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CRYPTOS/CRYPT2 USER'S GUIDE

Cooperative Redwood Yield Project Timber Output Simulator

Version 4.2

by

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ABSTRACT

This research note provides instructions for using the CRYPTOS computer program as it is currently implemented on the University of California's PDP-11/70 computer system. This writeup updates Research Note No. 16 (Sept, 1980) and describes several new enhancements that have been incorporated in the computer program. In addition, instructions for using the companion program, CRYPT2, have been included for situations requiring multiple plot processing capabilities.

Foreword

The CRYPTOS and CRYPT2 computer programs were written by Bruce Krumland and Lee C. Wensel (© Wensel, 1982) of the University of California. The Regents of the University of California make no representation or warranties with respect to the contents thereof and specifically disclaim any implied warranties of merchantability or fitness for any particular purpose. Further, the Regents of the University of California reserve the right to revise this software and/or documentation and to make changes from time to time in the content thereof without obligation of the Regents of the University of California to notify any person of such revision or change.

CONTENTS

I. INTRODUCTION

CRYPTOS is one of the major end results of the Redwood Yield Research Cooperative. It is an interactive computer program written in standard Fortran IV and can be compiled with a standard FORTRAN IV or a FORTRAN IV plus compiler. is designed to simulate growth and harvests of single-acre representations of forest stands found in the north coastal region of California. The CRYPTOS model relies on a species-specific tree list (i.e., a modified stand table) to describe the initial characteristics of the stand for which a growth and yield projection is desired. Estimates of future stand growth are made as the sum of individual tree growth and mortality projections.

The CRYPT2 computer program is a modified and shortened version of CRYPTOS designed to perform limited forest growth, yield, and inventory processing tasks for data files of multiple tree lists.

The architecture and development of the growth models that comprise the Version 4.0 CRYPTOS program is described in more detail by Krumland (1982) for the more interested reader.

Theoretically, the CRYPTOS program can be applied to stands of any coastal species and size/age composition. Similarly, the stands may be "real" (i.e. the initial tree list is based on an actual on-the-ground stand) or imaginary. It is recognized that the theoretical projection capabilities of the CRYPTOS program may be somewhat heroic and some forecasting situations may be without empirical supporting data. Potential users should familiarize themselves with section II to gain some perspective of reasonable limits of applicability.

The program is organized into three distinct parts for the standard run option of projecting future stand yields and harvests:

(1) Reading in the initial stand description
(2) Specifying initialization procedures (optional altering of program default values)
(3) Projecting growth and harvests

The program responds to a series of two letter commands for each of the operations desired. These commands are listed below.

NOTE: After typing in commands or any subsequent information requested by the computer, the "return" key must be pressed to signify the end of information.

II. RANGE IN APPLICABILITY

The growth models imbedded in the CRYPTOS program have been developed from the records of an extensive collection of permanent growth plots located in Del Norte, Humboldt, and Mendocino counties. The majority of growth plots were located in the coastal zone that is subject to fog influence and is commonly referred to as the northern redwood region. By basal area, the average composition of sample plots was

approximately 60% young-growth redwood, 25% other young-growth conifers (mostly Douglas fir), and the remainder being comprised of residual old growth and hardwoods. The main species groups (young-growth redwood, Douglas fir, and tanoak) ranged in composition from 0-100% although single species compositions greater than 70% were mostly restricted to redwood. Very few stands composed of trees under 15 years of breast high age or over 90 years of age were sampled. In terms of stocking, over 85% of the sample plots had between 50 and 450 trees per acre. About 70% of the sample plots were from apparently even-aged stands with the remainder being from two-storied or multi-aged conditions. About 25% of the growth plots had been partially harvested prior to growth sampling.

For stand conditions comparable to the sample data, extensive testing of the CRYPTOS model has indicated a reasonable compliance between simulated yields and empirical growth plot development. Detailed tests are described by Krumland (1982). The reliability of the CRYPTOS model beyond these sample ranges is currently unknown and users who are contemplating using the model in such situations are cautioned to do some additional checking.

III. HIGHLIGHTS OF VERSION 4.0

In addition to the features included in CRYPTOS version 3.0 (see Research Note No. 16), several enhancements have been added by the popular request of several users of earlier versions of the model. These include

- The program will now display a log inventory of the current stand or the trees that were removed in a harvest (the 'sl' and 'hl' commands). The inventory includes numbers of 16 foot logs by 2 inch d.i.b. classes along with cubic and board foot volumes for redwood and other conifers. The feature relies on the taper equations described in Research Note No. 9.

- An option has been included (see the 'un' command in the initialization section) to print all of the main summary statistics in metric units.

- Another harvesting option has been added that attempts to mimic a classical low or high thinning by basal area control.

- In addition to the summary stock table and past growth displays (the 'st' and 'cg' commands), the program will now print the same statistics by diameter classes(see the 'dc' command).

- The program will also print a diamter class table of trees that were removed in a harvest operation (see the 'hc' command in the cutting routine.)

- A companion program has also been developed to provide limited processing of several CRYPTOS tree list files such as might result from a stand inventory. The program (CRYPT2) will 1) produce conventional inventory summary statistics, 2) update all of the plot tree list files for a specified number of years, and 3) condense a

data file of several plot tree lists to produce an "average" tree list for subsequent use with CRYPTOS.

