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A Spruce Budworm Sampling Program for HUSKY HUNTER Field Data Recorders

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Abstract

A program for receiving sampling data for all immature stages of the western spruce budworm (*Choristoneura occidentals* Freeman) is described. Versions were designed to be used on field data recorders with either CP/M or DOS operating systems, such as the HUSKY HUNTER (Models 1, 2, and 16), but they also may be used on personal computers with compatible operating systems. The algorithm for the program was derived, primarily, from the findings of Srivastava and others (1984). The program allows the user to review the current plot statistics, including sampling precision, at any time while still sampling the plot. It also allows the user to determine how many more trees need to be sampled to arrive at a sampling precision specified by the user. The program has been used for 4 years by the author to monitor budworm densities on research plots.

Keywords: Sampling program, western spruce budworm, HUSKY HUNTER, field data recorders.

Introduction

Field data recorders allow for both efficient collection of data in the field, and the subsequent transfer of that data to office computers (Fins and Rust 1988). These handheld microcomputers are used to perform various tasks in the forests, in such areas as tree improvement plantations (Fins and Rust 1987, 1988), log scaling (Bonfonti 1987), forest inventory stand exams (Atterbury 1990, Cooney 1985), and many others. Data recorders have been little used in such areas as insect suppression projects and entomological research applications, particularly in those applications that require recording of data in the forest. Reasons for this limited use include the unavailability of suitable software, and hardware durable enough to withstand harsh handling and field conditions. In recent years, however, hardware has been developed that is both shock- and weather-resistant and that has an operating system, such as DOS as well as CP/M, that can accommodate commonly used programming languages.[1]

In the past, forest entomologists recorded field observations and data on paper and then entered those data later into an office computer. This necessitated the handling of entries for a second time, thereby increasing not only opportunities for making errors but also the time and expense of entering data into other computers containing programs with sophisticated statistical capabilities. Field data recorders can maximize efficiency by allowing whole files to be transferred to host computers in seconds or minutes.

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[1] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

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Hardware Needed

The program presented here is designed to receive sample data of all immature stages of the western spruce budworm *(Choristoneura occidentalis* Freeman) on HUSKY HUNTER recorders with either CP/M or DOS operating systems. The algorithm for the program was derived from the findings of Srivastava and others (1984).

HUSKY HUNTER recorders with CP/M operating systems (models 1 and 2) have been commonly used within the USDA Forest Service in the Pacific Northwest since 1987. Since then, Husky Computers, Inc. and other companies have developed recorders with DOS operating systems. The program described below was developed and intended to be used on CP/M-based HUSKY HUNTER models, but a subsequent, compiled version also is available for the DOS-based HUSKY HUNTER (model 16), and perhaps for other DOS-based recorders with an 8-line by 40-character display, although the latter has not been investigated. The compiled version also could be run on a DOS-based PC. File size for the CP/M version is about 22,000 bytes, whereas that for the executable DOS version is about 61,000 bytes.

The Program Language

The CP/M version of the program (appendix A) is written in a modified BASIC language unique to Husky recorders with the CP/M operating system. This language is called HUNTER BASIC and is installed as firmware within the HUSKY HUNTER. The compiled DOS version is written in QuickBASIC^{R} 4.0 of Microsoft. Either or both versions are available on floppy disks from the author.

The Program

The program (appendix A) follows the scheme presented, with some modification, in Srivastava and others (1984) for sampling immature stages of the western spruce budworm. It is menu driven, relatively user friendly, and initially asks the observer to enter certain critical information, such as the date, plot number, initials of user, immature budworm stage to be sampled, crown level to be sampled, and tree-height class.

The program then asks whether data will be entered via either the keyboard or a bar code, whereupon it successively loops through a routine allowing for the entry of host, branch tip length and width (in centimeters), and the number of budworms or egg masses found on the measured tip. The sampling scheme requires that two 45-centimeter tips per tree be measured before allowing the user to go to the next tree.

The program also prompts the user to estimate whether budworm density on the plot will be low, medium, or high. This estimate is necessary to trigger a subroutine within the program that computes some of the plot statistics as described below. This trigger REQUIRES the entry of at least one budworm after sampling 3 trees for a high-density estimate, one budworm after 7 trees for the medium-density estimate, and one budworm after 10 trees for the low-density estimate. These density levels are arbitrary and are selected only to make the program run more efficiently.

As successive trees on the plot are sampled, the program accumulates the total number of budworms found, converts the tip measurements to square meters of foliage, accumulates the total square meters examined, and computes the "average plot'density" (Srivastava'and[1] others 1984). This average plot density, expressed in budworms per square-meters of foliage, is updated after each tree is sampled. After the minimum number of trees have been sampled, within the constraints of the original estimate of density (that is,, low, imediurn, or high), additional statistics are calculated by the program:, ttiese include mean budworm density per tree, Sampling variance, standard-deviation, and standard error of the mean, and sampling precision. At this, time, the program also allows the user to determine how many additional trees must

be sampled (that is, sample size) to arrive at a sampling precision specified by the user. This option is also menu driven. All the above information is available while the user is still at the plot and before the program is exited.

After each tree is sampled and the data for each recorded, a menu entitled "Host, EXIT(4), STIX(5), Trees Needed(6)" will appear on the screen, thereby giving the user the options to (1) continue sampling the plot by identifying the host of the next tree, (2) conclude the sample on the plot (EXIT), (3) request an update on the statistics for the plot (STIX) (up to that point in time), or (4) request how many more trees needed to be sampled to arrive at a desired sampling precision. It is from this menu only that the user may exit the program and save all data collected to that point.

Bar Code Capability

The program can accommodate data entry by using bar codes once the initial critical information has been entered (that is, date, plot, observer, etc.). To provide for this option, however, the HUSKY HUNTER (Models 1, 2, and 16) first must be loaded with a firmware package of type code 3 of 9 enabling the use of bar codes and stored as a system file. This type code is commonly used in U.S. Government agencies. In addition, an opto-electronic scanning device, or wand, must be acquired, which can be attached to the recorder either through a 4-pin LEMO plug (all three models) or a 5-pin FISCHER plug (only model 16). This scanner and vendor-installed firmware can be purchased from a HUSKY distributor, but the latter must be installed for the program to recognize bar code input. Another requirement for entering data with bar codes is to have code 3 of 9 bar codes available for each of the digits 0 through 9, and for the letters E (for ENTER), Y (Yes), and N (No). These also are available from the HUSKY distributor. It must be stressed, however, that the program will RUN VERY WELL by entering all information through the keyboard WITHOUT the recorder having ANY bar code reading capability.

