Research Note

USDA FOREST SERVICE INT-289
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
507—25th STREET, OGDEN, UTAH 84401

March 1980

MEASURING ANNUAL GROWTH RINGS USING AN ELECTRONIC MEASURING MACHINE

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ABSTRACT

Measurement of tree diameter growth is important in most forestry research. The electronic Addo-X system for measuring annual growth rings is described. The measurements, accurate to 0.01 mm, are recorded on printed tape and punched cards. The problems, time, and costs of measuring increment cores and tree cross sections are discussed.

KEYWORDS: Increment cores, measurement, growth, equipment

Measuring of tree diameter growth, important in most forestry research, may be accomplished by a variety of methods. Repeated diameter measurements on tagged trees was one of the first methods used. This procedure involves following individual trees over time, remeasuring each tree at 5- to 10-year intervals. Increment cores, used in assessing diameter increment, are easy to collect and use. Cross sections, also used in tree growth studies, generally are more difficult to transport, store, prepare and measure than increment cores.

A forest growth experiment may require many samples consisting of increment cores or cross sections. It is time consuming to measure accurately the width of each annual ring in cores or cross sections from thousands of trees, using a hand-operated measuring device. Also, hand recording the reading from a measuring device onto data forms may result in many errors. Additional errors may occur during transcription from the forms to punched cards or tapes. Much time and effort may be spent in finding and correcting errors.

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Several different pieces of equipment have been developed and used to measure increment cores. They range in sophistication from a modified ruler to electronic and mechanical systems. In 1939, the development of the Bannister incremental measuring machine was started.[2] It is a hand-operated machine, but through an interface system it may be connected with automatic data processing equipment. With electronic measuring systems becoming more sophisticated, the Addo-X[3] electronic annual growth ring measuring machine was developed. It is a power driven machine that is capable of automatically recording the increment measurements onto punched cards or tape.

THE ADDO-X SYSTEM

The Addo-X system is an electronic system developed to measure the width of annual growth rings on increment cores or cross sections. It makes the measurement of the samples easy, efficient, and accurate. The system contains three components: a measuring unit, a mechanical adding machine, and an IBM 029 keypunch.

The measuring unit does the actual measuring of the samples. The samples are measured by viewing the annual rings through a 20 or 40 power microscope with a cross hair. The increment cores or cross sections are held in special holders while being measured and are moved under the microcsope by a motor-driven mechanical stage. To facilitate rapid sample measurements, the stage may be moved at various speeds, which are controlled by light hitting a photo resistor. The more light hitting the photo resistor, the faster the stage moves; the less light hitting the photo resistor, the slower the stage moves. A manual fine adjustment is provided for accurately placing the cross hairs on the beginning and end of each annual increment. An electronic counter in the measuring unit is controlled by the same light source as the speed control. If the light source fails, the carriage will not move. To insure measurement accuracy, the angle at which the cores move under the microscope may be adjusted. This enables each core or cross section that is being measured to be turned so that the vertical cross hair is perpendicular to the radius or core. From the electronic counter, the measurement is sent to an indicator box that visually shows the width of each annual ring and the total number of rings measured.

The second part of this system is a mechanical adding machine with electronic input. It receives the measurements from the measuring unit and records the subtotal of the measurements or subtracts the measurement from the total previous measurements.

The third part of the system is a modified 029 IBM keypunch, with two drums to control the spacing and locating of data on each keypunch card. The keypunch receives the information from the adding machine via an electronic interface. The data may be arranged on the keypunch card in almost any manner desired.

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[2]Fred C. Henson Co., 27402 Camino Capistrano, Laguna, California 92677.

[3]Technicon Systems Service, 304 East Alameda Avenue, Burbank, California 95102. Approximate price, 1977, $25,000.

Measuring Capabilities

The Addo-X system has many options for recording annual ring measurements. Ring widths may be measured in 0.01 mm intervals up to a maximum ring width of 9.99 mm. Ring widths also can be measured in 0.1 mm intervals up to a maximum ring width of 99.9 mm. Ring width measured in 0.1 mm may be multiplied by 2, up to a maximum ring width of 49.9 mm, converting to a diameter measurement from a radial measurement. Each increment measurement and the subtotal after each measurement may be recorded. Also, a diameter measurement may be entered (at the beginning of the core) and each annual ring subtracted from that diameter. The last recording capability of the system is a total number of measurements, or age, up to 999. For consistency in the measurements, the measurement option should be selected before the ring width measuring is started.

