1)
  440 FORMAT('+', 26X,8F13.4,12X,E14.6)
      GO TO 490
  450 DO 460 K = K1, K2
      L=LISCOH(K)
  460 WRITE (6,470) (COHNAM(L,J),J=1,4),APOP(K),AVEIND(K)
  470 FORMAT ( 5X,4A4,6X, F13.4,12X,E14.6)
      WRITE (6,480) POPSP(I)
  480 FORMAT ( 10X,'TOTAL', 12X,8F13.4)
      WRITE (6,350)
  490 CONTINUE

C...........CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS.
  500 IF(NPRT(5).EQ.0)GO TO 550
```

```
      WRITE (6,510)
  510 FORMAT ('0CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS  ')
      WRITE (6,520) ((FRANAM(I,J),J=1,3),I=1,NFRELM)
  520 FORMAT ('    MICROBIAL  TYPE',13X,24A4)
  530 FORMAT(12X,'TOTAL',10X,8F12.6)
      DO 540 I=1,MICROB
      WRITE (6,320) (BACNAM(I,J),J=1,4),(ACBACT(I,J),J=1,NFRELM)
  540 CONTINUE
      WRITE (6,530) (CBACTT(K),K=1,NFRELM)

C...........SUSPENDED DETRITUS CONSTITUENTS.
  550 IF(NPRT(6).EQ.0)GO TO 600
      WRITE (6,560)
  560 FORMAT('0SUSPENDED DETRITUS CONSTITUENTS')
      WRITE (6,570) ((FRANAM(I,J), J = 1,3), I = 1,NFRELM)
  570 FORMAT ( 3X,'DETRITUS TYPE', 14X, 24A4)
      DO580 I = 1, NOLIT
      WRITE (6,320) (ALINAM(I,J), J=1,4),(ACLIT(I,J),J=1,NFRELM)
  580 CONTINUE
  590 FORMAT ( 1X, 4A4, 10X, 8F12.5)
      WRITE (6,530) (CLITT(K),K=1,NFRELM)

C...........BIOLOGICALLY ACTIVE SEDIMENTS.
  600 IF(NPRT(7).EQ.0)GO TO 640
      WRITE (6,610)
  610 FORMAT ('0BIOLOGICALLY ACTIVE SEDIMENTS')
      WRITE (6,570) ((FRANAM(I,J), J = 1,3), I = 1,NFRELM)
      DO 620 I=1,NOLIT
      WRITE(6,320)(ALINAM(I,J),J=1,4),(ACORG(I,J),J=1,NFRELM)
  620 CONTINUE
      WRITE(6,530)(CORGT(K),K=1,NFRELM)
      WRITE (6,630) (TOT(K), K = 1,NFRELM)
  630 FORMAT ('0TOTAL DETRITUS',12X,8F12.6)

C...........DISSOLVED CONSTITUENTS IN THE WATER.
  640 IF(NPRT(8).EQ.0)GO TO 690
      WRITE(6,650)((FRANAM(I,J),J=1,3),I=1,NFRELM)
  650 FORMAT ('0DISSOLVED CONSTITUENTS',7X,24A4)
      WRITE (6,660)(AAQUA(I), I = 1, NFRELM)
  660 FORMAT ( 3X, 'IN WATER' , 16X, 8F12.5)
      WRITE(6,670) (AAQUAB(I),I=1,NFRELM)
  670 FORMAT(3X,'IN BENTHOS',14X,8F12.5)
      WRITE(6,680) (AQUATT(I),I=1,NFRELM)
  680 FORMAT(12X,'TOTAL',10X,8F12.5)

C...........TOTAL CONSTITUENTS IN THE ECOSYSTEM.
  690 CONTINUE
      IF(NPRT(9).EQ.0)GO TO 720
      WRITE(6,700)((FRANAM(I,J),J=1,3),I=1,NFRELM)
  700 FORMAT('0AVERAGE IN ECOSYSTEM',9X,24A4)
      WRITE (6,710)(TOTAL(K),K=1,NFRELM)
  710 FORMAT(27X,8F12.5)

C...........NET GAIN OR LOSS TO THE ECOSYSTEM.
  720 IF (NCHECK.EQ.0) GO TO 780
      IF(NPRT(10).EQ.0)GO TO 780
      WRITE (6,740)
      WRITE (6,730)     ((FRANAM(K,J),J=1,3),K=1,NFRELM)
  730 FORMAT ( 31X ,24A4)
      DO 750 I = 1,NCHAN
  740 FORMAT ( //'0ACCUMULATED NET GAIN OR LOSS OF ORGANIC CONSTITUENTS
     1TO THE ENTIRE ECOSYSTEM. (GRAMS OR KCAL.)')
  750 WRITE(6,760)(SOURCE(L,I),L=1,5), (AGAIN(I,L),L=1,NFRELM)
  760 FORMAT ( 2X,5A4,5X,7E12.5)
      WRITE (6,770)       (AGAINT(K), K=1,NFRELM)
  770 FORMAT ('0    TOTAL',18X,7E12.5)
  780 CONTINUE
      NTOTPR=0
      DO790 I=11,15
  790 NTOTPR=NTOTPR+NPRT(I)
      IF(NTOTPR.LE.0)GOTO1080
      IF(NPORT.EQ.3)GO TO 810
      WRITE(6,800)REACH
  800 FORMAT('0THE FOLLOWING CONSTITUENTS ARE INORGANIC AND ARE PRINTED
     1IN GRAMS PER SQ. METER AVERAGED OVER',F6.1,' METERS OF STREAM.')
      GO TO 830
  810 WRITE (6,820)REACH
  820 FORMAT('0THE FOLLOWING CONSTITUENTS ARE INORGANIC AND ARE PRINTED
     1IN GRAMS PER SQ. METER AVERAGED OVER',F6.1,' METERS OF STREAM.')
  830 IF((NPRT(11).EQ.0).OR.(INORGP.EQ.0)) GO TO 890

C...........SUSPENDED PARTICULATE MATTER (INORGANIC).
      WRITE(6,840)
  840 FORMAT('0SUSPENDED PARTICULATE MATTER(INORGANIC)')
      WRITE(6,850)((PINAM(I,J),J=1,3),I=1,INORGP)
  850 FORMAT(2X,'SIZE',10X,29A4)
      DO 860 I=1,ISTRTM
  860 WRITE (6,870)(STRNAM(I,J),J=1,3),(AWPINR(I,K),K=1,INORGP)
  870  FORMAT(1X, 3A4,9F12.5,F11.5)
      WRITE(6,880)(WPINRT(K),K=1,INORGP)
  880 FORMAT(3X,'TOTAL',5X,9F12.5,F11.5)
  890 IF((NPRT(12).EQ.0).OR.(INORGP.EQ.0)) GO TO 920

C...........BENTHIC PARTICULATE MATTER (INORGANIC)
      WRITE(6,900)
  900 FORMAT('0BENTHIC PARTICULATE MATTER(INORGANIC)')
      WRITE(6,850)((PINAM(I,J),J=1,3),I=1,INORGP)
      DO 910 I=1,ISTRTM
  910 WRITE (6,870)(STRNAM(I,J),J=1,3),(ABPINR(I,K),K=1,INORGP)
      WRITE(6,890)(BPINRT(K),K=1,INORGP)
  920 IF((NPRT( 11).EQ.0).AND.(NPRT(12).EQ.0))GO TO 940
      WRITE(6,930)(PINRTT(I),I=1,INORGP)
  930 FORMAT('0ALL P.M.',4X,9F12.5,F11.5)
  940 IF(NPRT(13).EQ.0)GO TO 1000

C...........DISSOLVED INORGANIC CONSTITUENTS.
      WRITE (6,950)
  950 FORMAT('0DISSOLVED INORGANIC CONSTITUENTS')
      WRITE(6,960)((DINAM(I,J),J=1,3),I=1,INORGD)
  960 FORMAT(16X,29A4)
      WRITE(6,970) (AWDINR(I),I=1,INORGD)
  970 FORMAT(' IN WATER',4X,9F12.5,F11.5)
      WRITE(6,980)(ABDINR(I),I=1,INORGD)
  980 FORMAT(' IN BENTHOS',2X,9F12.5,F11.5)
      WRITE(6,990)(WDINRT(I),I=1,INORGD)
  990 FORMAT(3X,'TOTAL',5X,9F12.5,F11.5)

C...........PH AND TEMP.
 1000 IF(NPRT(14).LE.0)GOTO1020
      WRITE (6,1010) PHW,PHB, TEMPW,TEMPB
 1010 FORMAT('0PH IN WATER COLUMN ',F5.2,' PH IN BENTHOS ',F5.2,
     1'    WATER COLUMN TEMP. ',F5.2,' BENTHOS TEMP. ',F5.2,
     2' DEGREES CENTIGRADE',/,)

C...........NET GAIN OR LOSS TO THE ECOSYSTEM OF INORGANIC MATERIALS.
 1020 IF((NPRT(15).LE.0).OR.(NCHECK.LE.0))GOTO1080
       WRITE(6,1030)
 1030 FORMAT('0ACCUMULATED NET GAIN OR LOSS OF INORGANIC MATERIAL TO THE
     1 ENTIRE ECOSYSTEM (GRAMS)...(WATER IN CUBIC METERS).')
      WRITE(6,1040)((PINAM(I,J),J=1,3),I=1,INORGP),((DINAM(I,J),J=1,3),I
     1=1,INORGD)
 1040 FORMAT(31X,' WATER',7X,21A4)
      DO1050 I=1,NCHAN
 1050 WRITE(6,1060)(SOURCE(L,I),L=1,5),H2O(I),(CGAIN(I,J),J=1,INORGP),
     1(DGAIN(I,J),J=1,INORGD)
 1060 FORMAT(2X,5A4,5X,7E12.5)
      WRITE(6,1070)H2OTOT,(CGAINT(K),K=1,INORGP),(DGAINT(K),K=1,INORGD )
 1070 FORMAT(4X,'0TOTAL',18X,8F12.5)
 1080 CONTINUE
      IF(NCHECK.EQ.0)GOTO1460
      NTOTPR=0
      DO1090 I=16,23
 1090 NTOTPR=NTOTPR+NPRT(I)
      IF(NTOTPR.LE.0)GOTO1460
      L=NPORTI
      NTOTPR=0
C-----------------------------------------------------------------
C     MATERIALS ENTERING AND LEAVING THE SYSTEM ARE PRINTED
C-----------------------------------------------------------------
      DO1100 I=16,21
 1100 NTOTPR=NTOTPR+NPRT(I)
      IF(NTOTPR.LE.0)GOTO 1340
      WRITE(6,1110)(FRANAM(L ,J),J=1,3)
 1110 FORMAT('0 THE FOLLOWING SECTION DEALS WITH ORGANIC MATTER ENTERING
     1 AND LEAVING THE SYSTEM PER TIME UNIT. ALL OF THE',/,1X,'FIGURES A
     2RE OF ',3A4,'. TOTALS ARE IN GRAMS (OR KCAL.) AND AVERAGES IN GRAM
     3S (OR KCAL.) PER CUBIC METER OF WATER.')
       IF(NPRT(16).EQ.0)GOTO1160

C...........PLANTS.
      IF(NSPECV.LE.0)GOTO1160
      WRITE(6,1120)
 1120 FORMAT('0PRIMARY PRODUCERS')
      WRITE(6,1130)
 1130 FORMAT(' ',41X,'TOTAL ENTERING      AVERAGE ENTERING     TOTAL DOWNS
     1TREAM    AVERAGE DOWNSTREAM')
      DO1150 I=1,NSPECV
      WRITE(6,140)(VSPNAM(I,J),J=1,7)
      AVEENT=XDRIFV(I,1,L)/(WATTOT-WATSYS)
      TODOWN=DRIFTV(I,1,L)*FLOUT
      WRITE(6,1140)XDRIFV(I,1,L),AVEENT,TODOWN,DRIFTV(I,1,L)
 1140 FORMAT('+',33X,4E20.8)
 1150 CONTINUE
 1160 IF(NSPECA.LE.0)GOTO1270
      IF(NPRT(17).LE.0)GOTO1220

C...........ANIMAL BIOMASS.
      WRITE(6,1170)
 1170 FORMAT('0ANIMAL CONSTITUENTS')
      WRITE(6,1130)
      DO1210 I=1,NSPECA
      K1=1
      IF(I.GT.1) K1=NCOHCU(I-1)+1
      K2=NCOHCU(I)
      WRITE(6,270)(ASPNAM(I,J),J=1,7)
      IF(K2.GT.K1)GOTO1180
      AVEENT=XDRIFA(K1,L)/(WATTOT-WATSYS)
      TODOWN=DRIFTV(K1,1,L)*FLOUT
      WRITE(6,1140)XDRIFA(K1,L),AVEENT,          TODOWN,DRIFTA(K1,L)
      GOTO1210
 1180 DO1200 K=K1,K2
      LL=LISCOH(K)
      WRITE(6,1190)(COHNAM(LL,J),J=1,4)
 1190 FORMAT(5X,4A4)
      AVEENT=XDRIFA(K,L)/(WATTOT-WATSYS)
      TODOWN=DRIFTA(K,L)*FLOUT
      WRITE(6,1140)XDRIFA(K,L),AVEENT,          TODOWN,DRIFTA(K,L)
 1200 CONTINUE
 1210 CONTINUE
 1220 IF(NPRT(18).LE.0)GOTO1270

C...........ANIMAL NUMBERS.
      WRITE(6,1230)
 1230 FORMAT('0ANIMAL NUMBERS')
      WRITE(6,1130)
      DO1260 I=1,NSPECA
      K1=1
      IF(I.GT.1) K1=NCOHCU(I-1)+1
      K2=NCOHCU(I)
      WRITE(6,270)(ASPNAM(I,J),J=1,7)
      IF(K2.GT.K1)GOTO1240
      AVEENT=XDRIFO(K1)/(WATTOT-WATSYS)
      TODOWN=DRIFPO(K1)*FLOUT
      WRITE(6,1140)XDRIFO(K1),AVEENT,          TODOWN,DRIFPO(K1)
      GOTO1260
 1240 DO1250 K=K1,K2
      LL=LISCOH(K)
      WRITE(6,1190)(COHNAM(LL,J),J=1,4)
      AVEENT=XDRIFO(K)/(WATTOT-WATSYS)
      TODOWN=DRIFPO(K)*FLOUT
 1250 WRITE(6,1140)XDRIFO(K),AVEENT,          TODOWN,DRIFPO(K)
 1260 CONTINUE
 1270 CONTINUE

C...........HETEROTROPHIC MICROORGANISMS.
      IF(NPRT(19).LE.0)GOTO1300
      IF(MICROB.LE.0) GO TO 1300
      WRITE(6,1280)
```

```
 1280 FORMAT('0MICROORGANISMS')
      WRITE(6,1130)
      DO1290 I=1,MICROB
      WRITE(6,280)(BACNAM(I,J),J=1,4)
      AVEENT=XDRIFM(I,L)/(WATTOT-WATSYS)
      TODOWN=DRIFTM(I,L)*FLOUT
 1290 WRITE(6,1140)XDRIFM(I,L),AVEENT,         TODOWN,DRIFTM(I,L)
 1300 IF(NPRT(20).LE.0)GOTO1340
      IF(NOLIT.LE.0) GO TO 1340

C..........SUSPENDED DETRITUS.
      WRITE(6,1310)
 1310 FORMAT ('0SUSPENDED DETRITUS')
      WRITE(6,1130)
      DO1330 I=1,NOLIT
      WRITE(6,1320)(ALINAM(I,J),J=1,4)
 1320 FORMAT(5X,7A4)
      AVEENT=XDETIN(I,L)/(WATTOT-WATSYS)
      TODOWN=DETIN(I,L)*FLOUT
 1330 WRITE(6,1140)XDETIN(I,L),AVEENT,         TODOWN,DETIN(I,L)
 1340 NTOTPR=0
      DO1350 I=21,22
 1350 NTOTPR=NTOTPR+NPRT(I)
      IF(NTOTPR.LE.0)GOTO1420

C..........DISSOLVED ORGANIC AND INORGANIC MATTER.
      WRITE(6,1360)
 1360 FORMAT('0THE FOLLOWING SECTION DEALS WITH ALL THE DISSOLVED MATER
     1AL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.' ,/,' TOTALS ARE
     2IN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.')
      IF(NPRT(21).LE.0)GOTO1390
      WRITE(6,1370)
 1370 FORMAT('0ORGANIC MATTER')
      WRITE(6,1130)
      DO1380 I=1,NFRELM
      WRITE(6,1190)(FRANAM(I,J),J=1,3)
      AVEENT=XCOMPN(I)/(WATTOT-WATSYS)
      TODOWN=COMPIN(I)*FLOUT
 1380 WRITE(6,1140)XCOMPN(I),AVEENT,           TODOWN,COMPIN(I)
 1390 IF(NPRT(22).LE.0)GOTO1420
      WRITE(6,1400)
 1400 FORMAT('0INORGANIC MATTER')
      DO1410 I=1,INORGD
      WRITE(6,1190)(DINAM(I,J),J=1,3)
      AVEENT=XDNORG(I)/(WATTOT-WATSYS)
      TODOWN=DNORG(I)*FLOUT
 1410 WRITE(6,1140)XDNORG(I),AVEENT,           TODOWN,DNORG(I)
 1420 IF(NPRT(23).LE.0)GOTO1460

C..........INORGANIC PARTICULATE MATTER.
      WRITE(6,1430)
 1430 FORMAT('0THE FOLLOWING SECTION DEALS WITH INORGANIC PARTICULATE MA
     1TERIAL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.',/,' TOTALS
     2ARE IN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.')
      WRITE(6,1130)
      DO1450 I=1,ISTRTM
      WRITE(6,270)(STRNAM(I,J),J=1,3)
      DO1440 K=1,INORGP
      WRITE(6,1190)(PINAM(K,J),J=1,3)
      AVEENT=XPNORG(I,K)/(WATTOT-WATSYS)
      TODOWN=PNORG(I,K)*FLOUT
 1440 WRITE(6,1140)XPNORG(I,K),AVEENT,         TODOWN,PNORG(I,K)
 1450 CONTINUE
 1460 CONTINUE
```

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C-----------------------------------------------------------------
C     NET PRODUCTIVITY FOR VARIOUS TROPHIC LEVELS IS PRINTED
C-----------------------------------------------------------------
      IF(NCHECK.EQ.0) GO TO 1610
      NTOTPR=0
      DO 1470 I=24,26
 1470 NTOTPR=NTOTPR + NPRT(I)
      IF(NTOTPR.LE.0)GO TO 1610
      IF(NPORT.EQ.3) GO TO 1490
      WRITE(6,1480)REACH
 1480 FORMAT('0THE FOLLOWING FIGURES ARE OF NET PRODUCTIVITY FROM THE BE
     1GINNING OF THE SIMULATION.',/,' CONSTITUENTS ARE PRINTED IN GRAMS'
     2  '(OR KCAL.) PER SQUARE METER, AVERAGED OVER ', F6.1,' METERS OF
     3STREAM.')
      GO TO 1510
 1490 WRITE(6,1500)REACH
 1500 FORMAT('0THE FOLLOWING FIGURES ARE OF NET PRODUCTIVITY FROM THE BE
     1GINNING OF THE SIMULATION.',/,' CONSTITUENTS ARE PRINTED IN GRAMS'
     2  '(OR KCAL.) PER CUBIC  METER, AVERAGED OVER ', F6.1,' METERS OF
     3STREAM.')
 1510 IF((NSPECV.LE.0).OR.(NPRT(24).EQ.0)) GO TO 1530

C..........PLANTS.
      WRITE(6,130)
      WRITE(6,260)((FRANAM(I,J),J=1,3),I=1,NFRELM)
      DO 1520 I=1,NSPECV
      WRITE(6,140)(VSPNAM(I,J),J=1,7)
 1520 WRITE(6,150)(APVEG(I,1,K),K=1,NFRELM)
      WRITE(6,210)
      WRITE(6,200)(PVSUM(K),K=1,NFRELM)
 1530 IF((NSPECA.LE.0).OR.(NPRT(25).EQ.0)) GO TO 1580

C..........ANIMALS.
      WRITE(6,1540)
 1540 FORMAT('0ANIMAL PRODUCTIVITY')
      WRITE(6,260)((FRANAM(I,J),J=1,3),I=1,NFRELM)
      DO 1570 I=1,NSPECA
      K1=1
      IF(I.GT.1) K1=NCOHCU(I-1)+1
      K2=NCOHCU(I)
      WRITE(6,270)(ASPNAM(I,J),J=1,7)
      IF(K2.GT.K1)GO TO 1550
      WRITE(6,290)(APBIOM(K1,J),J=1,NFRELM)
      GO TO 1570
 1550 DO 1560 K=K1,K2
      L=LISCOH(K)
 1560 WRITE(6,320)(COHNAM(L,J),J=1,4),(APBIOM(K,J),J=1,NFRELM)
      WRITE(6,370)(PASUMS(I,K),K=1,NFRELM)
      WRITE(6,350)
 1570 CONTINUE
      WRITE(6,360)(PASUMA(K),K=1,NFRELM)
 1580 IF((NPRT(26).EQ.0).OR.(MICROB.LE.0)) GO TO 1600
      WRITE(6,510)
      WRITE(6,520)((FRANAM(I,J),J=1,3),I=1,NFRELM)

C..........MICRO-ORGANISMS.
      DO 1590 I=1,MICROB
      WRITE(6,320)(BACNAM(I,J),J=1,4),(APBACT(I,J),J=1,NFRELM)
 1590 CONTINUE
      WRITE(6,530)(PBSUM(K),K=1,NFRELM)
 1600 CONTINUE
 1610 CONTINUE
      RETURN
      END
```

APPENDIX D

Listing of the Subroutine GRAF

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      SUBROUTINE GRAF
C-----------------------------------------------------------------------
C     COMMON BLOCK /DIAGR/ CONTAINS INFORMATION REQUIRED FOR GRAPHS.
C-----------------------------------------------------------------------
      COMMON/DIAGR/FIGS(8,70),EXPLAN(5,8),TITLE(20),YTITLE(10),
     1 XDOT(71), XMAX, XMIN, YMAX, YMIN, NOSYM, INITYR
      DIMENSION FMT1(7),SYMBOL(8),GRAPH(51,71), ANUM(10)
     1 ,YAXIS(6), XLINE(18), IDAYS(8), IYEARS(8)
      DATA XLINE/'+---','----','-+--',2*'----','+---','----','--+-',
     1 2*'----','+---','----','-+--',2*'----','+---','----','--+ '/
      DATA ANUM /'0','1','2','3','4','5','6','7','8','9'/
      DATA FMT1/'(1H+',',',' ',' ','PF18','.4,8','0A1)'/
      DATA BLANK /' '/ STAR /'*'/  SMALL/1.E-8/
      DATA APOS/'I' /  PLUS/'+'/ HYPHEN /'-'/
      DATA SYMBOL/'A','B','C','D','E','F','G','H'/
      DATA /INTERV/1/, ISTART/1/, IEND/71/, NOCOL/71/
      INDEX = 1
      GO TO 10
       ENTRY HIST
      NOSYM = 0
      INDEX = 3
   10 FMT1(4) = BLANK
      FMT1(3) = BLANK
C-----------------------------------------------------------------------
C     IF THE LIMITS OF THE X AXIS ARE EQUAL, AN ERROR MESSAGE RESULTS.
C     IF THE LIMITS OF THE Y AXIS ARE BOTH ZERO, THEY ARE SEPARATED.
C-----------------------------------------------------------------------
      IF (XMAX.GT.XMIN) GO TO 30
      WRITE (6,20)
      RETURN
   20 FORMAT ('1NO GRAPH POSSIBLE BECAUSE NO TIME SIMULATED')
   30 IF (YMAX.NE.YMIN) GO TO 50
      IF (YMAX.NE.0.) GO TO 40
      YMAX = SMALL
      YMIN = - SMALL
      GO TO 50
   40 YMAX = YMAX * 1.001
      YMIN = YMIN * .999
   50 DO 70 I = 1, 51
      DO 60 J = 1, 71
   60 GRAPH(I,J) = BLANK
   70 CONTINUE
      B = AMAX1(ABS(YMIN), ABS(YMAX))
      I = 0
      A = XMAX - XMIN
      IF ((A.GT.0.).AND.(B.GT.0.).AND.(YMAX.GE.YMIN)) GO TO 90
      WRITE (6,80) XMAX, XMIN, YMAX, YMIN
   80 FORMAT ('0ERROR IN LIMITS:', 4E20.6)
      RETURN
C-----------------------------------------------------------------------
C     THE Y AXIS IS SCALED.
C-----------------------------------------------------------------------
   90 IF (B.GE.1.) GO TO 100
      B = B * 10.
      I = I - 1
      GO TO 90
  100 IF (B.LT.10.) GO TO 110
      B = B * .1
      I = I + 1
      GO TO 100
  110 I102 = I
      J = IABS(I)
      IF (J.LE.9) GO TO 130
C-----------------------------------------------------------------------
C     IF THE VALUES TO BE GRAPHED EXCEED PERMISSIBLE LIMITS, AN ERROR
C     MESSAGE RESULTS.
C-----------------------------------------------------------------------
      WRITE (6,310) (TITLE(K), K=1,20)
      WRITE (6,120)
  120 FORMAT ('0FACTOR FOR Y AXIS .GT. 10**9 OR .LT. 10**-9')
      RETURN
C-----------------------------------------------------------------------
C     THE APPROPRIATE SCALING FACTOR IS INSERTED IN THE FORMAT FOR
C     THE Y AXIS.
C-----------------------------------------------------------------------
  130 IF (I.LE.0) GO TO 140
      FMT1(3) = HYPHEN
  140 FMT1(4)       = ANUM(J+1)
C-----------------------------------------------------------------------
C     THE Y BOUNDARY OF THE GRAPH IS INSERTED.
C-----------------------------------------------------------------------
      DO 150 I = 1, 51
  150 GRAPH(I,1) = APOS
      DO 160 I = 1,51,10
  160 GRAPH(I,1) = PLUS
      YUNIT = 50./(YMAX-YMIN)
      XUNIT= 70./(XMAX - XMIN)
      GO TO (220,170 , 190                ), INDEX
  170 WRITE (6,180)
  180 FORMAT ('0DOT DIAGRAM FACTLITY NOT AVAILABLE')
      RETURN
C-----------------------------------------------------------------------
C     THE BLOCK GRAPH IS CONTRUCTED.
C-----------------------------------------------------------------------
  190 Y = YMIN
      YUN = 1./YUNIT
      DO 210 I = 1, 51
      DO 200 K = 2, NOCOL
      IF (XDOT(K).GE.Y) GRAPH(I,K) = STAR
  200 CONTINUE
      Y = Y + YUN
  210 CONTINUE
      GO TO 250
C-----------------------------------------------------------------------
C     THE LINE GRAPH IS CONSTRUCTED.
C-----------------------------------------------------------------------
  220 DO 240 I = 1, NOSYM
      DO 230 J = 1, 70
      K = (FIGS(I,J) - YMIN)*YUNIT+ .1
      IF (K.GT.50) GO TO 230
      GRAPH(K+1,J+1)= SYMBOL(I)
  230 CONTINUE
  240 CONTINUE
  250 XUNIT = (YMAX - XMIN)/7.
C-----------------------------------------------------------------------
C     THE X AXIS IS SCALED.
C-----------------------------------------------------------------------
      IDAYS(1) = XMIN
      IYEARS(1) = INITYR
      DO 260 I = 2,8
  260 IDAYS(I) = XMIN + XUNIT * FLOAT(I-1)
      DO 290 I = 2,8
      IYEARS(I) = IYEARS(I-1)
  270 NYRDAY = 365
      IF (MOD(IYEARS(I),4).EQ.0) NYRDAY = 366
      IF (IDAYS(I).LE.NYRDAY) GO TO 290
      IYEARS(I) = IYEARS(I) + 1
      DO 280 J=I,8
  280 IDAYS(J) = IDAYS(J) - NYRDAY
      GO TO 270
  290 CONTINUE
      YUNIT = (YMAX - YMIN )/5.
      YAXIS(1) = YMAX
      DO 300 J = 2, 6
  300 YAXIS(J) = YAXIS(J-1) - YUNIT
C-----------------------------------------------------------------------
C     THE GRAPH IS PRINTED.
C-----------------------------------------------------------------------

C..........HEADINGS ARE PRINTED
      WRITE (6,310) (TITLE(I), I = 1, 20)
  310 FORMAT (1H1, 20A4)
      IF (NOSYM.GT.1)WRITE(6,330)SYMBOL(1),(EXPLAN(I,1),I=1,5)
      WRITE (6,320)
  320 FORMAT (1H )
      IF (NOSYM.GT.1)WRITE(6,330)SYMBOL(2),(EXPLAN(I,2),I=1,5)
  330 FORMAT (1H+, 95X, 6A4)
      WRITE (6,340) I102, (YTITLE(I), I = 1,10)
  340 FORMAT ('  Y AXIS (*10**',I2,') IS ',10A4)
      IF (NOSYM.GT.2) WRITE(6,330) SYMBOL(3),(EXPLAN(I,3),I=1,5)

C..........THE GRAPH ITSELF IS PRINTED.
  350 J = 1
      I3 = 3
      DO 380 I1= 1, 51
      I3 = I3 + 1
      I = 52 - I1
      WRITE (6,360) (GRAPH(I,K), K = 1, 71)
  360 FORMAT (20X, 71A1)
      IF (I-I/10*10.NE.1) GO TO 370
      WRITE (6,FMT1) YAXIS(J)
      J = J + 1
  370 IF(I3.LE.NOSYM)WRITE(6,330)SYMBOL(I3),(EXPLAN(K,I3),K=1,5)
  380 CONTINUE
      WRITE (6,390) (XLINE(I), I = 1,18)
  390 FORMAT (20X, 18A4)
      WRITE (6,400) (IDAYS(I), I = 1,8)
  400 FORMAT ('    TIME - DAY     ', I5, 7(6X, I4))
      WRITE (6,410) (IYEARS(I), I = 1,8)
  410 FORMAT (9X,'YEAR       ', I5, 7(6X,I4))
      RETURN
      END
```

APPENDIX E

Listing of the Subroutine EXTERN

```fortran
      SUBROUTINE EXTERN
      DIMENSION DRIFW(307),DRIFY(307),DRIFZ(307)
      DIMENSION MRAIN(100),RAIN(100),MRUNON(5 ),RUNON(5 ),
     1FLOPAS(307),RUNMIN(5 ,4),RUNORG(5 ,5,4),DUSTPT(12,5, 6),
     2 EVAPOR(12),PHOTOP(12),RADIA(12),DUST(12,5,4) ,AFLOW(366),
     3EXO(   63),MIRRIG(5 ),WATIRR(5 ),RUNPIN(5,5, 6), RUNDIN(5, 6)
      COMMON/CHK/YD(1), YCOMPN(4),YDETIN(5,4),YDRIFV( 8,1,4),YDRIFO(40 ),
     1YDRIFA(40,4),YDRIFM(3,4),YPH(1) ,YPNORG(5, 6),YDNORG( 6),YWTEMP(1)
C-----------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------------
      COMMON/SPEC/       NCHAN,INSTRU(20),    WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,TDAY, ATOT, ATOTO,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOP               ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,               MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                 NOLIT1,LOOP,         IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRI(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,MDRIFM( 3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C-----------------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/METEOR/WIRRIG,    RUNSOL(4),RUNDEB(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4), TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6), TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RAINCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)   ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4) ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
      EQUIVALENCE (EXO,WIRRIG),(FLOPAS,FLOWIN),(DRIFY,YD)
C-----------------------------------------------------------------------
C     THE NAME LIST CONTAINS THE PARAMETERS THAT ARE TO BE
C     READ IN AT EXECUTION TIME.
C-----------------------------------------------------------------------
      NAMELIST/EPUT/  PHW,PHB, TRBFAC,          LIMEXO,APWIDE
     1,TRBH20  ,TEMPW,TEMPB
      MONOLD = 0.
   10 FORMAT (16I5)
   20 FORMAT (8F10.8)
   30 FORMAT (8F10.4)
      IF (IRUN.LE.1) GO TO 40
      IRAIN = JTRAIN
      IRUNN = JTRUNN
      KDAY = JKDAY
      IRRIG = JTRRIG
      GO TO 190
C-----------------------------------------------------------------------
C     EXOGENOUS AND METEROLOGICAL DATA IS READ.
C-----------------------------------------------------------------------
   40 CONTINUE
      NCHEK1=0
      DO 50  I=1,12
      DO 50  J=1,NOLIT
   50 READ (5,30)(DUST(I,J,K),K=1,NFRELM)
      DO 60 I=1,12
      DO 60 J=1,ISTRTM
   60 READ (5,30)(DUSTPI(I,J,K),K=1,INORGP)
      READ(5,10) NRAIN,NRUNON,NIRRIG

C..........PRECIPITATION DATA.
      IF (NRAIN.LE.0) GO TO 80
      READ (5,10) (MRAIN(I), I=1,NRAIN)
      READ (5,30) ( RAIN(I), I=1,NRAIN)
      READ (5,30) (RAINCO(K), K=1,NFRELM)
      READ (5,30)(RAINDI(K),K=1,INORGD)
      DO 70 IRAIN = 1, NRAIN
      IF (IDAY.LE.MRAIN(IRAIN)) GO TO 90
   70 CONTINUE
   80 IRAIN = NRAIN + 1

C..........SURFACE FLOW DATA.
   90 IF (NRUNON.LE.0) GO TO 130
      READ (5,10) (MRUNON(K), K=1,NRUNON)
      READ (5,30) (RUNON(I), I=1,NRUNON)
      DO 100 I = 1, NRUNON
      READ (5,30) (RUNMIN(I,K), K= 1,NFRELM)
      READ (5,30)(RUNDIN(I,K),K=1,INORGD)
      DO 100 J=1,NOLIT
  100 READ (5,30) (RUNORG(I,J,K),K=1,NFRELM)
      DO 110 I=1,NRUNON
      DO 110 J=1,ISTRTM
  110 READ(5,30)( RUNPIN(I,J,K),K=1,INORGP)
      DO 120 IRUNN= 1, NRUNON
      IF (IDAY.LE.MRUNON(IRUNN))GO TO 140
  120 CONTINUE
  130 IRUNN= NRUNON + 1

C..........WATER REMOVAL DATA.
  140 IF (NIRRIG.LE.0) GO TO 160
      READ (5,10) (MIRRIG(K),K=1,NIRRIG)
      READ (5,30) (WATIRR(K),K=1,NIRRIG)
      DO 150 IRRIG=1,NIRRIG
      IF (IDAY.LE.MIRRIG(IRRIG)) GO TO 170
  150 CONTINUE
  160 IRRIG=NIRRIG + 1

C..........EVAPORATION, PHOTOPERIOD, RADIATION, WATER TEMPERATURE.
  170 READ (5,30) (EVAPOR(I), I=1,12)
      READ (5,30) (PHOTOP(I), I=1,12)
      READ (5,30) (RADIA (I), I=1,12)
      IF(NSTRCH.GE.2) GO TO 180
      READ(5,20)(AFLOW(I),I=1,366)
  180 KDAY = IDAY-1
      JTRAIN = IRAIN
      JTRUNN = IRUNN
      JKDAY = KDAY
      JTRRIG = IRRIG
C-----------------------------------------------------------------------
C     CHECK FOR DAILY EVENTS AND TRANSFER INFORMATION TO METEOR
C     COMMON BLOCK.
C-----------------------------------------------------------------------
      ENTRY EXOGE2
  190 CONTINUE
      IF(NCHEK1.EQ.1) GO TO 590
      IF(LOOPER) 200,590,590

C..........DATA ON INFLOWING WATER FROM UPSTREAM.
  200 IF(NSTRCH.GE.2) GO TO 410
      DRIFW(1)=AFLOW(IYRDAY)
      IF (NCHECK.EQ.0) GO TO 240
      GOTO(210,420,220,230),JKFROM
  210 IF(JFROM.GT.IFROM)GOTO270
      GOTO240
  220 IF(JFROM.GT.IFROM)GOTO380
      JFROM=JFR
      IFROM=0
      GOTO270
  230 IF(JFROM.GT.IFROM)GOTO380
      JFROM=JFR
      GOTO360
  240 READ(5,10)JFROM,JKFROM
      IFROM=0
      GOTO260
  250 READ(5,10)JFR,JKFROM
      IFROM=0
      GOTO300
  260 GOTO(300,300,300,300),JKFROM
  270 DO 280 I=2,NPASS
  280 DRIFW(I)=DRIFY(I)
      JKFROM=1
  290 IFROM = IFROM+1
      GO TO 420
  300 READ(5,20)(YCOMPN(I),I=1,NFRELM)
      DO310 I=1,NOLIT
  310 READ(5,20)(YDETIN(I,J),J=1,NFRELM)
      DO320 I=1,NSPECV
  320 READ(5,20)(YDRIFV(I,1,J),J=1,NFRELM)
      DO330 I=1,NSPCOH
  330 READ(5,20)YDRIFO(I),(YDRIFA(I,J),J=1,NFRELM)
      DO340 I=1,MICROB
  340 READ(5,20)(YDRIFM(I,J),J=1,NFRELM)
      READ(5,20)YWTEMP,YPH
      DO350 I=1,ISTRTM
  350 READ(5,20)(YPNORG(I,J),J=1,INORGP)
      READ(5,20)(YDNORG(I),I=1,INORGD)
      IF(JKFROM.EQ.1) GO TO 270
      IF(JKFROM.EQ.2)GOTO360
      GOTO380
  360 DO 370 I=2,NPASS
  370 DRIFZ(I)=DRIFY(I)
      GOTO250

C..........DAILY VALUES MAY BE INTERPOLATED FROM THE DATA SETS.
  380 DJFAC=FLOAT(IFROM)/FLOAT(JFROM)
      DO 390 I=2,NPASS
  390 DRIFW(I)=DRIFZ(I)+(DJFAC*(DRIFY(I)-DRIFZ(I)))
  400 IFROM=IFROM+1
      GO TO 420
  410 CONTINUE
      CALL INOUT(1,9, DRIFW(1),NPASS)
  420 CONTINUE
      IF(NTRIB.NE.1)GOTO500
      IF(NCHECK.EQ.0)GOTO430
      IF(JTFROM.GT.ITFROM)GOTO490