If the recorder has bar code reading capability, and digit and letter bar codes are available, data entry and responses to questions prompted by the program are similar to sequences followed when entering data or responding to questions from the keyboard. For example, when entering the value 41 (for example, the tip length in centimeters), scan the 4 and then the 1 bar codes and enter the value by scanning the E bar code. If you enter the value 2 (for example, the number of budworms found on a tip), bar code 2 is scanned followed by scanning bar code E. To respond to the question, "Are these values correct? 'Y' or ^{f}N\" the user scans either the Y or N bar codes. Once the value has been entered (E) or the question has been answered (Y or N), the program will prompt the user for the next bit of information. Just as in keyboard entry, exiting the program can be accomplished only from the "Host, EXIT(4), STIX(5), Trees Needed(6)" menu.

Error Correction

Keystroke errors made while running the program can be corrected in several ways. If a keystroke error is made and discerned before that value is entered, backspace over the error, correct the value, and then enter it. If the error is recognized after the erroneous value is entered, several options can be used: If the error was made in response to some of the critical information asked early in the program (for example, date, plot, and observer), it is advisable to exit the program at the earliest opportunity (that is, via the menu "Host, EXIT(4), STIX(5), Trees Needed(6)") and restart it. The reason for this is that all this information is reproduced in the resulting data file for every tree in the sample and would thus compound the error as well as the subsequent correction chore. At this point, the data file has been created, but no tree or

insect data have been entered, so the file is empty. If the error was made in one of the components of the file name (see "Files," below), a new file will be opened and, on restarting the program, be ready for data entry. If the error was made in information other than a component of the file name, restarting the program will allow the corrected input to be entered into the data file as it is generated.

If an error was made when tip measurements and budworm counts were recorded, the user has several options. If the error was discerned before the value was entered, it can be corrected before entering. If the erroneous value was entered, it can be verified in a screen that will then appear asking if all the entries shown are correct. Errors may be corrected at this time by following the directions given on the screen. This is the last opportunity for corrections to be made while still in the program. If, however, even this opportunity to correct an error is missed, corrections can still be made within the created file residing in the memory of the HUSKY HUNTER by invoking the file through the editing facility of the recorder. This can be done only after exiting the program.

Program Operation

Once in the program, continuity of operation is preserved even if the HUSKY HUNTER is turned off. Thus, if the user stops operation for any reason (for example, time between sample trees to conserve battery life), the recorder power can be turned off; when the power is once again turned on, the program will resume from where the interruption occurred.

Files

The program creates two files, a plot data file and a plot statistics file. The data file contains all the critical information to identify the sample and the tip measurements and budworm counts for each tree. It also includes foliage area, expressed in square meters, for each tip. The format of this file is shown in appendix B. The name of the data file for the individual plot is generated by the program from information provided by the user early in the program. This includes abbreviated budworm stage sampled, plot number, and year, followed by a DTA suffix. For example, the name for a larval sample on plot number 130 in 1992 would appear as LAR13092.DTA, and the name for a pupal sample on plot 220 in 1992 would appear as PUP22092.DTA.

The statistics file also contains all the critical information to identify the sample and lists some of the pertinent plot statistics. The format and representative contents are shown in appendix C. The name of this file also is generated by the program, but it is not as explicit as the name for the data file. It includes a prefix (STIX) identifying it as a statistics file, plot number, arid a DTA suffix. For example, the names of the statistics files paired with the data files mentioned above would be STIX130.DTA and STIX220.DTA.

Discussion

Although some programmers may object to much of the programming code and procedures used in the program and, perhaps, even to the use of the BASIC language, the program has served the needs of our research team for 4 years. During that period, we have been involved with monitoring the population dynamics of the western spruce budworm to construct life tables for that defoliator, and all the budworm density information collected in the field was entered on .the HUSKY HUNTER (model 1), by using the program described herein. Although ,no real measure was made; between the time data recorded on paper versus that, recorded by means of the HUSKY HUNTER; we felt that the latter was at least as efficient and error-free as 4he former. In addition, data entry into the recorder was not affected by conditions that often plague field Workers-when recording data oh paper--windy and damp conditions, for example.

The greatest benefit was in the time saved in transferring the files to databases in host computers, such as the Data General (DG) system used by the USDA Forest Service, where the files could be subjected to more critical statistical scrutiny. In test transfers of 13 sets of 20-tree data files from the HUSKY HUNTER to the DG, about 60 seconds was needed (59.85 ± 2.79 [mean ± SE]). The entry of a comparable set of files would take over 30 minutes each if they were entered into the DG, excluding the additional time required to check for errors. Similarly, transfer of 23 sets of STIX files took about 54 seconds (53.83 ± 1.56 [mean ± SE]).

The budworm program formats the entered information according to that shown in appendix B. Changing either the variable order or entries in this format can be done easily by modifying statements in lines 8650-8660 and 8860-8870 of the program. This expedites the transfer of files to a host computer in their final format. Thus, no extra formatting routines have to be developed, and no extra time has to be spent formatting the information on the host computer once the files are transferred.

The HUSKY HUNTER and this budworm sampling program were used at a time when our research operating budgets were limited. Use of this program, therefore, permitted us not only to monitor as many budworm research plots as we did when personnel and budgets were less restrictive, but also to provide ourselves and our cooperators with important information on fluctuations in budworm populations and to provide that in a timely manner.

The above program would be ideal for researchers monitoring budworm densities according to the scheme proposed by Srivastava and others (1984); however, parts of the program might be useful to other workers developing programs to study their particular systems.

