Chapter 13

What Can be Learned about Forest Dynamics from the Age Distribution of Trees?

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Reprinted From: Gustell, S. L. and E. A. Johnson. 1998. What can be learned about forest dynamics from the age distribution of trees? Pages 217-226, *in* Tested studies for laboratory teaching, Volume 19 (S. J. Karcher, Editor). Proceedings of the 19th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 365 pages.

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Introduction

This exercise gives students a chance to sample and analyse data collected for tree age distributions which will allow them to gain an understanding of forest dynamics. Students will set up the sample plot, collect the data, and then prepare samples in the laboratory. They will learn various ways of presenting and interpreting data. Also, limitations of various sampling techniques for interpreting forest dynamics will be outlined.

Students will have some initial difficulty coring trees with an increment borer. When using the cores, care must be taken to include the pith when samples are collected. When sanding the cores, they must be mounted such that the xylem cells are perpendicular to the long axis of the core board.

This exercise has been designed for a third year terrestrial ecology course and should be completed in a 6 hour period. Field work should be completed in the first 3 hour period, and data analysis should be completed in the second 3 hour period. The instructor must pre-select a sample plot.

Materials

The following materials are adequate for one class of 20 students.

Field Equipment

tape measure (2)
20 cm stakes (4)
flagging tape (1 roll)
increment borers (6) (These can be purchased from Forestry Supplies, Inc. The price depends on the size of the borer. Prices start at roughly $150.)
medium tipped felt markers (6)

mounting boards for tree cores (enough for cores from 50 to 80 trees)
masking tape (6 rolls)
data sheets (6)
pencils (6)

Laboratory Equipment

white glue for wood (6 small bottles)
electric sander (optional)
sandpaper: 100, 150, 220, 350, 400 grit (5 sheets of each grain)
sanding blocks (6)
dissecting microscopes and lights (15)
11 inch x 8.5 inch graph paper (20 sheets)

Notes for the Instructor

Care must be taken when using the increment borers. The instructor should refer to Appendix A, and demonstrate proper coring techniques. When coring trees, it is essential that the tree is cored as close to the base of the tree as possible. This is to ensure accurate aging. To facilitate this, students should clear away forest floor material from around the base of the tree. Also, it is essential that the pith of the tree is not missed when obtaining a core, again to ensure accurate aging. This will take some practise and may require that each tree be cored more than once. When glueing cores onto boards, the students should ensure that the annual rings are perpendicular to the long axis of the core (see Figure 13.1), such that when the cores are sanded the xylem cells are clearly visible. Sanding of wood cores using an electric sander is useful at the coarse grain level (*i.e.*, 100 to 150). The instructor should ensure that students are familiar with the operation of the sander prior to use.

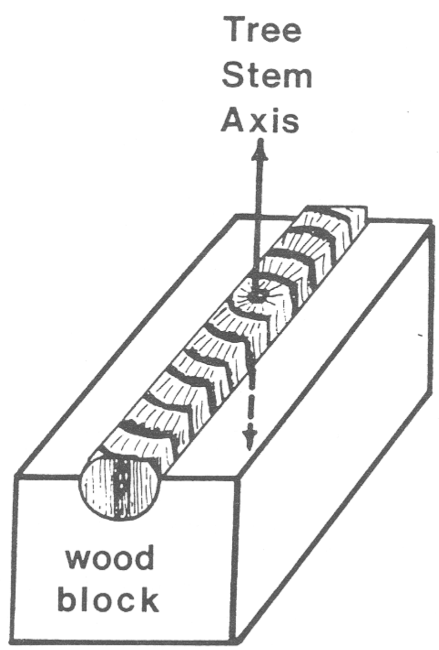

Figure 13.1. The core should be mounted such the pith and annual rings are vertically aligned.

Student Outline

Background Information

The major purposes of this study are:

1. To learn field sampling techniques for determining age distributions of trees and how to interpret data collected.
2. To examine the limitations of various sampling techniques for interpreting forest dynamics.