C..........DATA ON INFLOWING WATER FROM TRIBUTARIES IS READ.
  430 READ(5,10)JTFROM
      READ(5,20)TRFLOW
      READ(5,20)(TCOMPN(I),I=1,NFRELM)
      DO440 I=1,NOLIT
  440 READ(5,20)(TDETIN(I,J),J=1,NFRELM)
      DO450 I=1,NSPECV
  450 READ(5,20)(TDRIFV(I,1,J),J=1,NFRELM)
      DO 460 I=1,NSPCOH
  460 READ(5,20) TDRIFO(I),(TDRIFA(I,J),J=1,NFRELM)
      DO470 I=1,MICROB
  470 READ(5,20)(TDRIFM(I,J),J=1,NFRELM)
      DO480 I=1,ISTRTM
  480 READ(5,20)(TPNORG(I,J),J=1,INORGP)
      READ(5,20)(TDNORG(I),I=1,INORGD)
      ITFROM=0
  490 ITFROM=ITFROM+1
  500 CONTINUE

C..........DATA ON INFLOWING WATER FROM TRIBUTARIES IS CALCULATED.
      IF(NTRIB.NE.2) GO TO 590
      TRFLOW=FLOWIN*TRBH20
      DO 550 J=1,NFRELM
      TCOMPN(J)=XCOMPN(J)*TRBFAC
      DO510 I=1,NOLIT
  510 TDETIN(I,J)=XDETIN(I,J)*TRBFAC
      DO520 I=1,NSPECV
  520 TDRIFV(I,1,J)=XDRIFV(I,1,J)*TRBFAC
      DO530 I=1,NSPCOH
  530 TDRIFA(I,J)=XDRIFA(I,J)*TRBFAC
      DO540 I=1,MICROB
  540 TDRIFM(I,J)=XDRIFM(I,J)*TRBFAC
  550 CONTINUE
      DO560 I=1,NSPCOH
  560 TDRIFO(I)=XDRIFO(I)*TRBFAC
      DO570 I=1,INORGD
  570 TDNORG(I)=XDNORG(I)*TRBFAC
      DO580 I=1,ISTRTM
      DO 580 J=1,INORGP
  580 TPNORG(I,J)=XPNORG(I,J)*TRBFAC
  590 CONTINUE
      IF(LOOPER.EQ.0)GO TO 610
      DO 600 I=1,NPASS
  600 FLOPAS(I)=DRIFW(I)
```

```
610 NCHEK1=NCHEK1+1
    IF(LOOPER)620,670,660
620 IF (IRAIN.LE.1) GO TO 630
    IF (IYRDAY.EQ.MRAIN(IRAIN - 1)) IRAIN = IRAIN - 1
630 KRAIN = IRAIN
    IF (IRUNN.LE.1) GO TO 640
    IF (IYRDAY.EQ.MRUNON(IRUNN-1)) IRUNN = IRUNN - 1
640 KRUNN = IRUNN
    IF ( IRRIG.LE.1) GO TO 650
    IF (IYRDAY.EQ.MIRRIG(IRRIG-1))IRRIG =  IRRIG - 1
650 KIRRIG = IRRIG
    GO TO 680
660 IRAIN = KRAIN
    IRUNN = KRUNN
    IRRIG = KIRRIG
    GO TO 680
670 IF (KDAY.EQ.IYRDAY) GO TO 870
680 DO 690 I =      1, LIMEXO
690 EXO(I) = 0.
    IF(KYR.GE.IYR) GO TO 700

C.........INFORMATION ON RAIN, OVERLAND FLOW AND WATER WITHDRWAL.
    IRAIN = IRAIN + 1
700 IF (MRAIN(IRAIN).LE.0) GO TO 730
    IF (MRAIN(IRAIN)-IYRDAY) 720, 710, 730
710 DARAIN = DARAIN + RAIN(IRAIN)
720 IRAIN = IRAIN + 1
730 IF(KYR.GE.IYR) GO TO 740
    IRUNN = IRUNN + 1
740 IF (MRUNON(IRUNN).LE.0) GO TO 810
    IF (MRUNON(IRUNN)-IYRDAY) 800,750,810
750 DAYRUN = DAYRUN +RUNON(IRUNN)
    DO760 K = 1, NFRELM
760 RUNSOL(K) = RUNMIN(IRUNN,K)
    DO 770 K=1,INORGD
770 RUNDNP(K)=RUNDIN(IRUNN,K)
    DO780 K = 1, NFRELM
    DO780 J=1,NOLIT
780 RUNDEB(J,K)=RUNORG(IRUNN,J,K)
    DO 790 K=1,INORGP
    DO 790 J=1,ISTRTM
790 RUNPNR(J,K)= RUNPIN(IRUNN,J,K)
800 IRUNN = IRUNN + 1
810 IF(KYR.GE.IYR) GO TO 820
    IRRIG =IRRIG +1
820 IF (MIRRIG(IRRIG).LE.0) GO TO 850
    IF (MIRRIG(IRRIG)-IYRDAY) 840,830,850
830 WIRRIG = WIRRIG + WATIRR(IRRIG)
840 IRRIG =IRRIG +1
850 KDAY = IYRDAY
    KYR = IYR
C---------------------------------------------------------------
C      INTERPOLATE DAILY METEOROLOGICAL VALUES FROM MONTHLY DATA
C---------------------------------------------------------------
860 CONTINUE
870 FLOW=FLOWIN+TRFLOW+(DAYRUN/86400)+(REACH*APWIDE*DARAIN/86400000.)
    EXTERP= FLOAT(NUMMON)/FLOAT(MONDAY(MONTH))
    MON1= MONTH+1
    IF(MON1.EQ.13)MON1=1
    EVAP=EVAPOR(MONTH)+(EXTERP*(EVAPOR(MON1)-EVAPOR(MONTH)))
    DO 880 I=1,NOLIT
    DO 880 K=1,NFRELM
880 DADUST(I,K)=DUST(MONTH,I,K)+(EXTERP*(DUST(MON1,I,K)-DUST
   1(MONTH,I,K)))
    DO 890 I=1,ISTRTM
    DO 890 K=1,INORGP
890 DUSTIP(I,K)=DUSTPI(MONTH,I,K)+(EXTERP*(DUSTPI(MON1,I,K)-DUSTPI
   1(MONTH,I,K)))
    DAYRAD=RADIA(MONTH)+(EXTERP*(RADIA(MON1)-RADIA(MONTH)))
    DAPHOT=PHOTOP(MONTH)+(EXTERP*(PHOTOP(MON1)-PHOTOP(MONTH)))
    RETURN
    ENTRY EINPUT
    READ (5,EPUT)
    RETURN
    END
```

APPENDIX F

Listing of the Subroutines SENSIT, SENOUT, DERIVD

```
      SUBROUTINE SENSIT (IRUN)                                          SENS0001
C THIS SUBROUTINE READS IN THE SPECIFICATIONS OF ANY SENSITIVITY TESTS  SENS0004
C TO BE PERFORMED, AND THEN MODIFIES PROCESS PARAMETERS OR THE INITIAL  SENS0005
C VALUES OF STATE VARIABLES AS SPECIFIED (IN SUBSEQUENT COMMENTS        SENS0006
C REFERRED TO COLLECTIVELY AS 'PARAMETERS') AT THE BEGINNING OF EACH    SENS0007
C REPEATED RUN.                                                         SENS0008
C                                                                       SENS0009
C THE FOLLOWING ARE DEFINITIONS OF VARIABLE NAMES USED IN THIS          SENS0010
C SUBROUTINE AND NOT IN THE MAIN PROGRAMME.  VARIABLES USED ONLY FOR    SENS0011
C TEMPORARY PURPOSES, OR WITH DIFFERENT MEANINGS AT DIFFERENT TIMES,    SENS0012
C ARE IN THE MAIN OMITTED.                                              SENS0013
C                                                                       SENS0014
C A               TEMPORARY STORAGE OF MULTIPLYING FACTOR FOR           SENS0015
C                 PARAMETER SET                                         SENS0016
C ANEW(I,J)       THE J'TH ALTERNATIVE VALUE FOR THE I'TH PARAMETER IN  SENS0017
C                 SETS TO BE VARIED ARBITRARILY                         SENS0018
C B               TEMPORARY STORAGE OF NEW PARAMETER VALUE              SENS0019
C FACTOR(I)       MULTIPLYING FACTOR FOR THE I'TH PARAMETER SET         SENS0020
C IA              TEMPORARY STORAGE FOR IPA(I)                          SENS0021
C IB              TEMPORARY STORAGE FOR IPB(I)                          SENS0022
C IDA             TEMPORARY STORAGE OF PARAMETER ADDRESS                SENS0023
C IDAYT(I)        THE TIME AT WHICH THE I'TH RESPONSE VARIABLE IS TO    SENS0024
C                 BE CALCULATED                                         SENS0025
C IDB             TEMPORARY STORAGE OF PARAMETER ADDRESS                SENS0026
C IDERIV          COUNTER FOR RESPONSE VARIABLES TO BE CALCULATED BY THE SENS0027
C                 SUBROUTINE DERIVD                                     SENS0028
C IDPAQ(I)        THE ADDRESS OF THE SECOND PARAMETER TO BE TESTED      SENS0029
C                 IN INTERACTION IN THE I'TH RUN                        SENS0030
C IDPAR(I)        THE ADDRESS OF THE FIRST PARAMETER TO BE TESTED IN    SENS0031
C                 INTERACTION IN THE I'TH RUN                           SENS0032
C INSETS(I,J)     THE SEQUENCE NUMBER OF THE J'TH PARAMETER SET IN THE  SENS0033
C                 I'TH INTERACTION PAIR                                 SENS0034
C INTSET          NUMBER OF PAIR-WISE INTERACTIONS BETWEEN SETS OF      SENS0035
C                 PARAMETERS TO BE TESTED                               SENS0036
C INTXXX          INDEX TO DISTINGUISH INTERACTION OPERATIONS ON SETS   SENS0037
C INU             ADDRESS FOR TRANSMISSION AS ARGUMENT TO               SENS0038
C INUM(I)         THE ADDRESS OF THE I'TH RESPONSE VARIABLE, OR, IF THE SENS0039
C                 RESPONSE VARIABLE IS TO BE CALCULATED BY THE          SENS0040
C                 SUBROUTINE DERIVD, THE SEQUENCE NUMBER OF THE SET OF  SENS0041
C                 MULTIPLIERS TO BE USED FOR IT                         SENS0042
C IP              ADDRESS (IN P OR STATE) OF A SINGLE-VALUE PARAMETER   SENS0043
C                 TO BE VARIED                                          SENS0044
C IPA(I)          SEQUENCE NUMBER OF FIRST PARAMETER OF THE I'TH PAIR   SENS0045
C                 FOR INTERACTION TESTING                               SENS0046
C IPAR(I)         THE ADDRESS OF THE I'TH PARAMETER SUBJECT TO          SENS0047
C                 MODIFICATION                                          SENS0048
C IPB(I)          SEQUENCE NUMBER OF SECOND PARAMETER OF THE I'TH PAIR  SENS0049
C                 FOR INTERACTION TESTING                               SENS0050
C IQ              TEMPORARY STORAGE OF PARAMETER SEQUENCE NUMBER        SENS0051
C IQA(I)          THE SERIAL NUMBER OF A SINGLE-VALUE PARAMETER TO BE   SENS0052
C                 VARIED IN THE I'TH RUN   .                            SENS0053
C IQB(I)          THE SERIAL NUMBER OF A SECOND SINGLE-VALUE PARAMETER  SENS0054
C                 TO BE VARIED IN THE I'TH RUN                          SENS0055
C IQQ             TEMPORARY STORAGE OF PARAMETER SEQUENCE NUMBER        SENS0056
C ISTORE(I)       THE SEQUENCE NUMBER OF THE FINAL RUN FOR THE I'TH     SENS0057
C                 PARAMETER SET INTERACTION                             SENS0058
C ISV             SWITCH TRANSMITTED AS ARGUMENT TO SUBROUTINE DERIVD - - SENS0059
C                 1 FOR INPUT, 2 FOR RESPONSE CALCULATION               SENS0060
C ITY             PARAMETER TYPE                                        SENS0061
C ITYP(I)         THE TYPE (STATE VARIABLE SUM OR CALCULATED FUNCTION)  SENS0062
C                 OF THE I'TH RESPONSE VARIABLE                         SENS0063
C IY(I)           THE TYPE (PROCESS-MODEL CONSTANT, OR STATE VARIABLE)  SENS0064
C                 OF THE I'TH PARAMETER UNDERGOING MODIFICATION         SENS0065
C IYY             TEMPORARY STORAGE FOR PARAMETER TYPE                  SENS0066
C I91             COUNTER FOR PARAMETER SETS BEING MODIFIED IN          SENS0067
C                 INTERACTIVE PAIRS                                     SENS0068
C JPAR(I)         TEMPORARY STORAGE OF IPAR (I) FOR ORDERING PURPOSE    SENS0069
C JRUN            NUMBER OF RUN WHEN A PARTICULAR PARAMETER SET WAS     SENS0070
C                 MODIFIED.  USED IN INTERACTION WITH ANOTHER           SENS0071
C                 PARAMETER SET                                         SENS0072
C K1              SERIAL NUMBER OF PARAMETER CURRENTLY UNDERGOING       SENS0073
C                 MODIFICATION                                          SENS0074
C K2              TEMPORARY STORAGE OF ADDRESS OF PARAMETER IN SET      SENS0075
C                 CURRENTLY UNDERGOING MODIFICATION                     SENS0076
C MADDR(I)        NUMBER OF RUNS BEFORE THE I'TH SET OF PARAMETERS      SENS0077
C                 VARIED                                                SENS0078
C MAPAR           NUMBER OF SINGLE-VALUE PARAMETERS, PLUS THOSE IN      SENS0079
C                 SETS TO BE VARIED ARBITRARILY                         SENS0080
C MARUN           SEQUENCE NUMBER OF LAST RUN BEFORE SETS TO BE VARIED  SENS0081
C                 BY A COMMON FACTOR                                    SENS0082
C MINADD          TEMPORARY STORAGE OF ADDRESS OF MININUM VALUE IN IPAR SENS0083
C MINPAR          MINIMUM VALUE IN ARRAY JPAR                           SENS0084
C MPAR            TOTAL NUMBER OF PARAMETERS TO BE VARIED               SENS0085
C MRUN            NUMBER OF RUNS WITH SINGLE PARAMETERS, OR INTERACTING SENS0086
C                 PAIRS, VARIED                                         SENS0087
C NALT            NUMBER OF PARAMETERS IN A SET SUBJECT TO ALTERATION   SENS0088
C NALT1(I)        STORED VALUE OF NALT FOR THE I'TH SET                 SENS0089
C NDI             NUMBER OF VALUES OF A PARAMETER TO BE USED IN         SENS0090
C                 ADDITION TO THE ORIGINAL VALUE                        SENS0091
C NDIF(I)         THE NUMBER OF ALTERNATIVE VALUES OF THE I'TH PARAMETER SENS0092
C                 TO BE MODIFIED SINGLY                                 SENS0093
C                 NUMBER OF ALTERNATIVE SETS OF VALUES FOR A SET OF     SENS0094
C                 PARAMETERS VARIED ARBITRARILY, OR NUMBER OF POWERS OF SENS0095
C                 THE MULTIPLYING FACTOR TO BE USED                     SENS0096
C NDIFF1(I)       STORED VALUE OF NDIFF FOR THE I'TH SET                SENS0097
C NINTER          NUMBER OF PAIRS OF SINGLE-VALUE PARAMETERS FOR        SENS0098
C                 INTERACTION TESTS                                     SENS0099
C NNA             NUMBER OF ALTERNATIVE VALUES FOR THE FIRST OF A PAIR  SENS0100
C                 OF SINGLE-VALUE PARAMETERS SUBJECT TO INTERACTIVE     SENS0101
C                 TESTING                                               SENS0102
C NNB             NUMBER OF ALTERNATIVE VALUES FOR THE SECOND OF A PAIR SENS0103
C                 OF SINGLE-VALUE PARAMETERS SUBJECT TO INTERACTIVE     SENS0104
C                 TESTING                                               SENS0105
C NOPAR(I)        ORDERED VALUES FROM IPAR                              SENS0106
C NPAR            NUMBER OF SINGLE-VALUE PARAMETERS TO BE VARIED        SENS0107
C NPARAM          NUMBER OF ADDRESSES OF PROCESS-MODEL CONSTANTS IN     SENS0108
C                 NOPAR                                                 SENS0109
C NPARA1          NPARAM + 1 (NEEDED FOR DO-LOOP OPERATIONS)            SENS0110
C NRA             RUN NUMBER DURING SINGLE-PARAMETER MODIFICATION       SENS0111
C NRESP           NUMBER OF RESPONSE VARIABLES TO BE TESTED             SENS0112
C NRU             RUN NUMBER DURING TESTING OF SINGLE-PARAMETER         SENS0113
C                 INTERACTIONS                                          SENS0114
C NRUN            TOTAL NUMBER OF RUNS                                  SENS0115
C NRUNN           TOTAL NUMBER OF RUNS, APART FROM THOSE INVOLVING      SENS0116
C                 SET INTERACTION                                       SENS0117
C NSETS1          NUMBER OF SETS OF PARAMETERS TO BE VARIED ARBITRARILY SENS0118
C NSETS2          NUMBER OF SETS OF PARAMETERS TO BE VARIED BY A COMMON SENS0119
C                 FACTOR                                                SENS0120
C NSETS3          TOTAL NUMBER OF SETS OF PARAMETERS TO BE VARIED       SENS0121
C NSETS4          SEQUENCE NUMBER OF FIRST SET OF PARAMETERS TO BE      SENS0122
C                 VARIED BY A COMMON FACTOR                             SENS0123
C NSTATE          NUMBER OF STATE-VARIABLE ADDRESSES IN NOPAR           SENS0124
C NUM             NUMBER OF RUNS REQUIRED FOR A SET INTERACTION         SENS0125
C P(I)            THE I'TH PARAMETER IN PROCESS SUB-ROUTINES            SENS0126
C PDIF(I,J)       THE J'TH ALTERNATIVE VALUE TO BE TESTED FOR THE I'TH  SENS0127
C                 SINGLE-VALUE PARAMETER SUBJECT TO MODIFICATION        SENS0128
C VPAQ(I)         THE VALUE FOR THE I'TH RUN OF THE PARAMETER OF WHICH  SENS0129
C                 THE ADDRESS IS GIVEN IN IDPAQ(I)                      SENS0130
C VPAR(I)         THE VALUE FOR THE I'TH RUN OF THE PARAMETER OF WHICH  SENS0131
C                 THE ADDRESS IS GIVEN IN IDPAR(I)                      SENS0132
      COMMON / PARAM/ P( 4147)                                          SENS0134
      DIMENSION NDIF(50),PDIF(50,10),IPAR(100),IPA(10),IPB(10)          SENS0135
      DIMENSION IDPAR(300), IDPAQ(300),                                 SENS0136
     1 VPAR(300), VPAQ(300), IQA(300), IQB(300)                         SENS0137
      DIMENSION IY(50),INSETS(10,2),ISTORE(10)                          SENS0138
      DIMENSION MADDR(10), NALT1(10), NDIFF1(10), IP1(5,10)             SENS0139
     1 ,ANEW(100,5), FACTOR(10)                                         SENS0140
      COMMON/STAT/STATE( 364)                                           SENS0141
      COMMON/TOTALS/SUMS( 167)                                          SENS0142
      COMMON/ACC/ STNG(221)                                             SENS0143
C-----------------------------------------------------------------------SENS0144
C     THE COMMON BLOCK /RESP/ CONTAINS INFORMATION ON RESPONSES FOR     SENS0145
C     COMMUNICATION WITH THE SUBROUTINE SENOUT.                         SENS0146
C-----------------------------------------------------------------------SENS0147
      COMMON/RESP/ ITYP(20), INUM(20), IDAYT(20), NRESP,                SENS0148
     1 NPAR, NRUN, NOPAR(100), NPARAM, NPARA1, NSTATE                   SENS0149
      DIMENSION JPAR(100)                                               SENS0150
      NRU=NRUN                                                          SENS0151
      IF(IRUN.GT.1)GO TO 390                                            SENS0152
C-----------------------------------------------------------------------SENS0153
C     AT THE BEGINNING OF THE FIRST RUN, INITIAL VALUES OF THE          SENS0154
C     PARAMETERS ARE STORED.                                            SENS0155
C-----------------------------------------------------------------------SENS0156
      WRITE(0)STATE,P                                                   SENS0157
C-----------------------------------------------------------------------SENS0158
C     THE NUMBERS OF SENSITIVITY TESTS OF DIFFERENT KINDS TO BE         SENS0159
C     PERFORMED ARE SPECIFIED.                                          SENS0160
C-----------------------------------------------------------------------SENS0161
      READ (5,40) NPAR,NINTER,NRESP,NSETS1, NSETS2, INTSET              SENS0162
   40 FORMAT(16I5)                                                      SENS0163
C-----------------------------------------------------------------------SENS0164
C     PARTICULARS OF THE PARAMETER VARIATIONS TO BE PERFROMED ARE       SENS0165
C     READ IN.                                                          SENS0166
C-----------------------------------------------------------------------SENS0167
      NRA=1                                                             SENS0168
      NRU = 1                                                           SENS0169
      IF (NPAR.LE.0) GO TO 110                                          SENS0170
                                                                        SENS0171
C..........SINGLE PARAMETERS                                            SENS0172
      DO 80 I=1,NPAR                                                    SENS0173
      READ (5,40) ITY, IP, NDI                                          SENS0174
      READ (5,50) (PDIF(I,J), J=1,NDI)                                  SENS0175
   50 FORMAT (8F10.5)                                                   SENS0176
      IPAR(I)=IP                                                        SENS0177
      NDIF(I)=NDI                                                       SENS0178
   60 CONTINUE                                                          SENS0179
      DO 70 J=1,NDI                                                     SENS0180
      NRA=NRA+1                                                         SENS0181
      IDPAR(NRA)=IP                                                     SENS0182
      VPAR(NRA)=PDIF(I,J)                                               SENS0183
      IQA(NRA)=I                                                        SENS0184
      IY(I)=ITY                                                         SENS0185
   70 CONTINUE                                                          SENS0186
   80 CONTINUE                                                          SENS0187
      NRU =NRA                                                          SENS0188
      IF (NINTER.EQ.0) GO TO 110                                        SENS0189
                                                                        SENS0190
C..........INTERACTIONS BETWEEN PAIRS OF PARAMETERS.                    SENS0191
      DO 100 I=1,NINTER                                                 SENS0192
      READ (5,40) IPA(I),IPB(I)                                         SENS0193
      IA=IPA(I)                                                         SENS0194
      IB=IPB(I)                                                         SENS0195
      NNA=NDIF(IA)                                                      SENS0196
      NNB=NDIF(IB)                                                      SENS0197
      DO 90 J=1,NNA                                                     SENS0198
      DO 90 K=1,NNB                                                     SENS0199
      NRU =NRU +1                                                       SENS0200
      IDPAR(NRU)=IPAR(IA)                                               SENS0201
      VPAR(NRU)=PDIF(IA,J)                                              SENS0202
      IDPAQ(NRU)=IPAR(IB)                                               SENS0203
      VPAQ(NRU)=PDIF(IB,K)                                              SENS0204
      IQA(NRU)=IA                                                       SENS0205
      IQB(NRU)=IB                                                       SENS0206
   90 CONTINUE                                                          SENS0207
  100 CONTINUE                                                          SENS0208
  110 CONTINUE                                                          SENS0209
      NRUN = NRU                                                        SENS0210
      MPAR = NPAR                                                       SENS0211
      MRUN = NRUN                                                       SENS0212
      MADDR(1) = NRUN                                                   SENS0213
      NSETS3 = NSETS2 + NSETS1                                          SENS0214
      NSETS4 = NSETS1 + 1                                               SENS0215
      IF (NSETS1.LE.0) GO TO 160                                        SENS0216
                                                                        SENS0217
C..........SETS OF PARAMETERS TO BE CHANGED TO NEW EMPIRICAL SETS OF    SENS0218
C..........VALUES.                                                      SENS0219
      K = 0                                                             SENS0220
      K1 = MPAR                                                         SENS0221
      K2 = 0                                                            SENS0222
      DO 150 I = 1, NSETS1                                              SENS0223
      I1 = I + NPAR                                                     SENS0224
      READ (5,40) ITY, NALT,NDIFF, (IP1(I,J), J = 1, NALT)              SENS0225
      K2 = K2 + NALT                                                    SENS0226
      MPAR = MPAR + NALT                                                SENS0227
      DO 120 J = 1, NALT                                                SENS0228
      K1 = K1 + 1                                                       SENS0229
      K2 = IP1(I,J)                                                     SENS0230
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      IPAR(K1) = K2                                                     SENS0231
      IY(K1) = ITY                                                      SENS0232
  120 CONTINUE                                                          SENS0233
      NDIFF1(I)= NDIFF                                                  SENS0234
      NALT1(I) = NALT                                                   SENS0235
  130 K = K + 1                                                         SENS0236
      READ (5,140) (ANEW(K,J), J=1,NDIFF)                               SENS0237
  140 FORMAT (8F10.4)                                                   SENS0238
      IF (K.LT.(K1-NPAR)) GO TO 130                                     SENS0239
      MADDR(I+1) = NDIFF + MADDR(I)                                     SENS0240
      NRUN = NRUN + NDIFF                                               SENS0241
  150 CONTINUE                                                          SENS0242
  160 MARUN = NRUN                                                      SENS0243
      MAPAR = MPAR                                                      SENS0244
      IF (NSETS2.LE.0) GO TO  200                                       SENS0245
                                                                        SENS0246
C.........SETS OF PARAMETERS TO BE MULTIPLIED BY A COMMON FACTOR.        SENS0247
      K1 = MAPAR                                                        SENS0248
      DO 190 I = NSETS4, NSETS3                                         SENS0249
      READ (5,40) ITY, NALT, NDIFF, (IP1(I,J), J=1,NALT)                SENS0250
      MPAR = MPAR + NALT                                                SENS0251
      DO 170 J = 1, NALT                                                SENS0252
      K1 = K1 + 1                                                       SENS0253
      K2 = IP1(I,J)                                                     SENS0254
      IPAR(K1) = K2                                                     SENS0255
      IY(K1) = ITY                                                      SENS0256
  170 CONTINUE                                                          SENS0257
      NALT1(I) = NALT                                                   SENS0258
      NDIFF1(I) = NDIFF                                                 SENS0259
      READ (5,140) FACTOR (I)                                           SENS0260
      IF (FACTOR(I).GT.0.) GO TO 180                                    SENS0261
      NRUN = NRUN + 1                                                   SENS0262
      GO TO 190                                                         SENS0263
  180 NRUN = NRUN + 2*NDIFF                                             SENS0264
  190 MADDR(I+1) = NRUN                                                 SENS0265
  200 NRUNN = NRUN                                                      SENS0266
                                                                        SENS0267
C.........INTERACTIONS BETWEEN SETS OF PARAMETERS.                      SENS0268
      IF (INTSET.LE.0) GO TO 220                                        SENS0269
      DO 210 I = 1, INTSET                                              SENS0270
      READ (5,40) J,K                                                   SENS0271
      NUM = NDIFF1(J) * NDIFF1(K)                                       SENS0272
      IF (J.GT.NSETS1) NUM = NUM * 2                                    SENS0273
      IF (K.GT.NSETS1) NUM = NUM * 2                                    SENS0274
      NRUN = NRUN + NUM                                                 SENS0275
      ISTORE(I) = NRUN                                                  SENS0276
      INSETS(I,1) = J                                                   SENS0277
  210 INSETS(I,2) = K                                                   SENS0278
      I91 = 1                                                           SENS0279
C----------------------------------------------------------------------- SENS0280
C     RESPONSE VARIABLES ARE IDENTIFIED.                                SENS0281
C----------------------------------------------------------------------- SENS0282
  220 CONTINUE                                                          SENS0283
      IDERIV = 0                                                        SENS0284
      DO 230 I=1,NRESP                                                  SENS0285
      READ (5,40) ITYP(I), INUM(I), IDAYT(I)                            SENS0286
      INU=INUM(I)                                                       SENS0287
      ISV=1                                                             SENS0288
      IF (ITYP(I).NE.5) GO TO 230                                       SENS0289
      IDERIV = IDERIV + 1                                               SENS0290
      CALL DERIVD(IDERIV,ISV)                                           SENS0291
      INUM(I) = IDERIV                                                  SENS0292
  230 CONTINUE                                                          SENS0293
      DO 240 I = 1, MPAR                                                SENS0294
  240 JPAR(I) = IPAR(I)                                                 SENS0295
      K = 0                                                             SENS0296
  250 MINADD = 0                                                        SENS0297
      MINPAS = 100000                                                   SENS0298
      DO 280 I = 1, MPAR                                                SENS0299
      IF ((IY(I).NE.1).OR.(JPAR(I).LE.0)) GO TO 280                     SENS0300
      IF (MINPAS - JPAR(I))   280, 260, 270                             SENS0301
  260 JPAR(I) = 0                                                       SENS0302
      GO TO 280                                                         SENS0303
  270 MINPAS = JPAR(I)                                                  SENS0304
      MINADD = I                                                        SENS0305
  280 CONTINUE                                                          SENS0306
      IF (MINADD.LE.0) GO TO 310                                        SENS0307
  290 K = K + 1                                                         SENS0308
      NOPAR(K) = MINPAS                                                 SENS0309
  300 JPAR(MINADD) = 0                                                  SENS0310
      GO TO 250                                                         SENS0311
  310 NPARAM = K                                                        SENS0312
      NPARA1 = K + 1                                                    SENS0313
  320 MINADD = 0                                                        SENS0314
      MINPAS = 100000                                                   SENS0315
      DO 350 I = 1, MPAR                                                SENS0316
      IF ((IY(I).NE.2).OR.(JPAR(I).LE.0)) GO TO 350                     SENS0317
      IF (MINPAS - JPAR(I)) 350, 330, 340                               SENS0318
  330 JPAR(I) = 0                                                       SENS0319
      GO TO 350                                                         SENS0320
  340 MINPAS = JPAR(I)                                                  SENS0321
      MINADD = I                                                        SENS0322
  350 CONTINUE                                                          SENS0323
      IF (MINADD.LE.0) GO TO 380                                        SENS0324
  360 K = K + 1                                                         SENS0325
      NOPAR(K) = MINPAS                                                 SENS0326
  370 JPAR(MINADD) = 0                                                  SENS0327
      GO TO 320                                                         SENS0328
  380 NSTATE = K                                                        SENS0329
      GO TO 730                                                         SENS0330
C----------------------------------------------------------------------- SENS0331
C     AT THE BEGINNING OF EACH SUCCESSIVE RUN, THE INITIAL VALUES OF    SENS0332
C     ALL PARAMETERS ARE RESTORED, AND THEN MODIFIED.                   SENS0333
C----------------------------------------------------------------------- SENS0334
  390 REWIND 0                                                          SENS0335
      READ(0) STATE,P                                                   SENS0336
      JRUN = IRUN                                                       SENS0337
      INTXXX = 0                                                        SENS0338
      IF (NPAR.LE.0) GO TO 480                                          SENS0339
      IF(IRUN.GT.NRA)GOTO420                                            SENS0340
                                                                        SENS0341
C.........SINGLE PARAMETERS ARE CHANGED.                                SENS0342
      IDA=IDPAR(IRUN)                                                   SENS0343
      IQ = IQA(IRUN)                                                    SENS0344
      IYY = IY(IQ)                                                      SENS0345
      GO TO(400,410), IYY                                               SENS0346
  400 P(IDA) = VPAR(IRUN)                                               SENS0347
      GO TO 730                                                         SENS0348
  410 STATE(IDA) = VPAR(IRUN)                                           SENS0349
      GO TO 730                                                         SENS0350
  420 IF (IRUN.GT.MRUN) GO TO 480                                       SENS0351
                                                                        SENS0352
C.........PAIRS OF PARAMETERS ARE CHANGED                               SENS0353
      IQ = IQA(IRUN)                                                    SENS0354
      IDA = IDPAR(IRUN)                                                 SENS0355
      IDB = IDPAQ(IRUN)                                                 SENS0356
      IQQ = IQB(IRUN)                                                   SENS0357
      IYY = IY(IQ)                                                      SENS0358
      GO TO (430,440), IYY                                              SENS0359
  430 P(IDA) = VPAR(IRUN)                                               SENS0360
      GO TO 450                                                         SENS0361
  440 STATE(IDA) = VPAR(IRUN)                                           SENS0362
  450 IYY = IY(IQQ)                                                     SENS0363
      GO TO (460,470), IYY                                              SENS0364
  460 P(IDB)=VPAQ(IRUN)                                                 SENS0365
      GO TO 730                                                         SENS0366
  470 STATE(IDB) = VPAQ(IRUN)                                           SENS0367
      GO TO 730                                                         SENS0368
  480 IF (IRUN.GT.MARUN) GO TO 570                                      SENS0369
  490 K = JRUN                                                          SENS0370
  500 K1 = NPAR                                                         SENS0371
                                                                        SENS0372
C.........SETS OF PARAMETERS ARE CHANGED TO NEW EMPIRICAL SETS.         SENS0373
      DO 510 I = 1, NSETS1                                              SENS0374
      IF (K.LE.MADDR(I+1)) GO TO 530                                    SENS0375
      K = K - NDIFF1(I)                                                 SENS0376
      K1 = K1 + NALT1(I)                                                SENS0377
  510 CONTINUE                                                          SENS0378
      WRITE (6,520)                                                     SENS0379
  520 FORMAT (' ERROR IN NSETS1')                                       SENS0380
      STOP                                                              SENS0381
  530 K2 = NALT1(I)                                                     SENS0382
      K = K - MRUN                                                      SENS0383
      DO 560 J1 = 1, K2                                                 SENS0384
      K1 = K1 + 1                                                       SENS0385
      IP = IPAR(K1)                                                     SENS0386
      K3 = K1 - NPAR                                                    SENS0387
      B = ANEW(K3,K)                                                    SENS0388
      IYY = IY(K1)                                                      SENS0389
      GO TO (540,550), IYY                                              SENS0390
  540 P(IP) = B                                                         SENS0391
      GO TO 560                                                         SENS0392
  550 STATE(IP) = B                                                     SENS0393
  560 CONTINUE                                                          SENS0394
      IF (INTXXX) 730, 730, 720                                         SENS0395
  570 IF (IRUN.GT.NRUNN) GO TO 670                                      SENS0396
                                                                        SENS0397
C.........SETS OF PARAMETERS ARE MULTIPLIED BY A COMMON FACTOR.         SENS0398
  580 K = JRUN - MARUN                                                  SENS0399
  590 K1 = MAPAR                                                        SENS0400
      DO 600 J = NSETS4, NSETS3                                         SENS0401
      IDIFF = MADDR(J+1) - MADDR(J)                                     SENS0402
      IF (K.LE.IDIFF) GO TO 620                                         SENS0403
      K = K - IDIFF                                                     SENS0404
      K1 = K1 + NALT1(J)                                                SENS0405
  600 CONTINUE                                                          SENS0406
      WRITE (6,610)                                                     SENS0407
  610 FORMAT (' ERROR IN NSETS2')                                       SENS0408
      STOP                                                              SENS0409
  620 A = FACTOR(J)                                                     SENS0410
      J11 = J + 1                                                       SENS0411
      IF (IDIFF.EQ.1) GO TO 630                                         SENS0412
      I22 = (K+1)/2                                                     SENS0413
      I21 = I22*2 - K                                                   SENS0414
      IF (I21.LE.0) I22 = -I22                                          SENS0415
      A = A**I22                                                        SENS0416
      K2 = NALT1(J)                                                     SENS0417
  630 DO 660 I = 1, K2                                                  SENS0418
      K1 = K1 + 1                                                       SENS0419
      IYY = IY(K1)                                                      SENS0420
      IP = IP1(J,I)                                                     SENS0421
      GO TO (640,650), IYY                                              SENS0422
  640 P(IP) = P(IP) * A                                                 SENS0423
      GO TO 660                                                         SENS0424
  650 STATE (IP) = STATE(IP) * A                                        SENS0425
  660 CONTINUE                                                          SENS0426
      IF (INTXXX) 730, 730, 720                                         SENS0427
  670 CONTINUE                                                          SENS0428
  680 IF (INTSET.LE.0) GO TO 730                                        SENS0429
      INTXXX = 1                                                        SENS0430
  690 IF (IRUN.LE.ISTORE(I91)) GO TO 700                                SENS0431
      I91 = I91 + 1                                                     SENS0432
      IF (I91.LE.INTSET) GO TO 690                                      SENS0433
      RETURN                                                            SENS0434
                                                                        SENS0435
C.........PARAMETER VALUES ARE CHANGED FOR SET INTERACTIONS.            SENS0436
  700 K20 = IRUN - NRUNN                                                SENS0437
      IF (I91.GT.1) K20 = IRUN - ISTORE(I91 - 1)                        SENS0438
      J21 = INSETS(I91,1)                                               SENS0439
      J22 = INSETS(I91,2)                                               SENS0440
      K22 = MADDR(J22+1) - MADDR(J22)                                   SENS0441
      K31 = (K20 - 1)/K22 + 1                                           SENS0442
      K32 = K20 - (K31 - 1)*K22                                         SENS0443
      K41 = K31 + MADDR(J21)                                            SENS0444
      K42 = K32 + MADDR(J22)                                            SENS0445
      JRUN = K41                                                        SENS0446
  710 CONTINUE                                                          SENS0447
      IF (J21 - NSETS1) 490,490,580                                     SENS0448
  720 INTXXX = 0                                                        SENS0449
      JRUN = K42                                                        SENS0450
      IF (J22 - NSETS1) 490,490,580                                     SENS0451
  730 CONTINUE                                                          SENS0452
C----------------------------------------------------------------------- SENS0453
C     INITIAL VALUES OF THE STATE VARIABLES FOR THE CURRENT RUN ARE     SENS0454
C     RECORDED FOR USE BY THE SENOUT SUBROUTINE.                        SENS0455
C----------------------------------------------------------------------- SENS0456
      REWIND 8                                                          SENS0457
      WRITE (8) STATE                                                   SENS0458
      RETURN                                                            SENS0459
      END                                                               SENS0460
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      SUBROUTINE SENOUT (ISW,IDAY,IRUN)
C THIS SUBROUTINE RECORDS THE VALUES OF RESPONSE VARIABLES SPECIFIED
C IN THE SENSIT SUBROUTINE, AND PRINTS THE RESULTS OF THE SENSITIVITY
C TESTS AT THE CONCLUSION OF THE JOB.
C
C THE FOLLOWING ARE DEFINITIONS OF VARIABLE NAMES USED IN THIS
C SUBROUTINE AND NOT ELSEWHERE.    VARIABLES USED ONLY FOR TEMPORARY
C PURPOSES, OR WITH DIFFERENT MEANINGS AT DIFFERENT TIMES, ARE IN THE
C MAIN OMITTED
C
C INA             ADDRESS OF RESPONSE VARIABLE
C ISV             SWITCH FOR TRANSMISSION TO SUBROUTINE DERIVD
C IT              TYPE OF RESPONSE VARIABLE (1 FOR STATE VARIABLE, 2 FOR
C                 A SUM OF STATE VARIABLES, 4 FOR AN ACCUMULATED
C                 EXCHANGE, AND 5 FOR A RESPONSE VARIABLE CALCULATED BY
C                 THE SUBROUTINE DERIVD)
C PARXX(I,J)      THE VALUE OF THE I'TH PARAMETER DURING THE J'TH RUN
C RX(I,J)         THE VALUE OF THE I'TH RESPONSE VARIABLE DURING THE
C                 J'TH RUN
C VNEW(K)         THE K'TH RESPONSE VARIABLE CALCULATED BY THE
C                 SUBROUTINE DERIVD
      COMMON /PARAM/ P( 4147)
C-----------------------------------------------------------------------
C     THE COMMON BLOCK /NEWVAR/ IS REQUIRED FOR RESPONSE VALUES
C     CALCULATED BY THE SUBROUTINE DERIVD.
C-----------------------------------------------------------------------
      COMMON/NEWVAR/VNEW(10)
      COMMON/STAT/STATE( 364)
      COMMON/TOTALS/SUMS( 167)
      COMMON/ACC/ STNG(221)
      COMMON/RESP/ ITYP(20), INUM(20), IDAYT(20) , NRESP,
     1 MPAR, NRUN,NOPAR(100),NPARAM,NPARA1, NSTATE
      DIMENSION PARXX(30,30), RX(30,30)
      DATA LIMRUN/30/
      IF (ISW.GT.3) ISW = 1
      GO TO (10, 110, 160, 10, 10), ISW
   10 IF  (NRUN.LE.LIMRUN) GO TO 30
      WRITE (6,20)
   20 FORMAT ('0TOO MANY RUNS')
      STOP
C-----------------------------------------------------------------------
C     IF RESPONSES ARE REQUIRED ON THE CURRENT DAY OF THE SIMULATION,
C     THEY ARE STORED, AFTER CALCULATION IF NECESSARY.
C-----------------------------------------------------------------------
   30 DO 100 I = 1, NRESP
      IF (IDAY.NE.IDAYT(I)) GO TO 100
      INA = INUM(I)
      IT = ITYP(I)
      ISV=2
      IF(IT.EQ.5)CALL DERIVD(INA,ISV)
      GOTO(40,50,60,70,80),IT
   40 RX(I,IRUN) = STATE (INA)
      GO TO 90
   50 RX(I,IRUN) = SUMS  (INA)
      GO TO 90
   60 CONTINUE
      GO TO 90
   70 RX(I,IRUN) = STNG  (INA)
      GOTO90
   80 RX(I,IRUN) = VNEW  (INA)
   90 CONTINUE
  100 CONTINUE
      GO TO 330
  110 IF (NPARAM.LE.0) GO TO 130
C-----------------------------------------------------------------------
C     AT THE END OF EACH RUN, THE VALUES OF THE PARAMETERS SUBJECT TO
C     CHANGE ARE RECORDED.
C-----------------------------------------------------------------------
      REWIND 8
      READ (8) STATE
      DO 120 I = 1, NPARAM
      J = NOPAR(I)
  120 PARXX(I,IRUN) = P(J)
  130 IF(NSTATE.LE.NPARAM) GO TO 150
      DO 140 I = NPARA1, NSTATE
      J = NOPAR(I)
  140 PARXX(I,IRUN) = STATE(J)
  150 WRITE (6,152) IRUN
  152 FORMAT ('0FOR RUN NO.', I3)
      WRITE (6,154)
  154 FORMAT (' PARAMETERS WERE')
      WRITE (6,156) (PARXX(I,IRUN), I = 1, NSTATE)
  156 FORMAT (15X, 10F11.5)
      WRITE (6,158)
  158 FORMAT (' RESPONSES WERE')
      WRITE (6,156) (RX(I,IRUN), I = 1, NRESP)
      IF (IRUN.LT.NRUN) GO TO 330
  160 CONTINUE
C-----------------------------------------------------------------------
C     WHEN THE WHOLE JOB IS COMPLETED, THE RESULTS ARE PRINTED.
C-----------------------------------------------------------------------
      WRITE (6,170)
  170 FORMAT ('1  SUMMARY   OF   RUNS')
  180 FORMAT (1H , 5X, I5, 8F15.4)
      IF (NPARAM.LE.0) GO TO 230
      M1 = 1
      M2 = 8
  190 IF (M1.GT.NRUN) GO TO 240
      M = MINO(M2, NRUN)
      WRITE (6,200)          (I, I=M1, M)
  200 FORMAT ('0   IRUN', I13, 7I15)
      WRITE (6,210)
  210 FORMAT (' PARAMETER')
      DO 220 I = 1,NPARAM
  220 WRITE (6,180) NOPAR(I), (PARXX(I,J), J=M1, M)
  230 IF (NSTATE.LE.NPARAM) GO TO 280
      M1 = M  + 1
      M2 = M + 8
      GO TO 190
  240 IF (NSTATE.LE.NPARAM) GO TO 290
      M1 = 1
      M2 = 8
  250 IF (M1.GT.NRUN) GO TO 290
      M = MINO(M2, NRUN)
      WRITE (6,200) (I, I = M1, M)
      WRITE (6,260)
  260 FORMAT ('0STATE VARIABLE')
      DO 270 I = NPARA1, NSTATE
  270 WRITE (6,180) NOPAR(I), (PARXX(I,J), J=M1,M)
  280 M1 = M + 1
      M2 = M + 8
      GO TO 250
  290 M1 = 1
      M2 = 8
  300 IF (M1.GT.NRUN) STOP
      M = MINO(M2, NRUN)
      WRITE (6,200) (I, I=M1,M)
      WRITE (6,310)
  310 FORMAT (' RESPONSE')
      DO 320 I = 1, NRESP
  320 WRITE (6,180) I, (RX(I,J), J=M1, M)
      M1 = M + 1
      M2 = M + 8
      GO TO 300
  330 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE DERIVD (INA,ISV)
C THIS SUBROUTINE CALCULATES WEIGHTED SUMS OF STATE VARIABLES AS
C REQUIRED BY THE SUBROUTINE SENOUT.
C
C THE FOLLOWING ARE DEFINITIONS OF VARIABLE NAMES SPECIAL TO THIS
C SUBROUTINE.    THOSE USED FOR TEMPORARY PURPOSES ONLY ARE OMITTED
C
C ITYP(I)         THE TYPE (SEE SUBROUTINE SENOUT) OF THE I'TH RESPONSE
C                 VARIABLE TO BE CALCULATED BY THIS SUBROUTINE
C IVAR(I,J)       THE ADDRESS OF THE J'TH PARAMETER TO BE USED IN
C                 CALCULATING THE I'TH RESPONSE VARIABLE
C NVAR(I)         THE NUMBER OF PARAMETERS USED IN CALCULATING THE I'TH
C                 RESPONSE VARIABLE
C WVAR(I,J)       THE MULTIPLIER TO BE APPLIED TO THE J'TH PARAMETER IN
C                 CALCULATING THE I'TH RESPONSE VARIABLE
      COMMON/STAT/STATE( 364)
      COMMON/TOTALS/SUMS( 167)
      COMMON/ACC/ STNG(221)
      COMMON/NEWVAR/VNEW(10)
      DIMENSION ITYP(10),NVAR(10),IVAR(10,20),WVAR(10,20)
      IF(ISV.EQ.2) GOTO30
C-----------------------------------------------------------------------
C     PARAMETER ADDRESSES AND MULTIPLIERS ARE READ IN.
C-----------------------------------------------------------------------
      READ10,ITYP(INA),NVAR(INA)
      NV=NVAR(INA)
      READ10, (IVAR(INA,J),J=1,NV)
      READ20,(WVAR(INA,J),J=1,NV)
   10 FORMAT(16I5)
   20 FORMAT(8F10.4)
      RETURN
   30 CONTINUE
C-----------------------------------------------------------------------
C     THE RESPONSE VARIABLE IS CALCULATED.
C-----------------------------------------------------------------------
      VNEW(INA)=0.
      NV=NVAR(INA)
      DO90 J=1,NV
      IV=IVAR(INA,J)
      IT=ITYP(INA)
      GOTO(40,50,60,70),IT
   40 Q=STATE(IV)
      GOTO80
   50 Q=SUMS(IV)
      GOTO80
   60 CONTINUE
      GOTO80
   70 Q=STNG(IV)
   80 VNEW(INA)=VNEW(INA)+Q*WVAR(INA,J)
   90 CONTINUE
      RETURN
      END
```

APPENDIX G

Listing of the Subroutines PHYSIC, VARIED, DYX