Acknowledgments

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Appendix A

The Spruce Budworm Sampling Program - CP/M Version

```
1 REM Sampling the Western Spruce Budworm - Larvae, Pupae, and
2 ' Egg Masses [As described in Srivastava, et at. 1984.
3 '   Forest Sci. 30 (4): 883-892 (with modification)].
4 '
5 ' VERSION 1.07 : January 27, 1993
7 ' Program written by: Fred H. Schmidt
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10 '                    La Grande, Oregon 97850
11 '                    Tel: (503)963-7122 / FTS 8-421 -5577
12 '
18 ' Program Name is 'SBW_DENS.HBA'
20' ABSTRACT:
30 ' Computes SBW Ave Plot Density in
31 ' SBW/sqrM foliage examined after the
32 ' user inputs the number of SBW found
33 ' in the sample and the length and
34 ' width dimensions of the foliated
35 ' branch examined. Also computes the
36 ' Stand Density, Sampling Precision, &
37 ' Trees needing to be sampled for a given
38 ' sampling precision for larvae, pupae, &
39 ' egg masses.
40 ' VARIABLES:
41 ' YEAR$=Year; D=Sample Date; D1=Examination Date; S1$=Sampler's Initials;
42 ' S2$=Examiner's Initials; P=Plot Number; F$=Sample (L,P,E,or EM);
43 ‘ F1$=Data File Name; F2$=Stix File Name; T=Tree Hgt Class; C=Crown Level;
44 ' QD=SBW Density Estimate; QTR=Sample Size (Trees) for Estimated Density;
45 ' TNo=Tree Number; TR=No of Trees Sampled; TC=Tip Code; W=SBW on Tip;
46 ' SW=Sum of SBW; B1=Tip Length; B2=Tip Width; A=Tip Area in sq Meters;
47 ' SA=Sum Tip Areas; STRA=Sum Tree Areas; H$=Host; UH$=Other Hosts;
48 ' DEN=Ave Plot Density; Stand Densities for: LAR(LSD), PUP or EXU(PSD), &
49 REM EGG(ESD); Sampling Precisions for: LAR(LSP), PUP or EXU(PSP), & EGG(ESP)
50 CLEAR:CLS:ONPOWERRESUME
60 PRINT: PRINT “SPRUCE BUDWORM SAMPLING PROGRAM"
64 MAXFILES=2
65 DIMX$(13,20)
66 WAND=0:TNo=0
70 PRINT:PRINT”Year? (YY)"
75 INPUTUSING(“99”,2,2)YEAR$
80 PRINT”Date? (DDMM)"
90 INPUTUSING("9999",3,4)D
95 CLS
100 PRINT:PRINT”Sampler's Initials?"
110 INPUTUSING("BAA",2,3)S1 $:CLS
120 PRINT:PRINT”Will you EXAMINE the sample today? (Y or N)"
124 INPUTUSING("A",1,1 )ANS$:CLS
128 IFANS$=”N"ORANS$="n"THENGOT0150
132 IFANS$="Y"ORANS$=”y”THENGOTO162
134 GOSUB9100
138 BEEP:GOTO120
150 PRINTiPRIN”Examiner's Initials?”
153 INPUTUSING("BAA",2,3)S2$:CLS
156 PRINT:PRINT”Examination Date? (DDMM)
158 INPUTUSING("9999”,3,4)D1
```

A 2 - BUDWORM PROGRAM - CP/M VERSION

```
160 CLS:GOTO164
162 S2$=S1$:D1=D
164 CLS:PRINT:PRINT"Plot number (nnn)"
166 INPUTUSING("999",3,3)P$:CLS
170 PRINT:PRINT"Enter Sample to be Made:"
172 PRINTPRINT"   IF LARVAL     Press 1 + ENTER "
174 PRINT"        IF PUPAL      Press 2 + ENTER "
176 PRINT"        IF EXUVIAL    Press 3 + ENTER "
178 PRINT"        IF EGG MASS Press 4 + ENTER "
180 INPUTUSING("9",1,1)F$:CLS:PRINT
182 IFF$="1"THENF$="LAR"+P$
184 IFF$="2"THENF$="PUP"+P$
186 IFF$="3"THENF$="EXU"+P$
188 IFF$="4"THENF$="EGG"+P$
190 F1$=F$+YEAR$+".DTA"
192 PRINT"File name will be: ";F1 $
194 FORI=1 TO1000:NEXTI:CLS
200 OPENF1$FORAPPENDAS1
202 KEYOFF:PRINT:PRINT"Do you expect the DENSITY today"
204 PRINT"to be LOW(1), MEDIUM(2), or HIGH(3)?"
206 PRINT:PRINT"Please enter '1', '2', or'3'"
207 PRINT:PRINT"[If in doubt, select 1"
208 PRINT"(ie Sample size = >10 trees)]"
209 INPUTUSING("9",1,1 )QD:CLS:KEYON
210 IFQD=1THENQTR=9
212 IFQD=2THENQTR=6
214 IFQD=3THENQTR=2
216 IFQD=1ORQD=2ORQD=3THENGOTO224
218 IFQD<>1ORQD<>20RQD<>3THENGOT0220
220 BEEP:PRINT:PRINT"Please respond to the query!"
221 FORI=1TO1000:NEXTI
222 GOTO202
224 PRINT:PRINT"Crown level to be sampled? "
226 PRINT"(1=Upper, 2=Mid, 3=Lower)"
228 INPUTUSING("9",1,1)C:CLS
230 IFC=1ORC=2ORC=3THEN236
232 IFC<>1ANDC<>2ANDC<>3THENBEEP
234 BEEP:GOTO224
236 PRINT:PRINT"Tree height= 7 to 14 meters? (Y or N)"
240 INPUTUSING("A",1,1)ANS$
244 IFANS$="Y"ORANS$="y"THEN278
248 IFANS$="N"ORANS$="n"THEN260
252 GOSUB9100
256 BEEP:GOTO230
260 PRINT:PRINT"Enter tree height class:"
262 PRINT"(1=>14m, 2=7-14m, 3=<7m)"
270 INPUTUSING("9",1,1)T:CLS
272 IFT=1ORT=2ORT=3THEN280
274 IFT<>1ANDT<>2ANDT<>3THENBEEP
276 PRINT"Please enter appropriate height class: ":GOTO262
278 T=2
280 CLS:PRINT:PRINT"Let's measure some branches!"
290 FORI=1TO500:NEXTI
304 GOTO310
```