A forest can be thought of as being made up of different species of trees, with each species being grouped into those individuals born at the same time. These groups are called cohorts and are the basic unit for understanding forest dynamics. If one follows the individuals in these cohorts through their lives, the number in the cohort decreases as the cohort ages due to the deaths of individuals. The curve of their progressive loss by death over time is referred to as the survivorship curve (Figure 13.2). Consequently it takes a large number of seedlings to get one surviving mature tree into the forest canopy.

The forest is composed of populations of trees of different species with each population being made up of one or more (birth) cohorts. The age distribution of the population is the number of trees in the different cohorts which have survived to the time when the age distribution was determined. Since cohorts will have had different numbers of individuals born into them and suffered different mortality, they may have different numbers in their age class. (The relationship between mortality and survivorship is: mortality = 1 - survivorship.)

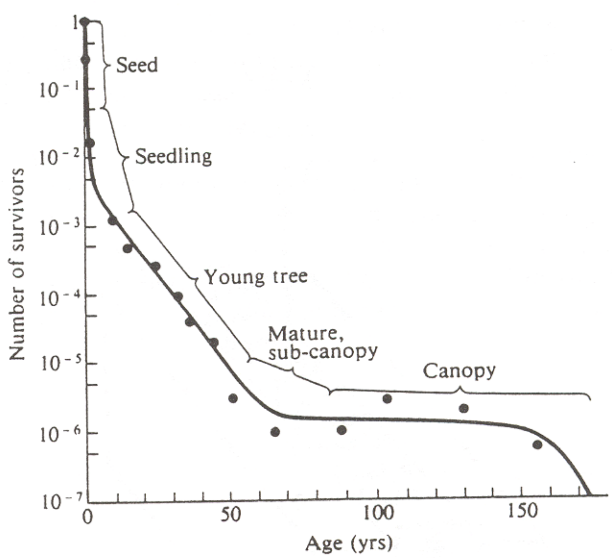

Figure 13.2. An example of a survivorship curve for a tree.

The *objective* of studying forest dynamics is to understand how the age patterns (*i.e.* age distribution) we see at any particular time are produced by the processes of birth and death.

Temperate forest trees, because they produce annual rings and thus keep a record of the age and conditions under which the tree grew, allow ecologists to gain an understanding of forest dynamics. In this lab we will use cores from live and dead trees to construct the age distribution. Cross-dating techniques will be used to determine the date of death of dead trees so they can be incorporated into the age distribution. Cross-dating is the method of matching distinctive ring patterns, usually very narrow rings, on trees of unknown age to similar patterns in trees of known age. The lab will emphasize the limitations of using only live trees in interpreting forest dynamics.

Procedures

Field Sampling

1. Locate a field site, preferably one that has not been logged or commercially thinned.
2. With measuring tapes, two students will mark off an area approximately ten meters by ten meters square. To do this, one student stands in place with the tape measure while another student walks in a straight line for ten metres. A stake is placed at the starting point and the ten metre mark. From the ten metre mark the second student must determine the direction perpendicular to the first line, either with a compass or square. The first student walks to the ten metre mark and the second student walks in the direction perpendicular to the first line for another 10 meters. The procedure is repeated until they return to the first corner. Some adjustments may be necessary as it is often difficult to locate the perpendicular lines.
3. With flagging tape number all trees within the 10 meter by 10 meter square area. Make a map of the location of each tree in the plot, including dead standing and downed trees. A tree here means any plant capable of growing into the forest canopy or sub-canopy (*i.e.*, tree, sapling or seedling).
4. Divide the group into three person teams. Each team gets one tree borer, some core boards and a data sheet. For all trees (live and dead) in the study plot, identify the species and core the tree at its base with the increment borer. See Appendix A for instructions on how to use an increment borer. When coring the tree the pith must be included in the core (see Figure 13.3, core B). All trees should be cored and measured as close to the base as possible. To do this, the forest floor around the base of the tree must be cleared of all debris before sampling. Small seedlings cannot be cored but will have to be sectioned or counted by bud scar scales.