IV. INPUT DATA FILES

After CRYPTOS has been invoked, the first thing the program will request is an input fileset number. The input fileset number may be any number from 1 to 3 or from 11 to 15. It may not be 4 through 10. (Fileset 5 is the standard input (keyboard), fileset 6 is the output (screen), filesets 8-10 are used internally by the program, filesets 4 and 7 are used by operating system). With the f4p compiler of the UNIX operating system of the U.C. Computer Center where the program is currently implemented (PDP-11/70 computer), this will imply that your input data file resides on a file called forxxx.dat where 'xxx' is the input fileset number (For example if the input fileset number is 2, this would indicate that the input data is on a file called for002.dat).

Your data file is presumed to have the following structure:

Record(1) Stand identifier and tree record count (nrec) in format 10A2,I10. The stand identifier is composed of up to 20 alphanumeric characters and the rightmost digit of the tree record count is in column 30.

Record(2) 50 year base age site indices for (in this order) redwood, Douglas-fir, tanoak, and alder in format 4F5.0. Either the redwood and/or the Douglas-fir site index must be specified. Other site index values may be entered as zeros, in which case they will be estimated internally.

Record(3) Breast high ages for redwood, Douglas-fir, tanoak, and alder in format 4F5.0. Zeros may be entered if the actual values are unknown or the species component is absent. (Age is a descriptive feature only and is not needed for the model to function.)

Record(4-end) The 'nrec' tree records specified on record 1 follow. Each tree record has the following 5 items in format 5F8.3:

1) Species code (see below)
2) DBH in inches
3) Total height in feet
4) Live crown ratio (decimal fraction)
5) Per acre weight (i.e. the number of trees per acre represented by this tree record)

Species Codes - The following species codes are all that are permissable:

1 - young growth redwood
2 - " " Douglas-fir
3 - " " other conifers
4 - tanoak
5 - alder
6 - other hardwoods
7 - residual redwood
8 - other residual trees

The input file is rewound before any read operations if the input fileset number is input prefixed with a minus sign.

NOTE: - Version 4.0 of CRYPTOS has a maximum internal storage capacity for 300 tree records. If 'nrec' is greater than this amount, the program will abort.

An example of an input data file is shown in Appendix I.

As part of the initialization procedures, the program attempts to quadruple each tree record, reapportion the per acre weights, and assign percent growth deviations to each tree record. Details are documented by Krumland (1982). The net effect of the storage limitation is that if there are more than about 75 initial tree records, the quadrupling process will not be completed in a reasonable manner. Experience has indicated that about 15 tree records per species is usually satisfactory.

V. INITIALIZATION COMMANDS AND PROGRAM DEFAULTS

Once you have told the program where the data is (i.e. entered an input fileset number), you will be given a one time only opportunity to alter some program parameters. If you choose to do this, you will enter an initialization routine and be given a prompt which is:

initgo:

At this point, you may enter any of the following commands:

pc Print the list of permissable initialization commands and what they do in case you do not have this writeup with you.

cm This will print and allow changes in the current minimum DBH used in computing summary statistics for cubic foot volumes, basal area, and average (quadratic mean) DBH. Default is 0.0 inches.

ct This will print and allow changes in the merchantable top limit for cubic foot volume estimation. may be 5, 6, 7, or 8 inches. Default is 5 inches.

NOTE: In estimating cubic volumes, if the merchantable top is less

than cubic foot minimum DBH, trees will have zero volume assigned to them.

bm Same as the 'cm' command, only it applies to minimum board foot Scribner volumes only. Default is 8.0 inches DBH.

bt Same as the 'ct' command, only it applies to board foot merchantable tops. Default is 5 inches.

NOTE: If the board foot merchantable top is greater than a tree's DBH, 0 volume will be assigned to it.

sp This will allow you to combine species into several possible groups for summary reporting. The following code indicators are permissable:

0 Report by totals (all species combined).

1 (This is the default). No combining occurs. Reports will be for all the species codes that were indicated as being permissable in the input section.

2 Make two groups:

(1) Whitewoods - composed of all conifer species
(2) Hardwoods - composed of all hardwood species

3 Make three groups:

(1) Redwoods - young growth and residual redwoods
(2) Whitewoods - all other conifers
(3) Hardwoods - all hardwoods

4 Make four groups:

(1) Redwoods - young growth redwoods
(2) Whitewoods - all other young growth conifers
(3) Hardwoods - all hardwoods
(4) Residuals - all residuals

In any event, totals are always reported.

fl Set print flag for non-existent species groups:

0 - Print a line of 0's if the species is not present.
1 - Do not print if the species is not present (default).

yf Set yield table flag. Unbeknownst to you, there is a gnome in this program who keeps track of everything that happens (i.e. it makes a yield table and harvest report). This flag refers to the way you want this information accumulated:

0 - by totals only
1 - by the same criteria as specified with the 'fl' and 'sp' options (default).

cl Modify calibration options. Calibration procedures are still experimental and a methodological internal adjustment based on past tree growth is currently unavailable in the program. However, a provisional ad hoc procedure can be used to effect basal area growth changes.

A.) you will initially be asked for a species adjustment code which have the following definitions.