```
      SUBROUTINE PHYSIC
C-----------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------------
      COMMON/SPEC/      NCHAN,INSTRU(20),    WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,IDAY, ATOT, ATOT0,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR               ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,              MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                NOLIT1,LOOP,         IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
      COMMON/PHYS/ FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
      COMMON/HYDRA/BI(10),FMI(10),FNI(10),B7(20),FM(20),FN(20),SI(10),S7
     1(20),XI(10),X7(20),YN(20),Y7(20),AA(20),Q7(20),PP(20),TOP(20),V7
     2(20),Q0,FAC1,FAC2,FAC3,XINC,XBEG,ERR,QC2,QG2,NSO,NP,NSTART,NSINC,
     3NEND,MCURVE,I7,I8,I9,MCT,IVARR,YSTART
C-----------------------------------------------------------------------
C     THE NAME LIST CONTAINS THE PARAMETERS THAT ARE TO BE
C     READ IN AT EXECUTION TIME.
C-----------------------------------------------------------------------
      NAMELIST/PPUT/ NSI,NSO,INFLOW,NSECB,NSECE,XINC,XBEG,YSTART,XI,SI,
     1Q7,BI,FMI,FNI,FLODIF
      IF(LOOPER .GE. 0) RETURN
C..........NEW CHARACTERISTICS ARE CALCULATED ONLY IF STREAMFLOW HAS
C..........MARKEDLY CHANGED.
      IF(ABS(FLOW-FLOW1 ).LT.FLODIF) RETURN
      FLOW1=FLOW
      IVARR=0
      NEND=1
      NSINC=-1
      NSTART=NSO
      XINC2=XINC/2.
      MCURVE=1
      Q0=35.3146667*FLOW
   10 FORMAT(7A6)
      MSO=NSI
      IF(INFLOW .EQ. 0) MSO=NSO
      YSTART=0.
      DO 20 I=1,MSO
   20 Q7(I)=Q0
   30 I7=1
      I8=2
      I9=3
      DO 80 I=1,NSO
      X7(I)=XBEG+XINC*FLOAT(I-1)
      IF(I .EQ. 1) GO TO 50
   40 IF(X7(I) .LT. .5*(XI(I8)+XI(I9)) .OR. I9 .EQ. NSI) GO TO 60
      I7=I7+1
      I8=I8+1
      I9=I9+1
   50 DN1=(XI(I7)-XI(I8))*(XI(I7)-XI(I9))
      DN2=(XI(I8)-XI(I7))*(XI(I8)-XI(I9))
      DN3=(XI(I9)-XI(I7))*(XI(I9)-XI(I8))
      GO TO 40
   60 FAC1=(X7(I)-XI(I8))*(X7(I)-XI(I9))/DN1
      FAC2=(X7(I)-XI(I7))*(X7(I)-XI(I9))/DN2
      FAC3=(X7(I)-XI(I7))*(X7(I)-XI(I8))/DN3
      B7(I)=FAC1*BI(I7)+FAC2*BI(I8)+FAC3*BI(I9)
      FM(I)=FAC1*FMI(I7)+FAC2*FMI(I8)+FAC3*FMI(I9)
   70 S7(I)=FAC1*SI(I7)+FAC2*SI(I8)+FAC3*SI(I9)
      IF(INFLOW .GT. 0) AA(I)=FAC1*Q7(I7)+FAC2*Q7(I8)+FAC3*Q7(I9)
   80 FN(I)=FAC1*FNI(I7)+FAC2*FNI(I8)+FAC3*FNI(I9)
      IF(NDEBUG .LE. 0)GO TO 180
   90 WRITE(6,120) (X7(I),I=1,NSO)
  100 WRITE(6,110) (Q7(I),I=1,NSO)
  110 FORMAT('0 DISCHARGE ALONG CHANNEL',/,(1H ,13F10.2))
  120 FORMAT('0SECTIONS ALONG CHANNEL',/,(1H ,13F10.1))
      WRITE(6,130) (B7(I),I=1,NSO)
  130 FORMAT('0 BOTTOM WIDTHS',/,( 1H ,13F10.3))
      WRITE(6,140) (FM(I),I=1,NSO)
  140 FORMAT('0 SLOPES OF SIDE OF CHANNEL',/,(1H ,13F10.3))
  150 WRITE(6,160) (FN(I),I=1,NSO)
  160 FORMAT('0 MANNINGS  N  FOR SECTIONS OF CHANNEL',/,(1H ,13F10.3))
      WRITE(6,170) (S7(I),I=1,NSO)
  170 FORMAT('0 SLOPE OF CHANNEL BOTTOM AT SECTIONS',/,(1H ,13F10.5))
C-----------------------------------------------------------------------
C     SOLUTION OF NORMAL DEPTH BASED ON MANNINGS EQUATION
C-----------------------------------------------------------------------
  180 CONTINUE
      Y0=1.5*((Q7(1)/B7(1))**2/32.2)**.333333
      DO 230 I=1,NSO
      IF(S7(I) .LT. 1.E-6) GO TO 190
      IF(Q7(I) .GT. .0005 ) GO TO 200
  190 YN(I)=0.
      GO TO 230
  200 FM2=2.*FM(I)
      QCN=FN(I)*Q7(I)/1.49
      SQS=SQRT(S7(I))
      SS3=1.6666667*SQS
      STDS=2.*SQRT(FM(I)**2+1.)
      QCN2=.66666667*QCN
      NCT=0
  210 PR=B7(I)+STDS*Y0
      AR=(B7(I)+FM(I)*Y0)*Y0
      P23=PR**.6666667
      A23=AR**.6666667
      F=QCN*P23-AR*A23*SQS
      DF=QCN2*STDS*P23/PR-SS3*A23*(B7(I)+FM2*Y0)
      DIF=F/DF
      Y0=Y0-DIF
      NCT=NCT+1
      IF(ABS(DIF) .GT. .0001 .AND. NCT .LT. 10) GO TO 210
      IF(NCT .EQ. 10) WRITE(6,220) I,DIF,Y0
  220 FORMAT(' FAILED TO CONVERGE FOR SECTION,',I5,' DIF =',F10.4,'   Y0 ='
     1,F10.3)
      YN(I)=Y0
  230 CONTINUE
      IF(NDEBUG .LE. 0)GO TO 260
  240 WRITE(6,250) (YN(I),I=1,NSO)
  250 FORMAT('0 NORMAL DEPTHS AT SECTIONS',/,(1H ,13F10.3))
  260 CONTINUE
      II=1
      ELEV=0.
      IF(YN(1).GT. .0001)GO TO 270
      EL1=0.
      ELM=0.
      GO TO 280
  270 CONTINUE
      V7(1)=Q7(1)/((B7(1)+FM(1)*YN(1))*YN(1))
      EL1=YN(1)+V7(1)**2/64.4
      ELM=EL1
  280 DO 310 I=2,NSO
      IM=I-1
      ELEV=ELEV-XINC2*(S7(I)+S7(IM))
      IF(YN(I).GT. .0001) GO TO 290
      EL=ELEV
      GO TO 300
  290 CONTINUE
      V7(I)=Q7(I)/((B7(I)+FM(I)*YN(I))*YN(I))
      EL=ELEV+YN(I)+V7(I)**2/64.4
  300 IF(EL .LT. EL1) GO TO 310
      II=I
      ELM=EL
  310 EL1=EL
      IF(YSTART.LE.  .001) GO TO 320
      EL1=ELEV+YSTART+(Q7(NSO)/((B7(NSO)+FM(NSO)*YSTART)*YSTART))**2/
     164.4
      IF(EL1 .GT. ELM) GO TO 340
  320 NSTART=II
      YSTART=YN(II)+.005
      Y7(NSTART)=YSTART
      IF(II .EQ. 1) GO TO 330
      IF(II .LT. NSECE) IVARR=1
      CALL VARIED
      IF(IVARR .EQ. 0) GO TO 350
  330 NEND=NSO
      NSINC=1
      MCURVE=2
  340 Y7(NSTART)=YSTART
      CALL VARIED
  350 YMAX=0.
      DEPTH=0.
      VELOCT=0.
      PERIM=0.
      WIDTH=0.
      AREA=0.
      FI=0.
      DO 360 I=NSECB,NSECE
      IF(Y7(I) .GT. YMAX) YMAX=Y7(I)
      IF(Y7(I) .LT. .001)GO TO 360
      DEPTH=DEPTH+Y7(I)
      VELOCT=VELOCT+V7(I)
      PERIM=PERIM+PP(I)
      WIDTH=WIDTH+TOP(I)
      AREA=AREA+AA(I)
  360 FI=FI+1.
      AREA=AREA/FI
      FI=.3048/FI
      DEPTH=FI*DEPTH
      VELOCT=FI*VELOCT
      PERIM=FI*PERIM
      WIDTH=FI*WIDTH
      WATSYS=.09290304*AREA*REACH
      AREA=WIDTH*REACH
      YMAX=.3048*YMAX
      RETURN
C-----------------------------------------------------------------------
C     PARAMETERS ARE READ AND INITIAL VALUES SET.
C-----------------------------------------------------------------------
      ENTRY PINPUT
      READ (5,PPUT)
      FLOW1=100000.
      DO 370 I=1,NSI
      XI(I)=3.28084*XI(I)
      Q7(I)=35.3146667*Q7(I)
  370 BI(I)=3.28084*BI(I)
      XINC=3.28084*XINC
      XBEG=3.28084*XBEG
      YSTART=3.28084*YSTART
      RETURN
      END
```

```
      SUBROUTINE VARIED
      COMMON/HYDRA/BI(10),FMI(10),FNI(10),B7(20),FM(20),FN(20),SI(10),S7
     1(20),XI(10),X7(20),YN(20),Y7(20),AA(20),Q7(20),PP(20),TOP(20),V7
     2(20),Q0,FAC1,FAC2,FAC3,XINC,XBEG,ERR,QC2,QG2,NSO,NP,NSTART,NSINC,
     3NEND,MCURVE,I7,I8,I9,MCT,IVARR
C-----------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------------
      COMMON/SPEC/      NCHAN,INSTRU(20),    WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,IDAY, ATOT, ATOT0,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR               ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,              MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                NOLIT1,LOOP,         IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 5)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
      REAL DY(20)
      J=NSTART
      XINC=X7(NSTART+NSINC)-X7(NSTART)
      DY(J)=DYX(J)
      AA(J)=(B7(J)+FM(J)*Y7(J))*Y7(J)
      PP(J)=B7(J)+2.*Y7(J)*SQRT(FM(J)*FM(J)+1.)
      TOP(J)=B7(J)+2.*Y7(J)*FM(J)
   10 JM=J
      J=J+NSINC
      NCT=0
      Y7(J)=Y7(JM)+XINC*DY(JM)
```

```
 20   NCT=1
      DY(J)=DYX(J)
      DY1=.5*(DY(JM)+DY(J))
      ZC=Y7(JM)+XINC*DY1
      DIF=ZC-Y7(J)
      IF(ZC .LT. 1.E-5)ZC=1.E-5
      Y7(J)=ZC
      NCT=NCT+1
      IF(ABS(DIF) .GT. ERR .AND. NCT .LT. 8) GO TO 20
      IF(MCURVE-2) 30,90,110
 30   IF(Y7(J) .GT. 1.02*YN(J)) GO TO 150
      WRITE(6,40) NSTART,J,Y7(J)
 40   FORMAT(' M1 - CURVE BEGAN AT SECTION',I5,' AND ENDED AT SECTION',
     1I5,' WITH Y7=',F10.3)
      J=J-NSINC
 50   J=J+NSINC
      Y7(J)=YN(J)
      AA(J)=(B7(J)+FM(J)*Y7(J))*Y7(J)
      PP(J)=B7(J)+2.*Y7(J)*SQRT(FM(J)*FM(J)+1.)
      TOP(J)=B7(J)+2.*Y7(J)*FM(J)
 60   IF(NSINC) 70,260,80
 70   IF(J .GT. NEND) GO TO 50
      GO TO 200
 80   IF(J .LT. NEND) GO TO 50
      GO TO 200
 90   YC= (Q7(J)/(.5*(B7(J)+TOP(J)))**2/32.2)**.3333333333
      IF(Y7(J) .GT. YC+.05*(YN(J)-YC)) GO TO 160
      WRITE(6,100) J,Y7(J)
 100  FORMAT(' CONTROL AT SECTION',I5,' CAUSING CRITICAL DEPTH',F10.3,
     1'.  EXAMINE RESULTS TO DETERMINE ITS NATURE.')
      WRITE(6,210)(Y7(I),I=NSTART,J)
      GO TO 260
 110  AR=(B7(J)+FM(J)*YN(J))*YN(J)
      VEL=Q7(J)/AR
      YCONJ=.5*YN(J)*(SQRT(1.+.24845*VEL*VEL/YN(J))-1.)
      QG2=Q7(J)**2/32.2
      FFM=QG2/AR+(.5*B7(J)+FM(J)*YN(J)/3.)*YN(J)**2
      NCT=0
 120  Y2=YCONJ*YCONJ
      AR=B7(J)*YCONJ+FM(J)*Y2
      FAC=.5*B7(J)+FM(J)*YCONJ/3.
      F=QG2/AR+FAC*Y2-FFM
      DF=2.*YCONJ*FAC+Y2*FM(J)/3.-QG2*(B7(J)+2.*FM(J)*YCONJ)/(AR*AR)
      DIF=F/DF
      YCONJ=YCONJ-DIF
      NCT=NCT+1
      IF(ABS(DIF) .LT. .0001 .AND. NCT .LT. 7) GO TO 120
      IF(NCT .EQ. 7) WRITE(6,130) J,DIF,YCONJ
 130  FORMAT(' DID NOT CONVERGE IN DETERMINING CONJUGATE DEPTH AT SECTIO
     1N',I5,2E12.5)
      IF(Y7(J) .LT. YCONJ) GO TO 160
      WRITE(6,140) YCONJ
 140  FORMAT(' CONJUGATE DEPTHS TO NORMAL DEPTHS' ,(1H ,13F10.3))
      WRITE(6,150) J,YCONJ,YN(J)
 150  FORMAT(' A HYDRAULIC JUMP OCCURS BEFORE SECTION',I5,' TAKING DEPT
     1H FROM',F10.3,' TO NORMAL DEPTH',F10.3)
      MCURVE=1
      Y7(J)=YN(J)
 160  AA(J)=(B7(J)+FM(J)*Y7(J))*Y7(J)
      V7(J)=Q7(J)/AA(J)
      PP(J)=B7(J)+2.*Y7(J)*SQRT(FM(J)*FM(J)+1.)
      TOP(J)=B7(J)+2.*Y7(J)*FM(J)
 170  IF(NSINC) 180,260,190
 180  IF(J .GT. NEND) GO TO 10
      GO TO 200
 190  IF(J .LT. NEND) GO TO 10
 200  IF(IVARR .GT. 0) RETURN
      IF(NDEBUG .LE. 0)GO TO 260
      WRITE(6,210) (Y7(I),I=1,NSO)
 210  FORMAT(' DEPTHS OF FLOW AT SECTIONS',/,(1H ,13F10.3))
      WRITE(6,220) (V7(I),I=1,NSO)
 220  FORMAT(' VELOCITIES',/,(1H ,13F10.1))
      WRITE(6,230) (AA(I),I=1,NSO)
 230  FORMAT(' CROSS-SECTIONAL AREAS',/,(1H ,13F10.1))
      WRITE(6,240) (PP(I),I=1,NSO)
 240  FORMAT(' WETTED PERIMETERS',/,(1H ,13F10.1))
      WRITE(6,250) (TOP(I),I=1,NSO)
 250  FORMAT(' TOP WIDTH',/,(1H ,13F10.2))
 260  RETURN
      END
```

```
      FUNCTION DYX(I)
      COMMON/HYDRA/BI(10),FMI(10),FNI(10),B7(20),FM(20),FN(20),SI(10),S7
     1(20),XI(10),X7(20),YN(20),Y7(20),AA(20),Q7(20),PP(20),TOP(20),V7
     2(20),Q0,FAC1,FAC2,FAC3,XINC,XBEG,ERR,QC2,QG2,NSO,NP,NSTART,NSINC,
     3NEND,MCURVE,I7,I8,I9,NCT,IVARR
      IF(Y7(I) .GT. 0.)GO TO 20
      WRITE(6,10)I,Y7(I),Q7(I)
 10   FORMAT(' NEG. Y',I3,2F12.3)
      DYX=S7(I)
      RETURN
 20   QG2=Q7(I)**2
      QC2=QG2/2.22
      QG2=QG2/32.2
      AR=(B7(I)+FM(I)*Y7(I))*Y7(I)
      A2=AR*AR
      TR=B7(I)+2.*FM(I)*Y7(I)
      PR=B7(I)+2.*Y7(I)*SQRT(FM(I)**2+1.)
      IF(I .EQ. 1) GO TO 30
      IF(I .EQ. NSO) GO TO 40
      DFL2=2.*XINC
      IP=I+1
      IM=I-1
      DAX=(B7(IP)-B7(IM)+Y7(I)*(FM(IP)-FM(IM)))*Y7(I)/DFL2
      DQX=(Q7(IP)-Q7(IM))/DFL2
      GO TO 50
 30   DAX=(B7(2)-B7(1)+Y7(1)*(FM(2)-FM(1)))*Y7(1)/XINC
      DQX=(Q7(2)-Q7(1))/XINC
      DQXF=(Q7(2)+Q7(1))*DQX/(16.1*A2)
      GO TO 60
 40   DAX=(B7(NSO)-B7(NSO-1)+Y7(NSO)*(FM(NSO)-FM(NSO-1)))*Y7(NSO)/XINC
      DQX=(Q7(NSO)-Q7(NSO-1))/XINC
 50   DQXF=(Q7(I)+Q7(IM))*DQX/(16.1*A2)
 60   A3=AR*A2
      IF(DQX .GT. 0.0) DQXF=2.*DQXF
      SF=QC2*FN(I)**2*(PR/AR)**1.3333333/A2
      DYX=(S7(I)-SF+QG2/A3*DAX-DQXF)/(1.-QG2*TR/A3)
      RETURN
      END
```

APPENDIX H

Listing of the Subroutine MEDIUM

```
      SUBROUTINE MEDIUM
      DIMENSION A(13,4),TOTLIT(3),AVELIT(3)
      DIMENSION AVENRP(10),TOTNRP(5),AINRP(13,5),AINRD(13)
C------------------------------------------------------------------
C     COMMON BLOCK /ACC/ CONTAINS ACCUMULATED CHANGES, WHICH MAY BE
C     NEGATIVE.  COMMON BLOCK /ACCINC/ CONTAINS THE INCREMENTS TO THE
C     ARRAYS IN /ACC/ FOR A SINGLE TIME UNIT.
C------------------------------------------------------------------
      COMMON/ACC/AGAIN(13,4),H2O(13),CGAIN(13, 6),DGAIN(13, 6)
      COMMON/ACCINC/AGAINQ(13,4),H2OQQ(13),CGAINQ(13, 6),DGAINQ(13, 6)
C------------------------------------------------------------------
C     COMMON BLOCKS/PROSUM/,/PRODUC/,/PRODCH/ DEAL WITH PRODUCTIVITY
C     IN THE SYSTEM.
C------------------------------------------------------------------
      COMMON/PROSUM/PVTOT(4),PBTOT(4),PATOTS(15,4),PATOTA(4),PVSUM(4),
     1PBSUM(4),PASUMS(15,4),PASUMA(4)
      COMMON/PRODUC/PCVEG( 8,1,4),PCBIOM(40,4),PCBACT(3,4)
      COMMON/PRODCH/CVEGP( 8,1,4), CBIOMP(40,4),CBACTP(3,4)
      COMMON/OTHER/AVEIND(40)
C------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     EXOGENOUS VARIABLES.
C------------------------------------------------------------------
      COMMON/SPEC/       NCHAN,INSTRU(20),   WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,TDAY, ATOT, ATOTO,IYRDAY,NRECFT(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR               ,NSPCOH,NDEBUG
     3,FLOUT,MICROP  ,                 MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                  NOLIT1,LOOP,         IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C------------------------------------------------------------------
C     COMMON BLOCK /STAT/ CONTAINS THE STATE VARIABLES, AND /CHANGE/
C     THEIR INCREMENTS OR DECREMENTS FOR THE CURRENT TIME UNIT.
C------------------------------------------------------------------
      COMMON/STAT/CVEG( 8,1,4),CORG(5,4),POP(40),CBIOM(40,4),AQUA(4),
     1CLIT(5,4),CBACT(3,4),AQUAB(4),WDINR( 6),WPINR(5, 6),BDINR( 6)
     2,BPINR(5, 6)
      COMMON/CHANGE/CVEGQQ( 8,1,4),CORGQQ(5,4),POPQQ(40),CBIOMQ(40,4)
     1,AQUAQQ(4),CLITQQ(5,4),CBACTQ(3,4),AQUABQ(4),
     2WDINRQ( 6),WPINRQ(5, 6),BDINRQ( 6),BPINRQ(5, 6)
C------------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C------------------------------------------------------------------
      COMMON/METEOR/WIRRIG,     RUNSOL(4),RUNDER(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4),TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6),TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RAINCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)    ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4)  ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
C------------------------------------------------------------------
C     COMMON BLOCK/PARAM/ CONTAINS THE PARAMETERS OF THE SUBROUTINE.
C------------------------------------------------------------------
      COMMON/PARAM/ COAGUL,WATDAY, STRLO(5),STRHI(5), SDRF2(5),SDRF3(5)
     1,CDRF2(5),CDRF3(5),CLITLO(5),CLITHI(5),DUMM3(4105)
C------------------------------------------------------------------
C     THE NAME LIST CONTAINS THE PARAMETERS THAT ARE TO BE
C     READ IN AT EXECUTION TIME.
C------------------------------------------------------------------
      NAMELIST/INPUT/ WATDAY,COAGUL,STRLO,STRHI,SDRF2,SDRF3,
     1CDRF2,CDRF3,CLITLO,CLITHI,ALLMAX ,WETFAC,CFAC1,CFAC2

C.............CHARACTERISTICS CONCERNING WATER ARE CALCULATED
      IF(DEPTH)2,2,4
    2 WRITE(6,3)IYRDAY
    3 FORMAT('0NO WATER ON',I5,'PROGRAM STOPPED')
      STOP
    4 FLOWS=FLOWIN*86400.
      FLOWTR=TRFLOW*86400.
      PRECIP=DARAIN/1000.   *AREA
      EVAPO = EVAP / 1000. *AREA
      FLOUT=          (FLOWS-EVAPO+PRECIP+DAYRUN-WIRRIG+WATDAY-WATSYS
     1+FLOWTR)
      IF(FLOUT)5,7,7
    5 WRITE(6,6)IYRDAY
    6 FORMAT('0MORE WATER USED THAN AVAILABLE ON DAY', I5,
     1'. WATER IMBALANCE OCCURS.')
      FLOUT=0
    7 FLOSEC=FLOUT/86400.
      WATTOT=AMAX1(WATSYS,(FLOWS+DAYRUN+PRECIP-EVAPO+WATDAY+FLOWTR))
      H2OQQ(1) = H2OQQ(1) + PRECIP
      H2OQQ(2) = H2OQQ(2) - EVAPO
      H2OQQ(3) = H2OQQ(3) + DAYRUN
      H2OQQ(4) = H2OQQ(4) - WIRRIG
      H2OQQ(5) = H2OQQ(5) + FLOWS
      H2OQQ(8) = H2OQQ(8) - FLOUT
      H2OQQ(11)=H2OQQ(11)+FLOWTR
      CYCLE = WATTOT/WATSYS
      WATDAY=WATSYS
      WTEMP=XWTEMP
      TEMPW=XWTEMP
      TEMPB=XWTEMP
C------------------------------------------------------------------
C     PLANKTONIC-LIKE MATERIALS IN AND FLOWING THRU THE SYSTEM
C     ARE CALCULATED.
C------------------------------------------------------------------

C.............DISSOLVED AND PARTICULATE  ORGANIC MATTER.
      DO 90 J=1,NFRELM
      TOTSOL = 0.
      DO 10I=1,NOLIT1
      DO10 K=1,13
   10 A(K,I)=0.
      DO 20 I=1,NOLIT
      TOTLIT(I)=0.
   20 AVELIT(I)=0.
      A(1,NOLIT1) = PRECIP * RAINCO(J)
      A(3,NOLIT1) = DAYRUN * RUNSOL(J)
      A(5,NOLIT1) = FLOWS * XCOMPN(J)
      A(11,NOLIT1)=FLOWTR*TCOMPN(J)
      A(13,NOLIT1)=AQUA(J)
      DO 30 I=1,NOLIT
      A(1,I) =   DADUST(I,J) *AREA
      A(3,I) = DAYRUN * RUNDER(I,J)
      A(5,I) = FLOWS   *XDETIN(I,J)
      A(11,I)=FLOWTR*TDETIN(I,J)
      A(13,I)=CLIT(I,J)
   30 CONTINUE
      DO40 K=1,13,2
   40 TOTSOL= TOTSOL + A(K,NOLIT1)
      SOLAVE = TOTSOL /WATTOT
      COMPIN(J)=SOLAVE*(WATTOT-WATSYS)
      XCOMPN(J)=TOTSOL-AQUA(J)
      DO 60 L=1,NOLIT
      DO50 K=1,13,2
      TOTLIT(L)= TOTLIT(L) +A(K,L)
   50 CONTINUE
      AVELIT(L)= TOTLIT(L)/WATTOT
      DETIN(L,J)=AVELIT(L)*(WATTOT-WATSYS)
      XDETIN(L,J)=TOTLIT(L)-CLIT(L,J)
   60 CONTINUE
      DO 70 I=1,NOLIT
   70 CLIT(I,J)=AVELIT(I)*WATSYS
      AQUA(J)=WATSYS*SOLAVE        .
      DO80 I=1,12
      DO 80 K=1,NOLIT1
   80 AGAINQ(I,J) = AGAINQ(I,J) + A(I,K)
   90 CONTINUE

C.............DISSOLVED INORGANIC MATERIAL.
      IF(INORGD.LE.0)GO TO 140
      DO 130 J=1, INORGD
      TOTNRD=0.
      DO 100 K=1, 13
  100 AINRD(K)=0.
      AINRD (1) = PRECIP * RAINDI(J)
      AINRD (3) = DAYRUN * RUNDNR(J)
      AINRD (5) = FLOWS * XDNORG(J)
      AINRD(11)=FLOWTR*TDNORG(J)
      AINRD(13)=WDINR(J)
      DO110 K=1,13,2
  110 TOTNRD = TOTNRD + AINRD(K)
      AVENRD = TOTNRD/WATTOT
      DNORG(J)=AVENRD*(WATTOT-WATSYS)
      XDNORG(J)=TOTNRD-WDINR(J)
      WDINR(J)=WATSYS*AVENRD
      DO120 I=1,12
  120 DGAINQ(I,J) = DGAINQ(I,J) + AINRD(I)
  130 CONTINUE

C.............PARTICULATE INORGANIC MATERIAL
  140 IF(INORGP.LE.0)GO TO 240
      DO 230 J=1, INORGP
      DO 150 I=1, ISTRTM
      DO150 K=1,13
  150 AINRP(K,I)=0.
      DO 160 I=1, ISTRTM
      TOTNRP(I)=0.
  160 AVENRP(I)=0.
      DO 170 I=1, ISTRTM
      AINRP(1,I)= DUSTIP(I,J) * AREA
      AINRP(3,I) = DAYRUN * RUNPNR(I,J)
      AINRP(5,I)= FLOWS * XPNORG(I,J)
      AINRP(11,I)=TPNORG(I,J)*FLOWTR
      AINRP(13,I)=WPINR(I,J)
  170 CONTINUE
      DO 190 L=1, ISTRTM
      DO180 K=1,13,2
  180 TOTNRP(L)=TOTNRP(L)+AINRP(K,L)
      AVENRP(L)= TOTNRP(L)/WATTOT
      PNORG(L,J)=AVENRP(L)*(WATTOT-WATSYS)
      XPNORG(L,J)=TOTNRP(L)-WPINR(L,J)
  190 CONTINUE
      DO 200 I=1, ISTRTM
  200 WPINR(I,J)=WATSYS*AVENRP(I)
  210 DO220 I=1,12
      DO 220 K=1,ISTRTM
  220 CGAINQ(I,J) = CGAINQ(I,J) + AINRP(I,K)
  230 CONTINUE
  240 IF(NSPCOH.LE.0) GO TO 300

C.............ZOOPLANKTON.
      DO 290 I=1,NSPCOH
      M1=NDRIFA(I)
      GO TO (250,270,270,270),M1
  250 DO 260 J=1,NFRELM
      ANTOT=(FLOWS*XDRIFA(I,J))+CBIOM(I,J)+(FLOWTR*TDRIFA(I,J))
      ANAVE=ANTOT/WATTOT
      AGAINQ(5,J)=AGAINQ(5,J)+(FLOWS *XDRIFA(I,J))
      AGAINQ(11,J)=AGAINQ(11,J)+(FLOWTR*TDRIFA(I,J))
      DRIFTA(I,J)=ANAVE*(WATTOT-WATSYS)
      XDRIFA(I,J)=ANTOT-CBIOM(I,J)
      CBIOM(I,J)=WATSYS*ANAVE
  260 CONTINUE
      POPTOT=(FLOWS*XDRIFO(I))+POP(I)+(FLOWTR*TDRIFO(I))
      POPAVE=POPTOT/WATTOT
      DRIFPO(I)=POPAVE*(WATTOT-WATSYS)
      XDRIFO(I)=POPTOT-POP(I)
      POP(I)=POPAVE*WATSYS
      GO TO 290
  270 DO 280 J=1,NFRELM
      DRIFTA(I,J)=(XDRIFA(I,J)*FLOWS)+(TDRIFA(I,J)*FLOWTR)
      AGAINQ(5,J)=AGAINQ(5,J)+(XDRIFA(I,J)*FLOWS )
      AGAINQ(11,J)=AGAINQ(11,J)+(FLOWTR*TDRIFA(I,J))
      XDRIFA(I,J)=(XDRIFA(I,J)*FLOWS)+(TDRIFA(I,J)*FLOWTR)
  280 CONTINUE
      DRIFPO(I)=(XDRIFO(I)*FLOWS)+(TDRIFO(I)*FLOWTR)
      XDRIFO(I)=(XDRIFO(I)*FLOWS)+(TDRIFO(I)*FLOWTR)
  290 CONTINUE
```