6. Label core board with tree number and species, and glue core into place (see Figure 13.2). Mark location of the pith and bark on the core board.
7. On data sheets, record tree number, species and whether tree is live or dead (see Appendix B).

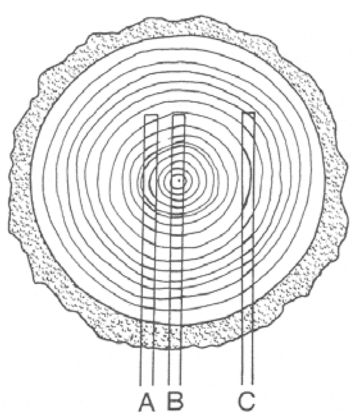

Figure 13.3. When coring a tree it is essential that the pith be included in the sample, as in core B.

Tree Core Preparation - Live Trees

1. Once the glue has dried, sand all cores from live trees with the electric sander, first with a coarse grit, 80 to 120, and then a finer grit, 150 to 180. Next, sand cores by hand with at least two successively finer papers (*e.g.*, 220 and 400). Cores must be sanded such that xylem cells are visible under the dissecting microscope.
2. Once cores from live trees have been fine sanded, count rings by starting with the outermost *complete* ring, adjacent to the bark. Label the outermost complete ring with the year prior to the year the study is undertaken. Count backwards towards the pith and, with a pencil, mark every decade year (*i.e.,* 1990, 1980, etc).
3. Record the age and year of birth of each tree on the appropriate data sheet.

Tree Core Preparation - Dead Trees

1. Sand all cores from dead trees as described above for live trees.
2. Choose 15 to 20 of the oldest *live* cores and construct a skeleton plot for each (Figure 13.4). Cut strips of graph paper and label the bottom axis with year, starting with the year of the study and going back in time. Examine each annual ring, indicating with a line on the graph paper, any years with relatively narrow growth. The narrower the ring, the longer the line to be drawn.

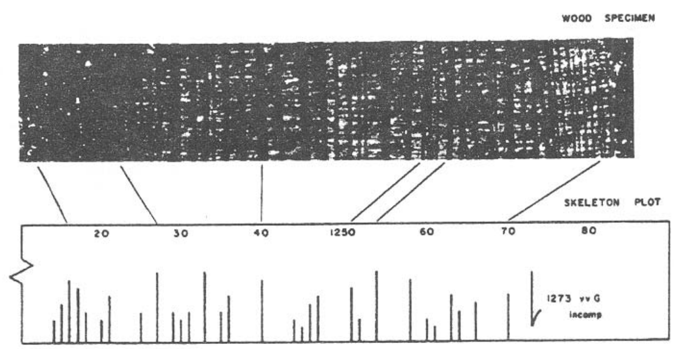

Figure 13.4. A skeleton plot for a wood sample. The skeleton plot high-lights the very narrow rings. The narrower the ring, the longer the marker drawn on the skeleton plot.

3. Compare all 20 skeleton plots and determine years which, on most or all trees, have relatively narrow growth *(i.e.,* marker ring). Using all marker rings, construct a master skeleton plot, also called master chronology [see Yamaguchi (1991) for one method of cross-dating].
4. Construct a skeleton plot for all *dead* trees. Compare each dead tree's skeleton plot with the master chronology in order to determine the date of death for each dead tree.

Analysis

1. Plot a Lexis diagram (Figure 13.5), with date on the abscissa and age on the ordinate.
2. For every 20-year period, construct an age distribution of all live and dead trees (Figure 13.6).

How to Interpret the Lexis Diagram

1. See if you can identify cohorts which have similar birth and death patterns. For example, cohorts which started in the open after a disturbance usually have no tree canopy above them. These cohorts will have different birth and death pattens than do cohorts which started and are growing under an existing tree canopy.
2. Try to determine the pattern of birth and death for each cohort.
3. Explain how the age distribution at different times was produced by your hypothesis about birth and death. An example of this kind of explanation can be found in Johnson (1992, Chapter 7).