1 apply adjustments to all species

2 adjustments for each young-growth species will be entered separately. (no adjustments are made for old-growth)

A larger integer in the range (3-9) will return you to the initialization shell

B.) You will next be asked to enter the adjustment mode which is either a

1 for straight percentage adjustment or

2 for adjustments based on tree DBH

Adjustments are all relative to the model norm, hence the default adjustment is 100%.

C.) If the adjustment mode is "1", you will be asked to enter a percent of normal growth for all species or for each species group individually, depending on the species adjustment code. For example, if you wanted to increase the initial basal area growth by 12%, you would enter 1.12. (A blank or a zero growth adjustment is interpreted to mean 100% - or normal growth.)

If the growth adjustment mode is "2", you will be asked to enter a lower DBH (dl), an upper DBH (du), a percent adjustment for dl (pl), and a percent adjustment for du (pu). Percent growth adjustments are typed in as decimal fractions. Trees less than dl are assigned an adjustment of pl, and trees larger than du are assigned pu. Straight line interpolation is used for trees with DBH's between dl and du. Depressing the return key without entering any information effectively defaults the adjustment to 100%.

un Set the summary statistic unit flag. The default for this option is to use English unit conventions (e.g., feet, inches, acres). The alternative is to use metric units (i.e. meters, hectares, etc.) Reporting conventions for both of these options are described in Section X. NOTE:. this is an output option only and has no effect

on any inputted quantities. The units are changed for only the following commands: st,yd,cg,ch,ih.

iq This command will allow you to inhibit the record quadrupling process if for some reason you don't want it to occur. The default is to quadruple the records. You had better know what you are doing before you use this command.

ex exit to the regular part of the program.

NOTE: If you happen to mispell a command, the program will respond with something equally unintelligable and mercifully allow you to try again.

VI. MAIN PROGRAM COMMANDS

Once your data file has been read in and initialization procedures are completed, you can now grow, harvest, and tailor the kinds of information resulting from these procedures to your own specifications. The possibilities are fairly obvious from the command descriptions. In the main program, the prompt is simply:

go:

pc Print list of possible commands.

pi Print initial stand description (stand identifier, site indicies, and initial ages if they were supplied by species).

pm Print cubic and board foot minimums and merchantable tops.

dp Display the current status of your tree record file. You will be asked for a record skip (ISKIP) which will cause the program to only print every ISKIP tree record.

st Print the current stand inventory (stock table indicating average DBH, stems/acre, basal area, cubic and board foot volumes by the species groups set by the 'sp' command.)

cg Print most current five years growth.

gr Grow the stand (see section VII).

ct Enter the harvesting (cut) routine (see section VIII).

dt Print graphs of the current diameter distribution. Immediately after this command you will be asked for the species code and a group indicator (2 digits in format 2I1):

(a) If the group indicator is '0' or blank , the species code is presumed to refer to the species listed as permissable in the input data file.

(b) If the group indicator is '1' (or anything else), the species code indicates the condensed groups set by the 'sp' command.

(c) A species code of 0 will result in a graph of all species combined irregardless of the group indicator.

pf This command behaves like the 'dt' command but instead of graphing the diameter distribution, it will display the average height and crown size by diameter class producing a stand profile. Try it, you'll like it.

et Print the simulated elapsed time since you installed your stand.

sv Internally save the current state of the stand (useful if you might want to try several possible harvests and don't want to have to start all over). Only one stand state can be in saved status at any time.

rt Internally restore a stand previously saved. If this command is executed, you have the opportunity to save the harvest and yield report for the stand up to the current elapsed time before the stand is restored to a previous state.

yd Print the current yield table and harvest report for the stand up to its present state.

cf Change the output fileset number. Initially, the output fileset is the screen (i.e. channel no. 6). If you want to store any information or some other fileset for later transfer to hardcopy for future reference, you can temporarily accomplish this with the 'cf' command.

NOTE: Fileset numbers 4 through 10 are used by the program. Very strange things will happen if you attempt to use them.

ns Start all over with a new stand. As with the 'rt' command, you have the opportunity to save the harvest and yield report for the current stand before this is done.

os Omit (remove) any stand in internal saved status and truncate the yield table so that the current stand state is the first entry in the yield table. This command is useful if, for example, you are no longer interested in the first 20-30 years of simulation and get tired of printing out the entire yield table everytime you want to observe the results of a harvest.

sc Print the species group code indicator and species groups.

es Externally save the current stand status. You will be asked for a fileset number, and the pertinent stand and tree information will be written in standard CRYPTOS formats. You can subsequently use the 'rs' command to restore this stand. Stands 'saved' by this command are flagged by placing '100' in columns (70-72) of the first input record. This flag indicates to the program that the

absolute height and basal area growth adjustments (user calibration factors x the program pseudo-stochastic assignments) are also preserved in the input file. If you restore such a stand, you will be given an opportunity to preserve these factors. This option is recommended because externally saved tree files have four times the number of tree records as the original file. If this option is bypassed, they will once again be quadrupled.

ig Add some ingrowth trees (see section IX).

sl Print the stand log inventory of the current stand by two inch diameter classes. The report is by 16 foot logs for cubic volumes and 16.3 foot logs by board foot volumes. The volumes reported by this command have all been adjusted to be compatible with the stand totals.

dc Print a diameter class table showing currents stocks and most recent five year growth. You will then be prompted for four items:

species group code (0 or blank for all species)

min this is the lower dbh limit to include in the table. The first diameter class printed is 0-min. min is defaulted to 0 if you leave this field blank.

max this is the upper dbh limit to include in the table. The last possible table entry will have all trees greater than "max" inches DBH. max is defaulted to 50 inches dbh if the field is left blank.

inc this is the class interval. It is defaulted to 2 inches if the entry is left blank.