```
C..........PHYTOPLANKTON.                                                 MF1095
  300 IF(NSPECV.LE.0) GO TO 360                                           MF1100
      DO 350 I=1,NSPECV                                                   MF1105
      M1=NDRIFV(I)                                                        MF1110
      GO TO (310,330),M1                                                  MF1115
  310 DO 320 J=1,NFRELM                                                   MF1120
      VGTOT=(FLOWS*XDRIFV(I,1,J))+CVEG(I,1,J)+(FLOWTR*TDRIFV(I,1,J))      MF1125
      VGAVE=VGTOT/WATTOT                                                  MF1130
      AGAINQ(5,J)=AGAINQ(5,J)+(FLOWS *XDRIFV(I,1,J))                      MF1135
      AGAINQ(11,J)=AGAINQ(11,J)+(FLOWTR*TDRIFV(I,1,J))                    MF1140
      DRIFTV(I,1,J)=VGAVE*(WATTOT-WATSYS)                                 MF1145
      XDRIFV(I,1,J)=VGTOT-CVEG(I,1,J)                                     MF1150
      CVEG(I,1,J)=VGAVE*WATSYS                                            MF1155
  320 CONTINUE                                                            MF1160
      GO TO 350                                                           MF1165
  330 DO 340 J=1,NFRELM                                                   MF1170
      DRIFTV(I,1,J)=(XDRIFV(I,1,J)*FLOWS)+(TDRIFV(I,1,J)*FLOWTR)          MF1175
      AGAINQ(5,J)=AGAINQ(5,J)+(XDRIFV(I,1,J)*FLOWS)                       MF1180
      AGAINQ(11,J)=AGAINQ(11,J)+(TDRIFV(I,1,J)*FLOWTR)                    MF1185
      XDRIFV(I,1,J)=(XDRIFV(I,1,J)*FLOWS)+(TDRIFV(I,1,J)*FLOWTR)          MF1190
  340 CONTINUE                                                            MF1195
  350 CONTINUE                                                            MF1200
                                                                          MF1205
C..........HETEROTROPHIC MICRO-ORGANISMS.                                 MF1210
  360 IF(MICROB.LE.0) GO TO 420                                           MF1215
      DO410 I=1,MICROB                                                    MF1220
      M1=NDRIFM(I)                                                        MF1225
      GOTO(370,390,390),M1                                                MF1230
  370 DO380 J=1,NFRELM                                                    MF1235
      HETTOT=(FLOWS*XDRIFM(I,J))+CBACT(I,J)+(FLOWTR*TDRIFM(I,J))          MF1240
      HETAVE=HETTOT/WATTOT                                                MF1245
      AGAINQ(5,J)=AGAINQ(5,J)+(FLOWS*XDRIFM(I,J))                         MF1250
      AGAINQ(11,J)=AGAINQ(11,J)+(FLOWTR*TDRIFM(I,J))                      MF1255
      DRIFTM(I,J)=HETAVE*(WATTOT-WATSYS)                                  MF1260
      XDRIFM(I,J)=HETTOT-CBACT(I,J)                                       MF1265
      CBACT(I,J)=WATSYS*HETAVE                                            MF1270
  380 CONTINUE                                                            MF1275
      GOTO410                                                             MF1280
  390 DO400 J=1,NFRELM                                                    MF1285
      DRIFTM(I,J)=(XDRIFM(I,J)*FLOWS)+(TDRIFM(I,J)*FLOWTR)                MF1290
      AGAINQ(5,J)=AGAINQ(5,J)+(XDRIFM(I,J)*FLOWS)                         MF1295
      AGAINQ(11,J)=AGAINQ(11,J)+(TDRIFM(I,J)*FLOWTR)                      MF1300
      XDRIFM(I,J)=(XDRIFM(I,J)*FLOWS)+(TDRIFM(I,J)*FLOWTR)                MF1305
  400 CONTINUE                                                            MF1310
  410 CONTINUE                                                            MF1315
  420 CONTINUE                                                            MF1320
C-------------------------------------------------------------------      MF1325
C     COAGULATION IS CALCULATED.                                          MF1330
C-------------------------------------------------------------------      MF1335
      COAG=COAGUL/CYCLE                                                   MF1340
      DO 430 I=1,2                                                        MF1345
      AQUAQQ(I)=AQUAQQ(I)-(COAG*AQUA(I))                                  MF1350
      COMPIN(I)=COMPIN(I)-(XCOMPN(I)*((COAG*CYCLE)-COAG))                 MF1355
      DETIN(1,I)=DETIN(1,I)+(XCOMPN(I)*((COAG*CYCLE)-COAG))               MF1360
      CLITQQ(1,I)=CLITQQ(1,I)+(COAG*AQUA(I))                              MF1365
  430 CONTINUE                                                            MF1370
C-------------------------------------------------------------------      MF1375
C     SCOURING AND DEPOSITION OF MATERIALS IS CALCULATED                  MF1380
C-------------------------------------------------------------------      MF1385
                                                                          MF1390
C..........PARTICULATED INORGANIC MATTER.                                  MF1395
      IF(ISTRTM.LE.0)GOTO500                                              MF1400
      DO490 I=1,ISTRTM                                                    MF1405
      IF(VELOCT.LE.0.)FALLS=ALLMAX                                        MF1410
      IF(VELOCT.LE.0.)GOTO470                                             MF1415
      IF((VELOCT.GT.STRLO(I)).AND.(VELOCT.LE.STRHI(I)))GOTO490            MF1420
      IF(STRLO(I)-VELOCT)440,460,460                                      MF1425
  440 SCOUR=AMIN1(ALLMAX,AMAX1(0.,(SDRF2(I)**VELOCT-SDRF2(I)**STRHI(I))) MF1430
     1)                                                                   MF1435
      DO450 J=1,INORGP                                                    MF1440
      IF(BPINR(I,J).LE.0)GO TO 450                                        MF1445
      GOES=SCOUR*BPINR(I,J)/WATTOT                                        MF1450
      WPINRQ(I,J)=WPINRQ(I,J)+(GOES*WATSYS)                               MF1455
      PNORG(I,J)=PNORG(I,J)+(GOES*(WATTOT-WATSYS))                        MF1460
      BPINRQ(I,J)=BPINRQ(I,J)-(GOES*WATTOT)                               MF1465
  450 CONTINUE                                                            MF1470
      GOTO490                                                             MF1475
  460 FALLS=AMIN1(ALLMAX,AMAX1(0.,(SDRF3(I)**STRLO(I)-SDRF3(I)**VELOCT)  MF1480
     1)                                                                   MF1485
  470 DEPOS=FALLS/CYCLE                                                   MF1490
      DO480 J=1,INORGP                                                    MF1495
      IF(WPINR(I,J).LE.0)GO TO 480                                        MF1500
      WPINRQ(I,J)=WPINRQ(I,J)-(WPINR(I,J)*DEPOS)                          MF1505
      PNORG(I,J)=PNORG(I,J)-(DEPOS*XPNORG(I,J))                           MF1510
      BPINRQ(I,J)=BPINRQ(I,J)+(DEPOS*XPNORG(I,J))+(WPINR(I,J)*DEPOS)      MF1515
  480 CONTINUE                                                            MF1520
  490 CONTINUE                                                            MF1525
                                                                          MF1530
C..........ORGANIC LITTER.                                                 MF1535
  500 IF(NOLIT.LE.0)GOTO580                                               MF1540
      DO570 I=1,NOLIT                                                     MF1545
      IF(VELOCT.LE.0.)FALLS=ALLMAX                                        MF1550
      IF(VELOCT.LE.0.)GOTO550                                             MF1555
      IF((VELOCT.GT.CLITLO(I)).AND.(VELOCT.LE.CLITHI(I)))GOTO570          MF1560
      IF(CLITLO(I)-VELOCT)510,540,540                                     MF1565
  510 SCOUR=AMIN1(ALLMAX,AMAX1(0.,(CDRF2(I)**VELOCT-CDRF2(I)**CLITHI(I))  MF1570
     1))                                                                  MF1575
      IF(NDEBUG.GT.0)WRITE(6,520)                                         MF1585
     1I,GOES,SCOUR,VELOCT                                                 MF1590
  520 FORMAT(' M9',1X,I2,1X,10F12.6)                                      MF1595
      DO530 J=1,NFRELM                                                    MF1600
      IF(CORG(I,J).LE.0) GO TO 530                                        MF1605
      GOES=SCOUR*CORG  (I,J)/WATTOT                                       MF1608
      CLITQQ(I,J)=CLITQQ(I,J)+(GOES*WATSYS)                               MF1610
      DETIN(I,J)=DETIN(I,J)+(GOES*(WATTOT-WATSYS))                        MF1615
      CORGQQ(I,J)=CORGQQ(I,J)-(GOES*WATTOT)                               MF1620
  530 CONTINUE                                                            MF1625
      GOTO570                                                             MF1630
  540 FALLS=AMIN1(ALLMAX,AMAX1(0.,(CDRF3(I)**CLITLO(I)-CDRF3(I)**VELOCT)  MF1635
     1))                                                                  MF1640
  550 DEPOS=FALLS/CYCLE                                                   MF1645
      IF(NDEBUG.GT.0)WRITE(6,520)                                         MF1650
     1I,DEPOS,FALLS,CYCLE,VELOCT                                          MF1655
      DO560 J=1,NFRELM                                                    MF1660
      IF(CLIT(I,J).LE.0)GO TO 560                                         MF1665
      CLITQQ(I,J)=CLITQQ(I,J)-(CLIT(I,J)*DEPOS)                           MF1670
      DETIN(I,J)=DETIN(I,J)-(XDETIN(I,J)*DEPOS)                           MF1675
      CORGQQ(I,J)=CORGQQ(I,J)+(CLIT(I,J)*DEPOS)+(XDETIN(I,J)*DEPOS)       MF1680
  560 CONTINUE                                                            MF1685
  570 CONTINUE                                                            MF1690
  580 CONTINUE                                                            MF1695
      C=(CYCLE-1.)/CYCLE                                                  MF1700
C-------------------------------------------------------------------      MF1705
C     DISSOLVED MATERIALS PASSING BETWEEN BENTHOS AND                     MF1710
C     WATER COLUMN IS CALCULATED.                                         MF1715
C-------------------------------------------------------------------      MF1720
      BENTH=0.                                                            MF1725
      DO 590 I=1,NOLIT                                                    MF1730
  590 IF(CORG(I,1).GT.0)BENTH=BENTH+(CORG(I,1)*WETFAC)                    MF1735
      DO 600 I=1,ISTRTM                                                   MF1740
      DO 600 J=1,INORGP                                                   MF1745
  600 IF(BPINR(I,J).GT.0)BENTH=BENTH+BPINR(I,J)                           MF1750
      CURV1=(1./(BENTH/(PERIM*REACH)))*CFAC1                              MF1755
      AMIX=1.-EXP(-CURV1*(CYCLE-1.))                                      MF1760
      BENWAT=BENTH*CFAC2                                                  MF1765
      IF(NDEBUG.GT.0)WRITE(6,610)                                         MF1770
     1BENWAT,AMIX,CURV1,BENTH,AQUA(1),AQUAB(1)                            MF1775
  610 FORMAT(' M10',1X,10E12.6)                                           MF1780
      DO 620 I=1,NFRELM                                                   MF1785
      DIF=(AQUA(I)/WATSYS)-(AQUAB(I)/BENWAT)                              MF1790
      AMIX2=AMIX*DIF                                                      MF1795
      AQUABQ(I)=AQUABQ(I)+(AMIX2*BENWAT)                                  MF1800
      COMPIN(I)=COMPIN(I)-(AMIX2*BENWAT*C)                                MF1805
  620 AQUAQQ(I)=AQUAQQ(I)-(AMIX2*BENWAT*(1.-C))                           MF1810
      DO 630 I=1,INORGP                                                   MF1815
      DIF=(WDINR(I)/WATSYS)-(BDINR(I)/BENWAT)                             MF1820
      AMIX2=AMIX*DIF                                                      MF1825
      BDINRQ(I)=BDINRQ(I)+(AMIX2*BENWAT)                                  MF1830
      DNORG(I)=DNORG(I)-(AMIX2*BENWAT*C)                                  MF1835
  630 WDINRQ(I)=WDINRQ(I)-(AMIX2*BENWAT*(1.-C))                           MF1840
      RETURN                                                              MF1845
C-------------------------------------------------------------------      MF1846
C     THE FOLLOWING ALLOWS FOR READING OF PARAMETERS.                     MF1847
C-------------------------------------------------------------------      MF1848
      ENTRY MINPUT                                                        MF1850
      READ (5,MPUT)                                                       MF1855
      RETURN                                                              MF1860
      END                                                                 MF1865
```

APPENDIX I

Listing of the Subroutine ANIMAL

```
      SUBROUTINE ANIMAL
      DIMENSION EATS(40),  NTRANE(40),NLAY1(15),NLAY2(15)
      DIMENSION            FEEDV( 8),FEEDA(40),FEEDL(5),FEEDO(5),
     1FOOD(40,4),IAFATE(40),NTRANS(40)             ,FEEDM(3)
     2, ISFATE(40) ,FEEDAD(40),LIVEAN(40),FEEDRF(3),FEEDRB(3)
     3                         ,IXFATE(40)
C-----------------------------------------------------------------------
C     COMMON BLOCK /ACC/ CONTAINS ACCUMULATED CHANGES, WHICH MAY BE
C     NEGATIVE.  COMMON BLOCK /ACCINC/ CONTAINS THE INCREMENTS TO THE
C     ARRAYS IN /ACC/ FOR A SINGLE TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/ACC/AGAIN(13,4),H2O(13),CGAIN(13, 6),DGAIN(13, 6)
      COMMON/ACCINC/AGAINQ(13,4),H2OQQQ(13),CGAINQ(13, 6),DGAINQ(13, 6)
C-----------------------------------------------------------------------
C     COMMON BLOCKS/PROSUM/,/PRODUC/,/PRODCH/ DEAL WITH PRODUCTIVITY
C     IN THE SYSTEM.
C-----------------------------------------------------------------------
      COMMON/PROSUM/PVTOT(4),PBTOT(4),PATOTS(15,4),PATOTA(4),PVSUM(4),
     1PBSUM(4),PASUMS(15,4),PASUMA(4)
      COMMON/PRODUC/PCVEG( 8,1,4),PCBIOM(40,4),PCBACT(3,4)
      COMMON/PRODCH/CVEGP( 8,1,4), CBIOMP(40,4),CBACTP(3,4)
      COMMON/OTHER/AVEIND(40)
C-----------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C-----------------------------------------------------------------------
      COMMON/SPEC/          NCHAN,INSTRU(20),    WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,     NOLIT ,NCHECK,IDAY, ATOT, ATOTO,IYRDAY,NREPET(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR                   ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,                MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                   NOLIT1,LOOP,           IRUN,SOURCE(5,17)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,TSTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C-----------------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/METEOR/WIRRIG,     RUNSOL(4),RUNDEB(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4),TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6),TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RAINCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)   ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4) ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
C-----------------------------------------------------------------------
C     COMMON BLOCK /STAT/ CONTAINS THE STATE VARIABLES, AND /CHANGE/
C     THEIR INCREMENTS OR DECREMENTS FOR THE CURRENT TIME UNIT.
C-----------------------------------------------------------------------
      COMMON/STAT/CVEG( 8,1,4),CORG(5,4),POP(40),CBIOM(40,4),AQUA(4),
     1CLIT(5,4),CBACT(3,4),AQUAB(4),WDINR( 6),WPINR(5, 6),BDINR( 6)
     2,BPINR(5, 6)
      COMMON/CHANGE/CVEGQQ( 8,1,4),CORGQQ(5,4),POPQQQ(40),CBIOMQ(40,4)
     1,AQUAQQ(4),CLITQQ(5,4),CBACTQ(3,4),AQUABQ(4),
     2WDINRQ( 6),WPINRQ(5, 6),BDINRQ( 6),BPINRQ(5, 6)
C-----------------------------------------------------------------------
C     COMMON BLOCK/PARAM/ CONTAINS THE PARAMETERS OF THE SUBROUTINE.
C-----------------------------------------------------------------------
      COMMON/PARAM/DUMM4(42)    ,PREFV(40, 8),PREFA(40,40),EGCOMP(15,4),
     1PREFL(40,5),PREFO(40,5),PREFM(40,3),TAKE(40),ASSIM(40),
     2AMORTA(40),CURVE(40),THRESH(40),ACCUM(40),AMAX(40),HATCON(40),
     3TEMCON(40),HATCOB(40), THRES2(40),RCONST(15),ANIHI(40),
     4REPROD(40),CONSA(15),UPTHRE(15),CONST(40),EXOGEN(40),ANILO(40),
     5SHELP(40),RESPM(3),ASSIMH(3),BEFAC4(40),ANDRF2(40),ANDRF3(40),
     6CONTA,CONTB,CONTC,CONS(3),BEFAC3(40),TMAX(40),TOPT(40),WMIN(40),
     7WMAX(40),     PREFRF(3,5),XCRSOL(40) ,PREFRB(3,5),PREFRW(3)
     8,FEDFRM(40),BACTLO(3),BACTHI(3),BDRF2(3),BDRF3(3)  ,    SLOPE(40),
     9DUMM5(383)
C-----------------------------------------------------------------------
C     THE NAME LIST CONTAINS THE PARAMETERS THAT ARE TO BE
C     READ IN AT EXECUTION TIME.
C-----------------------------------------------------------------------
      NAMELIST/APUT/ PREFV,PREFA,PREFL,PREFO,PREFM,TAKE,
     1NDRIFA,NTRANS,ASSIM,AMORTA,IAFATE,CURVE,THRESH          ,AMAX,
     2HATCON,TEMCON,HATCOB,THRES2,CONSA,UPTHRE,
     3 NDRIFM,        EGCOMP,RCONST,
     4                REPROD,SHELP,
     5          SLOPE,CONST,EXOGEN,CONTA,CONTB,CONTC,CONS,
     6           PREFRW,ACCUM,ISFATE,IXFATE,XCRSOL,FEDFRM,PREFRB,PREFRF,
     7BACTLO,BACTHI,ASSIMH,RESPM,BDRF2,BDRF3,              LIVEAN,ALLMAX
     8,ANIHI,ANILO,ANDRF2,ANDRF3,BEFAC3,BEFAC4,NLAY1,NLAY2,NTRANE
     9,TMAX,TOPT,WMIN,WMAX
C-----------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH ANIMAL CONSUMPTION.
C-----------------------------------------------------------------------

C..........THE AMOUNT OF FOOD AVAILABLE TO AN ANIMAL COHORT IS
C..........DETERMINED BY THE AVAILABILITY OF AND PREFERANCE FOR FOODS
      DO 10 J=1,NSPCOH
      DO 10 K=1,NFRELM
   10 FOOD(J,K)=0.
      DO 840 I=1,NSPCOH
      IF(POP(I).LE.0.) GO TO 840
      M1 = NDRIFA(I)
      SUM=0.
      TAKING=TAKE(I)*CBIOM(I,1)
      IF (TAKING.LE.0.) GO TO 840

C..........OF VEGETATION
      DO 70 J=1,NSPECV
      FEEDV(J)=0.
      A=PREFV(I,J)
      IF(A.LE.0)GO TO 70
      M2=NDRIFV(J)
      GO TO (20,40,40,40),M1
   20 GO TO (30,70),M2
   30 FEEDV(J)=CVEG(J,1,1)*A
      GO TO 60
   40 GO TO (50,30),M2
   50 FEEDV(J)= (XDRIFV(J,1,1)           +CVEG(J,1,1))*A
   60 SUM=SUM+FEEDV(J)
   70 CONTINUE

C..........OF ANIMAL COHORTS.
      DO 150 J=1, NSPCOH
      FEEDA(J)=0.
      M2=NDRIFA(J)
      A=PREFA(I,J)
      IF(A.LE.0)GO TO 150
      GO TO (80,100,100,120),M1
   80 GO TO (90,150,150,150),M2
   90 FEEDA(J)=CBIOM(J,1)*A
      GO TO 140
  100 GO TO (110,90,90,90),M2
  110 FEEDA(J)=(XDRIFA(J,1)+CBIOM(J,1))*A
      GO TO 140
  120 GO TO (110,130,130,90),M2
  130 FEEDAD(J)=XDRIFA(J,1)*A         *FEDFRM(J)
      SUM=SUM+FEEDAD(J)
      FEEDA(J)=CBIOM(J,1)*A*(1.-FEDFRM(J))
  140 SUM=SUM+FEEDA(J)
  150 CONTINUE

C..........OF SUSPENDED AND BENTHIC DETRITUS
      DO 210 J=1,NOLIT
      FEEDO(J)=0.
      FEEDL(J)=0.
      A=PREFL(I,J)
      B=PREFO(I,J)
      GO TO (170,160,160,160),M1
  160 FEEDO(J)=CORG(J,1)*B
      SUM=SUM+FEEDO(J)
  170 GO TO (180,190,190,190),M1
  180 FEEDL(J)=CLIT(J,1)*A
      GO TO 200
  190 FEEDL(J)=(XDETIN(J,1)+CLIT(J,1))*A
  200 SUM=SUM+FEEDL(J)
  210 CONTINUE

C..........OF HETEROTROPHIC MICRO ORGANISMS
      DO 270 J=1,MICROB
      FEEDM(J)=0.
      A=PREFM(I,J)
      M2=NDRIFM(J)
      IF(A.LE.0) GO TO 270
      GO TO (220,240,240,240),M1
  220 GO TO (230,270,270),M2
  230 FEEDM(J)=CBACT(J,1)*A
      GO TO 260
  240 GO TO (250,230,270),M2
  250 FEEDM(J)=(XDRIFM(J,1)+CBACT(J,1))*A
  260 SUM=SUM+FEEDM(J)
  270 CONTINUE
C-----------------------------------------------------------------------
C     THE AMOUNT OF FOOD CONSUMED IS CALCULATED AS A FUNCTION OF
C     BODY SIZE, TEMP., AND FOOD AVAILABILITY.
C-----------------------------------------------------------------------
      IF(SUM.LE.0)GO TO 840
      EATS(I)  =(SUM/AREA)
      IF(NDEBUG .GT. 0)WRITE(6,280)
    1 I,EATS(I),    SUM,AREA
  280 FORMAT(' ANI ',I3,1X,10E12.6)
      TEST=(-CURVE(I)*EATS(I))
      IF(TEST.LT.-15.) EATS(I)   =TAKE(I)
      IF(TEST.LT.-15.) GO TO 290
      EATS(I)  =TAKE(I)*(1.-EXP(-CURVE(I)*EATS(I)))
  290 BODSIZ =CBIOM(I,1)/POP(I)
      RESPAC=(BODSIZ**SLOPE(I))*CONST(I)*2.**(TOPT(I)/10.)
      GMAX=TAKE(I)*ASSIM(I)
      GMAX=GMAX-(WMIN(I)**SLOPE(I))*CONST(I)*2.**(TOPT(I)/10.)
      IF(NDEBUG.GT.0) GO TO 300
      IF(GMAX) 300,300,320
  300 WRITE(6,310) GMAX,ASSIM(I),TAKE(I),I,RESPAC
  310 FORMAT(1X,'   PROGRAM STOPPED ',/,' MAXIMUM GROWTH WAS CALCULATED
     1AS ',E10.4,/,' ASSIM= ',E10.4,' TAKE= ',E10.4,' FOR ANIMAL GROUP
     2NUMBER ',I3,/,' RESPIRATION AT OPT. TEMP. = ',E10.4)
      IF(NDEBUG.GT.0) GO TO 320
      STOP
  320 CONTINUE
      GPOT=(GMAX*WMAX(I))/(WMAX(I)-WMIN(I))
      GPOT=GPOT-(BODSIZ*GMAX)/(WMAX(I)-WMIN(I))
      B=2.*TMAX(I)*TOPT(I) - TOPT(I)**2. - 2.*TMAX(I)*   WTEMP
      P=B+ WTEMP**2.
      P=B/(2.*(TMAX(I)-TOPT(I)))
      IF(ASSIM(I)) 340,340,330
  330 B=(B*RESPAC*(-.069314)+ GPOT + RESPAC)/(ASSIM(I) *TAKE(I))
      IF(B-1.) 350,350,340
  340 P=1.
  350 IF(B) 360,370,370
  360 P=0.
  370 CONTINUE
  380 IF(M1.NE.1) GO TO 390
      FOOD(I,1) = EATS(I)  /CYCLE
      TAKING=FOOD(I,1)*(CBIOM(I,1))*B
      GO TO 400
  390 TAKING=EATS(I)   *CBIOM(I,1)*B
  400 IF(NDEBUG .GT. 0)WRITE(6,780)
    1 I,TAKING,FOOD(I,1),TAKE(I),CURVE(I),CBIOM(I,1),B,EATS(I)
      FOOD(I,1)=0.

C..........THE AMOUNT OF FOOD CONSUMED IS REMOVED
C..........FROM VEGETATION.
      DO 500 J=1,NSPECV
      IF(FEEDV(J).LE.0.) GO TO 500
      M2=NDRIFV(J)
      GO TO (410,460,460,460),M1
  410 GO TO (420,500),M2
  420 FACTOR= TAKING*FEEDV(J)/(SUM*CVEG(J,1,1))
  430 DO 450 K=1,NFRELM
      IF(M1.NE.1) GO TO 440
      CVEGQQ(J,1,K) = CVEGQQ(J,1,K) -(CVEG(J,1,K) * FACTOR)
```

```
      DRIFTV(J,1,K)=DRIFTV(J,1,K) -(XDRIFV(J,1,K)*FACTOR)
      FOOD(I,K)=FOOD(I,K) +(CVEG(J,1,K)*FACTOR)
      IF(M1.EQ.1)GO TO 450
  440 DRIFTV(J,1,K)=DRIFTV(J,1,K) -(XDRIFV(J,1,K)*FACTOR)
      CVEGQQ(J,1,K)=CVEGQQ(J,1,K)-(CVEG(J,1,K)*FACTOR)
      FOOD(I,K)=FOOD(I,K) +(XDRIFV(J,1,K)        *FACTOR)
     1+(CVEG(J,1,K)*FACTOR)
  450 CONTINUE
      GO TO 500
  460 GO TO (470,480),M2
  470 FACTOR=TAKING*FEEDV(J)/(SUM* (XDRIFV(J,1,1)          +CVEG(J,1,1)))
      GO TO 430
  480 FACTOR = TAKING*FEEDV(J)/(SUM*CVEG(J,1,1))
      DO 490 K=1,NFRELM
      CVEGQQ(J,1,K) = CVEGQQ(J,1,K) -(CVEG(J,1,K) * FACTOR)
      FOOD(I,K)=FOOD(I,K) +(CVEG(J,1,K)*FACTOR)
  490 CONTINUE
  500 CONTINUE

C..........FROM ANIMAL COHORTS.
      DO 650 J=1, NSPCOH
      M2 = NDRIFA (J)
      GO TO (510, 560, 560, 610),M1
  510 GO TO (520, 650, 650, 650), M2
  520 IF (FEEDA (J).LE.0.)GO TO 650
      FACTOR = TAKING* FEEDA (J) / ( SUM * CBIOM (J,1))
  530 POPQQQ(J)=POPQQQ(J)-(POP(J)*FACTOR)
      DRIFPO(J)=DRIFPO(J)-(XDRIFO(J)*FACTOR)
      DO 550 K=1, NFRELM
      CBIOMQ(J,K)= CBIOMQ(J,K)-(CBIOM(J,K)*FACTOR)
      IF(M1.NE.1) GO TO 540
      FOOD(I,K)=FOOD(I,K)+(CBIOM(J,K)*FACTOR)
  540 DRIFTA (J,K) = DRIFTA (J,K) - XDRIFA  (J,K) * FACTOR
      IF (M1.EQ.1) GO TO 550
      FOOD(I,K)=FOOD(I,K)+(XDRIFA(J,K)         *FACTOR)+(CBIOM(J,K)*FACTOR)
  550 CONTINUE
      GO TO 650
  560 GO TO (570, 580, 580, 580), M2
  570 IF (FEEDA(J).LE.0.) GO TO 650
      FACTOR = TAKING * FEEDA (J) / (SUM *(  XDRIFA (J,1)
     1+CBIOM(J,1)))
      GO TO 530
  580 IF(FEEDA(J).LE.0.) GO TO 650
  590 FACTOR = TAKING * FEEDA (J) / (SUM * CBIOM (J,1))
      POPQQQ(J)=POPQQQ(J)-(POP(J)*FACTOR)
      DO 600 K=1, NFRELM
      CBIOMQ (J,K) = CBIOMQ (J,K) - CBIOM (J,K) * FACTOR
      FOOD(I,K)=FOOD(I,K)+(CBIOM(J,K)*FACTOR)
  600 CONTINUE
      GO TO 650
  610 GO TO (570, 620, 620, 580), M2
  620 IF (FEEDAD (J).LE.0.)GO TO 640
      FACTOR = TAKING * FEEDAD (J) / (SUM * XDRIFA (J,1)          )
      DRIFPO(J)=DRIFPO(J)-(XDRIFO(J)*FACTOR)
      DO 630 K=1, NFRELM
      DRIFTA (J,K) = DRIFTA (J,K) - XDRIFA  (J,K) * FACTOR
      FOOD(I,K)=FOOD(I,K)+(XDRIFA(J,K)         *FACTOR)
  630 CONTINUE
  640 IF(FEEDA(J).LE.0) GO TO 650
      GO TO 590
  650 CONTINUE

C..........FROM SUSPENDED DETRITUS
      DO700 J=1,NOLIT
      IF(FEEDL(J).LE.0.)GOTO700
      GOTO(660,680,680,680),M1
  660 FACTOR=TAKING*FEEDL(J)/(SUM*CLIT(J,1))
      DO670 K=1,NFRELM
      CLITQQ(J,K)=CLITQQ(J,K)-(CLIT(J,K)*FACTOR)
      DETIN(J,K)=DETIN(J,K)-(XDETIN(J,K)*FACTOR)
  670 FOOD(I,K)=FOOD(I,K)+(CLIT(J,K)*FACTOR)
      GOTO700
  680 FACTOR=TAKING*FEEDL(J)/(SUM* (XDETIN(J,1)          +CLIT(J,1)))
      DO690 K=1,NFRELM
      DETIN(J,K)=DETIN(J,K)-(XDETIN(J,K)*FACTOR)
      CLITQQ(J,K)=CLITQQ(J,K)-(CLIT(J,K)*FACTOR)
      FOOD(I,K)=FOOD(I,K)+(XDETIN(J,K)         *FACTOR)+(CLIT(J,K)*FACTOR )
  690 CONTINUE
  700 CONTINUE

C..........FROM BENTHIC DETRITUS.
      DO730 J=1,NOLIT
      IF(FEEDO(J).LE.0.)GOTO730
      GOTO(730,710,710,710),M1
  710 FACTOR=TAKING*FEEDO(J)/(SUM*CORG(J,1))
      DO720 K=1,NFRELM
      CORGQQ(J,K)=CORGQQ(J,K)-(CORG(J,K)*FACTOR)
  720 FOOD(I,K)=FOOD(I,K)+(CORG(J,K)*FACTOR)
  730 CONTINUE

C..........FROM HETERTROPHIC MICRO ORGANISMS.
      DO830 J=1,MICROB
      M2=NDRIFM(J)
      IF(FEEDM(J).LE.0.)GOTO830
      GOTO(740,790,790,790),M1
  740 GOTO(750,830,830),M2
  750 FACTOR=TAKING*FEEDM(J)/(SUM*CBACT(J,1))
  760 DO780 K=1,NFRELM
      IF(M1.NE.1)GOTO770
      CBACTQ(J,K)=CBACTQ(J,K)-(CBACT(J,K)*FACTOR)
      DRIFTM(J,K)=DRIFTM(J,K)-(XDRIFM(J,K)*FACTOR)
      FOOD(I,K)=FOOD(I,K)+(CBACT(J,K)*FACTOR)
      IF(M1.EQ.1)GOTO780
  770 DRIFTM(J,K)=DRIFTM(J,K)-(XDRIFM(J,K)*FACTOR)
      CBACTQ(J,K)=CBACTQ(J,K) -(CBACT(J,K)*FACTOR)
      FOOD(I,K)=FOOD(I,K)+(XDRIFM(J,K)         *FACTOR)+(CBACT(J,K)*FACTOR
  780 CONTINUE
      GOTO830
  790 GOTO(800,810,810),M2
  800 FACTOR=TAKING*FEEDM(J)/(SUM* (XDRIFM(J,1)          +CBACT(J,1)))
      GOTO760
  810 FACTOR=TAKING*FEEDM(J)/(SUM*CBACT(J,1))
      DO820 K=1,NFRELM
      CBACTQ(J,K)=CBACTQ(J,K)-(CBACT(J,K)*FACTOR)
  820 FOOD(I,K)=FOOD(I,K)+(CBACT(J,K)*FACTOR)
  830 CONTINUE
  840 CONTINUE
C-----------------------------------------------------------------------
C      RESPIRATION, EGESTION AND ASSIMILATION ARE CALCULATED.
C-----------------------------------------------------------------------
      C=(CYCLE-1.)/CYCLE
      DO 930 I=1,NSPCOH
      IF((CBIOM(I,1) .LE. 0).OR.(POP(I).LE. 0))GO TO 930
      M1=NDRIFA(I)
      M2=LIVEAN(I)
      K2=IXFATE(I)
      IF(K2.GT.NOLIT)K2=K2-NOLIT
      RESPAC=EXP(SLOPE(I)*ALOG(CBIOM(I,1)/POP(I)))*CBIOM(I,1)
     1*CONST(I)*2.**( WTEMP/10.)
      ASSICA=ASSIM(I)*FOOD(I,1)
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 I,RESPAC,ASSICA,FOOD(I,1)
      DO920 K=1,NFRELM
      IF(CBIOM(I,K).LE.0.)GO TO  920
      RESPI=RESPAC*(CBIOM(I,K)/CBIOM(I,1))
      IF (M1.EQ.1) RESPI=RESPI/CYCLE
      ASSI=ASSICA*(CBIOM(I,K)/CBIOM(I,1))
      IF(ASSI .GT. FOOD(I,K))ASSI=FOOD(I,K)
      EXCR=FOOD(I,K)-ASSI
      IF(M1.EQ.1)GOTO860
      IF(M2.EQ.3)GOTO850

C..........PART OF EGESTION GOES INTO SOLUTION
      SOLUTE=EXCR*XCRSOL(I)/WATTOT
      AQUAQQ(K)=AQUAQQ(K)+(SOLUTE*WATSYS)
      COMPIN(K)=COMPIN(K)+(SOLUTE*(WATTOT-WATSYS))
      EXCR=EXCR*(1.-XCRSOL(I))
      IF(IXFATE(I).GT.NOLIT)CORGQQ(K2,K)=CORGQQ(K2,K)+EXCR
      IF(IXFATE(I).LE.NOLIT)DETIN(K2,K)=DETIN(K2,K)+(EXCR*C)
      IF(IXFATE(I).LE.NOLIT)CLITQQ(K2,K)=CLITQQ(K2,K)+(EXCR*(1.-C))
      GOTO870
  850 SOLUTE=EXCR*XCRSOL(I)
      AQUABQ(K)=AQUABQ(K)+SOLUTE
      EXCR=EXCR*(1.-XCRSOL(I))
      CORGQQ(K2,K)=CORGQQ(K2,K)+EXCR
      GOTO870
  860 SOLUTE=EXCR*XCRSOL(I)
      AQUAQQ(K)=AQUAQQ(K)+SOLUTE
      COMPIN(K)=COMPIN(K)+(SOLUTE*(CYCLE-1.))
      EXCR=EXCR*(1.-XCRSOL(I))
      CLITQQ(K2,K)=CLITQQ(K2,K)+EXCR
      DETIN(K2,K)=DETIN(K2,K)+(EXCR*(CYCLE-1.))