A 3 - BUDWORM PROGRAM - CP/M VERSION

```
306 REM**************************
310 REM CONTROL ROUTINE
320 CLS:PRINT:PRINT"Will you input the measurements using "
330 PRINT"the KEYBOARD (K) or by means of BARCODES"
340 PRINT"(B) (Press either K or B + ENTER) "
350 INPUTUSING("A",1,1)BK$:CLS
360 IFBK$="K"ORBK$="k"THENGOTO6020
370 IFBK$="B"ORBK$="b"THENGOTO7000
380 IFBK$<>"K"ORBK$<>"k"ORBK$<>"B"ORBK$<>"b"THENBEEP
390 PRINT"Please enter either 'K' or 'B' ":BEEP:GOTO320
440 PRINT:PRINT"Are you through sampling? (Y or N)"
444 INPUTUSING("AM",1,1)ANS$:CLS
448 IFANS$="Y"ORANS$="y"THENGOTO462
452 IFANS$="N"ORANS$="n"THENGOTO470
456 GOSUB9100
460 GOTO440
462 GOSUB11750:REM Print out & close STIX file (ie #2)
464 GOSUB9000:REM Close data file #1
465 CLS:GOTO510
470 PRINT:PRINT"Will you do another plot or continue "
472 PRINTwith this one? (Y or N)"
474 INPUTUSING("A",1,1)ANS$:CLS
478 IFANS$="Y"ORANS$="y"THEN120
482 IFANS$="N"ORANS$="n"THEN500
486 GOSUB9100
490 GOTO470
500 GOSUB9000
510 PRINT:PRINT"Do you want to know the "
512 PRINT-AVERAGE PLOT DENSITY? (Y or N) "
515 INPUTUSING("A",1,1)ANS$:CLS
520 IFANS$="Y"ORANS$="y"THEN530
523 IFANS$="N"ORANS$="n"THEN550
526 GOSUB9100
528 GOTO510
530 GOSUB860
540 IFLEFT$(F1 $,2)="PU"THENGOSUB960
544 IFLEFT$(F1 $,2)="EX"THENGOSUB960
550 PRINT:PRINT"Do you want to know the "
554 PRINT"STAND DENSITY? (Y or N) "
558 INPUTUSING("A",1,1)ANS$:CLS
562 IFANS$=-Y-ORANS$="y"THEN580
566 IFANS$="N"ORANS$="n"THEN590
570 GOSUB9100
574 GOTO550
580 GOSUB1000
590 PRINT:PRINT"Do you want to know the SAMPLING "
592 PRINT"PRECISION? (Y or N)"
600 INPUTUSINGC("AM",1,1)ANS$:CLS
604 IFANS$="Y"ORANS$="y"THEN620
608 IFANS$="N"ORANS$="n"THEN630
612 GOSUB9100
616 GOTO590
620 GOSUB2000
630 PRINT:PRINT"Would you like to know the NUMBER OF "
646 PRIN"TREES NEEDED to be sampled to reach "
```

A4 - BUDWORM PROGRAM - CP/M VERSION

```
650 PRINT”your specified sampling precision? (Y or N)"
654 INPUTUSING("A",1,1)ANS$:CLS
658 IFANS$="Y"ORANS$="y"THENGOSUB3000
660 IFANS$="N"ORANS$="n"THEN680
662 IFANS$="Y"ORANS$="y"THENGOTO680
666 GOSUB9100
670 GOTO630
680 PRINT:PRINT"Do you want to REVIEW the plot"
690 PRINT”sampling STATISTICS once again? (Y or N) "
700 INPUTUSING(“A",1,1)ANS$:CLS
710 IFANS$="Y"ORANS$="y"THEN750
720 IFANS$="N"ORANS$="n”THENGOTO760
730 GOSUB9110
740 GOTO680
750 GOSUB11500:REM Review Plot Statistics
760 CLS:KEYON
770 PRINT:PRINT"Nice job folks!   Let's go home!"
780 END
800 REM*******************************
810 REM COMPUTATIONS TO DETERMINE AVE PLOT DENSITY, TRo, TNo, & TC
814 AX=(B1*B2)/20000
817 A=INT(AX*10000+.5)/10000
820 A=A+.00001
825 RETURN
830 SW=SW+W
840 SA=SA+A
850 DEN=SW/SA
860 IFLEFT$(F1 $,2)="PU"THENGOTO940
862 IFLEFT$(F1 $,2)=”EX"THENGOTO940
864 PRINT:PRINT"SBW AVE PLOT DENSITY= “;DEN
866 IFTC=211THENGOTO5020
868 RETURN
870 R=.5
880 TR=TR+R
890 PRINT:PRINT"No. of TREES SAMPLED= ";TR
900 PRINT”Tree Number= ";TNo
910 PRINT”Tip Code-";TC
920 FORI=1TO2000:NEXTI
930 CLS:RETURN
940 MCDEN=DEN*1.881
950 RETURN:REM GOTO930
960 PRINT:PRINT"LOWER-Crown SBW AVE PLOT DENSITY=";DEN
970 PRINT"   MID-CROWN equivalent AVE PLOT DEN=";MCDEN
980 GOTO920
1000 REM ****************************************
1010 REM DETERMINATION OF STAND DENSITIES
1020 IFLEFT$(F1$,2)="LA"THENGOSUB5000
1030 IFLEFT$(F1$,2)="PU”THENGOSUB5050
1040 IFLEFT$(F1$,2)="EX”THENGOSUB5075
1050 IFLEFT$(F1$,2)=”EG'THENGOSUB5170
1060 CLS:RETURN
2000 REM ****************************************
2010 REM PRINT SAMPLING PRECISION (SE/M) = PRE
2020 PRINT:PRINT"SAMPLING PRECISION (SE/M)=";PRE
2030 FORI=1TO1600:NEXTI
2040 CLS.RETURN
```

A 5 - BUDWORM PROGRAM - CP/M VERSION

```
3000 REM•************************************
3010 REM DETERMINATION OF THE NUMBER OF TREES
3020 NEEDED TO BE SAMPLED TO REACH A SPECIFIED
3030 REM SAMPLING PRECISION
3050 GOSUB6600
3060 RETURN
4980 REM ************************************
4990 REM SUBROUTINE CALCULATIONS TO DETERMINE STAND DENSITIES
5000 LSD=.219*DEN+ 18.4
5010 PRINT:PRINT"Larval STAND DENSITY= ";LSD
5020 FORI=1TO1200:NEXTI
5030 CLS:RETURN
5050 PSD=.6*DEN
5060 PRINT:PRINT"Pupal STAND DENSITY= ";PSD
5070 GOTO5020
5075 PRINT:PRINT"PLEASE USE KEYBOARD!"
5080 PRINT:PRINT"Exuvial Stand Density CANNOT be"
5090 PRINT”estimated, but Pupal Stand Density "
5095 PRINT"should be close.":GOTO5110
5100 CLS:PRINT:PRINT"Please respond ‘Y’ or 'N':"
5110 PRINT:PRINT"Would you like to know the"
5115 PRINT"Pupal Stand Density? (Y or N)"
5120 INPUTUSING("A",1,1)ANS$:CLS
5130 IFANS$="Y"ORANS$="y"THENGOTO5163
5140 IFANS$="N"ORANS$="n"THEN5030
5150 GOSUB9100
5160 GOTO5100
5163 GOSUB5050
5166 GOTO5020
5170 ESD=.82*DEN
5180 PRINT:PRINT"Egg Mass STAND DENSITY=";ESD
5190 GOTO5020
5610 REM ****************************
5620 REM SUBROUTINE CALCULATIONS TO DETERMINE NUMBER OF TREES NEEDED
5630 PRINT:PRINT"Desired Precision? (.nn)"
5640 INPUTUSING("N99",2,3)DP:CLS
5650 PS=DP*DP
5660 RETURN
5970 REM ******************************************
5980 REM DATA INPUT LOOP
5990 PRINT:PRINT"(USE KEYBOARD)"
6000 PRINT:PRINT"What host are you sampling? "
6010 INPUTUSING("ABBBBBBBBBBBBBB",2,16)UH$:CLS
6014 H$=H$XORUH$:GOTO6030
6020 WSTR=0:STRA=0:GOTO6300
6030 TC=111:TNo=TNo+1
6040 GOTO6070
6050 PRINT”Next tree branch:"
6060 TC=211
6070 PRINT:PRINT”Tip LENGTH (In cm)? "
60801NPUTUSING("999",2,3)B1
6090 PRINT”Tip WIDTH (In cm)?
6100 INPUTUSING("999" I1,3)B2
6110 PRINT”Number of IIve SBW found on branch? "
6120 INPUTUSING (“999”,1,3)W:CLS
```