As matters of interest, 'max' will sometimes be adjusted from the user supplied input to a) make 'max' an even multiple of 'inc' and b) to insure that there are not more than 25 classes. The growth entries in the diameter class table are not printed if a) the elapsed time is zero, b) the stand was harvested in the last five years, or c) the request is made in the first cycle after a restore operation.

After the table is printed, you will be given a prompt that says 'more?'. If you press return here, you will return to the 'go' prompt. If you enter a '1', the table will be reprinted showing averages rather than totals by DBH classes. If a '2 ' is entered, the table will be converted to a percentage table where the entries are a percent of the species group totals. If a '3' is entered, the percentages are expressed as a percent of the stand totals. Anything else will return you to the 'go' prompt. Some more information on the diameter class table growth figures is detailed in section XI.

ex Exit the program. The program will tell you on which file (9 or 10) the latest harvest and yield report resides.

VII. GROWING TREES - the 'gr' command

After a 'gr' command, the computer will ask for 3 items:

(1) Number of cycles: this is the number of 5 year periods for which growth is to be simulated.

(2) Tree detail code:

0 - ignored and no tree growth detail displayed.
1 to 9 - functions as a skip increment in printing out individual tree growth detail (this is primarily the remains of debugging statements).

(3) Summary code:

0 - ignored
1 - a summary of 5 year growth by the species groups specified by the 'sp' command option is printed every cycle.
2 - summary for totals only.

NOTE: If the number of 5 year cycles is entered prefixed by a minus sign (e.g. -2), this will function to turn off the mortality estimates for the given number of growth cycles. Hence if, for example, you feel that after a simulated harvest, all mortality for the next 10 years is captured, and after that, mortality should proceed "as usual", then you initially execute the 'gr' command with the number of cycles equal to "-2", and after that, whatever positive number of cycles you want.

VIII. HARVESTING TREES - the 'ct' command

If the 'ct' command is executed, the program will enter a harvesting routine. The routine will initially request a label that will be printed in the harvest and yield report (see example in Appendix XIII.) The purpose of the label is for the user to document the type of harvest operation that s/he specified. The prompt in this routine is:

cutgo:

The following commands can be executed:

pc Print list of possible harvesting routine commands and functions.

dt Print frequency diagrams (same as in main program).

pf Graph heights and crowns (same as in main program)

st Print the current stand summary (same as in main program).

rl Harvest (remove) some trees with option 1. The program will then ask you for a harvest prescription. You will be asked to input numerical values of the following variables in a specified format:

(a) lower DBH (dl)
(b) upper DBH (du)
(c) percent of lower DBH trees (pl)
(d) percent of upper DBH trees (pu)
(e) species flag
(f) species list

The species flag can have the following values and functions:

0 - (or blank). In this case, harvests will be made irrespective of species. No species list is required.
1 - Species definitions will apply to the species input list.
2 - Species definitions will apply to the species group definitions set by the 'sp' command.

If the species flag is 1 or 2, it must be followed by a list of species codes or species group codes that are to be harvested.

The program then sorts through the tree records and ignores trees if they are not the appropriate species. If they qualify, the next sequence of events follow:

(a) if the tree diameter 'd' is between 'du' and 'dl', its per acre weight is reduced by the factor 'x' where:

$$x = pl - \{(d-dl)/(du - dl)\}(pl - pu)$$

Hence, if d = 12.0, du = 18.0, dl = 6.0, pu = 0.2, and pl = 0.8, then:

$$x = 0.8 - \{(12 - 6)/(18 - 6)\}(0.8 - 0.2) = 0.5$$

and .5 times the tree record's contributions to volume, basal area, etc. would be cumulated as harvests.

(b) if 'd' is less than 'dl', and 'dl' was entered prefixed by a minus sign, all of it would be removed. The same thing happens if 'd' is greater than 'du' and 'du' is prefixed with a minus sign.

(c) otherwise, the tree record is not altered.

NOTE: Several 'rl' commands can be executed successively so there is considerable flexibility in coding harvests.

r? Harvest (remove) some trees with option ?. You will be asked to enter the following information.

a) basal area (ft^2/acre) to remove.
b) species flag
c) species list

The function of the species flag and list is the same as with the 'rl' command. This harvesting option is intended to mimic a low thinning and attempts to remove the smaller, poorer growing trees. If the basal area to remove is prefixed by a minus sign, the harvest is concentrated in the larger, faster growing trees. This form of a harvest may have a rather dysgenic effect on the residual stand.

ch Print cumulative harvests since you entered the harvesting routine.

ih The first time this is executed, it behaves as a 'ch' command. The next time it is executed, it prints the intermediate harvests that have occured since the last time the 'ih' command was executed.

hl Same as the 'sl' command only the report is for logs that were harvested.

hc Same as the 'dc' command only the diameter class table is for harvested trees.

ex Allows you to exit and return to the main program.