C..........THE COHORT GROWS DEPENDENT  ON THE AMOUNT OF FOOD
C..........ASSIMILATED MINUS RESPIRATION.
  870 ASSIT=ASSI-RESPI
      IF(M1.EQ.1)DRIFTA(I,K)=DRIFTA(I,K)+ ((CYCLE-1.)*ASSIT)
      CBIOMQ(I,K)=CBIOMQ(I,K)+ASSIT
      IF(M1.EQ.1)CBIOMP(I,K) =CBIOMP(I,K)+((CYCLE-1.)*ASSIT)
      N=KORGSW(1,K)
      IF(M1.NE.1)CBIOMP(I,K)=CBIOMP(I,K)+ASSIT
      IF(M1.EQ.1)GOTO890
      RESP=RESPI/WATTOT
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-(RESP*WATTOT)
      IF(K.EQ.2)GOTO900
      AGAINQ(13,K)=AGAINQ(13,K)-(RESP*WATTOT)
      DGAINQ(13,N)=DGAINQ(13,N)+(RESP*WATTOT)
      IF(M2.EQ.3)GO TO 880
      WDINRQ(N)=WDINRQ(N)+(RESP*WATSYS)
      DNORG(N)=DNORG(N)+(RESP*(WATTOT-WATSYS))
      GO TO 900
  880 BDINRQ(N)=BDINRQ(N)+(RESP*WATTOT)
      GO TO 900

C..........RESPIRED CHEMICALS GO INTO INORGANIC COMPARTMENTS
  890 RESP=RESPI
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-(RESP*CYCLE)
      IF (K.EQ.2) GO TO 900
      WDINRQ(N)=WDINRQ(N)+RESP
      AGAINQ(13,K)=AGAINQ(13,K)-(RESP*CYCLE)
      DGAINQ(13,N)=DGAINQ(13,N)+(RESP*CYCLE)
      DNORG(N)=DNORG(N)+(RESP*(CYCLE-1.))
  900 IF(M1.EQ.1)GOTO910
      RESP=RESPI/(CBIOM(I,K)*CYCLE)
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-(RESP*XDRIFA(I,K))
      IF(K.EQ.2)GOTO910
      DNORG(N)=DNORG(N)+(RESP*XDRIFA(I,K))
      AGAINQ(13,K)=AGAINQ(13,K)-(RESP*XDRIFA(I,K))
      DGAINQ(13,N)=DGAINQ(13,N)+(RESP*XDRIFA(I,K))
      DRIFTA(I,K)=DRIFTA(I,K)-(RESP*XDRIFA(I,K))
  910 CONTINUE
  920 CONTINUE
  930 CONTINUE
C-----------------------------------------------------------------------
C      THE FOLLOWING SECTION ALLOWS FOR TRANSFER FROM ONE COHORT TO
C      ANOTHER.
C-----------------------------------------------------------------------

C..........J4 IS THE ADDRESS IN THE COHORT ARRAYS OF THE COHORT BEING
C..........CONSIDERED
C..........J6 IS THE ADDRESS IN THE COHORT ARRAYS OF THE FIRST COHORT
C..........OF THE SPECIES BEING CONSIDERED
      IF (KDAY.EQ.IDAY) GO TO 950
      KDAY=IDAY
      DO 940 I=1,NSPCOH
      IF(NTRANS(I).EQ.5)GO TO 940
      ACCUM(I)=ACCUM(I)+WTEMP
  940 CONTINUE
  950 J4=0
      C=(CYCLE-1.)/CYCLE
      DO 1160 I=1,NSPECA
      J3=NCOH(I)
      J6=J4+1
      DO 1150 J=1,J3
      HATCH=0.
      J4=J4+1
      K12=NDRIFA(J4)
      K1=NTRANS(J4)
```

```
      K7=NTRANE(J4)
      IF((J .EQ. J3).AND.(K1 .NE. 3))GO TO 1040
      IF (CBIOM(J4,1).LE.0.) GO TO 1150
      GO TO (960,970,960,980,990,1040),K1

C.........THE FRACTION OF ANIMALS TRANSFERED IS CALCULATED AND
C.........TRANSFERS ARE MADE
  960 IF(CBIOM(J4,1).LE.0.)ACCUM(J4)=0.
      IF (ACCUM(J4).LE.THRESH(J4)) GO TO 1040
      HATCH=AMIN1(ALLMAY,((ACCUM(J4)-THRESH(J4))/(AMAX(J4)-THRESH(J4)))
      IF (ACCUM(J4).GE.AMAX(J4)) ACCUM(J4)=0.
      GO TO 1000
  970 HATCH=AMIN1(ALLMAY,AMAX1(HATCON(J4)*EXP(TEMCON(J4)*WTEMP )
     1-HATCOB(J4),0.))
      GO TO 1000
  980 IF(IYPDAY .EQ. 365)HATCH=ALLMAX
      GO TO 1000
  990 ANAVER=CBIOM(J4,1)/POP(J4)
      IF((ACCUM(J4)-ANAVER) .GE. 0.)GO TO 1000
      HATCH=AMIN1(ALLMAY,(((ANAVER-ACCUM(J4))*AMAX(J4))/ACCUM(J4)))
 1000 IF(HATCH .LE. 0)GO TO 1040
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 J4,HATCH,ACCUM(J4),ANAVER,AMAX(J4)
      IF(K12.EQ.1) HATCH=HATCH/CYCLE
      CHANGE=HATCH*POP(J4)
      POPQQ(J4)=POPQQQ(J4)-CHANGE
      IF(K12 .EQ. 1)DRIFPO(J4)=DRIFPO(J4)-(CHANGE*(CYCLE-1.))
      IF((K1 .NE. 3).OR.(K12 .EQ. 1))POPQQQ(J4+1)=POPQQ(J4+1)+CHANGE
      IF((K1 .NE. 3).OR.(K12 .EQ. 1))DRIFPO(J4+1)=DRIFPO(J4+1)+(CHANGE*
     1(CYCLE-1.))
      CHANGE=HATCH
      SHELLS=SHELP(J4)*CHANGE
      K11=ISFATE(J4)
      IF(K11.GT.NOLIT)K11=ISFATE(J4)-NOLIT
      DO1030 K=1,NFRELM
      A=CBIOM(J4,K)
      IF(A.LE.0.)GOTO1030
      GOTO(1010,1020,1020,1020),K12
 1010 CLITQQ(K11,K)=CLITQQ(K11,K)+(SHELLS*A)
      DETIN(K11,K)=DETIN(K11,K)+(SHELLS*A*(CYCLE-1.))
      CBIOMQ(J4,K)=CBIOMQ(J4,K)-(CHANGE*A)
      CBIOMQ(J4+1,K)=CBIOMQ(J4+1,K)+(CHANGE-SHELLS)*A
      DRIFTA(J4,K)=DRIFTA(J4,K)-(CHANGE*A*(CYCLE-1.))
      DRIFTA(J4+1,K)=DRIFTA(J4+1,K)+(CHANGE-SHELLS)*A*(CYCLE-1.)
      GOTO1030
 1020 IF(ISFATE(J4).GT.NOLIT)CORGQQ(K11,K)=CORGQQ(K11,K)+(SHELLS*A)
      IF(ISFATE(J4).LE.NOLIT)CLITQQ(K11,K)=CLITQQ(K11,K)+ (SHELLS*A*(1.-
     1C))
      IF(ISFATE(J4).LE.NOLIT)DETIN(K11,K)=DETIN(K11,K)+(SHELLS*A*C)
      CBIOMQ(J4,K)=CBIOMQ(J4,K)-(CHANGE*A)
      IF(K1 .NE. 3)CBIOMQ(J4+1,K)=CBIOMQ(J4+1,K)+(CHANGE-SHELLS)*A
      IF(K1.EQ.3)AGAINQ(2,K)=AGAINQ(2,K)-(CHANGE-SHELLS)*A
 1030 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH OVIPOSITION.
C---------------------------------------------------------------------
 1040 IF(CBIOM(J4,1).LE.0.) GO TO 1150
      HATCH=0
      GO TO(1080,1070,1050,1100),K7
 1050 IF(K12.EQ.1)GOTO1150
      IF(CHANGE .LE. 0.)GO TO 1150
      POPQQQ(J6)=POPQQQ(J6)+EXOGEN(I)*AREA
      DO 1060 K=1,NFRELM
      A=EXOGEN(I)*EGCOMP(I,K)*AREA
      AGAINQ(1,K) = AGAINQ (1,K) + A
 1060 CBIOMQ(J6,K)=CBIOMQ(J6,K)+A
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 J6,A
      GO TO 1150
 1070 IF((WTEMP .LT. CONSA(I)).OR.(WTEMP.GT.UPTHRE(I)))GO TO 1150
      HATCH=REPROD(J4)
      GO TO 1110
 1080 HATCH=0.
      IF(WTEMP .LT. CONSA(I).OR. WTEMP .GT. UPTHRE(I))GO TO 1150
      IF((IYRDAY.LE.NLAY1(I)).OR.(IYRDAY.GE.NLAY2(I)))GO TO 1090
      HATCH =SQRT(RCONST(I)**2-((((FLOAT(IYRDAY)-FLOAT(NLAY1(I)))*(2*
     1RCONST(I)/(FLOAT(NLAY2(I))-FLOAT(NLAY1(I)))))-RCONST(I))**2.))
      GO TO 1100
 1090 HATCH=0.
 1100 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH REPRODUCTION.
C---------------------------------------------------------------------
 1110 CHANGE=HATCH*CBIOM(J4,1)
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 J4,CHANGE,HATCH
      IF(K12.EQ.1)CHANGE=CHANGE/CYCLE
      IF (CHANGE.LE.0.) GO TO 1150
      DO 1140 K=1,NFRELM
      CHELEM=CHANGE*EGCOMP(I,K)/EGCOMP(I,1)
      GOTO(1130,1120,1120,1120),K12
 1120 CBIOMQ(J6,K)=CBIOMQ(J6,K)+CHELEM
      CBIOMQ(J4,K)=CBIOMQ(J4,K)-CHELEM
      GOTO1140
 1130 CBIOMQ(J4,K)=CBIOMQ(J4,K)-CHELEM
      DRIFTA(J4,K)=DRIFTA(J4,K)-(CHELEM*(CYCLE-1.))
      CBIOMQ(J6,K)=CBIOMQ(J6,K)+CHELEM
      DRIFTA(J6,K)=DRIFTA(J6,K)+(CHELEM*(CYCLE-1.))
 1140 CONTINUE
      POPQQ(J6)=POPQQQ(J6)+CHANGE/EGCOMP(I,1)
      IF(K12.EQ.1)DRIFPO(J6)=DRIFPO(J6)+(CHANGE/EGCOMP(I,1)*(CYCLE-1.))
 1150 CONTINUE
 1160 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH ANIMAL MORTALITY
C---------------------------------------------------------------------
      DO1200 I=1,NSPCOH
      C=(CYCLE-1)/CYCLE
      IF(CBIOM(I,1).LE.0)GOTO1200
      M1=NDRIFA(I)
      K10=IAFATE(I)
      IF(K10.GT.NOLIT)K10=K10-NOLIT
      DEAD=AMORTA(I)/CYCLE
      DRIFPO(I)=DRIFPO(I)-(DEAD*XDRIFO(I))
      DO1190K=1,NFRELM
      DEAD=AMORTA(I)/CYCLE
      DRIFTA(I,K)=DRIFTA(I,K)-(DEAD*XDRIFA(I,K))
      IF(IAFATE(I).GT.NOLIT)CORGQQ(K10,K)=CORGQQ(K10,K)+(DEAD*XDRIFA(I,K
     1))
      IF(IAFATE(I).LE.NOLIT)DETIN(K10,K)=DETIN(K10,K)+(DEAD*XDRIFA(I,K))
      IF(M1.GT.1)DEAD=AMORTA(I)
      CBIOMQ(I,K)=CBIOMQ(I,K)-(CBIOM(I,K)*DEAD)
      GOTO(1170,1180,1180,1180),M1
 1170 IF(IAFATE(I).LE.NOLIT)CLITQQ(K10,K)=CLITQQ(K10,K)+(DEAD*CBIOM(I,K)
     1)
      IF(IAFATE(I).GT.NOLIT)CORGQQ(K10,K)=CORGQQ(K10,K)+(DEAD*CBIOM(I,K)
     1)
      GOTO1190
 1180 IF(IAFATE(I).GT.NOLIT)CORGQQ(K10,K)=CORGQQ(K10,K)+(DEAD*CBIOM(I,K)
     1)
      IF(IAFATE(I).LE.NOLIT)DETIN(K10,K)=DETIN(K10,K)+(DEAD*CBIOM(I,K)*C
     1)
      IF(IAFATE(I).LE.NOLIT)CLITQQ(K10,K)=CLITQQ(K10,K)+(DEAD*CBIOM(I,K)
     1*(1.-C))
 1190 CONTINUE
      POPQQQ(I)=POPQQQ(I)-(POP(I)*DEAD)
 1200 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH CATASTROPHIC DRIFT
C---------------------------------------------------------------------
      IF(NSPCOH.LE.0)GOTO1280
      DO1270 I=1,NSPCOH
      K1=NDRIFA(I)
      GOTO(1270,1210,1210,1270),K1
 1210 IF(VELOCT.LE.0.)FALLS=ALLMAX
      IF(VELOCT.LE.0.)GOTO1250
      IF((VELOCT.GT.ANILO(I)).AND.(VELOCT.LE.ANIHI(I)))GOTO1270
      IF(ANIHI(I)-VELOCT)1220,1240,1240
 1220 SCOUR=AMIN1(ALLMAX,AMAX1(0.,(ANDRF2(I)**VELOCT-ANDRF2(I)**ANIHI(I)
     1)))
      DO1230 J=1,NFRELM
      IF(CBIOM(I,J).LE.0)GO TO1230
      GOES=SCOUR*CBIOM(I,J)
      CBIOMQ(I,J)=CBIOMQ(I,J)-GOES
      DRIFTA(I,J)=DRIFTA(I,J)+GOES
 1230 CONTINUE
      POPQQQ(I)=POPQQQ(I)-(SCOUR*POP(I))
      DRIFPO(I)=DRIFPO(I)+(SCOUR*POP(I))
      GOTO1270
 1240 FALLS=AMIN1(ALLMAX,AMAX1(0.,(ANDRF3(I)**ANILO(I)-ANDRF3(I)**VELOCT
     1)))
 1250 DEPOS=FALLS/CYCLE
      DO1260 J=1,NFRELM
      CBIOMQ(I,J)=CBIOMQ(I,J)+(DEPOS*XDRIFA(I,J))
 1260 DRIFTA(I,J)=DRIFTA(I,J)-(DEPOS*XDRIFA(I,J))
      POPQQQ(I)=POPQQQ(I)+(DEPOS*XDRIFO(I))
      DRIFPO(I)=DRIFPO(I)-(DEPOS*XDRIFO(I))
 1270 CONTINUE
 1280 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH BEHAVIORAL DRIFTERS
C---------------------------------------------------------------------
      IF(CYCLE.LE.1.)GOTO1330
      DO1320 I=1,NSPCOH
      K1=NDRIFA(I)
      IF(K1.NE.3)GOTO1320
      IF(CBIOM(I,1).GT.0.)GO TO 1290
      IF(XDRIFA(I,1).LE.0.)GO TO 1320
      BEFAC2=1.-ALLMAX
      GO TO 1300
 1290 CONTINUE
      IF(EATS(I)   .LE. 0.        )BEFAC2=ALLMAX
      IF(EATS(I)   .LE. 0.        )GO TO 1300
      BEFAC1=TAKE(I)/EATS(I)
      BEFAC6=ALOG(ALLMAX/BEFAC3(I))/ALOG(BEFAC4(I))
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 I,BEFAC1
      IF(BEFAC1.GT.BEFAC6)BEFAC2=ALLMAX
      IF(BEFAC1.GT.BEFAC6)GO TO 1300
      BEFAC2=AMIN1(ALLMAX,(BEFAC3(I)*(BEFAC4(I)**BEFAC1)))
 1300 BEFAC5=(1.-BEFAC2)/CYCLE
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 I,BEFAC5,BEFAC2,BEFAC1,FOOD(I,1),TAKE(I)
      IF(VELOCT.GT.ANIHI(I))BEFAC5=0.
      DO1310 J=1,NFRELM
      CBIOMQ(I,J)=CBIOMQ(I,J)+(BEFAC5*XDRIFA(I,J))-(BEFAC2*CBIOM(I,J))
 1310 DRIFTA(I,J)=DRIFTA(I,J)+(BEFAC2*CBIOM(I,J))-(BEFAC5*XDRIFA(I,J))
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 I,BEFAC2,BEFAC5,BEFAC1,FOOD(I,1),CBIOM(I,1),VELOCT,TAKE(I)
      POPQQ(I)=POPQQ(I)+(BEFAC5*XDRIFO(I))-(BEFAC2*POP(I))
      DRIFPO(I)=DRIFPO(I)+(BEFAC2*POP(I))-(BEFAC5*XDRIFO(I))
 1320 CONTINUE
 1330 CONTINUE
C---------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH HETEROTROPHIC MICRO ORGANISMS.
C---------------------------------------------------------------------

C.........THE AMOUNT OF FOOD AVAILABLE TO THE MICROBS DEPENDS ON
C.........THE AVAILABILITY OF AND PREFERENCE FOR FOODS.  THE
C.........MICROBS MAY CONSUME SUSPENDED AND BENTHIC DETRITUS
C.........AS WELL AS DISSOLVED SUBSTANCES.
      IF(MICROB.LE.0)GO TO 1590
      DO 1500 I=1,MICROB
      DO1340 K=1,NFRELM
 1340 FOOD(I,K)=0.
      FEEDRW=0.
      IF(CBACT(I,1).LE.0.)GO TO 1500
      SUM=0.
      K1=NDRIFM(I)
      DO 1370 J=1,NOLIT
      FEEDRF(J)=0.
      FEEDRB(J)=0.
      A=PREFRF(I,J)
      B=PREFRB(I,J)
      GO TO(1350,1360,1360),K1
 1350 FEEDRF(J)=CLIT(J,1)*A
      SUM=SUM+FEEDRF(J)
      GO TO 1370
 1360 FEEDRB(J)=CORG(J,1)*B
      SUM=SUM+FEEDRB(J)
 1370 CONTINUE
      GO TO(1380,1400,1390),K1
```

```
 1380 A=PREFRW(I)
      FEEDRW=AQUA(1)*A
      SUM=SUM+FEEDRW
      GO TO 1400
 1390 A=PREFRW(I)
      FEEDRW=AQUAB(1)*A
      SUM=SUM+FEEDRW
 1400 CONTINUE
      IF (SUM.LE.0.)GO TO 1500
      FOOD(I,1)=SUM/AREA
      B=EXP(CONTA+CONTB*WTEMP-CONTC*WTEMP*WTEMP)
      FOOD(I,1)=B/(1.+CONS(I)/FOOD(I,1))
      IF(NDEBUG .GT. 0)WRITE(6,280)
     1 I,FOOD(I,1),B
      IF(K1.EQ.1)FOOD(I,1)=FOOD(I,1)/CYCLE
      TAKING=FOOD(I,1)*CBACT(I,1)
      FOOD(I,1)=0.

C...........THOSE FOODS 'CONSUMED' ARE DECREMENTED
      GOTO(1410,1440,1440),K1
 1410 DO 1430 J=1,NOLIT
      IF(FEEDRF(J).LE.0.)GOTO1430
      FACTOR=TAKING*FEEDRF(J)/(SUM*CLIT(J,1))
      DO 1420 K=1,NFRELM
      CLITQQ(J,K)=CLITQQ(J,K)-(CLIT(J,K)*FACTOR)
      DETIN(J,K)=DETIN(J,K)-(XDETIN(J,K)*FACTOR)
 1420 FOOD(I,K)=FOOD(I,K)+(CLIT(J,K)*FACTOR)
 1430 CONTINUE
      GO TO 1480
 1440 DO 1460 J=1,NOLIT
      IF(FEEDRB(J).LE.0)GO TO 1460
      FACTOR=TAKING*FEEDRB(J)/(SUM*CORG(J,1))
      DO 1450 K=1,NFRELM
      CORGQQ(J,K)=CORGQQ(J,K)-(CORG(J,K)*FACTOR)
 1450 FOOD(I,K)=FOOD(I,K)+(CORG(J,K)*FACTOR)
 1460 CONTINUE
      IF(K1.NE.3)GO TO 1500
      IF(FEEDRW.LE.0)GO TO 1500
      FACTOR=TAKING*FEEDRW/(SUM*AQUAB(1))
      DO 1470 K=1,NFRELM
      AQUABQ(K)=AQUABQ(K)-(AQUAB(K)*FACTOR)
 1470 FOOD(I,K)=FOOD(I,K)+(AQUAB(K)*FACTOR)
      GO TO 1500
 1480 IF(FEEDRW.LE.0)GO TO 1500
      FACTOR=TAKING*FEEDRW/(SUM*AQUA(1))
      DO 1490 K=1,NFRELM
      AQUAQQ(K)=AQUAQQ(K)-(AQUA(K)*FACTOR)
      COMPIN(K)=COMPIN(K)-(XCOMPN(K)*FACTOR)
 1490 FOOD(I,K)=FOOD(I,K)+(AQUA(K)*FACTOR)
 1500 CONTINUE

C...........RESPERATION, ASSIMILATION AND  LYSING ARE CALCULATED
      DO 1580 I=1,MICROB
      IF(FOOD(I,1).LE.0.)GOTO1580
      M1=NDRIFM(I)
      IF(CBACT(I,1).LE.0.)GO TO 1580
      DO 1570 K=1,NFRELM
      N=KORGSW(1,K)
      GO TO(1510,1530,1550),M1
 1510 RESP=RESPM(I)*FOOD(I,K)
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-(RESP*CYCLE)
      IF(K.EQ.2)GO TO 1520
      WDINRQ(N)=WDINRQ(N)+RESP
      AGAINQ(13,K)=AGAINQ(13,K)-(RESP*CYCLE)
      DGAINQ(13,N)=DGAINQ(13,N)+(RESP*CYCLE)
      DNORG(N)=DNORG(N)+((RESP*CYCLE)-RESP)
 1520 ASSI=ASSIMH(I)*FOOD(I,K)
      DRIFTM(I,K)=DRIFTM(I,K)+((    ASSI*CYCLE)-ASSI)
      CBACTQ(I,K)=CBACTQ(I,K)+ASSI
      CBACTP(I,K)=CBACTP(I,K)+(ASSI*CYCLE)
      AGOORG=FOOD(I,K)-(ASSI+RESP)
      AQUAQQ(K)=AQUAQQ(K)+AGOORG
      COMPIN(K)=COMPIN(K)+((AGOORG*CYCLE)-AGOORG)
      GO TO 1570
 1530 RESP=RESPM(I)*FOOD(I,K)/WATTOT
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-(RESP*WATTOT)
      IF(K.EQ.2)GO TO 1540
      WDINRQ(N)=WDINRQ(N)+(RESP*WATSYS)
      AGAINQ(13,K)=AGAINQ(13,K)-(RESP*WATTOT)
      DGAINQ(13,N)=DGAINQ(13,N)+(RESP*WATTOT)
      DNORG(N)=DNORG(N)+(RESP*(WATTOT-WATSYS))
 1540 ASSI=ASSIMH(I)*FOOD(I,K)
      CBACTQ(I,K)=CBACTQ(I,K)+ASSI
      CBACTP(I,K)=CBACTP(I,K)+ ASSI
      AGOORG=(FOOD(I,K)-(ASSI+(RESP*WATTOT)))/WATTOT
      AQUAQQ(K)=AQUAQQ(K)+(AGOORG*WATSYS)
      COMPIN(K)=COMPIN(K)+(AGOORG*(WATTOT-WATSYS))
      GO TO 1570
 1550 RESP=RESPM(I)*FOOD(I,K)
      IF(K.EQ.2)AGAINQ(2,2)=AGAINQ(2,2)-RESP
      IF(K.EQ.2)GOTO1560
      BDINRQ(N)=BDINRQ(N)+RESP
      AGAINQ(13,K)=AGAINQ(13,K)-RESP
      DGAINQ(13,N)=DGAINQ(13,N)+RESP
 1560 ASSI=ASSIMH(I)*FOOD(I,K)
      CBACTQ(I,K)=CBACTQ(I,K)+ASSI
      AGOORG=FOOD(I,K)-(RESP+ASSI)
      CBACTP(I,K)=CBACTP(I,K)+ ASSI
      AQUABQ(K)=AQUABQ(K)+AGOORG
 1570 CONTINUE
 1580 CONTINUE
C---------------------------------------------------------------
C      MICROBIAL SCOURING AND DEPOSITION IS CALCULATED
C---------------------------------------------------------------
 1590 IF(MICROB.LE.0)GO TO 1660
      DO1650 I=1,MICROB
      K1=NDRIFM(I)
      IF(K1.EQ.1)GOTO1650
      IF(VELOCT.LE.0)FALLS=ALLMAX
      IF(VELOCT.LE.0)GOTO1630
      IF((VELOCT.GT.BACTLO(I)).AND.(VELOCT.LE.BACTHI(I)))GOTO1650
      IF(BACTLO(I)-VELOCT)1600,1620,1620
 1600 SCOUR=AMIN1(ALLMAX,AMAX1(0.,(BDRF2(I)**VELOCT-BDRF2(I)**BACTHI(I))
     1))
      DO1610 J=1,NFRELM
      IF(CBACT(I,J).LE.0)GO TO 1610
      GOES=SCOUR*CBACT(I,J)
      CBACTQ(I,J)=CBACTQ(I,J)-GOES
      DRIFTM(I,J)=DRIFTM(I,J)+GOES
 1610 CONTINUE
      GOTO1650
 1620 FALLS=AMIN1(ALLMAY,AMAX1(0.,(BDRF3(I)**BACTLO(I)-BDRF3(I)**VELOCT)
     1))
 1630 DEPOS=FALLS/CYCLE
      DO1640 J=1,NFRELM
      CBACTQ(I,J)=CBACTQ(I,J)+(DEPOS*XDRIFM(I,J))
 1640 DRIFTM(I,J)=DRIFTM(I,J)-(DEPOS*XDRIFM(I,J))
 1650 CONTINUE
 1660 CONTINUE
      RETURN
C---------------------------------------------------------------
C      THE FOLLOWING ALLOWS FOR READING OF PARAMETERS.
C---------------------------------------------------------------
      ENTRY AINPUT
      READ (5,APUT)
      RETURN
      END
```

APPENDIX J

Listing of the Subroutine VEGET

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      SUBROUTINE VEGET
      DIMENSION            REQ(4),SPREQ( 8,4),AINT(4),AEXT(4)
     1 ,IVFATE( 8) ,NVDAY1( 8),NVDAY2( 8),NVDRF8( 8),NVDRF9( 8)
C------------------------------------------------------------------
C     COMMON BLOCK /ACC/ CONTAINS ACCUMULATED CHANGES, WHICH MAY BE
C     NEGATIVE.  COMMON BLOCK /ACCINC/ CONTAINS THE INCREMENTS TO THE
C     ARRAYS IN /ACC/ FOR A SINGLE TIME UNIT.
C------------------------------------------------------------------
      COMMON/ACC/AGAIN(13,4),H20(13),CGAIN(13, 6),DGAIN(13, 6)
      COMMON/ACCINC/AGAINQ(13,4),H20QQG(13),CGAINQ(13, 6),DGAINQ(13, 6)
C------------------------------------------------------------------
C     COMMON BLOCKS/PROSUM/,/PRODUC/,/PRODCH/ DEAL WITH PRODUCTIVITY
C     IN THE SYSTEM.
C------------------------------------------------------------------
      COMMON/PROSUM/PVTOT(4),PBTOT(4),PATOTS(15,4),PATOTA(4),PVSUM(4),
     1PBSUM(4),PASUMS(15,4),PASUMA(4)
      COMMON/PRODUC/PCVEG( 8,1,4),PCBIOM(40,4),PCBACT(3,4)
      COMMON/PRODCH/CVEGP( 8,1,4), CBIOMP(40,4),CBACTP(3,4)
      COMMON/OTHER/AVEIND(40)
C------------------------------------------------------------------
C     COMMON BLOCK /SPEC/ CONTAINS SPECIFICATIONS AND OTHER INFORMATION
C     COMMON TO THE WHOLE SET OF PROGRAMS, BUT EXCLUDING STATE AND
C     EXOGENOUS VARIABLES.
C------------------------------------------------------------------
      COMMON/SPEC/       NCHAN,INSTRU(20),   WATER,NSPECV,NSPECA,NORGAN,
     1  PHW,PHB,      NOLIT ,NCHECK,IDAY, ATOT, ATOTO,IYRDAY,NREPRT(20)
     2,NCOH(15),LISCOH(40),NCOHCU(15),NCOHOR                ,NSPCOH,NDEBUG
     3,FLOUT,MICROB  ,               MONTH ,LOOPER,NSTRCH,JSAVE
     4,NSUBST,CYCLE,                 NOLIT1,LOOP,          IRUN,SOURCE(5,13)
     5,TDAYPR,WATTOT,NPRT(26) ,REACH,NPORT,AMIN,FLOWS
     6,NFRELM,ISTRTM,INORGP,INORGD,MONDAY(12),NUMMON
     7,KORGSW(5,4),KINRGP(5, 6),KINRGD(5, 6)
     8,NDRIFM(3),NDRIFA(40),NDRIFV( 8)
     9,NTRIB ,NPORTI,TEMPW,TEMPB,NPASS
C------------------------------------------------------------------
C     COMMON BLOCK /STAT/ CONTAINS THE STATE VARIABLES, AND /CHANGE/
C     THEIR INCREMENTS OR DECREMENTS FOR THE CURRENT TIME UNIT.
C------------------------------------------------------------------
      COMMON/STAT/CVEG( 8,1,4),CORG(5,4),POP(40),CBIOM(40,4),AQUA(4),
     1CLIT(5,4),CBACT(3,4),AQUAB(4),WDINR( 6),WPINR(5, 6),BDINR( 6)
     2,BPINR(5, 6)
      COMMON/CHANGE/CVEGQQ( 8,1,4),CORGQQ(5,4),POPQQ(40),CBIOMQ(40,4)
     1,AQUAQQ(4),CLITQQ(5,4),CBACTQ(3,4),AQUABQ(4),
     2WDINRQ( 6),WPINRQ(5, 6),BDINRQ( 6),BPINRQ(5, 6)
C------------------------------------------------------------------
C     COMMON BLOCK /METEOR/ CONTAINS THE VALUES OF EXOGENOUS VARIABLES
C     FOR THE CURRENT TIME UNIT.
C------------------------------------------------------------------
      COMMON/METEOR/WIRRIG,     RUNSOL(4),RUNDER(5,4),DARAIN,DAYRUN,
     1RUNPNR(5, 6),RUNDNR( 6),DUSTIP(5, 6),
     2TRFLOW,TCOMPN(4),TDETIN(5,4),TDRIFV( 8,1,4),TDRIFO(40),
     3TDRIFA(40,4),TDRIFM(3,4),TPNORG(5, 6),TDNORG( 6),
     4EVAP,RAINDI( 6),DAPHOT, DAYRAD,DADUST(5,4), EXOG(40),RAINCO(4),
     5FLOSEC,COMPIN(4),DETIN(5,4),DRIFTV( 8,1,4),DRIFPO(40),
     6DRIFTA(40,4),DRIFTM(3,4)   ,PH,PNORG(5, 6),DNORG( 6),WTEMP,
     7FLOWIN,XCOMPN(4),XDETIN(5,4),XDRIFV( 8,1,4),XDRIFO(40),
     8XDRIFA(40,4),XDRIFM(3,4) ,XPH,XPNORG(5, 6),XDNORG( 6),XWTEMP
      COMMON/PHYS/FLOW,PERIM,DEPTH,WATSYS,VELOCT,AREA,WIDTH
C------------------------------------------------------------------
C     COMMON BLOCK/PARAM/ CONTAINS THE PARAMETERS OF THE SUBROUTINE.
C------------------------------------------------------------------
      COMMON/PARAM/DUMMG(3764),SIEVEG(8),EXTINW,EXTINP,EXTINS,EXTIND,
     1CONRAD( 8),CONTE1( 8),CONTE2( 8),CONTE3( 8),
     2            RESPC( 8),RESPD( 8),AMORT( 8),       PLDEP( 8),CONNI2(
     3  8,4),CONNIT( 8,4),UPCON( 8,4),UPCON2( 8,4),ENERGY,UPCON1( 8,4),
     4VDRF3( 8),VDRF2( 8),VDRF11( 8),VDRF7( 8),VDRF15( 8),
     5NCOV( 8), NGOA(40),NGONRP(5),NGOL(5),VTDEDY( 8),VTDEDS( 8),
     6PERSED( 8),SEED(8),RESPE(8),VSPAS(8)
C------------------------------------------------------------------
C     THE NAME LIST CONTAINS THE PARAMETERS THAT ARE TO BE
C     READ IN AT EXECUTION TIME.
C------------------------------------------------------------------
      NAMELIST/VPUT/NDRIFV,          SIEVEG,EXTINW,EXTINP,EXTINS,EXTIND,
     1 CONRAD,CONTE1,CONTE2,CONTE3,RESPC, IVFATE,VSPAS,
     2RESPD,AMORT,       PLDEP,CONNI2,CONNIT,UPCON,UPCON2,ENERGY
     3,UPCON1,VDRF3,VDRF2,VDRF7,NVDRF8,NVDRF9,VDRF11,NVDAY1,NVDAY2
     4,VDRF15,NGOV,NGOA,NGONRP,NGOL,VTDEDY,VTDEDS ,PERSED,EXTINL,RESPE
C------------------------------------------------------------------
C     THE FOLLOWING SECTION DEALS WITH PHOTOSYNTHESIS.
C------------------------------------------------------------------
      DISOLV=0.
      DETRI=0.
      SED=0.
      DO 10 I=1,INORGD
   10 DISOLV=DISOLV + WDINR(I)
      DO 20 I=1,NFRELM
      IF(I.NE.2) DISOLV=DISOLV+AQUA(I)
   20 CONTINUE
      DO30 J=1,ISTRTM
      DO 30 I=1,INORGP
   30 SED =SED+WPINR(J,I)
   40 IF(NOLIT.LE.0)GOTO60
      DO 50 I=1,NOLIT
   50 DETRI = DETRI + CLIT(I,1)
   60 DO 80 K=1,NFRELM
      N=KORGSW(2,K)
      IF(N.EQ.0) GO TO 80
      AEXT(K)=WDINR(N)/(WATSYS*1000000.)
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 AEXT(K),WDINR(N),WATSYS
   70 FORMAT(' VEG',10F12.6)
   80 CONTINUE

C..........INCIDENT RADIATION IS CUT DOWN BY SEDIMENT, SUSPENDED
C..........DETRITUS AND MUTUAL SHADING OF PLANTS AS WELL AS
C..........EXTINCTION THROUGH THE WATER TO THE MEAN DEPTH OF THE
C..........PLANT
      DO 90 K=1,NFRELM
   90 REQ(K)=0.
      DISOLV=DISOLV/WATSYS
      SED=SED/WATSYS
      DETRI=DETRI/WATSYS
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 DISOLV,SED,DETRI,WATSYS
      DO 230 J=1,NSPECV
      A=0.
      J4=NDRIFV(J)
      PLDEP1=PLDEP(J)*DEPTH
      IF(CVEG(J,1,1).LE.0.)GO TO 230
      IF(NFRELM.LE.2)GOTO110
      DO100 K=3,NFRELM
  100 AINT(K)=CVEG(J,1,K)/CVEG(J,1,1)
  110 DO 140 I=1,NSPECV
      PLDEP2= PLDEP(I) * DEPTH
      IF (CVEG(I,1,1).LE.0.) GO TO 140
      IF(PLDEP2-PLDEP1)120,130,140
  120 A=A+CVEG(I,1,1)
      GO TO 140
  130 A=A+0.5*CVEG(I,1,1)
  140 CONTINUE
      A=A/WATSYS
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 A

C..........THE MAXIMUM ATTAINABLE PHOTOSYNTHESIS IS MODIFIED BY
C..........RADIATION,TEMPERATURE NUTRIENT REQUIREMENTS,AND SPACE.
      RADIA=DAYRAD*EXP(-((EXTINP*A+EXTINS*SED+EXTIND*DETRI+EXTINL*DISOLV
     1+EXTINW)*PLDEP1))
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 RADIA,DAYRAD,CONRAD(J),PLDEP1
      B=RADIA/CONRAD(J)
      A=1.
      IF(NFRELM.LE.2)GOTO170
      DO160K=3,NFRELM
      C=CONNI2(J,K)-CONNIT(J,K)*AINT(K)
      IF (C.LT.0.) GO TO 150
      A=0.
      GO TO 180
  150 A=A*(1.-EXP(C))
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 A,C,AINT(K)
  160 CONTINUE
  170 A=B*EXP(1.-B)*A*AMAX1(0.,(CONTE1(J)+CONTE2(J)* WTEMP+CONTE3(J)*
     1WTEMP* WTEMP))
  180 RESPV=(RESPE(J)+RESPC(J)*EXP(RESPD(J)*WTEMP))
      SPREQ(J,1)=CVEG(J,1,1)*(DAPHOT*A-RESPV)
      SPAS=1.*EXP(VSPAS(J)*(CVEG(J,1,1)/AREA))
      SPREQ(J,1)=SPREQ(J,1)*SPAS
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 A,WTEMP,RESPV,B,DAPHOT,SPREQ(J,1),SPAS,AREA,CVEG(J,1,1)
      SPREQ(J,2)=ENERGY*SPREQ(J,1)
      IF(SPREQ(J,1).LE.0.) GO TO 190
      REQ(1)=REQ(1)+SPREQ(J,1)
  190 CONTINUE
      IF(NFRELM.LE.2)GOTO220
      DO210 K=3,NFRELM
      A = CVEG(J,1,1) + SPREQ(J,1)
      IF (A.LE.0.) GO TO 210
      AINTER = CVEG(J,1,K)/(CVEG(J,1,1) + SPREQ(J,1))
      EQUIL = UPCON1(J,K) * (1. - EXP(UPCON2(J,K) * AEXT(K)))
      SPREQ(J,K)=UPCON(J,K)*(CVEG(J,1,1)+SPREQ(J,1))*(EQUIL-AINTER)
      IF(SPREQ(J,K) .LE. 0)GO TO 200
      REQ(K) = REQ(K) + SPREQ(J,K)
  200 CONTINUE
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 AINTER,EQUIL,SPREQ(J,K),REQ(K),CVEG(J,1,K),AEXT(K),CVEG(J,1,1)
  210 CONTINUE
  220 CONTINUE
  230 CONTINUE
      AA=1.
      N=KORGSW(2,1)
      IF(XDNORG(N)+WDINR(N)-REQ(1))240,250,250
  240 CONTINUE
      AA=(XDNORG(N)+WDINR(N))/REQ(1)
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 AA,XDNORG(N),WDINR(N),REQ(1)
  250  IF(NFRELM.LE.2) GO TO 280
      DO270 K=3,NFRELM
      N=KORGSW(2,K)
      IF(XDNORG(N)+WDINR(N)-REQ(K))260,270,270
  260 AA=AMIN1(AA,((XDNORG(N)+WDINR(N))/REQ(K)))
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 AA,XDNORG(N),WDINR(N),REQ(K),AA,AA
  270 CONTINUE

C..........APPROPRIATE VARIABLES ARE INCREMENTED OR DECREMENTED
  280 IF(AA.GT.1)AA=1.
      C=(CYCLE-1.)/CYCLE
      DO 350 J=1,NSPECV
      DO 285 M=1,NFRELM
      IF(CVEG(J,1,M).LE.0.) GO TO 350
  285 CONTINUE
      J4=NDRIFV(J)
      DO340 K=1,NFRELM
      N=KORGSW(2,K)
      N1=1
      B=AA*SPREQ(J,K)
      IF(NDEBUG .GT. 0)WRITE(6,70)
     1 B,AA,SPREQ(J,K),C,CYCLE
      CVEGP(J,1,K)=CVEGP(J,1,K)+B
  290 IF(B.LT.0) N1=2
      IF(K.EQ.2) GOTO330
      DNORG(N)=DNORG(N)-(B*C)
      GOTO(300,310),J4
  300 DRIFTV(J,1,K)=DRIFTV(J,1,K)+(B*C)
      CVEGQQ(J,1,K)=CVEGQQ(J,1,K)+(B*(1-C))
      GOTO320
  310 CVEGQQ(J,1,K)=CVEGQQ(J,1,K)+B
  320 WDINRQ(N)=WDINRQ(N)-(B*(1-C))
      AGAINQ(13,K)=AGAINQ(13,K)+B
      DGAINQ(13,N)=DGAINQ(13,N)-B
      GO TO 340
  330 AGAINQ(N1,K)=AGAINQ(N1,K)+B
      IF(J4.EQ.1)CVEGQQ(J,1,K)=CVEGQQ(J,1,K)+(B*(1-C))
      IF(J4.EQ.1)DRIFTV(J,1,K)=DRIFTV(J,1,K)+(B*C)
      IF(J4.NE.1)CVEGQQ(J,1,K)=CVEGQQ(J,1,K)+B
  340 CONTINUE
```

```
  350 CONTINUE
  360 CONTINUE
C-------------------------------------------------------------------
C       THE FOLLOWING SECTION DEALS WITH PLANT MORTALITY
C-------------------------------------------------------------------
      DO410J=1,NSPECV
      IF (CVEG(J,1,1).LE.0)GO TO 410
      C=(CYCLE-1.)/CYCLE
      SEED(J)=AMAX1(SEED(J),(CVEG(J,1,1)*PERSED(J)))
      IF(IYRDAY.EQ.150)SEED(J)=CVEG(J,1,1)*PERSED(J)
      IF(CVEG(J,1,1).LE.0.)GOTO410
      K1=NDRIFV(J)
      K2=IVFATE(J)
      V3=-VTDEDY(J)/VTDEDS(J)
      DO400K=1,NFRELM
      DEADT=0.
      DEAD=AMORT(J)
      IF((CVEG(J,1,1).LT.SEED(J)).OR.(V3.LE.WTEMP))GOTO370
      DEADT=(VTDEDS(J)*WTEMP)+VTDEDY(J)
  370 IF(K2.GT.NOLIT)K2=IVFATE(J)-NOLIT
      ALLDED=((DEAD/CYCLE)*YDRIFV(J,1,K))+((DEADT/CYCLE)*XDRIFV(J,1,K))
      DRIFTV(J,1,K)=DRIFTV(J,1,K)-ALLDED
      IF(IVFATE(J).LE.NOLIT)DETIN(K2,K)=DETIN(K2,K)+ALLDED
      IF(IVFATE(J).GT.NOLIT)CORGQQ(K2,K)=CORGQQ(K2,K)+ALLDED
      IF(K1.LE.1)DEAD=AMORT(J)/CYCLE
      IF(K1.LE.1)DEADT=DEADT/CYCLE
      ALLDED=(DEAD*CVEG(J,1,K))+(DEADT*CVEG(J,1,K))
      CVEGQQ(J,1,K)=CVEGQQ(J,1,K)-ALLDED
      GOTO(380,390),K1
  380 IF(IVFATE(J).LE.NOLIT)CLITQQ(K2,K)=CLITQQ(K2,K)+ALLDED
      IF(IVFATE(J).GT.NOLIT)CORGQQ(K2,K)=CORGQQ(K2,K)+ALLDED
      GOTO400
  390 IF(IVFATE(J).GT.NOLIT)CORGQQ(K2,K)=CORGQQ(K2,K)+ALLDED
      IF(IVFATE(J).LE.NOLIT)DETIN(K2,K)=DETIN(K2,K)+(ALLDED*C)
      IF(IVFATE(J).LE.NOLIT)CLITQQ(K2,K)=CLITQQ(K2,K)+(ALLDED*(1.-C))
  400 CONTINUE
  410 CONTINUE
C-------------------------------------------------------------------
C       THE FOLLOWING SECTION DEALS WITH PLANT LEAKAGE
C-------------------------------------------------------------------
      DO430J=1,NSPECV
      K1=NDRIFV(J)
      IF(CVEG(J,1,1).LE.0)GOTO430
      DO420K=1,NFRELM
      ALEAK=STEVEG(J)/CYCLE
      DRIFTV(J,1,K)=DRIFTV(J,1,K)-(ALEAK*XDRIFV(J,1,K))
      COMPIN(K)=COMPIN(K)+(ALEAK*XDRIFV(J,1,K))
      IF(K1.GT.1)ALEAK=STEVEG(J)
      CVEGQQ(J,1,K)=CVEGQQ(J,1,K)-(ALEAK*CVEG(J,1,K))
      IF(K1.EQ.1)AQUAQQ(K)=AQUAQQ(K)+(ALEAK*CVEG(J,1,K))
      IF(K1.EQ.1)GOTO420
      ALEAK=(ALEAK*CVEG(J,1,K))/WATTOT
      COMPIN(K)=COMPIN(K)+(ALEAK*(WATTOT-WATSYS))
      AQUAQQ(K)=AQUAQQ(K)+(ALEAK*WATSYS)
  420 CONTINUE
  430 CONTINUE
C-------------------------------------------------------------------
C      THE FOLLOWING SECTION DEALS WITH SCOURING AND SEED DISPERSAL
C-------------------------------------------------------------------
      DO 490 J=1,NSPECV
      K1 = NDRIFV(J)
      IF(K1.EQ.1)GOTO490
      K2 = IVFATE (J)
      DO480 K=1,NFRELM
      VDRF4=0.
      VDRF5=0.
      VDRF12=0.
      VDRF14=0.
      VSTAYS = 0.
      VDRF10=0.
      IF(CVEG(J,1,K).LE.0.) GO TO 460
      VDRF1=AMIN1(1., AMAX1(0.,(VDRF2(J)**VELOCT - VDRF2(J)**VDRF3(J))))
       VDRF4=            VDRF1*CVEG(J,1,K)
      IF((IYRDAY.GE.NVDAY1(J)).AND.(IYRDAY.LE.NVDAY2(J)))VDRF5=VDRF11
     1(J)*CVEG(J,1,K)
      IF((IYRDAY.LE.NVDRF8(J)).OR.(IYRDAY.GE.NVDRF9(J)))GO TO 440
      VDRF6=ABS(SQRT(VDRF7(J)**2-((((FLOAT(IYRDAY)-FLOAT(NVDRF8(J)))
     1*(2.*VDRF7(J)/(FLOAT(NVDRF9(J))-FLOAT(NVDRF8(J)))))-VDRF7(J))**2.)
     2))
      GO TO 450
  440 VDRF6=0.
  450 VDRF10= AMIN1(CVEG(J,1,K),((VDRF4*VDRF6)+VDRF5))
      VDRF13= VDRF4-(VDRF4*VDRF6)
      VDRF14=VDRF13/WATTOT
  460 IF((IYRDAY.LT.NVDRF8(J)).OR.(IYRDAY.GT.NVDRF9(J))) GO TO 470
      IF(VDRF3(J).LT.VFLOCT)GO TO 470
      VSTAYS= VDRF15(J)*XDRIFV(J,1,K)
  470 DRIFTV(J,1,K)=DRIFTV(J,1,K)-VSTAYS+VDRF10
      CVEGQQ(J,1,K)=CVEGQQ(J,1,K)-VDRF13-VDRF10+VSTAYS
      IF(K2.GT.NOLIT)K2=K2-NOLIT
      DETIN(K2,K)=DETIN(K2,K)+(VDRF14*(WATTOT-WATSYS))
      CLITQQ(K2,K)=CLITQQ(K2,K)+(VDRF14*WATSYS)
  480 CONTINUE
  490 CONTINUE
C-------------------------------------------------------------------
C      THE FOLLOWING SECTION DEALS WITH ALL MATERIALS LEAVING THE ECOSYST
C      AS DRIFT.
C-------------------------------------------------------------------
      IF((WIRRIG+FLOUT).LE.0.)GO TO 790
      GOA=WIRRIG/(WIRRIG+FLOUT)
      GOB=FLOUT/(WIRRIG+FLOUT)
      GOC=WIRRIG+FLOUT

C...........ORGANIC MATTER
      DO670 J=1,NFRELM
      AGAINQ(4,J)=AGAINQ(4,J)-(COMPIN(J)*GOA)
      AGAINQ(8,J)=AGAINQ(8,J)-(COMPIN(J)*GOB)
      COMPIN(J)=COMPIN(J)/GOC
      IF(NOLIT.LE.0)GOTO540
      DO530 I=1,NOLIT
      K1=NGOL(I)
      GOTO(500,510,520),K1
  500 AGAINQ(4,J)=AGAINQ(4,J)-(DETIN(I,J)*GOA)
      AGAINQ(8,J)=AGAINQ(8,J)-(DETIN(I,J)*GOB)

      DETIN(I,J)=DETIN(I,J)/GOC
      GOTO530
  510 AGAINQ(4,J)=AGAINQ(4,J)-DETIN(I,J)
      DETIN(I,J)=0.
      GOTO530
  520 AGAINQ(8,J)=AGAINQ(8,J)-DETIN(I,J)
      DETIN(I,J)=DETIN(I,J)/FLOUT
  530 CONTINUE
  540 IF(NSPECV.LE.0)GOTO590
      DO580 I=1,NSPECV
      K2=NGOV(I)
      GOTO(550,560,570),K2
  550 AGAINQ(4,J)=AGAINQ(4,J)-(DRIFTV(I,1,J)*GOA)
      AGAINQ(8,J)=AGAINQ(8,J)-(DRIFTV(I,1,J)*GOB)
      DRIFTV(I,1,J)=DRIFTV(I,1,J)/GOC
      GOTO580
  560 AGAINQ(4,J)=AGAINQ(4,J)-DRIFTV(I,1,J)
      DRIFTV(I,1,J)=0.
      GOTO580
  570 AGAINQ(8,J)=AGAINQ(8,J)-DRIFTV(I,1,J)
      DRIFTV(I,1,J)=DRIFTV(I,1,J)/FLOUT
  580 CONTINUE
  590 IF(NSPCOH.LE.0)GOTO640
      DO630 I=1,NSPCOH
      K3=NGOA(I)
      GOTO(600,610,620),K3
  600 AGAINQ(4,J)=AGAINQ(4,J)-(DRIFTA(I,J)*GOA)
      AGAINQ(8,J)=AGAINQ(8,J)-(DRIFTA(I,J)*GOB)
      DRIFTA(I,J)=DRIFTA(I,J)/GOC
      GOTO630
  610 AGAINQ(4,J)=AGAINQ(4,J)-DRIFTA(I,J)
      DRIFTA(I,J)=0.
      GOTO630
  620 AGAINQ(8,J)=AGAINQ(8,J)-DRIFTA(I,J)
      DRIFTA(I,J)=DRIFTA(I,J)/FLOUT
  630 CONTINUE
  640 IF(MICROB.LE.0)GOTO660
      DO650 I=1,MICROB
      AGAINQ(4,J)=AGAINQ(4,J)-(DRIFTM(I,J)*GOA)
      AGAINQ(8,J)=AGAINQ(8,J)-(DRIFTM(I,J)*GOB)
  650 DRIFTM(I,J)=DRIFTM(I,J)/GOC
  660 CONTINUE
  670 CONTINUE
      IF(NSPCOH.LE.0)GOTO720
      DO710 I=1,NSPCOH
      K3=NGOA(I)
      GOTO(680,690,700),K3
  680 DRIFPO(I)=DRIFPO(I)/GOC
      GOTO710
  690 DRIFPO(I)=0.
      GOTO710
  700 DRIFPO(I)=DRIFPO(I)/FLOUT
  710 CONTINUE
  720 CONTINUE

C...........INORGANIC MATTER
      DO730 J=1,INORGD
      DGAINQ(4,J)=DGAINQ(4,J)-(DNORG(J)*GOA)
      DGAINQ(8,J)=DGAINQ(8,J)-(DNORG(J)*GOB)
  730 DNORG(J)=DNORG(J)/GOC
      IF(INORGP.LE.0)GOTO790
      DO780 I=1,ISTRTM
      K4=NGONRP(I)
      DO770 J=1,INORGP
      GOTO(740,750,760),K4
  740 CGAINQ(4,J)=CGAINQ(4,J)-(PNORG(I,J)*GOA)
      CGAINQ(8,J)=CGAINQ(8,J)-(PNORG(I,J)*GOB)
      PNORG(I,J)=PNORG(I,J)/GOC
      GOTO770
  750 CGAINQ(4,J)=CGAINQ(4,J)-PNORG(I,J)
      PNORG(I,J)=0.
      GOTO770
  760 CGAINQ(8,J)=CGAINQ(8,J)-PNORG(I,J)
      PNORG(I,J)=PNORG(I,J)/FLOUT
  770 CONTINUE
  780 CONTINUE
  790 CONTINUE
      RETURN
C-------------------------------------------------------------------
C      THE FOLLOWING ALLOWS FOR READING OF PARAMETERS.
C-------------------------------------------------------------------
      ENTRY VINPUT
      READ (5,VPUT)
      RETURN
      END
```