A 6 - BUDWORM PROGRAM - CP/M VERSION

```
6130 GOSUB870
6140 GOSUB8500
6150 IFTC=111THEN6050
6160 IFTC=211THEN6300
6300 REM*******************************
6310 REM SUBROUTINE TO IDENTIFY HOST
6312 CLS:KEYOFF
6320 PRINT:PRINT"Host, EXIT(4), STIX(5), Trees Needed(6)? "
6330 PRINT"      Douglas-fir                Press 1 + ENTER "
6340 PRINT"      Grand Fir                  Press 2 + ENTER "
6350 PRINT'      Other Hosts                Press 3 + ENTER "
6360 PRINT"      To EXIT                    Press 4 + ENTER "
6370 PRINT"   Statistics Update             Press 5 + ENTER "
6380 PRINT"   Trees Needed for Pre          Press 6 + ENTER "
6390 INPUTUSING(“g”,1,1,)H$:CLS
6410 IFH$="1”THENGOTO6030
6420 IFH$="2"THENGOTO6030
6430 IFH$="3"THENGOTO6000
6440 IFH$="4"THENGOTO440
6450 IFH$="5"THENGOSUB11500
6460 IFH$="6"THENGOSUB6600
6470 IFH$<>"1"ORH$<>"2"ORH$<>"3"ORH$<>"4"ORH$<>"5"ORH$<>"6”THENGOT06490
6480 GOTO6020
6490 BEEP:PRINT:PRINT"Please respond 1 or 2 or 3 or 4 or 5 or 6"
6500 GOTO6300
6600 REM ******************************************************
6610 REM DETERMINE TREES NEEDED FOR GIVEN PRECISION USING VARIANCE
6620 IFTR>QTRTHENGOTO6630ELSE6800
6630 GOSUB5620:REM To determine desired precision
6640 KEYOFF
6650 IFLEFT$(F1 $,2)="LA"THENGOSUB6900ELSE6660
6660 REM SMDTR=MDTR*MDTR
6670 XTR=VAR/(PS*DSTR):REM VAR/(PS*SMDTR)
6680 PRINT:PRINT:PRINT"Number of trees needed (VARIANCE)=";XTR
6690 PRINT" for'";DP;"'sampling precision."
6700 IFLEFT$(F1$,2)<>"LA"THEN6780
6710 PRINT"Number of trees needed (TORG 91)=";LTR
6720 PRINT" for'";DP;"'sampling precision."
6780 PRINT:INPUT"[press ENTER to continue]",jk
6790 CLS:KEYON:GOTO6810
6800 GOSUB11670
6810 RETURN
6900 REM*************************************************************
6910 DETERMINE LARVAL TREES NEEDED FOR GIVEN PRECISION USING TORG 91
6920 REM TORG 91 = (No Trees=5.09541/[(p*p)(DEN to 0.52666 power)])
6930 CCC=LN(DEN)*0.52666
6940 ZA=EXP(CCC)
6950 LTR=5.09541/(ZA*PS)
6960 RETURN
7000 REM ****************************************
7010 REM BARCODES / DATA INPUT LOOP
7020 WSTR=0:STRA=0:GOTO7500
7030 TC=111:TNo=TNo+1
7040 GOTO7070
7050 PRINT:PRINT"Next tree branch:"
```