Sample Types

The Addo-X System is designed primarily to measure increment cores. The increment cores should be less than 200 mm in length and have a diameter greater than 4 mm and less than 5.5 mm. Currently the system can also handle increment cores mounted in blocks of wood (Haavisto 1970); it could be modified to handle most other type increment cores without much difficulty.

Cross sections 1 m to 1-1/2 m in diameter involving large amounts of wood can also be handled on the Addo-X. A normal cross section to be measured in its entirety should be less than or equal to 20 cm in diameter, and no greater than 2-1/2 cm thick. Cross sections larger than this require special preparation. The first step is to choose a radius or diameter to be measured, preferably in the field. This radius or diameter should be cut out of the cross section, leaving a portion of the cross section less than 13 cm wide, 20 cm long, and 2-1/2 cm thick. The partial cross section should be sanded, or grooved using a router or a dado blade on a table saw to make an even, uniform surface for measuring. Each portion of a large cross section should be properly labeled for later identification.

Sample Preparation

After an increment core is extracted from the tree it should be placed in a holder to prevent damage and permit labeling. A plastic drinking straw, taped or stapled at each end, works nicely for this purpose. Increment cores should be stored in a cool, dry place, making sure that the cores are not damaged. Cole (1977), in a study using lodgepole pine, recommended the increment cores be sealed tightly in a straw and frozen. This method is advised if the increment cores cannot be measured within 3 days after extraction. For most circumstances, freezing is not feasible, thus storing the cores in a cool, dry place and soaking prior to measurement, gives excellent results over long-term work. Soaking each core for at least 12 hours ensures that the entire core is a size comparable to when it was removed from the tree (table 1). This procedure also eliminates any differences in moisture content of cores taken over a summer field season.

One of the most difficult problems in handling large numbers of increment cores is properly identifying the sample. The identification code should be written on the straw in waterproof ink that will not disappear during the soaking procedure. All characters in the ID fields should be numeric to enable input through the adding machine. Special procedures can be used for entering alphabetic characters into the ID fields but require additional time.

Table 1.--*Percent radial shrinkage after air drying and resoaking increment cores*[1]

Species	Air dried	Average percent shrinkage from original length Soaking time					
		1/2	1	1-1/2	2	12	24
		Hours					
Western white pine	2.22	0.39	0.39	0.17	0.37	0.70	0.31
Western larch	3.58	.58	.85	.80	.26	1.26	.60
Douglas-fir	3.51	.85	1.06	1.12	1.48	1.50	.83
Grand fir	1.80	.52	.61	.97	.98	1.81	.77
Western redcedar	1.90	.80	.74	.81	.79	.69	.58
Lodgepole pine	3.68	.92	.59	.39	1.21	.90	1.62
Subalpine fir	2.50	1.16	.99	1.28	1.43	--	1.56
Ponderosa pine	3.91	1.28	1.23	.61	1.02	--	1.63
Treatment average	2.89	.81	.81	.77	.94	1.14	.99

[1]Adapted from: Ferguson, D. E. 1977. Operating manual for measurement of tree ring growth with the Addo system. Unpublished manuscript on file at Forestry Sciences Laboratory, Moscow, Idaho.

Boyd[4] developed a core-slicing device that fits over the increment core holder, slicing a flat surface on the core. The core slicer should have a sharp blade and be properly adjusted to provide a clean cut. After slicing, the increment core can be read easily under the 20- or 40-power microcsope without refocusing.

As with increment cores, the label on cross section samples should contain all identification information. This information can be written on the cross section itself or attached using small metal tags. Storage of cross sections is somewhat more difficult due to their size. Cold storage is the best procedure because it minimizes check and mold. Preservatives such as moth balls included inside the sacks that contain the cross sections create an unpleasant odor for the instrument operator and do not prevent sample deterioration. Therefore, preservatives are not recommended in cross section shipment or storage.

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[4]Boyd, R. J., Silviculturist, Forestry Sciences Laboratory, Intermountain Forest and Range Experiment Station, USDA Forest Service, Moscow, Idaho (personal communication).