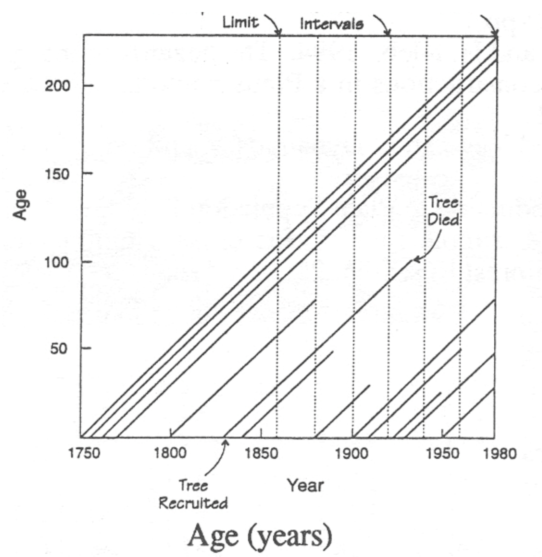

Figure 13.5. A Lexis Diagram.

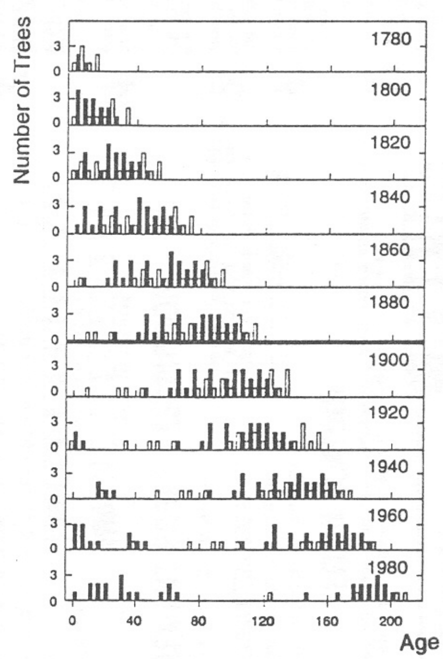

Figure 13.6. Age distributions at 20-year intervals.

Literature Cited and Further Readings

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Appendix A
How to Use an Increment Borer

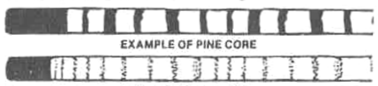
Increment Borers
Suggestions and Instructions for their Use and Care

WHAT IS AN INCREMENT BORER?

AN INCREMENT BORER IS THE ESSENTIAL TOOL FOR EXTRACTING A CORE OF WOOD FROM TREES, LOGS, POLES OR TIMBERS.*

The wood core is used for many purposes, among them are:

(1) determining the age of standing trees, by counting annual growth rings
(2) growth rate analysis
(3) specific gravity studies and



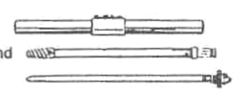
EXAMPLE OF PINE CORE

EXAMPLE OF OAK CORE

INCREMENT BORER DESCRIPTION

An increment borer consists of three parts:

(1) the HANDLE
(2) the BORER BIT and
(3) the EXTRACTOR.



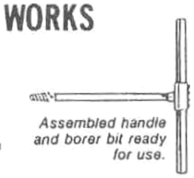
When not in use the BORER BIT and the EXTRACTOR fit inside the HANDLE and form a compact unit.

TEFLON COATING

Some increment borers come with Teflon coated bits. Teflon coating helps reduce friction, protects against rust, keeps the bit cleaner and in general extends the serviceable life of the bit.

HOW IT WORKS

An increment borer works somewhat like a brace and bit. The increment borer handle turns a threaded bit into the wood being sampled. A core of wood is collected inside the hollow borer bit. The extractor is used to pull the core from inside the bit.



Assembled handle and borer bit ready for use.

An increment borer being used on a Southern yellow pine.