A 7 - BUDWORM PROGRAM - CP/M VERSION

```
7060 TC=211
7070 PRINT:PRINT”Tip LENGTH (in cm)? "
7080 GOSUB8000
7090 B1=VAL(Z$)
7100 PRINT"Tip WIDTH (in cm)? "
7110 GOSUB8000
7120 B2=VAL(Z$)
7130 PRINT"Number of live SBW found on branch? "
7140 GOSUB8000
7150 W=VAL(Z$):CLS
7160 GOSUB870
7170 GOSUB8700
7180 IFTC=111THEN7050
7190 IFTC=211THEN7500
7500 REM *******************************
7510 REM BARCODE/HOST IDENTIFICATION
7520 CLS:KEYOFF:PRINT:PRINT"Host, EXIT(4), STIX(5), TREES NEEDED(6)? "
7530 PRINT"          Douglas-fir                    Barcode 1 "
7540 PRINT"         Grand Fir                       Barcode 2 "
7550 PRINT"         Other Hosts                     Barcode 3 "
7560 PRINT"          To EXIT                        Barcode 4"
7570 PRINT"      Statistics Update                  Barcode 5 "
7580 PRINT"      Trees Needed for Pre               Barcode 6 "
7590 PRINT"[Do NOT follow up with 'ENTER'              Barcode!]"
7600 WINPUTH$:CLS
7610 IFH$="1"THENGOTO7030
7620 IFH$="2"THENGOTO7030
7630 IFH$="3"THENGOSUB5990
7640 IFH$="4"THENGOTO9600
7650 IFH$="5"THENGOSUB11500
7660 IFH$="6"THENGOSUB10240
7670 IFH$<>"1”ORH$<>"2"ORH$<>"3"ORH$<>"4"ORH$<>”5”ORH$<>"6”THENGOT07690
7680 CLS:KEYON:GOTO7020
7690 CLS:BEEP:PRINT:PRINT"Please respond with barcodes"
7700 PRINT"1 or 2 or 3 or 4 or 5 or 6"
7710 GOTO7500
8000 REM*********************************
8010 REM BARCODE INPUT LOOP
8020 Z$=””
8030 FORI=1 TO12:X$(I)="":NEXTI
8040 1=1
8050 FORK=1TO4
8060 WINPUTY$:CLS
8070 IFY$="E"THENGOTO8110
8080 X$(I)=Y$
8090 1=1+1
8100 NEXTK
8110 FORJ=1TOI
8120 Z$=Z$+X$(J)
8130 NEXTJ
8140 PRINTZ$
8150 RETURN
8510 REM FILE MANAGEMENT OF KEYBOARD DATA
8530 GOSUB8900
8340 GOTO8560
```

```
8550 CLS:PRINT:PRINT"Please respond ‘Y’ or 'N':”
8560 PRINT:PRINT”If these values are CORRECT press ‘Y’ + ENTER"
8570 PRINT-If NOT press 'N' (=Mistake) + ENTER "
8580 INPUTUSING("A",1,1 )ANS$:CLS
8590 IFANS$="Y"ORANS$="y"THENGOTO8640
8600 IFANS$="N"ORANS$="n"THENGOTO8630
8610 GOSUB9100
8620 GOTO8550
8630 GOSUB9315
8640 GOSUB800
8644 GOSUB830
8646 WSTR=WSTR+W
8648 STRA=STRA+A
8650 PRINT#1,YEARS;" ";P$;” ";H$;" ";TNo;"";C;"";TC;"";B1 ;"";B2;"";W;"";
8660 PRINT#1.A;-;T;"";S1$;" ";D;YEAR$;" ";S2$;” ";D1 ;YEAR$
8663 PRINT
8670 IFTC=211THENGOSUB11300
8690 RETURN
8700 REM **********************************
8710 REM FILE MANAGEMENT OF BARCODE DATA
8720 GOSUB8900
8730 GOTO8750
8740 BEEP:PRINT:PRINT"Please respond 'Y' or 'N':"
8750 PRINT:PRINT"If these values are CORRECT=Barcode ‘Y’”
8760 PRINT"If NOT CORRECT-Barcode 'N' (mistake)"
8770 WINPUTANS$:CLS
8780 IFANS$="Y"THENGOTO8830
8790 IFANS$="N"THENGOTO8820
8800 GOSUB9100
8810 GOTO8740
8820 GOSUB9300
8830 GOSUB800
8840 GOSUB830
8850 WSTR=WSTR+W:STRA=STRA+A
8860 PRINT#1,YEARS;" ";P$ ";H$;" ";TNo;"";C;"";TC;"";B1 ;"";B2;"";W;"";
8870 PRINT#1,A;"";T;"";S1 $;" ";D;YEAR$;" ";S2$;" ";D1 ;YEAR$
8880 PRINT:IFTC=211THENGOSUB11300
8890 RETURN
8900 REM**********************************
8910 REM REVIEW OF INPUT DATA
8920 KEYOFF:PRINT
8930 PRINT@(2,1)"(1) Host= ";H$
8940 PRINT@(21,1)"(2) Tip Code= ";TC
8950 PRINT@(2,2)"(3) Length= ";B1
8960 PRINT@(21,2)"(4) Width= ";B2
8970 PRINT@(2,3)"(5) SBW Count= ";W
8980 PRINT@(21,3)"(6) Tree No= ";TNo
8990 RETURN
9000 REM*****************************
9010 REM CLOSE FILE
9020 CLOSE
9030 RETURN
9100 REM*******************************
9110 REM IMPROPER 'Y’/’N' RESPONSE
9120 IFANS$<>"Y"ORANS$<>"y"ORANS$<>"N"ORANS$<>"n”THENBEEP
9130 CLS:PRINT:PRINT"REENTER SELECTION: ":PRINT
```

```
9140 RETURN
9300 REM**************************************
9310 REM ERROR CORRECTION ROUTINE
9315 CLS:GOSUB8930
9320 PRINT”USING THE KEYBOARD:"
9330 PRINT"Indicate erroneous values to be corrected"
9340 PRINT"(e.g. '2' for 'Tip Code') & press ENTER"
9360 INPUTUSING("9",1,1)MIS
9370 CLS:GOSUB8930
9372 PRINT:PRINT"CORRECT if wrong, then press ENTER"
9380 IFMIS=1THENGOTO9440
9390 IFMIS=2THENGOTO9450
9400 IFMIS=3THENGOTO9460
9410 IFMIS=4THENGOTO9470
9420 IFMIS=5THENGOTO9480
9430 IFMIS=6THENGOTO9490
9440 INPUT@(11,1 )"";H$:GOTO9500
9450 INPUT@(35,1 )"";TC:GOTO9500
9460 INPUT@(14,2)"";B1 :GOTO9500
9470 INPUT@(32,2)"";B2:GOTO9500
9480 INPUT@(17,3)"";W:GOTO9500
9490 INPUT@(34,3)"";TNo:GOTO9500
9500 PRINT:PRINT:PRINT"Are these values NOW CORRECT?"
9510 PRINT"If so ENTER Y, if NOT ENTER 'N'"
9520 INPUTUSING("A",1,1 )ANS$:CLS
9530 IFANS$="Y"ORANS$="y"THENGOTO9570
9540 IFANS$="N"ORANS$="n"THENGOTO9315
9550 GOSUB9100
9560 PRINT"Please respond to 'Y' or 'N':":PRINT:GOTO9370
9570 KEYON
9580 RETURN
9600 REM *********************************
9610 REM BARCODE CONTROL ROUTINE
9620 PRINT:PRINT"Are you through sampling? (Barcodes 'Y' OR 'N')"
9630 WINPUTANS$:CLS
9640 IFANS$="Y"THENGOTO9680
9650 IFANS$="N"THENGOTO9690
9660 GOSUB9100
9670 BEEP:PRINT"Please respond: ":GOTO9620
9680 GOSUB11750:REM Print out & close STIX file (ie #2)
9685 GOSUB9000:REM Close File
9690 PRINT:PRINT"Will you do another plot? (Barcodes 'Y' or 'N')H
9700 WINPUTANS$:CLS
9710 IFANS$="Y"THENGOTO9770
9720 IFANS$="N"THENGOTO9750
9730 GOSUB9100
9740 BEEP:PRINT"Please respond: ":GOTO9690
9750 GOSUB9000:REM Close File
9760 GOTO9810