System Accuracy

The Addo-X system should be checked daily to make sure it is in proper adjustment. The measuring unit is influenced by decreases in line voltage that cause a decrease in the intensity of the light controlling the measuring unit, resulting in erroneous measurements. To minimize the problem the measuring unit should be connected to a separate electrical circuit. The light source should be checked each day by running a known width underneath the microscope to make sure that the light source has not faded. The keypunch machine including the drum cards should be checked daily for proper operation. A qualified repair technician should check frequently to assure the keypunch machine is properly adjusted.

Various problems may occur when measuring cores and cross sections:

1. Discontinuous or false rings are difficult to detect unless there is a cross section or more than one core is removed from the tree. The operator should be instructed as to how to handle such irregularities when recording the data.

2. The operator should be trained to take the slack out of the movable stage to assure that a proper measurement is obtained when passing over a gap or crack.

3. An error of 0.10 to 0.15 mm can be introduced in a measurement if the focus of the microscope is changed while measuring an annual ring.

4. Allowing the control switch for the entire system to rebound will cause erroneous measurements.

5. It is possible to operate the measuring unit faster than the adding machine and the keypunch can process the measurements. Therefore, each measurement should be completely through the system before the next measurement is entered.

When compared with measurements taken in the field the Addo-X measurements have greater accuracy. This may lead to some problems in analyzing the data. If differences in growth or age are required in the analysis, the same technology should be used for the two measurements used in determining the difference. For example, to find the difference between age at breast height and age at the base of the live crown, the same technology should be used in measuring the age at both places. The Addo-X should not be used at one point and a hand count in the field used at the other point. This procedure often leads to an error in the differences.

Time and Cost

The Addo-X system is an efficient system for handling large numbers of increment cores. In an hour, an experienced operator can measure approximately 15 increment cores less than 5 cm long, or about 10 cores 5-to 15-cm long (table 2). However, length of the core is not as important as the number of annual rings in determining the amount of time required for measuring. The time required for preparing increment cores is a small amount of the total measuring process.

Table 2.--*Time and cost of measuring increment cores and cross sections with the Addo-X system*

Sample type	Sample preparation	Measurement	Editing and corrections	Total cost sample ($)[1]
Cores (length)				
≤ 5 cm	Nominal	15/h	1 h/2000 cards	$0.34
> 5 cm	Nominal	10/h	1 h/2000 cards	.50
Cross sections[2] (diameter)				
≤ 5 cm	60/h	20/h	1 h/2000 cards	.34
5-35 cm	30/h	15/h	1 h/2000 cards	.50
> 35 cm[3]	2/h	2/h	1 h/2000 cards	5.00

[1]Costs include sample preparation, measuring, operator, and equipment maintenance.
[2]Radii per cross section.
[3]200-300 annual rings.

For cross sections less than 5 cm in diameter, about 60 cross sections per hour may be prepared and up to 30 cross sections (2 radii) per hour may be measured with the Addo-X. For cross sections 5 cm to 35 cm in diameter, 30 per hour may prepared and approximately 15 per hour (2 radii) may be measured. For cross sections greater than 35 cm (over 200 years old), more preparation is required, and approximately two per hour may be prepared, and two per hour (2 radii) measured.

The above examples are averages from the many thousands of cores and hundreds of cross sections that have been measured at the Moscow laboratory using the Addo-X system.

Data Editing

The data editing normally required on a set of Addo-X data involves checking for such things as the proper sample identification and plot numbers. Also, a check is made to determine that each one of the subtotals is increasing in size. A computer program used for data editing is provided in the appendix.

CONCLUSIONS

From past experience in measuring thousands of cores of all sizes and many hundreds of cross sections, the Addo-X system has been shown to be fast and accurate. This system minimizes the chance for transcription error or normal operator error such as may occur when using a ruler or other types of measuring devices. Also, this system provides a machine readable output in the form of punched cards, which can be read directly by a computer for checking and analysis.

The most important part of the entire procedure is proper sample preparation. It may take longer to prepare the samples (cross sections), make sure that the ID fields are correct, and transcribe any information that may not be included with the sample than it does to actually measure the sample. As mentioned before, the operator can usually operate the Addo-X system faster than the keypunch and adding machine can accept the information.