VII. INGROWTH

CRYPTOS makes no special provisions for ingrowth. The presumption is that the initial tree input list contains representations of all stems in the stand down to about 15 feet tall and 2 inches DBH. Stands with substantial components smaller than this may not work well in this model.

If you wish to add more trees to your stand at some point in the simulation to represent, for instance, sapling reproduction 10 to 15 years after a heavy harvest, this is accomplished by the 'ig' command.

You will next be asked whether or not you want to enter the ingrowth trees from the keyboard (mode = 1), or from a fileset (mode = 2).

Keyboard Ingrowth Input

You will initially be asked the number of ingrowth tree records you wish to add to your stand file in format I2.

For each tree record you will be asked to enter 6 items with the conventions for the first 5 items (species, DBH, total height, crown

ratio, per acre weight) being the same as the "regular" tree record input list. The sixth item is the calibration factor (percent of normal growth). If this value is zero (or blank), normal growth is assumed. Otherwise, it behaves like the adjustment factor described under the calibration options.

Fileset Ingrowth Input

You will initially be asked the fileset number (between 1-3 and 11-15) on which your information resides. The file is rewound if the fileset number is prefixed by a minus sign. The first line on this file has the number of ingrowth tree records (IGREC) in format I5 (you may use the rest of the line as an external label). This is followed by an ingrowth tree record list with the same conventions as the regular list except that there are 6 fields in format F8.3 instead of 5. The last field is for the tree basal area growth calibration factor. If it is zero (or blank), normal growth is assumed. Otherwise it will be what is in the field.

X. OUTPUT DEFINITIONS

In interpreting the output of CRYPTOS(I), captions are somewhat terse for the sake of presenting concise summaries. In the following list of captions, definitions appearing in parenthesis are the unit conventions printed if the metric (see the 'un' command in section V.) flag has been set.:

et Elapsed time in years since the start of the projection.

dbar Average stand quadratic mean DBH in inches (centimeters).

basar Basal area per acre (hectare) in square feet (square meters).

cfvol Cubic foot (meter) volume per acre (hectare) in thousands (hundreds).

bdvol Scribner board foot volume per acre (hectare) in thousands.

tpa Trees (stems) per acre (hectare).

bagro Five year basal area growth per acre (hectare) in square feet (square meters).

cvgro Five year cubic foot (meter) volume growth per acre (hectare) in thousands (hundreds).

bdgro Five year board foot volume growth per acre (hectare) in thousands.

The following items apply to individual trees if lists are requested.

sp species code

sg species group

dbh tree diameter at breast height in inches

ht total height in feet

cr crown ratio expressed as a decimal fraction

exp tree weight (expansion factor) on a per acre basis

dgro current five year DBH growth in inches

hgro current five year total height growth in feet

hcal absolute fraction of normal height growth

dcal absolute fraction of normal basal area growth

XI. MISCELLANEOUS NOTES

1) All growth estimates are net figures (gross growth minus mortality) and include trees that are part of the internal tree list that grow into the size classes specified by the 'cm' and 'bm' program options.

2) Lumpiness is periodic growth trends is due to the conventions listed in '1' above and the discrete nature of the growth projection (growth is based on a finite number of trees).

3) Harvest statistics are computed as the difference between before and after cut stand summaries. Hence, a negative harvest 'dbar' is indicative of a cut-induced increase in average stand DBH.

4) Young growth volume equations are applied to old growth trees. Tanoak volume equations are used for the "other hardwood" group.

5) Species codes are initially truncated to be 'real number' representations of integers in the range of 1-8. Tree records with species codes outside this range are deleted from the tree list or input.

6) All tree volume and taper estimates are based on models, scaling conventions, and merchantability standards described in research note no. 9.

7) If a non-zero positive integer is typed immediately after you input the input fileset number (i.e. you type a number in field 4 of the first keyboard input line), the program will default all program options, suppress all introductory remarks, and immediately transfer you to the main program (the 'go' prompt).

8) The diameter class table growth figures are not printed if the elapsed simulation time is zero years or if the stand was just restored or harvested and not subsequently grown for at least one five year cycle. The computed growth figures are the gross growth that occured over the last five years. If 'more' options 2 or 3 are selected, the table entries are divided by the appropriate net stand growth estimate for the last five years. Consequently, the proportions are slightly inflated and add up to slightly more than 1.00. You can find out what the estimated mortality for the last five years was by printing a diameter class table with min = 0, max = 200, and inc = 180. This will print a table with "one" class and the growth figures will be total gross growth. The difference between the gross growth figure and the net growth (obtained with the 'cg' command) is the last five years mortality.

XII. THE COMPANION PROGRAM CRYPT2

The CRYPT2 program has been developed to perform related computational tasks that are useful in growth, yield, and inventory analysis. The CRYPT2 program is essentially a smaller version of CRYPTOS that has been modified and adapted to perform in a limited batch capacity. The program presumes that there are several standard CRYPTOS tree list data files stacked sequentially on the input fileset. (For example, all of the plots in a stand inventory might be used as input). This data file structure will hereafter be referred to as a CRYPT2 data file. The CRYPT2 program has three run options that can be selected to accomplish the following functions; a) Inventory mode - produce average per acre stand statistics by species, b) Update mode - update (make growth projections) a CRYPT2 data file so it will look like a raw data file measured sometime in the future, and c) Condensing mode - produce an "average" tree list from a CRYPT2 data file that can be used directly by CRYPTOS.