★ ★ ★ IMPORTANT NOTICE — MISUSE DISCLAIMER ★ ★ ★

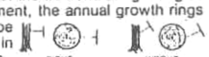
This increment borer was specifically designed and engineered for use with the accompanying handle ONLY. Non-conformity with the explicit instructions for use (i.e., using borer with brace & bit, power drill, etc...) will void any expressed or implied warranty from Forestry Suppliers, Inc. and the manufacturer.

TO TAKE AN INCREMENT CORE, FOLLOW THESE INSTRUCTIONS, STEP-BY-STEP. . .

1. Remove the borer bit and extractor from inside the handle. Place the extractor in a pocket of your cruiser vest for convenience and protection of the extractor.

2. Assemble the handle and borer bit by:
a. pushing the locking latch away from the handle with your thumb,
b. inserting the square end of the borer bit into the handle, and then
c. returning the locking latch completely around the borer bit "collar". You're now ready to start boring;
however, we suggest you apply beeswax to the threads and shank before you do. (See below)

3. Align the borer bit and the handle so that the bit will penetrate through or towards the center of the tree and at right angles to the tree. In any other alignment, the annual growth rings seen in the extracted core will be distorted and could result in erroneous growth rate analysis.



RIGHT WRONG

4. Place the borer bit threads against the tree (Fig. 1), preferably in a bark fissure where the bark is thinnest. Hold the threads in place with one hand. With your other hand push forward on the handle and simultaneously turn it to the right until the bit threads penetrate the wood enough to hold the bit firmly in place.

5. Then place both hands, palms open, on the ends of the handle and turn the handle to the right until the bit reaches the desired depth. (Fig. 2)

6. With the bit at the desired depth insert the full length of the extractor, concave side up like this "⌒". (Fig. 3) Then turn the handle one-half turn to the left to break the core from the tree and also to turn the extractor concave side down like this "◡".

7. Pull the extractor from the borer bit. (Fig. 4) The core will be resting in the channel and held in place by the small "teeth" at the tip of the extractor. Before examining the core sample, promptly remove the borer bit from the tree, clean it (See "Clean with WD-40" below), and place it and the extractor back in the handle.

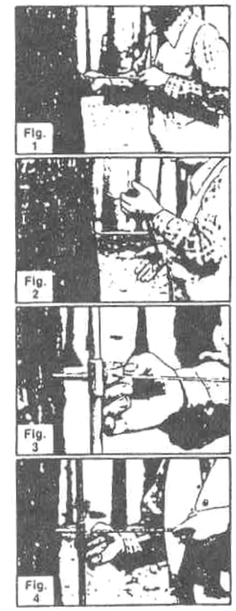


Fig. 1

Fig. 2

Fig. 3

Fig. 4

CARE AND MAINTENANCE OF INCREMENT BORERS

Here are a few suggestions Forestry Suppliers, Inc. feels will be helpful in maintaining the efficiency and extending the life of increment borers. We welcome any additional suggestions.

LUBRICATE WITH BEESWAX

Forestry Suppliers, Inc. provides a block of beeswax with every increment borer sold. Penetration and removal of the borer bit will be easier if beeswax is liberally applied to the threads and shank before each boring.

CLEAN WITH WD-40

WD-40 is an excellent cleaner and rust preventative for an increment borer. It will also prevent sap acid-etching of the borer. Spray it on and inside the bit and on the extractor at the end of each working day. Wipe clean.

BE QUICK

Obtain your core samples as rapidly as possible. It's best to remove the bit from the tree even before examining the core sample. This will reduce the possibility of the bit becoming stuck or locked in the tree.

AVOID COMPRESSION - TENSION WOOD

Never bore into suspected compression or tension wood. To explain: a tree leaning towards the North will have compression wood on the North side. If you bore into compression wood, the bit could be locked into the tree by the force of the "compressed" wood. If you bore into the South side, you are boring into "tension" wood, where the ring width may not be representative. We recommend boring on the East or West side or, if possible, select another tree.

Appendix B
Data Sheet

Tree #	Tree Species	Live or Dead	Tree Age	Year of Establishment