Personnel may be easily trained to use the equipment. After one day of operation, most operators can accurately measure increment cores or cross sections. The cost per sample is very reasonable for the accuracy obtained (table 2). Many types of measurements have been taken with the Addo-X system, and it may be adapted to almost any radial increment measurements or age determination.

PUBLICATIONS CITED

Cole, Dennis M.
1977. Protecting and storing increment cores in plastic straws. USDA For. Serv. Res. Note INT-216, 3 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Haavisto, V. F.
1970. A multiple core holder for Addo-X. For. Chron. 46(3):194-195.

APPENDIX
COMPUTER PROGRAM FOR SCREENING ADDO-X DATA

```
      DIMENSION IALL(80),NALL(80)
C     THIS IS AN EXAMPLE OF A COMPUTER PROGRAM WE USED TO SCREEN
C     DATA GENERATED BY THE ADDO SYSTEM.  OTHER JOBS REQUIRE
C     WRITING A NEW COMPUTER PROGRAM BUT GENERAL CONCEPTS
C     EXPLAINED BELOW WOULD APPLY.  THE SAMPLING DESIGN WAS
C     TWO HUNDRED 10 OR 14 POINT CLUSTERS.  ON EACH POINT
C     COMBINATIONS OF 10 DIFFERENT TREE SPECIES COULD OCCUR.
C     EACH TREE WAS CONSECUTIVELY NUMBERED, SPECIES WAS
C     RECORDED, AND TWO INCREMENT CORES WERE EXTRACTED
C     FROM EACH TREE.  THE SUBTOTALING METHOD WAS USED TO
C     RECORD THE DATA ON COMPUTER CARDS.
C
      N=0
C     COMPUTER CARD FORMAT:
C    VARIABLE  COLUMN  EXPLANATION
C    --------  ------  -----------
C       ICL       1-3  CLUSTER NUMBER.  RANGE IS FROM 1 THROUGH 200.
C       IPT       4-5  POINT NUMBER.  UP TO 14 POINTS PER CLUSTER.
C       ITRE      6-7  TREE NUMBER.  ALTHOUGH THIS VARIES FROM
C                      POINT TO POINT, THE MAXIMUM WAS ABOUT 20
C                      TREES PER POINT.
C       ICORE     8-9  CORE NUMBER.  THIS MUST BE EITHER CORE #1
C                      OR CORE #2.
C       ISPP    10-11  SPECIES CODE.  RANGE IS FROM 1 THROUGH 10.
C       I          12  COLUMN 12 WAS SKIPPED ON THE COMPUTER CARD.
C                      IT SHOULD ALWAYS BE BLANK.
C       I1      13-17
C       .         .
C       .         .
C       .         .
C       I13     73-77  THIRTEEN 5-DIGIT SUBTOTAL FIELDS.
C      IAGE     78-80  TREE AGE.  AGE VARIES BUT MAXIMUM WAS ABOUT
C                      150 YEARS.  AGE WAS NOT ALWAYS OBTAINABLE.
C
      READ(5,100) ICL,IPT,ITRE,
     ,ICORE,ISPP,I,I1,I2,I3,I4,I5,I6,I7,I8,I9,I10,I11,I12,I13,IAGE,IALL
      GO TO 1
C
C     READ COMPUTER CARD.  BRANCH TO STATEMENT '999' AT END OF DATA.
C
   10 READ(5,100,END=999) ICL,IPT,ITRE,
     ,ICORE,ISPP,I,I1,I2,I3,I4,I5,I6,I7,I8,I9,I10,I11,I12,I13,IAGE,IALL
C
C     CHECK FOR INCREMENTATION FROM ONE CARD TO ANOTHER
C
      IF(ICL.EQ.NCL.AND.IPT.EQ.NPT.AND.ITRE.EQ.NTRE.AND.ICORE.EQ.NCORE.
     , AND.ISPP.EQ.NSPP.AND.N13.GE.I1) WRITE (6,112) NALL,IALL
C
C     CHECK FOR CLUSTER VALUES OUTSIDE THE RANGE 1 THROUGH 200
C
    1 IF(ICL.GT.200.OR.ICL.LT.1) WRITE(6,102) IALL