Perceptive readers will note that combinations of runs with the CRYPTOS and CRYPT2 programs can be used to accomplish a stand growth projection in two different ways. For example, suppose a stand inventory has been made and all of the individual plot measurements have been coded into a CRYPT2 data file. The objective is to, say, make a 20 year growth projection for the stand. One way this could be accomplished would be to use CRYPT2 in the condensing mode to produce the "average" stand tree list and then use this average tree list as input to CRYPTOS and make a twenty year projection. The other way would be to use CRYPT2 in the update mode and then use the updated CRYPT2 file with the CRYPT2 inventory mode. Which of these ways is best is still a matter of debate. Theoretically, the latter method is technically correct although it requires much more computer time and it is not easily amenable to the detailed type of stand analysis available with the CRYPTOS program. It is anticipated that future research will produce results that can be used to develop recommendations concerning this choice in procedures.

After CRYPT2 has been invoked, the program will ask for the input fileset number and a run option. Conventions regarding input fileset numbers are the same as those listed in section IV. with the exception

that fileset numbers 14 and 15 are used by the program to output results. (Input data fileset numbers are 1-3 and 11-13). Alternative run options are selected by typing in an integer code. The following options can be selected:

Code	Option Function and Description

9 Inventory program mode. In this mode, a CRYPT2 data file is presumed to reside on the input fileset. The program then enters an initialization shell (the 'initgc' prompt) that is the same as the CRYPTOS program. You may select any merch standards or reporting options that are available with CRYPTOS. Upon an exit from the initialization shell, the program will write a plot-by-plot summary on file 14 and the average per acre stand summary and standard deviations will be written on file 15. (Due to definitional problems, the standard deviation of the average diameter per plot is not computed and is reported as 0.0) The inventory processing option assumes that the data derives from simple random sampling. If the run option '9' is preceded by a minus sign, the regular CRYPTOS initialization defaults are retained and the initialization process will be bypassed.

7 Create an average per acre tree list. With this option, the data is assumed to be of the same form as with option 9. The program will then ask you for a DBH class interval for each species. You also have the simplifying option of defaulting the DBH class interval for all species to two inches. After this procedure is completed, the entire plot inventory is averaged by species and diameter class to obtain a representative stand tree list. This tree list will be writtten on file 15 in the standard CRYPTOS file structure so it can be subsequently used as input for CRYPTOS. The program will also report the number of tree records developed by species so if there are to few (many) records, the program can be rerun and different class intervals selected.

5 Update a stand inventory. Again, this option assumes the data is in the same form as with option 9. You will then be asked for the nominal number of years you want the stand updated. It does not have to be an ever multiple of five years. (For example, 38.4 years is okay). However, fractional years must indicate the portion of the years growth to be applied rather than the fraction of a calendar year. The entire inventory, plot-by-plot, will be subjected to the CRYPTOS growth processor and then be written onto file 15. The record quadrupling is inhibited during this run option. You may then move this file to, say, file 1 and use any of the previous options for more detailed analyses. If the code '5' is prefixed by a minus sign, the nominal number of projection years that you supply the program will be overridden for any plot that has a non-negative real number typed in columns 46-50 of the first plot record. This number is substituted for the nominal numer of projection years.

Any other non-zero digit that is given as the run option causes the CRYPT2 program to abort.

LITERATURE CITED

Krumland, B. E., 1982. A Forest Yield Projection System for the North Coast Region of California. Ph.d Dissertation. Department of Forestry and Resource Management, Univ. of Calif., Berkeley, Calif.

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Krumland, B. and L. C. Wensel. 1978b. Volume and taper relationships for redwood, Douglas fir, and other conifers in the north coast of California. Res. Note. No. 9. Coop. Redwood Yield Research Proj. U.C. Berkeley. Mimeo.

Appendix I

SAMPLE CRYPTOS INPUT FILE

The following input file was created by the GENR program by specifying a stand with 150 redwood trees or a redwood site of 110 and aa breast high age of 20. Fifteen redwood records were gererated. The Douglas fir component was specified to be 150 trees, the Douglas fir site was 125, the breast high age was 16, and 15 records were generated for this species.

```
test stand                          30
  110.   125.    73.    94.
   20.    16.    18.    20.
   1.000   2.449  18.023   0.509  12.355   1.000
   1.000   3.595  23.144   0.486  16.453   1.000
   1.000   4.742  28.742   0.484  17.970   1.000
   1.000   5.889  34.453   0.497  17.834   1.000
   1.000   7.036  39.886   0.517  16.633   1.000
   1.000   8.183  44.719   0.539  14.808   1.000
   1.000   9.329  48.770   0.558  12.697   1.000
   1.000  10.476  51.998   0.573  10.545   1.000
   1.000  11.623  54.469   0.584   8.515   1.000
   1.000  12.770  56.303   0.593   6.705   1.000
   1.000  13.917  57.634   0.599   5.159   1.000
   1.000  15.063  58.582   0.603   3.886   1.000
   1.000  16.210  59.251   0.606   2.868   1.000
   1.000  17.357  59.718   0.608   2.078   1.000
   1.000  18.504  60.042   0.609   1.478   1.000
   2.000   1.883  24.050   0.745   8.699   1.000
   2.000   2.607  27.398   0.719  12.693   1.000
   2.000   3.331  30.715   0.698  15.291   1.000
   2.000   4.056  33.898   0.682  16.553   1.000
   2.000   4.780  36.861   0.671  16.641   1.000
   2.000   5.504  39.541   0.664  15.791   1.000
   2.000   6.228  41.905   0.659  14.274   1.000
   2.000   6.952  43.942   0.657  12.364   1.000
   2.000   7.676  45.664   0.656  10.305   1.000
   2.000   8.400  47.095   0.655   8.297   1.000
   2.000   9.124  48.269   0.655   6.445   1.000
   2.000   9.848  49.220   0.655   4.855   1.000
   2.000  10.572  49.984   0.655   3.547   1.000
   2.000  11.297  50.593   0.656   2.516   1.000
   2.000  12.021  51.076   0.656   1.735   1.000
%
```