APPENDIX K

Example of the Input Deck

(Numbers in left column refer to the actual
line in the program that called a
particular data card)

```
MA0575            THE FOLLOWING SIMULATION IS FOR A PERIOD OF ONE YEAR.
MA0575            SIMULATION STARTS AND ENDS DURING A FLOOD PERIOD.
MA0575
MA0650        DEEP CREEK STATION 2 CURLEW VALLEY UTAH
MA0670            5    8    1    1    3    2   26    2                     1    1         4
MA0685          91 1971  457    2    6         2    1    1
MA0695
MA0740          271  457
MA0850            1    0    2    3
MA0850            1    0    2    3
MA0850
MA0850
MA0850
MA0860
MA0860
MA0860
MA0860
MA0860
MA0870
MA0870
MA0870
MA0870
MA0870
MA0875        11 11 11 11 11 11 11 11 11 11 11 11 11
MA0880         40.5
MA0950            3    7    5    3    5    8    4    5
MA1060            1    2    3
MA1060            1    4    5    6    7    8    9
MA1060            1   15    6    7   18
MA1060            1   15    3
MA1060            1   16   17   18   10
MA1060            1   16   17   18   19   20   21   14
MA1060            1   11   22   14
MA1060            1   23   24   25   26
MA1110        BENTHIC DIATOMS                 CLADOPHORA
MA1110        SPIROGYRA                       CHARA
MA1110        POTOMOGETON
MA1120        RHINICHTHYS OSCULUS             HYALLELA AZTECA
MA1120        BAETIS TRICAUDATUS              OPTIOSERVUS DIVERGENS
MA1120        TRICORYTHODES MINUTUS           HYDROPSYCHE OCCIDENTALIS
MA1120        SIMULIUM ARGUS                  ARGIA VIVIDA
MA1140        CARBON        ENERGY      NITROGEN     PHOSPHORUS
MA1145        EGGS               YOUNG              ADULT              SIZE 1             SIZE 2
MA1145        SIZE 3             SIZE 4             SIZE 5             SIZE 6             SIZE 7
MA1145        SIZE 1-3           SIZE 4-6           SIZE 7-10          PUPAE              SIZE 1-5
MA1145        SIZE 1-2           SIZE 3-4           SIZE 5-6           SIZE 7-9           SIZE 10-12
MA1145        SIZE 13-15         SIZE 4-7           SIZE 1-4           SIZE 5-8           SIZE 9-12
MA1145        SIZE 13-16
MA1150        FINE PARTICLES     COARSE PARTICLES
MA1160        DRIFTING           BENTHIC
MA1165        SUBSTRATUM
MA1170        CARBON POOL NITROGEN     PHOSPHORUS
MA1175        PARTICULATES
MA1250             2.103     21.03       .254      .077
MA1250        .005        .0517       .000833     .000125
MA1250        .005        .0517       .000833     .000125
MA1250        .005        .04798      .000833     .000125
MA1250        .05         .4558       .00833      .00125
MA1300                                .004
MA1320
MA1320
MA1320        .001419     .0195       .000456     .000072
MA1300                                 88.         24.        12.        4.        4.
MA1320
MA1320
MA1320        .00249744   .0237376    .00044352   .00004752
MA1320        .0022704    .021576     .0004032    .0000432
MA1320        .00232710   .0221154    .00041328   .00004428
MA1320        .00157036   .0149234    .00027888   .00002988
MA1320        .0024596    .023374     .0004368    .0000468
MA1300
MA1320
MA1320
MA1320
MA1320
MA1320
MA1300                    860.
MA1320
MA1320        .0390768    .4654048    .01035168   .00143072
MA1320
MA1300                    292.        112.        24.
MA1320
MA1320        .00639496   .06444984   .00166296   .00022984
MA1320        .01364605   .13752795   .00354855   .00049045
MA1320        .01172567   .118414393  .00304917   .00042143
MA1320
MA1300                    60.         44.         48.        80.        12.
MA1320
MA1320        .0017028    .0212796    .0004428    .0000612
MA1320        .00490028   .06123796   .00127428   .00017612
MA1320        .0162712    .2033384    .0042312    .0005848
MA1320        .0590304    .7376928    .0153504    .0021216
MA1320        .027434     .3452024    .0071832    .0009928
MA1320
MA1320
MA1300
MA1320
MA1320
MA1320
MA1320
MA1300
MA1320
MA1320
MA1320
MA1320
MA1320
MA1340        .02691      .29439      .00565      .00054
MA1340        .057        .62358      .01197      .00114
MA1365        2.691       29.439      .5651       .05382
MA1365        .0308       .3136       .00098      .0000613
MA1375        3.97        43.4318     .8337       .0794
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MA1375              18.16      184.      3.813      .36
MA1380              80.67      887.528   16.9407    1.6134
MA1385
MA1400              110.63
MA1410
MA1415              117.208    .526      .0299
MA1420
MA1440 E1500         $EPUT
MA1440 E1500          LIMEXO=
MA1440 E1500           63.
MA1440 E1500          PHB=
MA1440 E1500           7.,
MA1440 E1500          PHW=
MA1440 E1500           7.,
MA1440 E1500          TEMPB=16.,
MA1440 E1500          TEMPW=10.,
MA1440 E1500         $END
MA1445 P0930         $PPUT
MA1445 P0930         PI=5*4.2,
MA1445 P0930          FLODIF=.15,
MA1445 P0930         FMI=5*.66,
MA1445 P0930         FNI=5*.06,
MA1445 P0930          INFLOW=0,
MA1445 P0930          NSECB=1,
MA1445 P0930          NSI=5,
MA1445 P0930          NSECE=4,
MA1445 P0930          NSO=5,
MA1445 P0930         SI=5*.0025,
MA1445 P0930         YBEG=0.,
MA1445 P0930          XI=0.,15.,30.,45.,60.,
MA1445 P0930          XINC=15.,
MA1445 P0930          YSTART=0.,
MA1445 P0930         $END
MA1450 ME1855        $MPUT
MA1450 ME1855         ALLMAX=.48,
MA1450 ME1855         CORF2=5*9.,
MA1450 ME1855          CORF3=14.,6.,
MA1450 ME1855          CFAC1=.1,
MA1450 ME1855         CFAC2=.001,
MA1450 ME1855         CLITHI=.51,.52,
MA1450 ME1855         CLITLO=.42,.43,
MA1450 ME1855         COAGUL=.025,
MA1450 ME1855         SDRF2=5*9.,
MA1450 ME1855         SDRF3=5*3.,
MA1450 ME1855         STRHI=5*.52,
MA1450 ME1855         STRLO=5*.37,
MA1450 ME1855         WATDAY=115.97,
MA1450 ME1855         WETFAC=.6,
MA1450 ME1855        $END
MA1455 A4110         $APUT
MA1455 A4110         ACCUM=4*0.,.00004,.000039,.00008,.00018,.00038,2*0.,.00003,.00006,
MA1455 A4110             .0002,2*0.,.00007,2*0.,.00003,.0001,.0005,2*0.,.000041,.0001,.0005,
MA1455 A4110             .0009,.004,.01,2*0.,.00008,.0006,2*0.,.00007,.0005,.001,0.,
MA1455 A4110          ALLMAX=.9,
MA1455 A4110           AMAX=2000.,2*0.,2000.,6*.2,2000.,7*.1,2*2000.,2*.08,2000.,3*.015,2*2000.,
MA1455 A4110            6*.05,2*2000.,2*.05,2*2000.,3*.1,2000.,
MA1455 A4110          AMORTA=.01,.001,.0005,.01,36*.0006,
MA1455 A4110          ANDRF2=40*5.
MA1455 A4110           ANDRF3=40*7.,
MA1455 A4110          ANIHI=35*.51,5*.50,
MA1455 A4110           ANILO=15*.3,3*.36,22*.3,
MA1455 A4110         ASSIM=0.,.86,.84,0.,.5,.49,.48,.47,.46,.45,0.,.4,.39,2*.38,0.,.9,.7,
MA1455 A4110          0.,.54,.58,.62,.6,0.,.55,.5,.45,.42,.4,.38,0.,0.,.7,.7,0.,0.,.75,.9,.84,.84,
MA1455 A4110          ASSIMH=3*.02,
MA1455 A4110          BACTHI=3*.51,
MA1455 A4110          BACTLO=3*.375,
MA1455 A4110          BORF2=2*9.,
MA1455 A4110          BORF3=2*6.,
MA1455 A4110           BEFAC3=40*.0003,
MA1455 A4110          BEFAC4=40*10.,
MA1455 A4110           CONTA=.2,
MA1455 A4110          CONTB=
MA1455 A4110           .02,
MA1455 A4110          CONTC=
MA1455 A4110           .0008,
MA1455 A4110           CONS=2*160.,
MA1455 A4110          CONSA=15*15.,
MA1455 A4110          CONST=3*.03,7*.07,5*.025,25*.06,
MA1455 A4110           CURVE=2*.1,.25,7*.00023,5*.0005,3*.0003,5*.00045,8*.000088,
MA1455 A4110             4*.00018,5*.3,
MA1455 A4110          EGCOMP=.0007,.0000031,.0000037,.000056,.00004,.00001,.00005,.00002,
MA1455 A4110             7*0.,.00078,.000029,.000044,.000091,.00044,.00015,.00005,.0022,
MA1455 A4110            7*0.,.000023,.0000055,.0000096,.0000183,.00001,.0000026,.00001,
MA1455 A4110           .000004, 7*0.,.0000034,.000000005,.0000013,.0000025,.0000014,
MA1455 A4110           .0000036,.0000017,.000007,
MA1455 A4110           EXOGEN=4*600.,900.,300.,200.,10.,
MA1455 A4110          FEDFRM=3*0.,
MA1455 A4110          HATCOB=40*.53,
MA1455 A4110          HATCON=40*.4,
MA1455 A4110          IAFATE=40*2,
MA1455 A4110          ISFATE=40*4.,
MA1455 A4110          IXFATE=40*2.,
MA1455 A4110          LIVEAN=
MA1455 A4110           3*1,37*3,
MA1455 A4110          NDRIFA=
MA1455 A4110           2,4,4,2,6*3,2,4*3,2,2*3,2,4*3,2,6*3,2*2,2*3,2*2,4*3,
MA1455 A4110          NDRIFM=
MA1455 A4110           1,3,
MA1455 A4110           NLAY1=145,130,130,140,4*200,
MA1455 A4110           NLAY2=150,150,150,160,4*210,
MA1455 A4110          NTRANE=4,4,1,6*4,1,4*4,3,2*4,1,4*4,3,7*4,3,3*4,3,4*4,7,
MA1455 A4110          NTRANS=1,4,6,1,5*5,6,1,3*5,3,1,5,6,1,3*5,3,1,6*5,3,1,2*5,3,1,3*5,7,
MA1455 A4110         PREFA=
MA1455 A4110          0.,2*5.,37*0.,
MA1455 A4110          40*0.,
MA1455 A4110          40*0.,
MA1455 A4110          0.,2*46.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10.,0.,4*5.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110          0.,2 30.,11 0.,2 1*0.,6*0.,4*20.,
MA1455 A4110         0.,2.,11.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10.,0.,4*47.,
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MA1455 A4110      0.,10.,55.,21*0.,6*3.,6*0.,4*188.,
MA1455 A4110      0.,10.,55.,21*0.,6*3.,6*0.,4*188.,
MA1455 A4110      0.,10.,55.,21*0.,6*3.,6*0.,4*188.,
MA1455 A4110      24*0.,6*1.,6*0.,4*47.,
MA1455 A4110      0.,1.,1.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10., 0.,4*2.,
MA1455 A4110      2*0.,2.,33*0.,4*6.,
MA1455 A4110      36*0.,4*2.,
MA1455 A4110      0.,1.,9.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10., 0.,4*22.,
MA1455 A4110      0.,1.,9.,21*0.,6*4.,6*0.,4*110.,10*0.,
MA1455 A4110      0.,1.,9.,21*0.,6*4.,6*0.,4*110.,10*0.,
MA1455 A4110      0.,1.,9.,21*0.,6*4.,6*0.,4*110.,10*0.,
MA1455 A4110      0.,1.,9.,21*0.,6*4.,6*0.,4*110.,10*0.,
MA1455 A4110      0.,2*3.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10.,0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,2*9.,33*0.,4*24.,
MA1455 A4110      0.,9.,12.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,7*10.,0.,4*0.,
MA1455 A4110      0.,27.,36.,37*0.,
MA1455 A4110      0.,27.,36.,37*0.,
MA1455 A4110      40*0.,
MA1455 A4110      0.,0.,1.,0.,6*10.,0.,4*10.,0.,2*10.,0.,4*10.,0.,6*1.,2*0.,3*10., 0.,4*0.,
MA1455 A4110      2*0.,1.,37*0.,
MA1455 A4110      2*0.,1.,37*0.,
MA1455 A4110      2*0.,1.,37*0.,
MA1455 A4110      2*0.,1.,37*0.,
MA1455 A4110     PREFL=
MA1455 A4110      24*0.,6*10.,2*0.,2*40.,6*0.,
MA1455 A4110      4*0.,6*22.,0.,4*8.,0.,24.,14.,0.,3*12.,2*0.,6*90.,10*0.,
MA1455 A4110     PREFM=
MA1455 A4110      32*0.,2*40.,6*0.,
MA1455 A4110      4*0.,6*22.,0.,3*8.,2*0.,2*24.,0.,4*12.,17*0.,
MA1455 A4110     PREFO=
MA1455 A4110      4*0.,6*22.,0.,4*8.,0.,24.,14.,0.,4*12.,17*0.,
MA1455 A4110       4*0.,6*44.,0.,3*16.,2*0.,2*48.,0.,4*24.,17*0.,
MA1455 A4110      PREFRB=15*1.,
MA1455 A4110      PREFRW=3*1.,
MA1455 A4110     PREFV=
MA1455 A4110      4*0.,6*1.,0.,3*10.,2*0.,5.,2*0.,4*6.,1*0.,6*70.,10*0.,
MA1455 A4110      4*0.,6*10.,0.,3*17.,2*0.,19.,23.,0.,4*8.,1*0.,6*5.,10*0.,
MA1455 A4110      11*0.,3*4.,2*0.,5.,4.,0.,4*8.,1*0.,6*10.,10*0.,
MA1455 A4110      4*0.,6*36.,0.,3*13.,2*0.,14.,16.,0.,4*20.,1*0.,6*5.,10*0.,
MA1455 A4110      4*0.,6*15.,0.,7*19.,2*0.,10.,12.,0.,4*15.,1*0.,6*5.,10*0.,
MA1455 A4110      RCONST=.015,.09,.05,.09,4*.05,
MA1455 A4110      REPROD=40*0.,
MA1455 A4110      RESPM=3*.1,
MA1455 A4110      SHELP=40*.2,
MA1455 A4110     SLOPE=4*1.,6*-.02,1.,4*.2,1.,2*.2,1.,3*-.04,7*1.,6*-.02,2*1.,2*1,2*1.,3*.2,.9
MA1455 A4110     TAKE=0.,.23,.12,0.,1.,.95,.92,.90,.86,.82,0.,.36,.3,.25,.18,0.,.8,.6,
MA1455 A4110      0.,.8,.75,.7,.65,0.,2*1.3,1.1,1.0,.9,.8,0.,0.,.3,.30,0.,0.,.47,.43,.4,.4,
MA1455 A4110      TEMCON=40*0.,
MA1455 A4110      THRESH=40*40.,
MA1455 A4110       TMAX=40*20.,
MA1455 A4110       TOPT=40*15.,
MA1455 A4110      UPTHRE=15*72.,
MA1455 A4110     WMAX=.00007,.12,.6,.0000062,.00001,.0005,.0001,.00025,.00045,.0009,
MA1455 A4110      .000037,.00004,.00008,.0006,.009,.0004,.00085,.001,.000004,
MA1455 A4110       .00006,.00025,.0007,.0012,.00001,.00006,.0002,.0006,.001,.005,
MA1455 A4110       .02,.03,.00005,.0001,.0009,.001,.0002,.0009,.0007,.002,.01,
MA1455 A4110     WMIN=.00006,.0007,.12,.000006,.0000062,.0001,.00005,.0001,.0025,
MA1455 A4110      .00045,.00003,.000037,.00004,.0008,.0005,.00038,.00004,.00085,
MA1455 A4110       .000038,.000004,.00006,.00025,.0007,.0009,.00001,.00006,.0002,
MA1455 A4110      .0006,.001,.005,.02,.000004,.00005,.0001,.0009,.000018,.00002,
MA1455 A4110      .00009,.0007,.002,
MA1455 A4110      XCRSOL=40*.6,
MA1455 A4110     $END
MA1460 VE2110     $VPUT
MA1460 VE2110      AMORT= 8*.005,
MA1460 VE2110      CONNIT=16*0., 8*30., 8*208.,
MA1460 VE2110      CONNI2= 32*1.,
MA1460 VE2110      CONRAD=10.2,25.8,9.,8.,30.,
MA1460 VE2110      CONTE1=-.017,-.048,-.01,-.04,-.035,
MA1460 VE2110      CONTE2=.0047,.0096,.0052,.0114,.01,
MA1460 VE2110      CONTE3=-.0001,-.00027,-.00013,-.00036,-.0001,
MA1460 VE2110      ENERGY=10.4,
MA1460 VE2110      EXTIND=.18,
MA1460 VE2110      EXTINL=.018,
MA1460 VE2110      EXTINP=.018,
MA1460 VE2110      EXTINS=.019,
MA1460 VE2110      EXTINW=.21,
MA1460 VE2110      IVFATE= 8*4,
MA1460 VE2110      NDRIFV= 8*2,
MA1460 VE2110      NGOA=
MA1460 VE2110       40*1,
MA1460 VE2110      NGOL=
MA1460 VE2110       5*1,
MA1460 VE2110      NGONRP=
MA1460 VE2110       5*1,
MA1460 VE2110      NGOV=
MA1460 VE2110       5*1,
MA1460 VE2110      NVDAY1= 8*120,
MA1460 VE2110      NVDAY2= 8*135,
MA1460 VE2110      NVDRF8= 8*138,
MA1460 VE2110      NVDRF9= 8*180,
MA1460 VE2110      PERSED=.15, 7*.02,
MA1460 VE2110      PLDEP=
MA1460 VE2110       1.,.7,.9,.7,.5,
MA1460 VE2110      RESPC=
MA1460 VE2110       .009,.008,.01,.006,.009,
MA1460 VE2110      RESPO=.105,.099,.12,.08,.099,
MA1460 VE2110      SIEVEC= 8*.005,
MA1460 VE2110      UPCON= 32*1.,
MA1460 VE2110      UPCON1=16*0., 8*.176, 8*.029,
MA1460 VE2110      UPCON2=24*-500000., 8*-9000000.,
MA1460 VE2110      VDRF2=8*5.,
MA1460 VE2110      VDRF3=8*.5,
MA1460 VE2110      VDRF7= 8*.05,
MA1460 VE2110      VDRF11= 8*.001,
MA1460 VE2110      VDRF15= 8*.01,
MA1460 VE2110      VSPAS=-.095,-.17,-.14,-.18,-.111,
MA1460 VE2110      VTDEOS=-.0087,-.007,-.0058,-.0065,-.0078,
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MA1460 VE2110          VTDEDY= 8*.07,
MA1460 VE2110         $END
MA2375                10037
MA2410                TOTAL PLANT CARBON (STANDING CROP)
MA2415                GRAMS PER SQUARE METER
MA2375                    150001
MA2410                BENTHIC DIATOMS
MA2415                GRAMS CARBON
MA2450                STANDING CROP
MA2450                TOT.NET PRODUCTIVITY
MA2375                10069
MA2410                TOTAL ANIMAL CARBON
MA2415                GRAMS PER SQUARE METER
MA2375                  68   69   70
MA2410                POPULATIONS OF OPIOSERVUS DIVERGENS
MA2415                NUMBERS PER SQUARE METER
MA2450                EGGS
MA2450                SIZE 1-5
MA2450                ADULT
MA2375                  277  278
MA2410                HETEROTROPHIC MICROORGANISM CARBON
MA2415                GRAMS PER SQUARE METER
MA2450                DRIFTING
MA2450                BENTHIC
MA2375                  33   34
MA2410                CARBON IN BENTHIC LITTER
MA2415                GRAMS PER SQUARE METER
MA2450                FINE
MA2450                COARSE
E0310
E0310                 0.02142    0.2171     0.00449    0.0004284
E0310
E0310                 0.02465    0.2497     0.00517    0.0004930
E0310
E0310                 0.02869    0.2907     0.00602    0.0005738
E0310
E0310                 0.00678    0.2277     0.00142    0.0001356
E0310
E0310                 0.0262     0.2663     0.00550    0.0005240
E0310
E0310                 0.01198    0.12147    0.00251    0.0002396
E0310
E0310                 0.02131    0.21595    0.00447    0.0004262
E0310
E0310                 0.03385    0.34297    0.00710    0.0006770
E0310
E0310                 0.02981    0.30205    0.00626    0.0005962
E0310
E0310                 0.06366    0.64503    0.01336    0.0012732
E0310
E0310                 0.01743    0.17664    0.00366    0.0003486
E0310
E0310                 0.02111    0.2139     0.00443    0.0004222
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0325
E0330                    97
E0350                     8     9    11    12    16    17    18    19    21    47    50    51    52    61    65    74
E0350                    84    85    86    87    88   108   109   110   111   112   113   114   115   116   117   118
E0350                   119   120   121   122   123   124   125   129   130   136   137   138   145   146   147   148
E0350                   152   156   157   158   159   164   172   174   195   196   235   236   237   244   248   249
E0350                   250   263   264   280   282   283   297   299   300   311   312   313   314   319   323   325
E0350                   328   329   330   331   332   334   335   336   337   342   345   351   352   353   355   356
E0350                   364
E0355                         .25         2.6         2.8         2.5         .75        1.50         6.4         16.
E0355                         7.9         .25         .50         3.8         .25         2.1         1.2         4.9
E0355                          1.         1.2          2.         2.1         7.1         7.8         2.2          1.
E0355                         .75        17.1         3.2        12.6         7.9         7.1          1.         3.4
E0355                         10.         27.         4.9          .5         .25         3.7         1.8         8.2
E0355                        5.25          .5        1.25          .5          1.         5.0         7.4         14.
E0355                         7.1         17.         .25         7.3         1.0         23.          1.          1.
E0355                          2.         3.2          2.         .75          .5        1.25         5.0         7.5
E0355                         7.5         7.5         7.4         .75         5.0         7.1         .75         2.5
E0355                         9.0         7.5         .75         .98         .25         6.2         .75        1.25
E0355                         .25         1.0          .5         3.0          .5          .5         4.1         .25
E0355                         15.         .58         2.1         .25         3.8         1.4         2.2         1.0
E0355                         5.
E0360                 16.        160.        3.2        .4
E0365                    .01         .01         .01
E0530                   1.18        1.47        2.98        3.32        4.35        5.15        5.92        5.42
E0530                   4.          2.98        1.91        1.3
E0535                   9.51       10.68        12.        13.43       14.61       15.23        14.9       13.81
E0535                  12.41       11.03        9.76        9.13
E0540                  135.        180.        350.        410.        520.        580.        550.        530.
E0540                  350.        270.        180.        110.
E0550                  .2901       .2620       .2340       .2515       .2691       .2867       .3043       .3219
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E0550                  .6207       .6383       .6559       .6735       .6910       .7086       .7262       .7438
E0550                  .7641       .7789       .7965       .8141       .8317       .8493       .7085       .5678
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E0550                  .7705       .8964       .8047       .7130       .6213       .5297       .4380       .3463
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E0550                  1.022       1.118       1.214      1.3099      1.4069      1.5018      1.5978      1.6106
E0550                 1.6234      1.6361      1.6489      1.6617      1.6745      1.6873      1.7001      1.6517
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E0550                  .7491       .7229       .7375       .7520       .7666       .7811       .7957       .8102
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E0550                 1.1249      1.1002      1. 755      1. 5 7      1. 259      1.   17      .9765      1.    9
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E0550                  .0488       .0567       .0646       .0726       .0804       .0884       .2263       .2957
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E0800      17 .       7.
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E0785      .1         .0 00 00 5      .0 00 06       .0 00 00 13      .0 00 00 01 79
E0785      .08        .0 00 01 6      .0 00 19 2     .0 00 00 41 6    .0 00 00 05 75
E0785      .06        .0 00 05 4      .0 00 64 8     .0 00 01 4       .0 00 00 19 4
E0785      .04        .0 00 16        .0 01 92       .0 00 04 16      .0 00 00 57
E0795      .0 26 91   .2 94 39        .0 05 65       .0 00 54
E0795      .0 04 55     .0 49 2        .00 09 45      .00 00 9
E0800      19 .       7.
E0810      11 0. 63
E0815      22 0.      .7 6            .1 6
```

APPENDIX L

Example of Output

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THE FOLLOWING SIMULATION IS FOR A PERIOD OF ONE YEAR.
SIMULATION STARTS AND ENDS DURING A FLOOD PERIOD.


DEEP CREEK STATION 2 CURLEW VALLEY UTAH

INITIAL REPORT ON APR   1 1971
  MEAN DEPTH      MEAN FLOW        MEAN WIDTH       MEAN VELOCITY       TOTAL VOLUME        AREA
   .62 METERS    1.506 CUM/S        5.02 METERS        .526 MPS           115.97CU.M       203.31 SQ. M.

THE FOLLOWING CONSTITUENTS ARE ORGANIC AND ARE PRINTED IN GRAMS (OR KCAL.) PER SQ. METER, AVERAGED OVER   40.5 METERS OF STREAM.