C
C     CHECK FOR PLOT VALUES OUTSIDE THE RANGE 1 THROUGH 14
C
      IF(IPT.GT.14.OR.IPT.LT.1) WRITE(6,104) IALL
```

```
C
C     CHECK FOR TREE NUMBERS OUTSIDE THE RANGE 1 THROUGH 20
C
      IF(ITRE.GT.20.OR.ITRE.LT.1) WRITE(6,105) IALL

C
C     CHECK FOR CORE NUMBERS NOT EQUAL TO '1' OR '2'
C
      IF(ICORE.LT.1.OR.ICORE.GT.2) WRITE(6,106) IALL
C
C     CHECK FOR SPECIES CODES OUTSIDE THE RANGE 1 THROUGH 10
C
      IF(ISPP.GT.10.OR.ISPP.LT.1) WRITE(6,107) IALL
C
C     CHECK FOR ANY PUNCHES IN COLUMN 12 - IT SHOULD BE BLANK
C
      IF(I.NE.0) WRITE(6,108) IALL
C
C     CHECK FOR NO VALUE ENTERED IN FIRST FIELD.  THIS WOULD INDICATE A
C     CARD WITH NO MEASUREMENTS ON IT.
C
      IF(I1.LE.0) WRITE(6,109) IALL
C
C     CHECK FOR INCREMENTATION ACROSS THE CARD
C
      IF(I2.LE.I1.AND.I2.NE.0)    WRITE(6,103) IALL
C
      IF(I3.LE.I2.AND.I3.NE.0)    WRITE(6,103) IALL
C
      IF(I4.LE.I3.AND.I4.NE.0)    WRITE(6,103) IALL
C
      IF(I5.LE.I4.AND.I5.NE.0)    WRITE(6,103) IALL
C
      IF(I6.LE.I5.AND.I6.NE.0)    WRITE(6,103) IALL
C
      IF(I7.LE.I6.AND.I7.NE.0)    WRITE(6,103) IALL
C
      IF(I8.LE.I7.AND.I8.NE.0)    WRITE(6,103) IALL
C
      IF(I9.LE.I8.AND.I9.NE.0)    WRITE(6,103) IALL
C
      IF(I10.LE.I9.AND.I10.NE.0)  WRITE(6,103) IALL
C
      IF(I11.LE.I10.AND.I11.NE.0) WRITE(6,103) IALL
C
      IF(I12.LE.I11.AND.I12.NE.0) WRITE(6,103) IALL
C
      IF(I13.LE.I12.AND.I13.NE.0) WRITE(6,103) IALL
C
C     CHECK FOR AGE GREATER THAN 150 YEARS
C
      IF(IAGE.GT.150) WRITE(6,111) IALL
C
C     INCREMENT THE CARD COUNTER
C
      N=N+1
```

```
C
C     SAVE VALUES OF CARD JUST READ TO CHECK FOR INCREMENTATION ON
C     CONTINUATION CARD
C
      NCL=ICL
      NPT=IPT
      NTRE=ITRE
      NCORE=ICORE
      NSPP=ISPP
      N13=I13
      DO 2 I=1,80
    2 NALL(I)=IALL(I)
C
C    RETURN AND READ A NEW CARD
C
      GO TO 10
  999 CONTINUE
C
C     WRITE OUT NUMBER OF CARDS SCREENED
C
      WRITE(6,114) N
C
C     FORMAT STATEMENTS
C
  100 FORMAT(I3,4I2,I1,13I5,I3,T1,80A1)
  102 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- CLUSTER')
  103 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- INCREMENTATION')
  104 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- POINT')
  105 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- TREE #')
  106 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- CORE #')
  107 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- SPECIES')
  108 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- COL 12 NOT BLANK')
  109 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- FIRST FIELD ZERO')
  111 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- AGE EXCEEDS 150 ')
  112 FORMAT('0',3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,/,' ',     3A1,1X,4(2A1,1X),A1,1X,7(5A1,1X),/,T20,6(5A1,1X),3A1,3X
     ,,'<-- CARD SEQUENCE')
  114 FORMAT('0NUMBER OF CARDS SCREENED = ',I6)
      STOP
      END
```