Appendix II
AN ILLUSTRATIVE EXAMPLE

This section contains a an illustrative example of using the program. The tree list used for input is listed in Appendix I. Circled items were typed in on the keyboard. Free hand script incircled by boxes is intended to be a commentary on program events.

*

%grow

INVOKE PROGRAM

WELCOME TO CRYPTOS

(copyright by Lee C. Wensel, 1982)

INITIALIZATION PROCEDURES

enter input fileset no. (i3)002

DATA IS ON FILE 2

In this program, if the computer is waiting for a command
it will give you a prompt that is
    gc: If you are in the main program
    initgc: If you are in the initialization routine
    cutgc: If you are in the cutting routine

A list of commands can be obtained by typing pc.
but first, do you want to change any of the initial
(default) control options? (1 = yes, 2 = no)2

DEFAULT OPTIONS

And here we go (current output file is 6 (the screen)

gc:st

CURRENT STOCK TABLE

STOCK TABLE
---
elapsed time =   0. years

species	dbar	tpa	basar	cfvol	bdvol
redwds	8.72	150.	62.2	0.78	2.38
dougfr	6.18	150.	31.3	0.26	0.61
totals	7.56	300.	93.4	1.04	2.99

gc:pi

INITIAL DESCRIPTION

Initial Description

stand label = test stand

	rdwd	dougfir	tanoak	alder
sites	110.	125.	73.	94.
ages	20.	16.	18.	20.

gc:gr

enter no. cycles, tree detail, and summary code,(i2,2i1)

03

GROW FOR 15 YRS

go

dc

enter species group code (0 for all species)

0

enter min, max, and inc (3i3)

0 50 2

PRINT STAND TABLE

standing diameter class table -- et = 15. yrs

species = totals
stand label = test stand

	stocks				growth			
	trees	basar	cfvol	bdvol	basar	cfvol	bdvol
2- 4	9.6	0.59	0.00	0.00	0.09	0.00	0.00
4- 6	25.5	3.82	0.00	0.00	0.59	0.00	0.00
6- 8	37.6	10.19	0.15	0.00	2.15	0.15	0.00
8-10	46.9	21.23	0.47	1.59	4.16	0.15	1.04
10-12	47.1	32.43	0.77	2.36	6.78	0.25	1.11
12-14	30.1	28.58	0.73	2.93	5.65	0.23	1.09
14-16	28.0	33.98	0.85	3.52	6.41	0.25	1.25
16-18	22.4	35.06	0.89	3.89	6.76	0.27	1.39
18-20	10.2	20.10	0.50	2.25	3.37	0.13	0.73
20-22	5.6	13.40	0.33	1.54	2.09	0.08	0.47
22-24	2.5	7.07	0.17	0.82	0.96	0.04	0.23
24-26	1.3	4.09	0.10	0.50	0.61	0.03	0.15

table is totals by DBH class

more? 0

go

sl

PRINT LOG TABLE

Standing log inventory

stand = test stand
elapsed time = 15.

	redwoods				Whitewoods			
dib	logs	cvol	logs	bdvol	logs	cvol	logs	bdvol
6	152.3	0.61	129.6	1.03	169.3	0.63	141.8	1.12
8	51.3	0.47	67.2	1.99	92.9	0.62	95.1	2.55
10	41.2	0.46	43.1	2.30	57.3	0.58	61.5	2.93
12	26.4	0.42	25.1	2.10	34.1	0.49	29.5	2.21
14	13.7	0.30	13.0	1.57	9.3	0.18	9.3	0.99
16	4.7	0.13	4.2	0.67	1.0	0.02	1.0	0.14
18	1.3	0.04	1.3	0.25	0.0	0.00	0.0	0.00
totals		2.43		9.91		2.52		9.99
eqn./taper		1.04		0.99		0.98		0.99

go:pdc

enter species code (0 for all species)
and species group indicator (blank is default) - 2i 1 (1)

PRINT REDWOOD DIAMETER DISTRIBUTION

species = Redwoods

dbh	trees	15	30	45	60
0 - 2	0.				
2 - 4	2.	!!			
4 - 6	13.	!!!!!!!!!!!!!			
6 - 8	25.	!!!!!!!!!!!!!!!!!!!!!!!!!			
8 -10	23.	!!!!!!!!!!!!!!!!!!!!!!!			
10-12	22.	!!!!!!!!!!!!!!!!!!!!!!			
12-14	12.	!!!!!!!!!!!!			
14-16	14.	!!!!!!!!!!!!!!			
16-18	11.	!!!!!!!!!!!			
18-20	7.	!!!!!!!			
20-22	5.	!!!!!			
22-24	2.	!!			
24-26	1.	!			
total	139.				