CONSTITUENTS OF PRIMARY PRODUCERS
                                 CARBON       ENERGY       NITROGEN     PHOSPHORUS
BENTHIC DIATOMS                  2.10300     21.03000       .25400        .02700
CLADOPHORA                        .00500       .05170       .00083        .00012
SPIROGYRA                         .00500       .05170       .00083        .00012
CHARA                             .00500       .04798       .00083        .00012
POTOMOGETON                       .05000       .45580       .00833        .00125

ALL SPECIES
          TOTAL                  2.16800     21.63718       .26483        .02862

CONSTITUENTS OF ANIMAL BIOMASS
                                 CARBON       ENERGY       NITROGEN     PHOSPHORUS
RHINICHTHYS OSCULUS
    EGGS                         .000000      .000000      .000000      .000000
    YOUNG                        .000000      .000000      .000000      .000000
    ADULT                        .001419      .019500      .000456      .000072
          TOTAL                  .001419      .019500      .000456      .000072

HYALLELA AZTECA
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1                       .000000      .000000      .000000      .000000
    SIZE 2                       .002497      .023734      .000444      .000048
    SIZE 3                       .002270      .021576      .000403      .000043
    SIZE 4                       .002327      .022115      .000413      .000044
    SIZE 5                       .001570      .014923      .000279      .000030
    SIZE 6                       .002460      .023374      .000437      .000047
          TOTAL                  .011125      .105722      .001976      .000212

BAETIS TRICAUDATUS
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-2                     .000000      .000000      .000000      .000000
    SIZE 3                       .000000      .000000      .000000      .000000
    SIZE 4                       .000000      .000000      .000000      .000000
    SIZE 5-6                     .000000      .000000      .000000      .000000
          TOTAL                  .000000      .000000      .000000      .000000

OPTIOSERVUS DIVERGENS
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-5                     .039077      .465405      .010352      .001431
    ADULT                        .000000      .000000      .000000      .000000
          TOTAL                  .039077      .465405      .010352      .001431

TRICORYTHODES MINUTUS
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-2                     .006395      .064450      .001663      .000230
    SIZE 3-4                     .013646      .137528      .003549      .000490
    SIZE 5-6                     .011726      .118414      .003049      .000421
    SIZE 7                       .000000      .000000      .000000      .000000
          TOTAL                  .031767      .320392      .008261      .001142

HYDROPSYCHE OCCIDENTALIS
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-2                     .001703      .021280      .000443      .000061
    SIZE 3-4                     .004900      .061238      .001274      .000176
    SIZE 5-6                     .016271      .203338      .004231      .000585
    SIZE 7-9                     .059030      .737693      .015350      .002122
    SIZE 10-12                   .027434      .345202      .007183      .000993
    SIZE 13-15                   .000000      .000000      .000000      .000000
    PUPAE                        .000000      .000000      .000000      .000000
          TOTAL                  .109339     1.368751      .028482      .003937

SIMULIUM ARGUS
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-3                     .000000      .000000      .000000      .000000
    SIZE 4-7                     .000000      .000000      .000000      .000000
    PUPAE                        .000000      .000000      .000000      .000000
          TOTAL                  .000000      .000000      .000000      .000000

ARGIA VIVIDA
    EGGS                         .000000      .000000      .000000      .000000
    SIZE 1-4                     .000000      .000000      .000000      .000000
    SIZE 5-8                     .000000      .000000      .000000      .000000
    SIZE 9-12                    .000000      .000000      .000000      .000000
    SIZE 13-16                   .000000      .000000      .000000      .000000
          TOTAL                  .000000      .000000      .000000      .000000


TOTAL, ALL SPECIES               .192726     2.279770      .049526      .006793

POPULATIONS ARE PRINTED IN NUMBERS PER SQ. METER,AVERAGED OVER  40.5 METERS OF STREAM.
AVERAGE WEIGHTS ARE EXPRESSED AS GRAMS OF CARBON (DRY WT.).
                                  POPULATIONS                WT. OF AVE. IND.
RHINICHTHYS OSCULUS
    EGGS                            .0000                    .000000
    YOUNG                           .0000                    .000000
    ADULT                           .0040                    .35475D+00
          TOTAL                     .0040

HYALLELA AZTECA
    EGGS                            .0000                    .000000
    SIZE 1                          .0000                    .000000
    SIZE 2                        88.0000                    .28380D-04
    SIZE 3                        24.0000                    .94600D-04
    SIZE 4                        12.0000                    .19393D-03
    SIZE 5                         4.0000                    .39259D-03
    SIZE 6                         4.0000                    .61490D-03
          TOTAL                  132.0000

BAETIS TRICAUDATUS
    EGGS                            .0000                    .000000
    SIZE 1-2                        .0000                    .000000
    SIZE 3                          .0000                    .000000
    SIZE 4                          .0000                    .000000
    SIZE 5-6                        .0000                    .000000
          TOTAL                     .0000
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OPTIOSERVUS DIVERGENS
     EGGS                              .0000                      .00000
     SIZE 1-5                       860.0000                      .454381-04
     ADULT                             .0000                      .00000
          TOTAL                     860.0000

TRICORYTHODES MINUTUS
     EGGS                              .0000                      .00000
     SIZE 1-2                       292.0000                      .219005-04
     SIZE 3-4                       112.0000                      .12184D-03
     SIZE 5-6                        24.0000                      .48857D-03
     SIZE 7                            .0000                      .00000
          TOTAL                     428.0000

HYDROPSYCHE OCCIDENTALIS
     EGGS                              .0000                      .00000
     SIZE 1-2                        60.0000                      .28380D-04
     SIZE 3-4                        44.0000                      .11137D-03
     SIZE 5-6                        48.0000                      .338983-03
     SIZE 7-9                        60.0000                      .98384D-03
     SIZE 10-12                      12.0000                      .228617-02
     SIZE 13-15                        .0000                      .00000
     PUPAE                             .0000                      .00000
          TOTAL                     224.0000

SIMULIUM ARGUS
     EGGS                              .0000                      .00000
     SIZE 1-3                          .0000                      .00000
     SIZE 4-7                          .0000                      .00000
     PUPAE                             .0000                      .00000
          TOTAL                        .0000

ARGIA VIVIDA
     EGGS                              .0000                      .00000
     SIZE 1-4                          .0000                      .00000
     SIZE 5-8                          .0000                      .00000
     SIZE 9-12                         .0000                      .00000
     SIZE 13-16                        .0000                      .00000
          TOTAL                        .0000

CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS
  MICROBIAL TYPE                 CARBON       ENERGY       NITROGEN    PHOSPHORUS
     DRIFTING                    .026910      .294390      .005650      .000540
     BENTHIC                     .057000      .623580      .011970      .001140
          TOTAL                  .083910      .917970      .017620      .001680

SUSPENDED DETRITUS CONSTITUENTS
  DETRITUS TYPE                  CARBON       ENERGY       NITROGEN    PHOSPHORUS
     FINE PARTICLES             2.691000    29.438999      .565100      .053820
     COARSE PARTICLES            .030800      .313600      .000880      .000061
          TOTAL                 2.721800    29.752599      .565980      .053881

BIOLOGICALLY ACTIVE SEDIMENTS
  DETRITUS TYPE                  CARBON       ENERGY       NITROGEN    PHOSPHORUS
     FINE PARTICLES             3.970000    43.431799      .833700      .079400
     COARSE PARTICLES          18.160000   183.999996     3.813000      .360000
          TOTAL                22.129999   227.431793     4.646700      .439400

TOTAL DETRITUS                 24.851799   257.184391     5.212680      .493281

DISSOLVED CONSTITUENTS           CARBON       ENERGY       NITROGEN    PHOSPHORUS
  IN WATER                      80.67000    882.52798     16.94070     1.61340
  IN BENTHOS                      .00000       .00000       .00000      .00000
          TOTAL                 80.67000    882.52798     16.94070     1.61340

AVERAGE IN ECOSYSTEM             CARBON       ENERGY       NITROGEN    PHOSPHORUS
                               107.96643   1164.54729     22.48535     2.14378

THE FOLLOWING CONSTITUENTS ARE INORGANIC AND ARE PRINTED IN GRAMS PER SQ. METER AVERAGED OVER  40.5 METERS OF STREAM.

SUSPENDED PARTICULATE MATTER(INORGANIC)
 SIZE           SUBSTRATUM
PARTICULATES    110.63000
  TOTAL         110.63000

BENTHIC PARTICULATE MATTER(INORGANIC)
 SIZE           SUBSTRATUM
PARTICULATES       .00000
  TOTAL            .00000

ALL P.M.        110.63000

DISSOLVED INORGANIC CONSTITUENTS
                CARBON POOL NITROGEN    PHOSPHORUS
IN WATER        117.20800     .52600      .02990
IN BENTHOS         .00000     .00000      .00000
  TOTAL         117.20800     .52600      .02990

PH IN WATER COLUMN  7.00 PH IN BENTHOS  7.00   WATER COLUMN TEMP. 16.00 BENTHOS TEMP. 16.00 DEGREES CENTIGRADE

STATE(  147) PERMITS ONLY  .9099117070 OF THE PROPOSED UNIT CHANGE AT 153 +  .000 DAYS
STATE(  127) PERMITS ONLY  .9061091915 OF THE PROPOSED UNIT CHANGE AT 163 +  .000 DAYS
STATE(  147) PERMITS ONLY  .7250190228 OF THE PROPOSED UNIT CHANGE AT 174 +  .000 DAYS
STATE(  147) PERMITS ONLY  .8126394153 OF THE PROPOSED UNIT CHANGE AT 176 +  .000 DAYS
STATE(  147) PERMITS ONLY  .7928182185 OF THE PROPOSED UNIT CHANGE AT 178 +  .000 DAYS
STATE(  147) PERMITS ONLY  .7739089280 OF THE PROPOSED UNIT CHANGE AT 180 +  .000 DAYS
STATE(  243) PERMITS ONLY  .1248788005 OF THE PROPOSED UNIT CHANGE AT 182 +  .000 DAYS
STATE(   67) PERMITS ONLY  .6341773868 OF THE PROPOSED UNIT CHANGE AT 182 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5995712802 OF THE PROPOSED UNIT CHANGE AT 184 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5924419463 OF THE PROPOSED UNIT CHANGE AT 186 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5890977234 OF THE PROPOSED UNIT CHANGE AT 188 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5890518874 OF THE PROPOSED UNIT CHANGE AT 190 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5890767351 OF THE PROPOSED UNIT CHANGE AT 192 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5890979767 OF THE PROPOSED UNIT CHANGE AT 194 +  .000 DAYS
STATE(   67) PERMITS ONLY  .5649888739 OF THE PROPOSED UNIT CHANGE AT 196 +  .000 DAYS
STATE(   67) PERMITS ONLY  .6022374099 OF THE PROPOSED UNIT CHANGE AT 198 +  .000 DAYS
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DEEP CREEK STATION 2 CURLEW VALLEY UTAH

REPORT NO.  1 ON SEPT 28 1971 (I.E., AFTER 180 DAYS OF SIMULATION)
  MEAN DEPTH      MEAN FLOW      MEAN WIDTH      MEAN VELOCITY        TOTAL VOLUME        AREA
   .23 METERS     .266 CUM/S     4.51 METERS       .289 MPS             40.80CU.M        182.47 SQ. M.

THE FOLLOWING CONSTITUENTS ARE ORGANIC AND ARE PRINTED IN GRAMS (OR KCAL.) PER SQ. METER, AVERAGED OVER   40.5 METERS OF STREAM.

CONSTITUENTS OF PRIMARY PRODUCERS
                              CARBON       ENERGY      NITROGEN    PHOSPHORUS
BENTHIC DIATOMS              25.98608    270.20707     3.07328       .75360
CLADOPHORA                   22.93557    238.52898     2.71251       .66513
SPIROGYRA                    20.77703    216.07981     2.45722       .60253
CHARA                        13.01801    135.37564     1.53960       .37752
POTOMOGETON                  24.51548    254.93773     2.89937       .71095

ALL SPECIES
          TOTAL             107.23218   1115.12921    12.68199      3.10973

CONSTITUENTS OF ANIMAL BIOMASS
                              CARBON       ENERGY      NITROGEN    PHOSPHORUS
RHINICHTHYS OSCULUS
    EGGS                      .000000      .000000     .000000      .000000
    YOUNG                     .188590     2.101433     .055405      .007480
    ADULT                     .002395      .032878     .000723      .000097
          TOTAL               .190985     2.134312     .056128      .007578

HYALLELA AZTECA
    EGGS                      .000000      .000000     .000000      .000000
    SIZE 1                    .000012      .000150     .000002      .000000
    SIZE 2                    .167339     1.573921     .029695      .002736
    SIZE 3                    .313459     2.949276     .055622      .005157
    SIZE 4                    .018693      .176256     .003317      .000315
    SIZE 5                    .009676      .092049     .001718      .000185
    SIZE 6                    .021409      .204228     .003802      .000426
          TOTAL               .530588     4.995879     .094157      .008815

BAETIS TRICAUDATUS
    EGGS                      .003600      .042806     .000934      .000126
    SIZE 1-2                 1.110615    13.203384     .288140      .039025
    SIZE 3                    .990093    11.756691     .256848      .034788
    SIZE 4                    .917069    10.897690     .237862      .032230
    SIZE 5-6                  .082478      .980165     .021393      .002899
          TOTAL              3.103854    36.880736     .805176      .109069

OPTIOSERVUS DIVERGENS
    EGGS                      .000000      .000000     .000000      .000000
    SIZE 1-5                  .942864    11.108555     .182842      .021567
    ADULT                   12.505298   110.925613    2.361373      .161829
          TOTAL             13.448161   122.034168    2.544216      .183396

TRICORYTHODES MINUTUS
    EGGS                      .005844      .064279     .001461      .000205
    SIZE 1-2                 2.173031    23.497917     .547633      .080191
    SIZE 3-4                  .856918     9.137148     .217303      .031032
    SIZE 5-6                  .392579     4.122140     .101809      .013712
    SIZE 7                    .002655      .027761     .000678      .000090
          TOTAL              3.431026    36.849244     .868884      .125230

HYDROPSYCHE OCCIDENTALIS
    EGGS                      .024790      .371853     .006445      .000897
    SIZE 1-2                  .178342     2.562561     .046341      .006419
    SIZE 3-4                  .102583     1.435763     .026652      .003692
    SIZE 5-6                  .532838     7.065580     .138462      .019144
    SIZE 7-9                  .111910     1.469058     .029086      .004022
    SIZE 10-12                .017622      .223227     .004613      .000637
    SIZE 13-15                .010724      .133788     .002788      .000375
    PUPAE                     .001986      .024775     .000516      .000070
          TOTAL               .980795    13.286605     .254905      .035252

SIMULIUM ARGUS
    EGGS                      .001746      .017460     .000349      .000059
    SIZE 1-3                  .818655     8.188190     .163829      .023594
    SIZE 4-7                  .041127      .425732     .009093      .001196
    PUPAE                     .000006      .000067     .000002      .000000
          TOTAL               .861535     8.631449     .173273      .024849

ARGIA VIVIDA
    EGGS                      .000322      .003544     .000064      .000011
    SIZE 1-4                  .033317      .317707     .006595      .000539
    SIZE 5-8                  .163749     1.521454     .033183      .002258
    SIZE 9-12                 .155903     1.449532     .031833      .002139
    SIZE 13-16                .027964      .260343     .005720      .000386
          TOTAL               .381255     3.552580     .077395      .005334


TOTAL, ALL SPECIES           22.928197   228.364946    4.874133      .499022

POPULATIONS ARE PRINTED IN NUMBERS PER SQ. METER,AVERAGED OVER  40.5 METERS OF STREAM.
AVERAGE WEIGHTS ARE EXPRESSED AS GRAMS OF CARBON (DRY WT.).
                              POPULATIONS              WT. OF AVE. IND.
RHINICHTHYS OSCULUS
    EGGS                          .0000                 .000000
    YOUNG                        1.5753                 .119715+00
    ADULT                         .0041                 .587922+00
          TOTAL                  1.5794

HYALLELA AZTECA
    EGGS                          .0000                 .000000
    SIZE 1                       1.5617                 .775110-05
    SIZE 2                    3551.0146                 .471242-04
    SIZE 3                    3567.4328                 .878669-04
    SIZE 4                     199.8193                 .935488-04
    SIZE 5                      22.5996                 .428170-03
    SIZE 6                      26.5205                 .807255-03
          TOTAL               7368.9483

BAETIS TRICAUDATUS
    EGGS                       972.8687                 .370000-05
    SIZE 1-2                 31753.9912                 .349756-04
    SIZE 3                   14064.8547                 .703949-04
    SIZE 4                    2929.7544                 .313019-03
    SIZE 5-6                   287.9557                 .286428-03
          TOTAL              50009.4238
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OPTIOSERVUS DIVERGENS
     EGGS                          .0000                    .00000 0
     SIZE 1-5                 11103.0072                    .849197-04
     ADULT                    12784.5076                    .978160-03
          TOTAL               23887.5146

TRICORYTHODES MINUTUS
     EGGS                      1460.8799                    .399999-05
     SIZE 1-2                 46310.0122                    .469236-04
     SIZE 3-4                  5722.8065                    .149737-03
     SIZE 5-6                   671.3531                    .584758-03
     SIZE 7                       3.1685                    .837913-03
          TOTAL               54168.2192

HYDROPSYCHE OCCIDENTALIS
     EGGS                      2479.0562                    .999987-05
     SIZE 1-2                  3594.8217                    .496107-04
     SIZE 3-4                   563.2452                    .182128-03
     SIZE 5-6                   951.5852                    .559947-03
     SIZE 7-9                   119.8905                    .933437-03
     SIZE 10-12                   4.5907                    .383863-02
     SIZE 13-15                    .6354                    .168771-01
     PUPAE                         .1578                    .175839-01
          TOTAL                7713.9825

SIMULIUM ARGUS
     EGGS                       349.1992                    .499999-05
     SIZE 1-3                  9283.7001                    .881820-04
     SIZE 4-7                   235.9109                    .174334-03
     PUPAE                         .0002                    .250689-01
          TOTAL                9868.8103

ARGIA VIVIDA
     EGGS                        16.1092                    .199999-04
     SIZE 1-4                   386.3521                    .862337-04
     SIZE 5-8                   254.5217                    .643361-03
     SIZE 9-12                   89.6761                    .173852-02
     SIZE 13-16                  10.6003                    .263800-02
          TOTAL                 757.2594


CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS
  MICROBIAL TYPE               CARBON        ENERGY        NITROGEN      PHOSPHORUS
    DRIFTING                    .006017       .065823       .001263       .000121
    BENTHIC                     .107986      1.161209       .019767       .002213
         TOTAL                  .114002      1.227032       .021030       .002333

SUSPENDED DETRITUS CONSTITUENTS
  DETRITUS TYPE                CARBON        ENERGY        NITROGEN      PHOSPHORUS
    FINE PARTICLES             1.005397     10.999042       .211092       .020104
    COARSE PARTICLES            .882434      9.653717       .185311       .017649
         TOTAL                 1.887831     20.652759       .396403       .037753

BIOLOGICALLY ACTIVE SEDIMENTS
  DETRITUS TYPE                CARBON        ENERGY        NITROGEN      PHOSPHORUS
    FINE PARTICLES            27.766942    303.770344      5.831057       .555339
    COARSE PARTICLES          90.681110    982.940826     14.012704      1.949434
         TOTAL               118.448051   1286.711166     19.843762      2.504773

TOTAL DETRITUS               120.335881   1307.363922     20.240165      2.542526

DISSOLVED CONSTITUENTS         CARBON        ENERGY        NITROGEN      PHOSPHORUS
  IN WATER                     4.41730      48.31658        .92735        .08824
  IN BENTHOS                  13.54747     151.32439       2.44633        .22906
         TOTAL                17.96476     199.64097       3.37368        .31731

AVERAGE IN ECOSYSTEM           CARBON        ENERGY        NITROGEN      PHOSPHORUS
                             268.57502    2851.72607      41.19099       6.47092


ACCUMULATED NET GAIN OR LOSS OF ORGANIC CONSTITUENTS TO THE ENTIRE ECOSYSTEM. (GRAMS OR KCAL.)
                                CARBON       ENERGY       NITROGEN     PHOSPHORUS
  FROM THE ATMOSPHERE          .18891+04    .60181+06    .39930+03    .45584+02
  TO THE ATMOSPHERE           -.69662+03   -.39688+06   -.17082+03   -.20539+02
  FROM OVERLAND FLOW           .00000       .00000       .00000       .00000
  BY WATER REMOVAL             .00000       .00000       .00000       .00000
  FROM UPSTREAM                .81282+09    .88918+10    .17065+09    .16257+08
  TO UPSTREAM                  .00000       .00000       .00000       .00000
  FROM DOWNSTREAM              .00000       .00000       .00000       .00000
  TO DOWNSTREAM               -.81281+09   -.88917+10   -.17065+09   -.16256+08
  FROM THE STREAM BED          .00000       .00000       .00000       .00000
  TO THE STREAM BED            .00000       .00000       .00000       .00000
  FROM TRIBUTARIES             .00000       .00000       .00000       .00000
  TO  TRIBUTARIES              .00000       .00000       .00000       .00000
  CHEMICAL CHANGES             .19631+05    .00000      -.67805+03    .61408+03

    TOTAL                      .28063+05    .29466+06    .31520+04    .76358+03

THE FOLLOWING CONSTITUENTS ARE INORGANIC AND ARE PRINTED IN GRAMS PER SQ. METER AVERAGED OVER  40.5 METERS OF STREAM.

SUSPENDED PARTICULATE MATTER(INORGANIC)
 SIZE          SUBSTRATUM
PARTICULATES    24.73192
  TOTAL         24.73192

BENTHIC PARTICULATE MATTER(INORGANIC)
 SIZE          SUBSTRATUM
PARTICULATES   298.06543
  TOTAL        298.06543

ALL P.M.       322.79735

DISSOLVED INORGANIC CONSTITUENTS
               CARBON POOL NITROGEN     PHOSPHORUS
IN WATER        51.26121     .05015       .05310
IN BENTHOS      92.49355    2.60145       .38264
  TOTAL        143.75476    2.65161       .43574

PH IN WATER COLUMN  7.00 PH IN BENTHOS  7.00   WATER COLUMN TEMP. 17.23 BENTHOS TEMP. 17.23 DEGREES CENTIGRADE


ACCUMULATED NET GAIN OR LOSS OF INORGANIC MATERIAL TO THE ENTIRE ECOSYSTEM (GRAMS) ..(WATER IN CUBIC METERS).
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                           WATER       SUBSTRATUM  CARBON POOL NITROGEN     PHOSPHORUS
FROM THE ATMOSPHERE       .47254+02   .00000      .47254+00   .47254+00    .47254+00
TO THE ATMOSPHERE        -.15747+03   .00000      .00000      .00000       .00000
FROM OVERLAND FLOW        .00000      .00000      .00000      .00000       .00000
BY WATER REMOVAL          .00000      .00000      .00000      .00000       .00000
FROM UPSTREAM             .82170+07   .90905+09   .18865+10   .42373+07    .14640+07
TO UPSTREAM               .00000      .00000      .00000      .00000       .00000
FROM DOWNSTREAM           .00000      .00000      .00000      .00000       .00000
TO DOWNSTREAM            -.82170+07  -.90901+09  -.18864+10  -.42376+07   -.14638+07
FROM THE STREAM BED       .00000      .00000      .00000      .00000       .00000
TO THE STREAM BED         .00000      .00000      .00000      .00000       .00000
FROM TRIBUTARIES          .00000      .00000      .00000      .00000       .00000
TO  TRIBUTARIES           .00000      .00000      .00000      .00000       .00000
CHEMICAL CHANGES          .00000      .00000     -.19631+05   .67805+03   -.61408+03
   TOTAL                 -.63062+02   .37696+05   .56005+04   .38330+03    .76950+02

 THE FOLLOWING SECTION DEALS WITH ORGANIC MATTER ENTERING AND LEAVING THE SYSTEM PER TIME UNIT. ALL OF THE
FIGURES ARE OF CARBON      . TOTALS ARE IN GRAMS (OR KCAL.) AND AVERAGES IN GRAMS (OR KCAL.) PER CUBIC METER OF WATER

PRIMARY PRODUCERS
                                        TOTAL ENTERING      AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
BENTHIC DIATOMS                         .00000000           .00000000            .00000000            .00000000
CLADOPHORA                              .00000000           .00000000            .00000000            .00000000
SPIROGYRA                               .00000000           .00000000            .00000000            .00000000
CHARA                                   .00000000           .00000000            .00000000            .00000000
POTOMOGETON                             .00000000           .00000000            .00000000            .00000000

ANIMAL CONSTITUENTS
                                        TOTAL ENTERING      AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
RHINICHTHYS OSCULUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     YOUNG                              .00000000           .00000000            .00000000            .00000000
     ADULT                              .00000000           .00000000            .00000000            .00000000
HYALLELA AZTECA
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1                             .12166934+00        .53001298-05         .12138985+00         .52879548-05
     SIZE 2                             .58539023+00        .25500624-04         .68528441+00         .29852190-04
     SIZE 3                             .17378055+01        .75701852-04         .19089394+01         .83159744-04
     SIZE 4                             .30991248+01        .13500331-03         .30992874+01         .13501039-03
     SIZE 5                             .54062510+01        .23550577-03         .53994327+01         .23520875-03
     SIZE 6                             .70591176+01        .30750753-03         .70549294+01         .30732487-03
BAETIS TRICAUDATUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .20660832+00        .90002203-05         .85513045+00         .37250981-04
     SIZE 3                             .12462499+02        .54288829-03         .13006542+02         .56658776-03
     SIZE 4                             .20660832+01        .90002202-04         .26009811+01         .11330330-03
     SIZE 5-6                           .18365184+02        .80001958-03         .18399637+02         .80152042-03
OPTIOSERVUS DIVERGENS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-5                           .29269033+01        .12750104-03         .34442178+01         .15003616-03
     ADULT                              .45912960+02        .20000490-02         .52792579+02         .22997373-02
TRICORYTHODES MINUTUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .21762264+01        .94800236-04         .33931252+01         .14781048-03
     SIZE 3-4                           .22359611+01        .97402385-04         .26737693+01         .11647408-03
     SIZE 5-6                           .21247322+03        .92557059-02         .21219568+03         .92435156-02
     SIZE 7                             .82643327+01        .36000881-03         .82518729+01         .35946604-03
HYDROPSYCHE OCCIDENTALIS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .65196403-01        .28400696-05         .15605167+00         .67978842-05
     SIZE 3-4                           .22956480+00        .10000245-04         .28598906+00         .12458185-04
     SIZE 5-6                           .49929865+02        .21750324-02         .50111238+02         .21829333-02
     SIZE 7-9                           .15794058+01        .68801684-04         .16358651+01         .71261151-04
     SIZE 10-12                         .31450378+01        .13700336-03         .31474673+01         .13710919-03
     SIZE 13-15                         .91825919+01        .40000979-03         .91682920+01         .39938687-03
     PUPAE                              .22956480+02        .10000245-02         .22954757+02         .99994928-03
SIMULIUM ARGUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-3                           .22956480+00        .10000245-04         .68631706+00         .29897174-04
     SIZE 4-7                           .45912960+01        .20000490-03         .46010784+01         .20043104-03
     PUPAE                              .10904329+02        .47501163-03         .10903526+02         .47497668-03
ARGIA VIVIDA
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-4                           .11478240+00        .50001224-05         .13280122+00         .57850537-05
     SIZE 5-8                           .36730368+00        .16000392-04         .45594499+00         .19861763-04
     SIZE 9-12                          .12396499+01        .54001322-04         .13222463+01         .57598364-04
     SIZE 13-16                         .36730368+01        .16000392-03         .36850623+01         .16052777-03

ANIMAL NUMBERS
                                        TOTAL ENTERING      AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
RHINICHTHYS OSCULUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     YOUNG                              .00000000           .00000000            .00000000            .00000000
     ADULT                              .00000000           .00000000            .00000000            .00000000
HYALLELA AZTECA
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1                             .22956480+05        .10000245+01         .22916812+05         .99829647+00
     SIZE 2                             .20660832+05        .90002203+00         .54880972+05         .23907113+01
     SIZE 3                             .18365184+05        .80001958+00         .16208340+08         .70605371+03
     SIZE 4                             .16069536+05        .70001714+00         .64541767+07         .28115525+03
     SIZE 5                             .13773888+05        .60001469+00         .13762874+05         .59953493+00
     SIZE 6                             .11478240+05        .50001224+00         .71330014+05         .31072604+01
BAETIS TRICAUDATUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .22956480+05        .10000245+01         .63497131+08         .27660463+04
     SIZE 3                             .19054356+06        .83004115+01         .54327469+08         .23665998+04
     SIZE 4                             .13773888+05        .60001469+00         .24351133+08         .10607780+04
     SIZE 5-6                           .91825919+04        .40000979+00         .17878359+08         .77881264+03
OPTIOSERVUS DIVERGENS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-5                           .18527792+05        .80710309+00         .24665564+05         .10744752+01
     ADULT                              .22956480+04        .10000245+00         .98477874+07         .42898688+03
TRICORYTHODES MINUTUS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .23850826+05        .10389838+01         .35331585+08         .41528109+04
     SIZE 3-4                           .18365184+05        .80001958+00         .40031230+08         .17438306+04
     SIZE 5-6                           .61454020+06        .26770447+02         .43893632+07         .19120835+03
     SIZE 7                             .91825919+04        .40000979+00         .19625101+06         .85490378+01
HYDROPSYCHE OCCIDENTALIS
     EGGS                               .00000000           .00000000            .00000000            .00000000
     SIZE 1-2                           .22956480+05        .10000245+01         .35914732+08         .15645087+04
     SIZE 3-4                           .20660832+04        .90002203-01         .24747513+07         .15135626+03
     SIZE 5-6                           .75593774+05        .32929972+01         .24537582+07         .10689001+03
     SIZE 7-9                           .16069536+04        .70001714-01         .58049348+06         .25287313+02
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    SIZE 10-12                           .13773888+04    .60001469-01    .23224309+05    .10116955+01
    SIZE 13-15                           .11478240+04    .50001224-01    .11461555+04    .49928547-01
    PUPAE                                .91825919+03    .40000979-01    .71790543+04    .13849517+00
SIMULIUM ARGUS
    EGGS                                 .00000000       .00000000       .00000000       .00000000
    SIZE 1-3                             .11478240+05    .50001224+00    .21118943+08    .91997816+03
    SIZE 4-7                             .11478240+05    .50001224+00    .45535506+07    .19835064+03
    PUPAE                                .11478240+05    .50001224+00    .11478228+05    .50001171+00
ARGIA VIVIDA
    EGGS                                 .00000000       .00000000       .00000000       .00000000
    SIZE 1-4                             .22956480+04    .10000245+00    .10532862+07    .45882993+02
    SIZE 5-8                             .18365184+04    .80001959-01    .92044577+06    .40009229+02
    SIZE 9-12                            .13773888+04    .60001469-01    .74765507+06    .32569165+02
    SIZE 13-16                           .91825919+03    .40000979-01    .67809897+06    .29579180+02

MICROORGANISMS
                                         TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    DRIFTING                             .61775887+03    .26910659-01    .61771704+03    .26908837-01
    BENTHIC                              .10445198+03    .45501114-02    .10439994+03    .45478444-02

SUSPENDED DETRITUS
                                         TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    FINE PARTICLES                       .10330416+06    .45001101+01    .11450989+06    .49892516+01
    COARSE PARTICLES                     .91148223+05    .39705763+01    .90594826+05    .39484694+01

THE FOLLOWING SECTION DEALS WITH ALL THE DISSOLVED MATERIAL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.
TOTALS AREIN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.

ORGANIC MATTER
                                         TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    CARBON                               .45325179+06    .19744442+02    .44220955+06    .19267423+02
    ENERGY                               .49576527+07    .21596404+03    .48369068+07    .21070414+03
    NITROGEN                             .95168719+05    .41457161+01    .95206050+05    .41473424+01
    PHOSPHORUS                           .90544185+04    .39442637+00    .90595850+04    .39468140+00

INORGANIC MATTER
    CARBON POOL                          .52627731+07    .22925562+03    .52627190+07    .22925326+03
    NITROGEN                             .51173819+04    .22292212+00    .51491676+04    .22430676+00
    PHOSPHORUS                           .54521639+04    .23750581+00    .54519890+04    .23749819+00

THE FOLLOWING SECTION DEALS WITH INORGANIC PARTICULATE MATERIAL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.
TOTALS ARE IN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.
                                         TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
PARTICULATES
    SUBSTRATUM                           .25396754+07    .11063271+03    .25390956+07    .11060745+03

THE FOLLOWING FIGURES ARE OF NET PRODUCTIVITY FROM THE BEGINNING OF THE SIMULATION.
CONSTITUENTS ARE PRINTED IN GRAMS(OR KCAL.) PER SQUARE METER, AVERAGED OVER   40.5 METERS OF STREAM.

CONSTITUENTS OF PRIMARY PRODUCERS
                           CARBON      ENERGY      NITROGEN    PHOSPHORUS
BENTHIC DIATOMS           65.24971    678.59700     8.19037     1.92692
CLADOPHORA                56.15984    584.06234     7.01694     1.62913
SPIROGYRA                 41.43152    430.88780     5.14120     1.20201
CHARA                     43.34854    450.82475     5.69431     1.25760
POTOMOGETON               71.55380    744.15937     9.39119     2.07562
ALL SPECIES
          TOTAL          277.74340   2888.53125    35.43400     8.09128

ANIMAL PRODUCTIVITY
                           CARBON      ENERGY      NITROGEN    PHOSPHORUS
RHINICHTHYS OSCULUS
    EGGS                  -.000000    -.000000    -.000000    -.000000
    YOUNG                  .204037    2.273553     .059940     .008093
    ADULT                  .001150     .015432     .000320     .000032
         TOTAL             .205186    2.288984     .060260     .008125

HYALLELA AZTECA
    EGGS                  -.000000    -.000000    -.000000    -.000000
    SIZE 1                 .103538     .972511     .018370     .001672
    SIZE 2                 .339535    3.193817     .060254     .005564
    SIZE 3                 .202361    1.904713     .035908     .003346
    SIZE 4                 .013438     .127630     .002386     .000249
    SIZE 5                 .009455     .089878     .001679     .000180
    SIZE 6                 .022711     .216289     .004037     .000444
         TOTAL             .691039    6.504838     .122629     .011456

BAETIS TRICAUDATUS
    EGGS                  -.000000    -.000005    -.000000    -.000000
    SIZE 1-2              2.970334   35.311077     .770622     .104374
    SIZE 3                1.696766   20.162107     .440063     .059625
    SIZE 4                4.376700   52.013977    1.135224     .153838
    SIZE 5-6               .355078    4.218277     .092110     .012485
         TOTAL            9.398878  111.705432    2.438019     .330322

OPTIOSERVUS DIVERGENS
    EGGS                  -.000001    -.000012    -.000000    -.000000
    SIZE 1-5              3.742717   43.890876     .746530     .082784
    ADULT                21.063160  181.992455    3.965499     .257165
         TOTAL           24.805876  225.883320    4.712029     .339949

TRICORYTHODES MINUTUS
    EGGS                  -.000002    -.000020    -.000000    -.000000
    SIZE 1-2              3.807071   40.990171     .961345     .140168
    SIZE 3-4               .768588    8.136575     .195523     .027559
    SIZE 5-6               .286741    2.980522     .074367     .009150
    SIZE 7                 .026428     .273317     .006605     .000894
         TOTAL            4.888826   52.380564    1.237840     .177771

HYDROPSYCHE OCCIDENTALIS
    EGGS                  -.000002    -.000030    -.000001    -.000000
    SIZE 1-2               .895179   12.546635     .232536     .032219
    SIZE 3-4               .721896    9.830365     .187565     .025973
    SIZE 5-6               .874135   11.400293     .227209     .031427
    SIZE 7-9               .056506     .740806     .014687     .002031
    SIZE 10-12             .029578     .373124     .007753     .001071
    SIZE 13-15             .013630     .170130     .003545     .000478
    PUPAE                 -.000208    -.002592    -.000054    -.000007
         TOTAL            2.590715   35.058730     .673242     .093192

SIMULIUM ARGUS
    EGGS                  -.000000    -.000005    -.000000    -.000000
    SIZE 1-3              1.901905   19.062957     .382311     .054344
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      SIZE 4-7                         .886671     9.169269     .195101     .025339
      PUPAE                           -.000026     -.000283    -.000006    -.000001
            TOTAL                     2.788550    28.231939     .577405     .079682

ARGIA VIVIDA
      EGGS                            -.000000     -.000005    -.000000    -.000000
      SIZE 1-4                         .108868     1.012212     .021476     .001460
      SIZE 5-8                         .540554     4.987473     .110179     .007018
      SIZE 9-12                        .745171     6.968857     .154058     .010435
      SIZE 13-16                       .833567     7.808562     .172691     .011766
            TOTAL                     2.228159    20.777100     .458404     .030679


TOTAL, ALL SPECIES                   47.597226   482.830891   10.279828    1.071176

CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS
   MICROBIAL TYPE                    CARBON       ENERGY      NITROGEN    PHOSPHORUS
      DRIFTING                         .006840      .074821     .001436     .000137
      BENTHIC                          .091615      .976476     .015766     .001893
            TOTAL                      .098455     1.051297     .017202     .002030
STATE( 247) PERMITS ONLY  .2040634323 OF THE PROPOSED UNIT CHANGE AT 278 +   .000 DAYS
STATE( 118) PERMITS ONLY  .9042930752 OF THE PROPOSED UNIT CHANGE AT 410 +   .000 DAYS
STATE( 161) PERMITS ONLY  .9504313543 OF THE PROPOSED UNIT CHANGE AT 411 +   .000 DAYS
STATE( 160) PERMITS ONLY  .9540765584 OF THE PROPOSED UNIT CHANGE AT 412 +   .000 DAYS


DEEP CREEK STATION 2 CURLEW VALLEY UTAH

REPORT NO.  2 ON APR   1 1972 (I.E., AFTER 366 DAYS OF SIMULATION)
   MEAN DEPTH      MEAN FLOW      MEAN WIDTH      MEAN VELOCITY       TOTAL VOLUME         AREA
    .62 METERS    1.506 CUM/S      5.02 METERS       .526 MPS          115.97 CU.M        203.31 SQ. M.

THE FOLLOWING CONSTITUENTS ARE ORGANIC AND ARE PRINTED IN GRAMS (OR KCAL.) PER SQ. METER, AVERAGED OVER   40.5 METERS OF STREAM.