9770 PRINT:PRINF”Plot number (nnn) «- 'E' [USE BARCODES]"
9780 GOSUB8000
9790 P=VAL(Z$)
9800 TNo="":GQtO7000
9810 PRINT:PRINT"Do you; want to know the"
9920 PRINT'AVERAGE PLOT DENSITY? (Barcodes ‘V’ or 'N')"
9830 WINPUTANS$:CLS
```

```
9840 IFANS$="Y"THENGOTO9880
9850 IFANS$="N"THENGOTO9900
9860 GOSUB9100
9870 BEEP:PRINT"Please respond: ":GOTO9810
9880 GOSUB860
9900 PRINT:PRINT"Do you want to know the"
9910 PRINT-STAND DENSITY? (Barcodes 'Y' or 'N')"
9920 WINPUTANS$:CLS
9930 IFANS$="Y"THENGOTO9970
9940 IFANS$="N"THENGOTO10010
9950 GOSUB9100
9960 BEEP:PRINT"Please respond: ":GOTO9900
9970 GOSUB1000
10010 PRINT:PRINT"Do you want to know the"
10020 PRINT"SAMPLING PRECISION? (Barcodes 'Y' or 'N')"
10030 WINPUTANS$:CLS
10040 IFANS$="Y"THENGOTO10080
10050 IFANS$="N"THENGOTO10160
10060 GOSUB9100
10070 BEEP:PRINT"Please respond: ":GOTO10010
10080 GOSUB11460
10160 PRINT:PRINT"Do you want to know the NUMBER OF"
10170 PRINT"TREES NEEDED to be sampled to reach your"
10180 PRINT"specified sampling precision? "
10185 PRINT"(Barcodes 'Y' or 'N')"
10190 WINPUTANS$:CLS
10200 IFANS$="Y"THENGOTO10232
10210 IFANS$="N"THENGOTO10330
10220 GOSUB9100
10230 BEEP:PRINT"Please respond: ":GOTO10160
10232 GOSUB10240
10234 GOTO10330
10240 PRINT:PRINT"Sampling Precision Desired? (nn + 'E')"
10250 PRINT"[Use Barcodes WITHOUT Including Decimal]"
10260 GOSUB8000
10270 DP=VAL(Z$):DP=DP/100:CLS
10280 GOSUB5650
10290 GOSUB6640
10292 RETURN
10330 PRINT:PRINT"Do you want to REVIEW the plot sampling"
10340 PRINT"STATISTICS once again? (Barcode 'Y' or 'N')"
10350 WINPUTANS$:CLS
10360 IFANS$="Y"THENGOTO10400
10370 IFANS$="N"THENGOTO760
10380 GOSUB9100
10390 BEEP:PRINT"Please respond: ":GOTO10330
10400 GOSUB11500
10410 GOTO760
11300 REM************************************
11302 "BASIC CALCULATIONS TO DETERMINE SAMPLING PRECISION & STATISTICS
11304 '   This is a subroutine to determine the SAMPLING PRECISION (PRE)
11306 '   using the computed SE and Mean Density of the sample
11308 '   DTR=SBW Density/Tree; DSTR=Sum of the Densities/Tree; SQSDTR=Square
11310 '   of the Sum of the Densities; MSQSDTR=Mean of SQ of the Sum of the
11312 '   Densities; DTRSQ=SBW Density/Tree Squared; ZZ=Sum SBW Density/Tree
```

```
11314 ' Squared; VAR=Variance; SD=Standard Deviation; SE=Standard Error of
11316 ' the Mean; MDTR=Mean SBW Density/Tree; PRE=SAMPLING PRECISION
11318 REM     =(SE/Mean Density/Tree).
11320 DTR=WSTR/STRA
11330 DSTR=DSTR+DTR
11340 SQSDTR=DSTR*DSTR
11350 MSQSDTR=SQSDTR/TR
11360 DTRSQ=DTR*DTR
11370 ZZ=ZZ+DTRSQ
11380 VAR1 =ZZ-MSQSDTR
11390 IFTR<QTRTHENGOTO11480ELSE11400
11400 VAR=VAR1/(TR-1)
11410 SD=SQR(VAR)
11420 SE=SD/SQR(TR)
11430 MDTR=DSTR/TR
11440 PRE=(SE/MDTR)
11450 GOTO11480
11460 PRINT"Sampling PRECISION (SE/M)=";PRE
11470 FORI=1TO1600:NEXTI
11480CLS:RETURN
11500 REM*****************************
11510 REM STATISTICS UPDATE (INCLUDING SAMPLING PRECISION)
11520 IFTR>QTRTHENGOTO11530ELSE11670
11530 KEYOFF:CLS
11540 IFLEFT$(F1$,2)="PU"THENGOSUB11700
11550 IFLEFT$(F1$,2)="EX"THENGOSUB11700
11552 IFLEFT$(F1$,2)="PUTHENGOTO11570
11554 IFLEFT$(F1$,2)="EX"THENGOTO11570
11560 PRINT:PRINT"Ave PLOT Density=";DEN
11570 PRINT"Mean Dens/Tree=";MDTR;" Sample=";TR;"Trees"
11580 PRINT"Total FOLIAGE Area Examined=";SA;"sq.m."
11590 PRINT"Total SBW Found on Plot=";SW
11600 PRINT:INPUT"[Press ENTER to Continue]",jk
11610 CLS:PRINT:PRINT"VARIANCE=";VAR
11620 PRINT"SD=";SD;"          SE=";SE
11630 PRINT-Samp PRECISION (SE/Mean Dens/TR)=";PRE
11650 PRINT:INPUT"[Press ENTER to continue]",jk:KEYON
11660 RETURN
11670 CLS:PRINT:BEEP:PRINT"You must first sample more trees!"
11680 FORI=1TO1200:NEXTI
11690 RETURN
11700 PRINT:PRINT"LOWER-crown AVE PLOT density=";DEN
11710 PRINT"       MID-Crown PUP/EXU Density Correction"
11720 PRINT"                  for ";F1$;" is";MCDEN
11730 RETURN
11750 REM***********************************************
11760 REM 'PRINT OUT STATISTICS FOR FILE #2
11770 PRINT:PRINT"File Name For ";F1$;" Statistics"
11780 PRINT-Will Be 'STIX";P$;".DTA'"
11790 FORI=1TO2000:NEXTI
11800 F2$="STIX"+P$
11810 OPENF2$+".DTA"FOR APPENDAS2
11820 PRINT#2,STRING$(45,42)
11830 PRINT#2,"REViEW OF PLOT ";P$;" STIX FOR RLE ";F1$
```

```
11840 PRINT#2,STRING$(45,"-")
11850 PRINT#2,"Sample Date=";D;YEAR$;"   SAMPLE=";TR;" Trees"
11860 IFLEFT$(F1$,2)="PU"THENGOSUB12500
11870 IFLEFT$(F1$,2)="EX"THENGOSUB12500
11880 IFLEFT$(F1$,2)<>"PU”THEN11900ELSE11910
11890 IFLEFT$(F1$,2)<>"EXTHEN11900ELSE11910
11900 PRINT#2, “Ave PLOT Density=”;DEN
11910 PRINT#2,"Mean Density/Tree=";MDTR
11920 PRINT#2,"Total Foliage Area Examined=";SA;” sq. m."
11930 PRINT#2,"Total SBW Found on Plot=";SW
11940 PRINT#2,"VARIANCE=";VAR
11950 PRINT#2,"SD=";SD;"             SE=";SE
11960 PRINT#2,"Samp PRECISION (SE/Mean Dens/TR)=";PRE
11980 PRINT#2,"Sampler=";S1$;"           Examiner=";S2$
11990 PRINT#2,"Examination Date=";D1 ;YEAR$
12000 PRINT#2,STRING$(45,42)
12010 CLOSE#2
12020 RETURN
12500 PRINT#2,"LOWER-Crown AVE PLOT DENSITY=";DEN
12510 PRINT#2,"          MID-Crown PUP/EXU Density Correction"
12520 PRINT#2,"                   for ";F1$;" is ";MCDEN
12530 RETURN
```