SAMPLE DATA WITH ERRORS UNDERLINED

```
20005020201 00091002410037900501006590080700965011060124701366014851
20005020201 001180026800421005410038000820009510107001193013220140201479     015
                                --------
20001030201 000670014600229003220040200479005380061200689007740085800940     015

20302060201 000970023300361004730055700738009000107501246014111
---
20009070201 0007200179002640034500473005770068900797009350107701198013090 1416

20009070201 01101                                                            015
            -----
20002050289 0009100199003170042100520006240073200843009210100501088011860 1282
         --
20006060101 000920025900412005080066100806009340105101166012 65              014

20052070101 000330010500203002800037100465005480064600754008600094701056     014
   --
20003030101 0004500122001600021600298004130050900597007050079900873009430 1021

20003030101 01048                                                            014

20008030231 00095002440038200523006500075700879009860112101252013820 1486
         --
20006050201 00078001990031400395004990059000663007480084600950010270 1104    214
                                                                             ---
20009060201 0007100208003250044300570006950078600889000200115301296014250 1559
                                                    -----
20009660201 01680
     --
2000303020110007600194003160042400539006560076100862009480104601128012120127 6014
           -
20021040201 00072001800026400343004270051900621007200082900944010550 1173
   --
20009040201 0008200217001560049100654008040074601076012280136301516016550 1790
                      -----               -----
20009040201 00000
            -----
20006050101 000920020500321004150051100620007250081600919010200 1102          614
                                                                              ---
```

SCREENED COMPUTER OUTPUT

```
200 05 02 02 01     00118 00268 00421 00541 00380 00820 00951
                    01070 01193 01322 01402 01479       015    <-- INCREMENTATION
203 02 06 02 01     00097 00233 00361 00473 00557 00738 00900
                    01075 01246 01411                          <-- CLUSTER
200 09 07 02 01     00072 00179 00264 00345 00473 00577 00689
                    00797 00935 01077 01198 01309 01416
200 09 07 02 01     01101
                                                        015    <-- CARD SEQUENCE
200 02 05 02 89     00091 00199 00317 00421 00520 00624 00732
                    00843 00921 01005 01088 01186 01282        <-- SPECIES
200 52 07 01 01     00033 00105 00203 00280 00371 00465 00548
                    00646 00754 00860 00947 01056       014    <-- POINT
200 08 03 02 31     00095 00244 00382 00523 00650 00757 00879
                    00986 01121 01252 01382 01486              <-- SPECIES
200 06 05 02 01     00078 00199 00314 00395 00499 00590 00663
                    00748 00846 00950 01027 01104       214    <-- AGE EXCEEDS 150
200 09 06 02 01     00071 00208 00325 00443 00570 00695 00786
                    00889 00020 01153 01296 01425 01559        <-- INCREMENTATION
200 09 66 02 01     01680
                                                               <-- TREE #
200 03 03 02 01 1   00076 00194 00316 00424 00539 00656 00761
                    00862 00948 01046 01128 01212 01276 014    <-- COL 12 NOT BLANK
200 21 04 02 01     00072 00180 00264 00343 00427 00519 00621
                    00720 00829 00944 01055 01173              <-- POINT
200 09 04 02 01     00082 00217 00156 00491 00654 00804 00746
                    01076 01228 01363 01516 01655 01790        <-- INCREMENTATION
200 09 04 02 01     00082 00217 00156 00491 00654 00804 00746
                    01076 01228 01363 01516 01655 01790        <-- INCREMENTATION
200 09 04 02 01     00082 00217 00156 00491 00654 00804 00746
                    01076 01228 01363 01516 01655 01790
200 09 04 02 01     00000
                                                               <-- CARD SEQUENCE
200 09 04 02 01     00000
                                                               <-- FIRST FIELD ZERO
200 06 05 01 01     00092 00205 00321 00415 00511 00620 00725
                    00816 00919 01020 01102             614    <-- AGE EXCEEDS 150
NUMBER OF CARDS SCREENED =      20
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☆ U.S. GOVERNMENT PRINTING OFFICE: 1979-0-677-121/112

The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

The Intermountain Station includes the States of Montana, Idaho, Utah, Nevada, and western Wyoming. About 273 million acres, or 85 percent, of the land area in the Station territory are classified as forest and rangeland. These lands include grasslands, deserts, shrublands, alpine areas, and well-stocked forests. They supply fiber for forest industries; minerals for energy and industrial development; and water for domestic and industrial consumption. They also provide recreation opportunities for millions of visitors each year.

Field programs and research work units of the Station are maintained in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)