CONSTITUENTS OF PRIMARY PRODUCERS
                                     CARBON       ENERGY      NITROGEN    PHOSPHORUS
BENTHIC DIATOMS                      3.77271     39.23578      .52975      .10941
CLADOPHORA                           6.50397     67.64127      .91314      .18862
SPIROGYRA                            5.07062     52.73442      .71189      .14705
CHARA                                7.67628     79.83322     1.07772      .22261
POTOMOGETON                         11.52657    119.87615     1.61826      .33427

ALL SPECIES
          TOTAL                     34.55015    359.32085     4.85075     1.00195

CONSTITUENTS OF ANIMAL BIOMASS
                                     CARBON       ENERGY      NITROGEN    PHOSPHORUS
RHINICHTHYS OSCULUS
      EGGS                             .000000      .000000     .000000     .000000
      YOUNG                            .013898      .154863     .004083     .000547
      ADULT                            .641697     7.180248     .188614     .025465
            TOTAL                      .655595     7.335111     .192697     .026012

HYALLELA AZTECA
      EGGS                             .000000      .000000     .000000     .000000
      SIZE 1                           .000002      .000023     .000000     .000000
      SIZE 2                           .000571      .005623     .000102     .000010
      SIZE 3                           .001585      .015051     .000281     .000027
      SIZE 4                           .004256      .040223     .000755     .000072
      SIZE 5                           .074203      .699142     .013168     .001741
      SIZE 6                           .406672     3.835404     .072173     .006915
            TOTAL                      .487288     4.595466     .086479     .008266

BAETIS TRICAUDATUS
      EGGS                             .006715      .079849     .001742     .000236
      SIZE 1-2                         .247068     2.937409     .064101     .008681
      SIZE 3                           .307859     3.657656     .079871     .010817
      SIZE 4                           .347686     4.129864     .090198     .012217
      SIZE 5-6                         .018560      .220462     .004815     .000652
            TOTAL                      .927888    11.025241     .240727     .032603

OPTIOSERVUS DIVERGENS
      EGGS                             .000000      .000000     .000000     .000000
      SIZE 1-5                         .087858     1.023914     .016966     .001803
      ADULT                           2.299847    20.826867     .437387     .031597
            TOTAL                     2.387704    21.850781     .454353     .033399

TRICORYTHODES MINUTUS
      EGGS                             .011040      .121444     .002760     .000386
      SIZE 1-2                         .293604     3.190555     .073828     .009180
      SIZE 3-4                        1.124885    12.107609     .284075     .033553
      SIZE 5-6                        2.567334    27.453658     .652316     .072675
      SIZE 7                           .013419      .143280     .003413     .000378

            TOTAL                     4.010283    43.016545    1.016392     .116173

HYDROPSYCHE OCCIDENTALIS
      EGGS                             .003437      .051549     .000894     .000124
      SIZE 1-2                         .419794     6.296701     .109146     .015117
      SIZE 3-4                         .182712     2.736919     .047505     .006578
      SIZE 5-6                         .247029     3.003655     .064167     .008766
      SIZE 7-9                         .004190      .044143     .001088     .000148
      SIZE 10-12                       .001300      .016280     .000341     .000047
      SIZE 13-15                       .002214      .027623     .000576     .000078
      PUPAE                            .000000      .000000     .000000     .000000
            TOTAL                      .860676    12.176870     .223716     .030852

STMULIUM ARGUS
      EGGS                             .003394      .033935     .000679     .000115
      SIZE 1-3                         .196036     1.961021     .039247     .005637
      SIZE 4-7                         .001691      .018600     .000440     .000051
      PUPAE                            .000010      .000114     .000003     .000000
            TOTAL                      .201131     2.013670     .040368     .005803

ARGIA VIVIDA
      EGGS                             .000528      .005804     .000106     .000018
      SIZE 1-4                         .075091      .258762     .005006     .000559
      SIZE 5-8                         .097459      .937072     .019606     .001600
      SIZE 9-12                        .084167      .802581     .016973     .001749
      SIZE 13-16                       .001698      .016191     .000342     .000027
            TOTAL                      .208943     2.020409     .042033     .003555


TOTAL, ALL SPECIES                    9.739507   104.034082    2.296766     .256663
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POPULATIONS ARE PRINTED IN NUMBERS PER SQ. METER,AVERAGED OVER  40.5 METERS OF STREAM.
AVERAGE WEIGHTS ARE EXPRESSED AS GRAMS OF CARBON (DRY WT.).
                                    POPULATIONS               WT. OF AVE. IND.
RHINICHTHYS OSCULUS
    EGGS                                 .0000                .000000
    YOUNG                                .1163                .119476+00
    ADULT                               1.1101                .578059+00
         TOTAL                          1.2264

HYALLELA AZTECA
    EGGS                                 .0000                .000000
    SIZE 1                               .3291                .513271-05
    SIZE 2                             20.8715                .273437-04
    SIZE 3                             23.0744                .686774-04
    SIZE 4                             28.4088                .149827-03
    SIZE 5                            255.3847                .290552-03
    SIZE 6                            850.7057                .478041-03
         TOTAL                       1178.7742

BAETIS TRICAUDATUS
    EGGS                             2802.2053                .239617-05
    SIZE 1-2                        18461.1504                .133831-04
    SIZE 3                           6971.1934                .441616-04
    SIZE 4                           2239.7998                .155231-03
    SIZE 5-6                          139.4217                .133123-03
         TOTAL                      30613.7695

OPTIOSERVUS DIVERGENS
    EGGS                                 .0000                .000000
    SIZE 1-5                         1073.2533                .818612-04
    ADULT                            3073.5481                .748271-03
         TOTAL                       4146.8013

TRICORYTHODES MINUTUS
    EGGS                             4291.4008                .257268-05
    SIZE 1-2                        20778.3665                .141303-04
    SIZE 3-4                         8696.2349                .129353-03
    SIZE 5-6                         6314.8030                .406558-03
    SIZE 7                             13.2657                .101156-02
         TOTAL                      40094.0703

HYDROPSYCHE OCCIDENTALIS
    EGGS                              373.5816                .919905-05
    SIZE 1-2                         9728.2894                .454899-04
    SIZE 3-4                         1137.1689                .160672-03
    SIZE 5-6                          645.5592                .382869-03
    SIZE 7-9                            5.2841                .792991-03
    SIZE 10-12                           .5535                .239851-02
    SIZE 13-15                           .2915                .759639-02
    PUPAE                                .0000                .000000
         TOTAL                      11890.7280

SIMULIUM ARGUS
    EGGS                             1115.0766                .304332-05
    SIZE 1-3                         5068.3222                .386787-04
    SIZE 4-7                            3.2282                .523784-03
    PUPAE                                .0748                .138629-03
         TOTAL                       6186.7018

ARGIA VIVIDA
    EGGS                               44.6669                .118125-04
    SIZE 1-4                          401.1283                .625502-04
    SIZE 5-8                          213.8369                .455764-03
    SIZE 9-12                          61.7734                .136252-02
    SIZE 13-16                          1.6491                .102959-02
         TOTAL                        723.0545


CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS
  MICROBIAL TYPE                   CARBON       ENERGY       NITROGEN     PHOSPHORUS
    DRIFTING                       .015350      .167925      .003223      .000308
    BENTHIC                        .056110      .589014      .008976      .000856
         TOTAL                     .071460      .756938      .012199      .001164

SUSPENDED DETRITUS CONSTITUENTS
  DETRITUS TYPE                    CARBON       ENERGY       NITROGEN     PHOSPHORUS
    FINE PARTICLES                2.567077    28.083822      .539082      .051341
    COARSE PARTICLES              2.179729    23.843016      .457218      .043591
         TOTAL                    4.746806    51.926839      .996301      .094932

BIOLOGICALLY ACTIVE SEDIMENTS
  DETRITUS TYPE                    CARBON       ENERGY       NITROGEN     PHOSPHORUS
    FINE PARTICLES                2.267936    24.811223      .476267      .045359
    COARSE PARTICLES             46.093182   481.746369     6.919298      .660100
         TOTAL                   48.361118   506.557587     7.395565      .705458

TOTAL DETRITUS                   53.107924   558.484421     8.391865      .800390

DISSOLVED CONSTITUENTS             CARBON       ENERGY       NITROGEN     PHOSPHORUS
  IN WATER                          .78841      8.62348       .16548       .01576
  IN BENTHOS                       2.09618     23.00992       .34860       .02352
         TOTAL                     2.88459     31.63341       .51408       .03928

AVERAGE IN ECOSYSTEM               CARBON       ENERGY       NITROGEN     PHOSPHORUS
                                 100.35363   1054.22969     16.06566      2.09945


ACCUMULATED NET GAIN OR LOSS OF ORGANIC CONSTITUENTS TO THE ENTIRE ECOSYSTEM. (GRAMS OR KCAL.)
                                  CARBON       ENERGY      NITROGEN     PHOSPHORUS
  FROM THE ATMOSPHERE            .33747+04    .12172+07    .72221+03    .81823+02
  TO THE ATMOSPHERE             -.45377+04   -.21171+07   -.10996+04   -.13633+03
  FROM OVERLAND FLOW             .00000       .00000       .00000       .00000
  BY WATER REMOVAL               .00000       .00000       .00000       .00000
  FROM UPSTREAM                  .10087+10    .11034+11    .21179+09    .20174+08
  TO UPSTREAM                    .00000       .00000       .00000       .00000
  FROM DOWNSTREAM                .00000       .00000       .00000       .00000
  TO DOWNSTREAM                 -.10086+10   -.11033+11   -.21176+09   -.20172+08
  FROM THE STREAM BED            .00000       .00000       .00000       .00000
  TO THE STREAM BED              .00000       .00000       .00000       .00000
  FROM TRIBUTARIES               .00000       .00000       .00000       .00000
  TO  TRIBUTARIES                .00000       .00000       .00000       .00000
  CHEMICAL CHANGES              -.71092+05    .00000      -.28729+05   -.22158+04

    TOTAL                       -.53974+03   -.13056+05   -.10829+04    .96971+01
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THE FOLLOWING CONSTITUENTS ARE INORGANIC AND ARE PRINTED IN GRAMS PER SQ. METER AVERAGED OVER  40.5 METERS OF STREAM.

SUSPENDED PARTICULATE MATTER(INORGANIC)
 SIZE          SUBSTRATUM
PARTICULATES    63.10922
  TOTAL         63.10922

BENTHIC PARTICULATE MATTER(INORGANIC)
 SIZE          SUBSTRATUM
PARTICULATES    83.22003
  TOTAL         83.22003

ALL P.M.       146.32925

DISSOLVED INORGANIC CONSTITUENTS
               CARBON POOL NITROGEN    PHOSPHORUS
IN WATER       125.49794      .18103     .18446
IN BENTHOS      32.39376      .69711     .11865
  TOTAL        157.89170      .87813     .30311

PH IN WATER COLUMN  7.00 PH IN BENTHOS  7.00   WATER COLUMN TEMP. 18.04 BENTHOS TEMP. 18.04 DEGREES CENTIGRADE


ACCUMULATED NET GAIN OR LOSS OF INORGANIC MATERIAL TO THE ENTIRE ECOSYSTEM (GRAMS)...(WATER IN CUBIC METERS).
                                WATER      SUBSTRATUM  CARBON POOL NITROGEN     PHOSPHORUS
  FROM THE ATMOSPHERE         .63320+02   .00000      .63320+00   .63320+00   .63320+00
  TO THE ATMOSPHERE          -.22890+03   .00000      .00000      .00000      .00000
  FROM OVERLAND FLOW          .00000      .00000      .00000      .00000      .00000
  BY WATER REMOVAL            .00000      .00000      .00000      .00000      .00000
  FROM UPSTREAM               .19234+08   .21278+10   .43566+10   .71572+07   .46340+07
  TO UPSTREAM                 .00000      .00000      .00000      .00000      .00000
  FROM DOWNSTREAM             .00000      .00000      .00000      .00000      .00000
  TO DOWNSTREAM              -.19233+08  -.21278+10  -.43566+10  -.71858+07  -.46361+07
  FROM THE STREAM BED         .00000      .00000      .00000      .00000      .00000
  TO THE STREAM BED           .00000      .00000      .00000      .00000      .00000
  FROM TRIBUTARIES            .00000      .00000      .00000      .00000      .00000
  TO  TRIBUTARIES             .00000      .00000      .00000      .00000      .00000
  CHEMICAL CHANGES            .00000      .00000      .71092+05   .28729+05   .22158+04
    OTOTAL                     .13500+02   .89280+04   .12148+05   .79554+02   .60355+02

 THE FOLLOWING SECTION DEALS WITH ORGANIC MATTER ENTERING AND LEAVING THE SYSTEM PER TIME UNIT. ALL OF THE
FIGURES ARE OF CARBON      . TOTALS ARE IN GRAMS (OR KCAL.) AND AVERAGES IN GRAMS (OR KCAL.) PER CUBIC METER OF WATER.

 PRIMARY PRODUCERS
                                    TOTAL ENTERING     AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
 BENTHIC DIATOMS                    .00000000          .00000000            .00000000            .00000000
 CLADOPHORA                         .00000000          .00000000            .00000000            .00000000
 SPIROGYRA                          .00000000          .00000000            .00000000            .00000000
 CHARA                              .00000000          .00000000            .00000000            .00000000
 POTOMOGETON                        .00000000          .00000000            .00000000            .00000000

 ANIMAL CONSTITUENTS
                                    TOTAL ENTERING     AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
 RHINICHTHYS OSCULUS
     EGGS                           .00000000          .00000000            .00000000            .00000000
     YOUNG                          .00000000          .00000000            .00000000            .00000000
     ADULT                          .00000000          .00000000            .00000000            .00000000
 HYALLELA AZTECA
     EGGS                           .00000000          .00000000            .00000000            .00000000
     SIZE 1                         .68944435+00       .52997085-05         .68927465+00         .52994041-05
     SIZE 2                         .33171379+01       .25498597-04         .33232262+01         .25545398-04
     SIZE 3                         .98473465+01       .75695835-04         .98639349+01         .75823350-04
     SIZE 4                         .17561318+02       .13499258-03         .17608782+02         .13535743-03
     SIZE 5                         .30634744+02       .23548705-03         .71535879+02         .24241401-03
     SIZE 6                         .40000780+02       .30748308-03         .45190342+02         .34737487-03
 BAETIS TRICAUDATUS
     EGGS                           .00000000          .00000000            .79781141-01         .61327183-06
     SIZE 1-2                       .11707546+01       .89995050-05         .43062932+01         .33102163-04
     SIZE 3                         .62440243+01       .47997360-04         .10173736+02         .78204765-04
     SIZE 4                         .12958352+02       .99609905-04         .17529469+02         .13474776-03
     SIZE 5-6                       .10406707+03       .79995600-03         .10439567+03         .80248190-03
 OPTIOSERVUS DIVERGENS
     EGGS                           .00000000          .00000000            .00000000            .00000000
     SIZE 1-5                       .61739792+02       .47458928-03         .62797749+02         .48272173-03
     ADULT                          .26016768+03       .19998900-02         .28832193+03         .22153097-02
 TRICORYTHODES MINUTUS
     EGGS                           .00000000          .00000000            .13115129+00         .10081504-05
     SIZE 1-2                       .42636980+02       .32774736-03         .46300218+02         .35590641-03
     SIZE 3-4                       .12670166+02       .97399643-04         .26595377+02         .20443672-03
     SIZE 5-6                       .38114565+02       .29299388-03         .59464334+02         .53395728-03
     SIZE 7                         .46830182+02       .35998020-03         .47096230+02         .36202529-03
 HYDROPSYCHE OCCIDENTALIS
     EGGS                           .00000000          .00000000            .39889896-01         .30663073-06
     SIZE 1-2                       .36943810+00       .28398438-05         .52856236+01         .40630204-04
     SIZE 3-4                       .16510641+01       .12691609-04         .38735438+01         .29775649-04
     SIZE 5-6                       .11760380+04       .90401182-02         .11786306+04         .90600478-02
     SIZE 7-9                       .10756933+02       .82687759-04         .10805215+02         .83059905-04
     SIZE 10-12                     .17821486+02       .13699246-03         .17833877+02         .13708771-03
     SIZE 13-15                     .52033536+02       .39997800-03         .52050952+02         .40011188-03
     PUPAE                          .13008384+03       .99994500-03         .13008377+03         .99994446-03
 SIMULIUM ARGUS
     EGGS                           .00000000          .00000000            .40563425-01         .31180809-06
     SIZE 1-3                       .13008384+01       .99994498-05         .36249317+01         .27899583-04
     SIZE 4-7                       .25666542+02       .19729684-03         .25687277+02         .19745620-03
     PUPAE                          .61789824+02       .47497388-03         .61789961+02         .47497494-03
 ARGIA VIVIDA
     EGGS                           .00000000          .00000000            .99949652-02         .76830570-07
     SIZE 1-4                       .65041919+00       .49997249-05         .11127493+01         .85535227-05
     SIZE 5-8                       .20813414+01       .15999120-04         .39395962+01         .30283390-04
     SIZE 9-12                      .70245273+01       .53997030-04         .86656932+01         .66612552-04
     SIZE 13-16                     .20813414+02       .15999120-03         .21278152+02         .16355360-03

 ANIMAL NUMBERS
                                    TOTAL ENTERING     AVERAGE ENTERING     TOTAL DOWNSTREAM     AVERAGE DOWNSTREAM
 RHINICHTHYS OSCULUS
     EGGS                           .00000000          .00000000            .00000000            .00000000
     YOUNG                          .00000000          .00000000            .00000000            .00000000
     ADULT                          .00000000          .00000000            .00000000            .00000000
 HYALLELA AZTECA
     EGGS                           .00000000          .00000000            .00000000            .00000000
     SIZE 1                         .13008384+06       .99994500+00         .13008399+06         .99994614+00
     SIZE 2                         .11707546+06       .89995050+00         .12069425+06         .92775790+00
     SIZE 3                         .10406707+06       .79995599+00         .10408117+06         .80005434+00
     SIZE 4                         .91058687+05       .69996150+00         .91076091+05         .70009528+00
     SIZE 5                         .78050304+05       .59996700+00         .78206801+05         .60115999+00
     SIZE 6                         .65041920+05       .49997250+00         .65574066+05         .50405308+00
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BAETIS TRICAUDATUS
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-2                      .13008384+06    .99994500+00    .16574762+09    .12710151+04
    SIZE 3                        .10406707+06    .79995599+00    .10849518+06    .83399457+00
    SIZE 4                        .84354366+05    .64842587+00    .25777059+05    .65936201+00
    SIZE 5-6                      .52033536+05    .39997800+00    .52150870+05    .40097994+00
OPTIOSERVUS DIVERGENS
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-5                      .24025484+06    .18468215+01    .24091495+06    .18519957+01
    ADULT                         .13008384+05    .99994499-01    .34958966+06    .72994266+01
TRICORYTHODES MINUTUS
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-2                      .15134754+06    .11633976+01    .25295081+09    .19944145+04
    SIZE 3-4                      .10406707+06    .79995599+00    .10942056+06    .84110790+00
    SIZE 5-6                      .78050304+05    .59996700+00    .73506757+07    .56504109+02
    SIZE 7                        .52033536+05    .39997800+00    .52096820+05    .40045446+00
HYDROPSYCHE OCCIDENTALIS
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-2                      .13008384+06    .99994500+00    .68722805+08    .52825720+03
    SIZE 3-4                      .20012898+05    .15383769+00    .41899645+07    .32207952+02
    SIZE 5-6                      .17645873+07    .13564254+02    .84056595+07    .64613693+02
    SIZE 7-9                      .10656868+05    .81918571-01    .10660112+05    .81943506-01
    SIZE 13-15                    .65041920+04    .49997250-01    .65043677+04    .49998601-01
    PUPAE                         .52033536+04    .39997800-01    .52033508+04    .39997779-01
SIMULIUM ARGUS
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-3                      .65041920+05    .49997250+00    .53596866+08    .41199521+03
    SIZE 4-7                      .67743660+05    .52074058+00    .67745599+05    .52075549+00
    PUPAE                         .65041920+05    .49997250+00    .65041885+05    .49997224+00
ARGIA VIVIDA
    EGGS                          .00000000       .00000000       .00000000       .00000000
    SIZE 1-4                      .13008384+05    .99994499-01    .26440559+07    .20329665+02
    SIZE 5-8                      .10406707+05    .79995600-01    .10537704+05    .81002567-01
    SIZE 9-12                     .78050304+04    .59996700-01    .78439444+04    .60295830-01
    SIZE 13-16                    .52033536+04    .39997800-01    .40896340+06    .31436719+01

MICROORGANISMS
                                  TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    DRIFTING                      .35005561+04    .26908520-01      .35007235+04      .26909807-01
    BENTHIC                       .59188147+03    .45497497-02      .59329459+03      .45607123-02

SUSPENDED DETRITUS
                                  TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    FINE PARTICLES                .58537727+06    .44997525+01      .58993319+06      .45347735+01
    COARSE PARTICLES              .49683009+06    .38190967+01      .49711283+06      .38212701+01

THE FOLLOWING SECTION DEALS WITH ALL THE DISSOLVED MATERIAL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.
TOTALS AREIN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.

ORGANIC MATTER
                                  TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
    CARBON                        .17956573+06    .13803087+01      .17532419+06      .13477043+01
    ENERGY                        .19640658+07    .15097631+02      .19176725+07      .14741009+02
    NITROGEN                      .37706802+05    .28984944+00      .37739988+05      .29010455+00
    PHOSPHORUS                    .35923152+04    .27613865-01      .35944851+04      .27630545-01

INORGANIC MATTER
    CARBON POOL                   .28618445+08    .21998790+03      .28621278+08      .22000968+03
    NITROGEN                      .41326635+05    .31767483+00      .41285232+05      .31735658+00
    PHOSPHORUS                    .42077119+05    .32344375+00      .42068412+05      .32337682+00

THE FOLLOWING SECTION DEALS WITH INORGANIC PARTICULATE MATERIAL ENTERING AND LEAVING THE SYSTEM PER TIME UNIT.
TOTALS ARE IN GRAMS AND AVERAGES IN GRAMS PER CUBIC METER OF WATER.
                                  TOTAL ENTERING  AVERAGE ENTERING  TOTAL DOWNSTREAM  AVERAGE DOWNSTREAM
PARTICULATES
    SUBSTRATUM                    .14391175+08    .11062391+03      .14392797+08      .11063638+03

THE FOLLOWING FIGURES ARE OF NET PRODUCTIVITY FROM THE BEGINNING OF THE SIMULATION.
CONSTITUENTS ARE PRINTED IN GRAMS(OR KCAL.) PER SQUARE METER, AVERAGED OVER   40.5 METERS OF STREAM.

CONSTITUENTS OF PRIMARY PRODUCERS
                        CARBON      ENERGY     NITROGEN   PHOSPHORUS
BENTHIC DIATOMS       101.45219  1055.10278   13.26043     2.97324
CLADOPHORA            104.74240  1089.32092   13.69991     3.03798
SPIROGYRA              79.60679   827.91056   10.43458     2.30904
CHARA                  96.20217  1000.50249   12.79600     2.79031
POTOMOGETON           148.58080  1545.24026   19.81016     4.30935
ALL SPECIES
           TOTAL      530.58434  5518.07697   70.00107    15.41990

ANIMAL PRODUCTIVITY
                        CARBON      ENERGY     NITROGEN   PHOSPHORUS
RHINICHTHYS OSCULUS
    EGGS               -.000000    -.000000    -.000000    -.000000
    YOUNG               .182964    2.038744     .053749     .007257
    ADULT               .554372    6.205392     .162930     .021988
         TOTAL          .737336    8.244136     .216680     .029240

HYALLELA AZTECA
    EGGS               -.000000    -.000000    -.000000    -.000000
    SIZE 1              .093041     .874400     .016507     .001503
    SIZE 2              .306820    2.886598     .054448     .005030
    SIZE 3              .364484    3.430265     .064676     .006010
    SIZE 4              .731443    6.887369     .129800     .012126
    SIZE 5             1.022666    9.637268     .181485     .017172
    SIZE 6             1.762837   16.639354     .312871     .030353
         TOTAL         4.281291   40.355254     .759788     .072194

BAETIS TRICAUDATUS
    EGGS               -.000001    -.000008    -.000000    -.000000
    SIZE 1-2           5.839247   69.418865    1.514944     .205183
    SIZE 3             5.116123   60.770609    1.327180     .179765
    SIZE 4            17.721267  210.524345    4.596885     .622756
    SIZE 5-6           2.847565   33.826387     .738678     .100076
         TOTAL        31.524201  374.540195    8.177686    1.107780

OPTIOSERVUS DIVERGENS
    EGGS               -.000001    -.000011    -.000000    -.000000
    SIZE 1-5           3.460849   40.568599     .688885     .075451
    ADULT             27.307854  238.785763    5.151878     .343379
         TOTAL        30.768702  279.354347    5.840763     .418831
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TRICORYTHODES MINUTUS
    EGGS                      -.000007     -.000034     -.000001     -.000000
    SIZE 1-2                  9.560749   103.365137     2.409697      .332650
    SIZE 3-4                 10.671127   114.355018     2.700097      .343044
    SIZE 5-6                 16.603845   176.660576     4.240468      .483938
    SIZE 7                    1.473837    15.668227      .376131      .045695
          TOTAL              38.309549   410.048920     9.726392     1.205326

HYDROPSYCHE OCCIDENTALIS
    EGGS                      -.000005     -.000072     -.000001     -.000000
    SIZE 1-2                  3.515279    51.133756      .913587      .126536
    SIZE 3-4                  4.418192    63.213261     1.148151      .159020
    SIZE 5-6                  7.919167   106.343523     2.057733      .284297
    SIZE 7-9                  1.873710    25.026675      .486904      .067308
    SIZE 10-12                1.271630    16.479100      .331739      .045852
    SIZE 13-15                 .059132      .741591      .015383      .002079
    PUPAE                     -.000593     -.007400     -.000154     -.000021
          TOTAL              19.056507   262.930428     4.953341      .685071

SIMULIUM ARGUS
    EGGS                      -.000001     -.000009     -.000000     -.000000
    SIZE 1-3                  4.126339    41.308635      .827350      .117910
    SIZE 4-7                  9.184884    93.678375     1.946401      .262471
    PUPAE                     -.001555     -.015868     -.000330     -.000045
          TOTAL              13.309668   134.971134     2.773421      .380337

ARGIA VIVIDA
    EGGS                      -.000001     -.000009     -.000000     -.000000
    SIZE 1-4                   .242496     2.355491      .048088      .004097
    SIZE 5-8                  1.429444    13.410030      .289321      .020743
    SIZE 9-12                 2.328950    21.861048      .474505      .033950
    SIZE 13-16                3.555437    33.394130      .724790      .052013
          TOTAL               7.556326    71.020689     1.536704      .110807


TOTAL, ALL SPECIES          145.543573  1581.465012    33.994773     4.009582

CONSTITUENTS OF HETEROTROPHIC MICROORGANISMS
  MICROBIAL TYPE              CARBON       ENERGY      NITROGEN     PHOSPHORUS
   DRIFTING                    .007137      .078073      .001498      .000143
   BENTHIC                     .946800     9.960084      .151593      .014814
           TOTAL               .953937    10.038157      .153091      .014957
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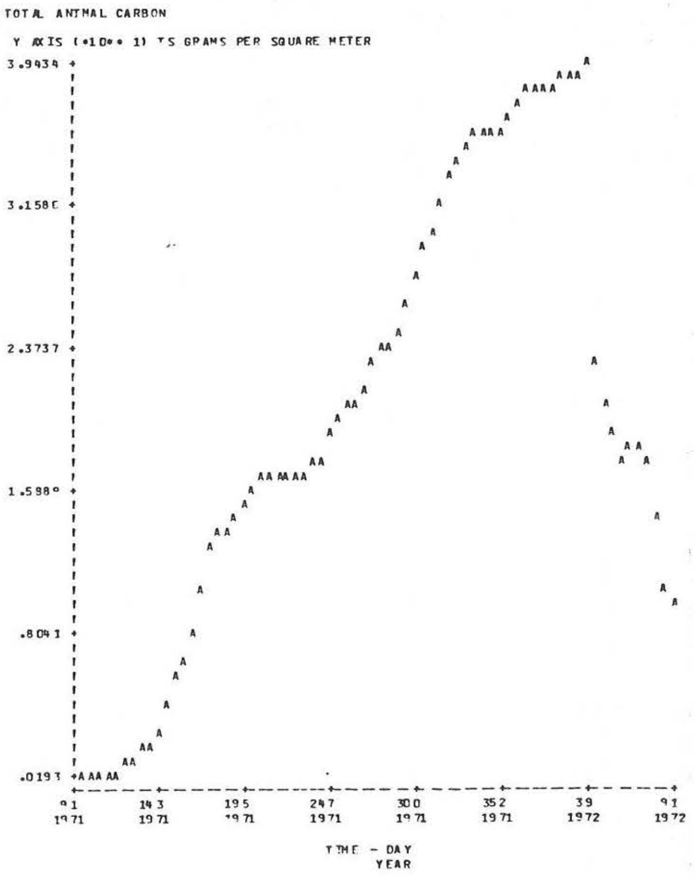
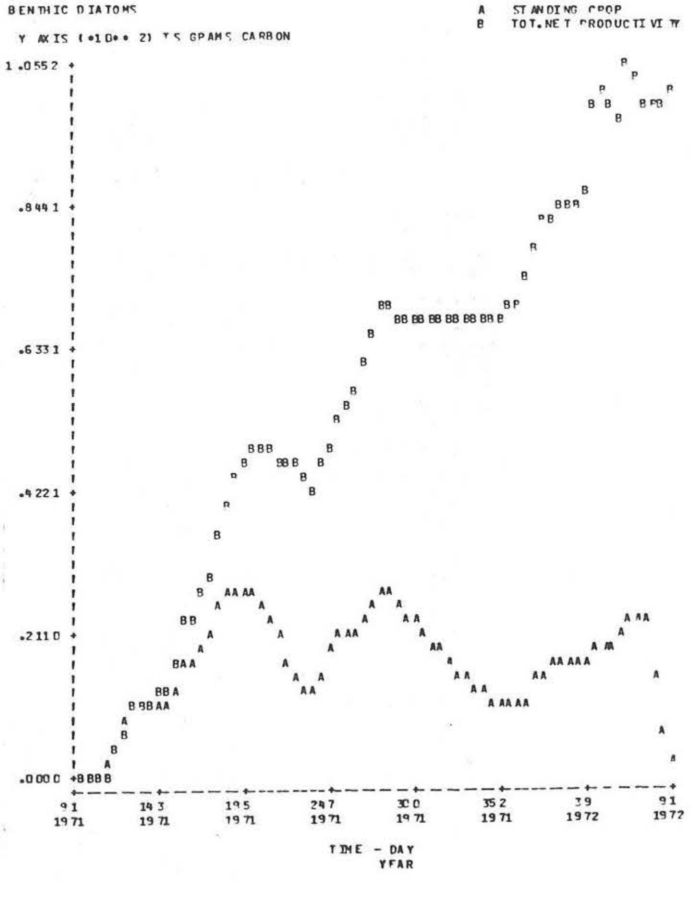
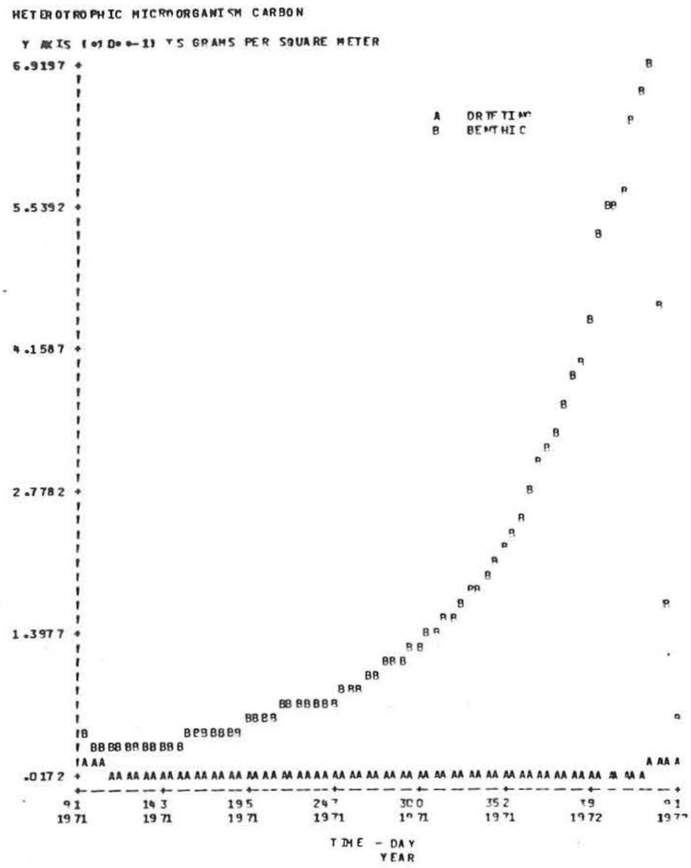
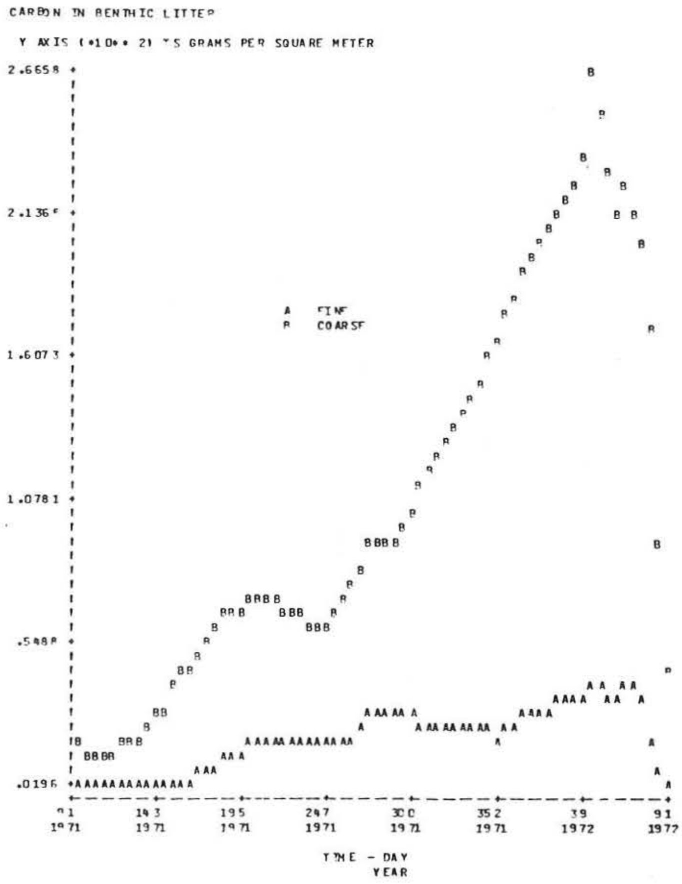
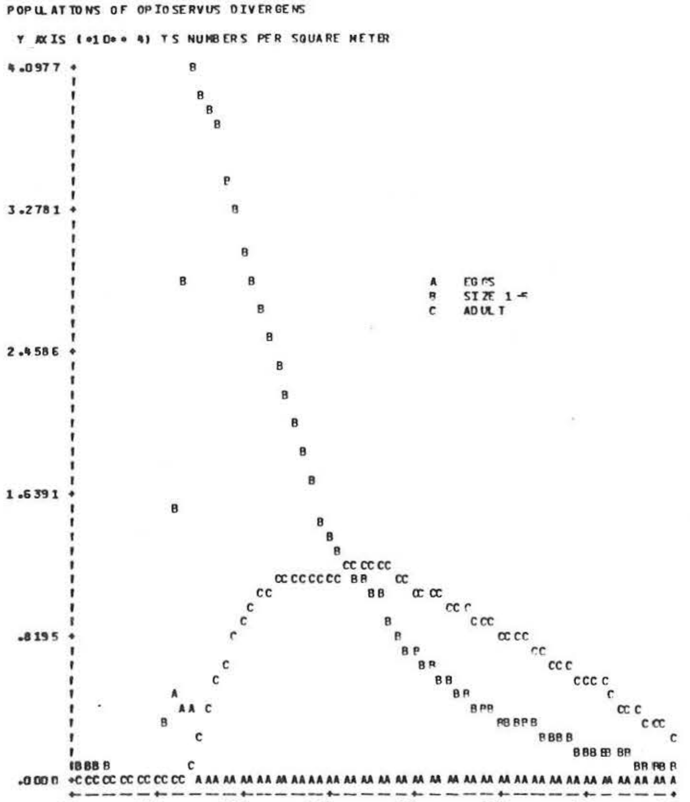
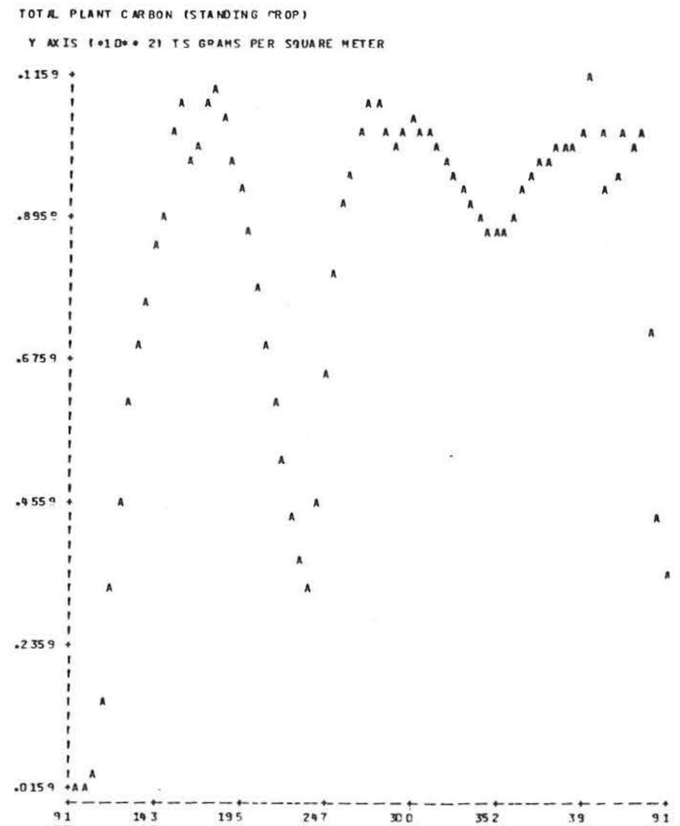





HETEROTROPHIC MICROORGANISM CARBON
Y AXIS (*10** -1) IS GRAMS PER SQUARE METER
6.9197
5.5392
4.1587
2.7782
1.3977
.0172
A DRIFTING
B BENTHIC
91 1971
143 1971
195 1971
247 1971
300 1971
352 1971
39 1972
91 1972
TIME - DAY
YEAR


CARBON IN BENTHIC LITTER
Y AXIS (*10** 2) IS GRAMS PER SQUARE METER
2.6658
2.1365
1.6073
1.0781
.5488
.0196
A FINE
B COARSE
91 1971
143 1971
195 1971
247 1971
300 1971
352 1971
39 1972
91 1972
TIME - DAY
YEAR


POPULATIONS OF OPIOSERVUS DIVERGENS
Y AXIS (*10** 4) IS NUMBERS PER SQUARE METER
4.0977
3.2781
2.4586
1.6391
.8195
.0000
A EGGS
B SIZE 1-5
C ADULT
91 1971
143 1971
195 1971
247 1971
300 1971
352 1971
39 1972
91 1972
TIME - DAY
YEAR


TOTAL PLANT CARBON (STANDING CROP)
Y AXIS (*10** 2) IS GRAMS PER SQUARE METER
.1159
.8959
.6759
.4559
.2359
.0159
91 1971
143 1971
195 1971
247 1971
300 1971
352 1971
39 1972
91 1972
TIME - DAY
YEAR