Appendix B

Actual Data Set Created by the Spruce Bud worm Sampling Program

Variable														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
92	130	1	1	2	111	47	35	1	.08231	2	FHS	506 92	FHS	506 92
92	130	1	1	2	211	56	34	14	.09521	2	FHS	506 92	FHS	506 92
92	130	1	2	2	111	48	51	10	.12241	2	FHS	506 92	FHS	506 92
92	130	1	2	2	211	40	43	6	.08601	2	FHS	506 92	FHS	506 92
92	130	2	3	2	111	46	41	6	.09431	2	FHS	506 92	FHS	506 92
92	130	2	3	2	211	46	40	6	.09201	2	FHS	506 92	FHS	506 92
92	130	2	4	2	111	42	52	12	.10921	2	FHS	506 92	FHS	506 92
92	130	2	4	2	211	45	53	22	.11931	2	FHS	506 92	FHS	506 92
92	130	1	5	2	111	45	60	20	.13501	2	FHS	506 92	FHS	506 92
92	130	1	5	2	211	43	45	3	.09681	2	FHS	506 92	FHS	506 92
92	130	2	6	2	111	52	65	12	.16901	2	FHS	506 92	FHS	506 92
92	130	2	6	2	211	44	35	10	.07701	2	FHS	506 92	FHS	506 92
92	130	1	7	2	111	49	40	12	.09801	2	FHS	506 92	FHS	506 92
92	130	1	7	2	211	45	30	4	.06751	2	FHS	506 92	FHS	506 92
92	130	1	8	2	111	41	32	3	.06561	2	FHS	506 92	FHS	506 92
92	130	1	8	2	211	47	47	22	.11051	2	FHS	506 92	FHS	506 92
92	130	1	9	2	111	50	26	13	.06501	2	FHS	506 92	FHS	506 92
92	130	1	9	2	211	45	41	22	.09231	2	FHS	506 92	FHS	506 92
92	130	1	10	2	111	45	40	8	.09001	2	FHS	506 92	FHS	506 92
92	130	1	10	2	211	47	37	5	.08701	2	FHS	506 92	FHS	506 92
92	130	1	11	2	111	43	26	3	.05591	2	FHS	506 92	FHS	506 92
92	130	1	11	2	211	52	26	5	.06761	2	FHS	506 92	FHS	506 92
92	130	1	12	2	111	44	44	1	.09681	2	FHS	506 92	FHS	506 92
92	130	1	12	2	211	49	37	10	.09071	2	FHS	506 92	FHS	506 92
92	130	2	13	2	111	48	43	5	.10321	2	FHS	506 92	FHS	506 92
92	130	2	13	2	211	46	52	10	.11961	2	FHS	506 92	FHS	506 92
92	130	1	14	2	111	46	30	12	.06901	2	FHS	506 92	FHS	506 92
92	130	1	14	2	211	52	45	11	.11701	2	FHS	506 92	FHS	506 92
92	130	1	15	2	111	54	53	8	.14311	2	FHS	506 92	FHS	506 92
92	130	1	15	2	211	44	46	5	.10121	2	FHS	506 92	FHS	506 92
92	130	2	16	2	111	43	39	2	.08391	2	FHS	506 92	FHS	506 92
92	130	2	16	2	211	41	45	31	.09231	2	FHS	506 92	FHS	506 92
92	130	2	17	2	111	40	35	7	.07001	2	FHS	506 92	FHS	506 92
92	130	2	17	2	211	41	31	11	.06361	2	FHS	506 92	FHS	506 92
92	130	2	18	2	111	42	43	3	.09031	2	FHS	506 92	FHS	506 92
92	130	2	18	2	211	41	35	19	.07181	2	FHS	506 92	FHS	506 92
92	130	2	19	2	111	41	33	12	.06771	2	FHS	506 92	FHS	506 92
92	130	2	19	2	211	40	38	15	.07601	2	FHS	506 92	FHS	506 92
92	130	1	20	2	111	53	59	27	.15641	2	FHS	506 92	FHS	506 92
92	130	1	20	2	211	48	39	23	.09361	2	FHS	506 92	FHS	506 92

KEY TO VARIABLES:

1. Year of the sample
2. Plot number
3. Host code: 1 =Douglas-fir, 2=Grand Fir
4. Sample tree number
5. Crown level: 1=Upper, 2=Middle 3=Lower
6. Tip code: 111 = 1st Tip, 211 = 2nd Tip
7. Tip length (cm)
8. Tip width (cm)
9. Number of live budworms/egg masses found
10. Square meters of foliage on tip
11. Tree height class: 1=<7m, 2=7-14m, 3=>14m
12. Sampler's initials
13. Sample date
14. Examiner's initials
15. Examination date

Appendix C

Actual Statistics File Created by the Spruce Budworm Sampling Program

```
**********************************************************
REVIEW OF PLOT 130 STIX FOR FILE LAR13092.DTA
--------------------------------------------------------------------------------

Sample Date= 506 92 Sample= 20 Trees
Ave PLOT Density- 113.885
Mean Density/Tree= 98.801
Total Foliage Area Examined= 3.7845 sq. m.
Total SBW Found on Plot= 431
VARIANCE- 95.2631
SD= 9.76028            SE= 2.18246
Samp PRECISION (SE/Mean Dens/TR)= .0220894
Sampler=FHS     Examiner=FHS
Examination Date= 506 92
**********************************************************
```

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