gc(pf)

enter species code (0 for all species)
and species group indicator (blank is default) - 2i 1 (2)

PRINT AVERAGE HEIGHT AND CROWN LENGTH FOR DOUGLAS FIR

species = Douglas-fir

DBH	Trees	feet above ground 24	48	72	96	120	144	168	192	216	240
0 - 2	0.										
2 - 4	7.	=====>>>>									
4 - 6	13.	=======>>>>>>>									
6 - 8	12.	========>>>>>>>>									
8 -10	23.	=========>>>>>>>>>									
10-12	25.	=========>>>>>>>>>>									
12-14	18.	==========>>>>>>>>>>									
14-16	14.	==========>>>>>>>>>>									
16-18	11.	==========>>>>>>>>>>>									
18-20	3.	==========>>>>>>>>>>>									
20-22	0.	==========>>>>>>>>>>>>									
total	128.										

gc:et

ENTER HARVEST ROUTINE

HARVEST ROUTINE - enter harvest label(up to 40 chars)
test cut

cutgo:rl

REMOVE TREES BY DBH CLASS

enter dl,du,pl,pu, species I.D. and species list(opt.) (4f4.0,i1,9i1)
0.00 50. .30 .30

cutgo ih

CHECK IMMEDIATE HARVESTS

IMMEDIATE HARVESTS
---
elapsed time = 15. years

species	dbar	tpa	basar	cfvol	bdvol
redwds	-0.00	42.	35.5	0.73	2.97
dougfr	0.00	38.	27.7	0.76	3.00
totals	-0.00	80.	63.2	1.49	5.97

cutgo r2

enter basal area to cut (ft**2/acre), species I.D. and species list
Use format(f6.0,i1,9i1)
40.

THIN from BELOW - 40 sq. feet of basal AREA

cutgo ch

CUMULATIVE HARVESTS
---
elapsed time = 15. years

species	dbar	tpa	basar	cfvol	bdvol
redwds	-3.01	94.	59.1	1.14	4.37
dougfr	-2.26	31.	44.1	1.18	4.47
totals	-2.61	175.	103.2	2.33	8.84

PRINT TOTAL HARVESTS

cutgo ex

EXIT HARVEST ROUTINE

go gr
enter no. cycles, tree detail, and summary code.(i2,2i1)
-2

GROW for 10 YRS - NO MORTALITY

go yd

PRINT YIELD SUMMARY

YIELD SUMMARY: units = english

stand label = test stand

redwood site 110. init. age 20.
doug fir site 125. init. age 16.

species	et	dbar	tpa	basar	cfvol	bdvol	bagrc	cvgrc	bdgrc
redwds	0.	8.72	150.0	62.2	0.78	2.38	0.0	0.00	0.00
dougfr	0.	6.18	150.0	31.3	0.26	0.61	0.0	0.00	0.00
totals	0.	7.56	300.0	93.4	1.04	2.99	0.0	0.00	0.00
redwds	5.	10.18	145.6	82.3	1.27	4.36	20.1	0.49	1.98
dougfr	5.	8.29	140.5	52.6	0.87	2.52	21.3	0.60	1.91
totals	5.	9.30	286.1	134.9	2.13	6.89	41.5	1.09	3.90
redwds	10.	11.42	142.1	101.1	1.81	6.89	18.8	0.54	2.52
dougfr	10.	10.02	133.4	73.0	1.64	5.75	20.4	0.77	3.22
totals	10.	10.77	275.5	174.2	3.45	12.63	39.2	1.31	5.75
redwds	15.	12.43	139.2	118.2	2.43	9.91	17.0	0.62	3.02
dougfr	15.	11.52	127.6	92.4	2.52	9.99	19.3	0.88	4.24
totals	15.	12.03	266.8	210.5	4.95	19.90	36.4	1.51	7.26
HARVESTS : test cut									
redwds	15.	-3.01	94.0	59.1	1.14	4.37			
dougfr	15.	-2.26	80.9	44.1	1.19	4.47			
totals	15.	-2.61	174.9	103.2	2.33	8.84			
STAND AFTER HARVEST									
redwds	15.	15.49	45.2	59.1	1.29	5.54	17.0	0.62	3.02
dougfr	15.	13.73	46.7	48.3	1.34	5.52	19.3	0.88	4.24
totals	15.	14.64	91.8	107.4	2.62	11.06	36.4	1.51	7.26
redwds	20.	16.33	44.9	69.8	1.68	7.63	10.7	0.39	2.14
dougfr	20.	15.31	46.7	63.7	1.99	9.07	15.3	0.56	3.55
totals	20.	16.34	91.6	133.4	3.67	16.75	26.1	1.05	5.69
redwds	25.	18.23	44.9	81.4	2.12	10.29	11.6	0.45	2.61
dougfr	25.	17.65	46.7	79.4	2.75	13.51	15.7	0.76	4.43
totals	25.	17.94	91.6	160.8	4.87	23.79	27.3	1.20	7.04

go ex

EXIT CRYPTOS

yield summary is on file 10

stop