

## **Hot Topics in Kootenay National Park:**

### **Tree-rings and Forest Fires**

In this introduction to trees and forests, Park visitors will begin by learning about tree growth and annual rings. They will examine cross-sectional “cookies” from local trees for information about climate and forest growth conditions. Tree cookies with fire scars will introduce the concept of tree adaptations and ecology of forest fires. Using images of fire scarred trees, students will use several types of evidence derived from tree-ring analysis to determine the date of a forest fire and map its impact in the forest.

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# I. INTRODUCTION TO DENDROCHRONOLOGY

## A. Tree Growth and Annual Rings

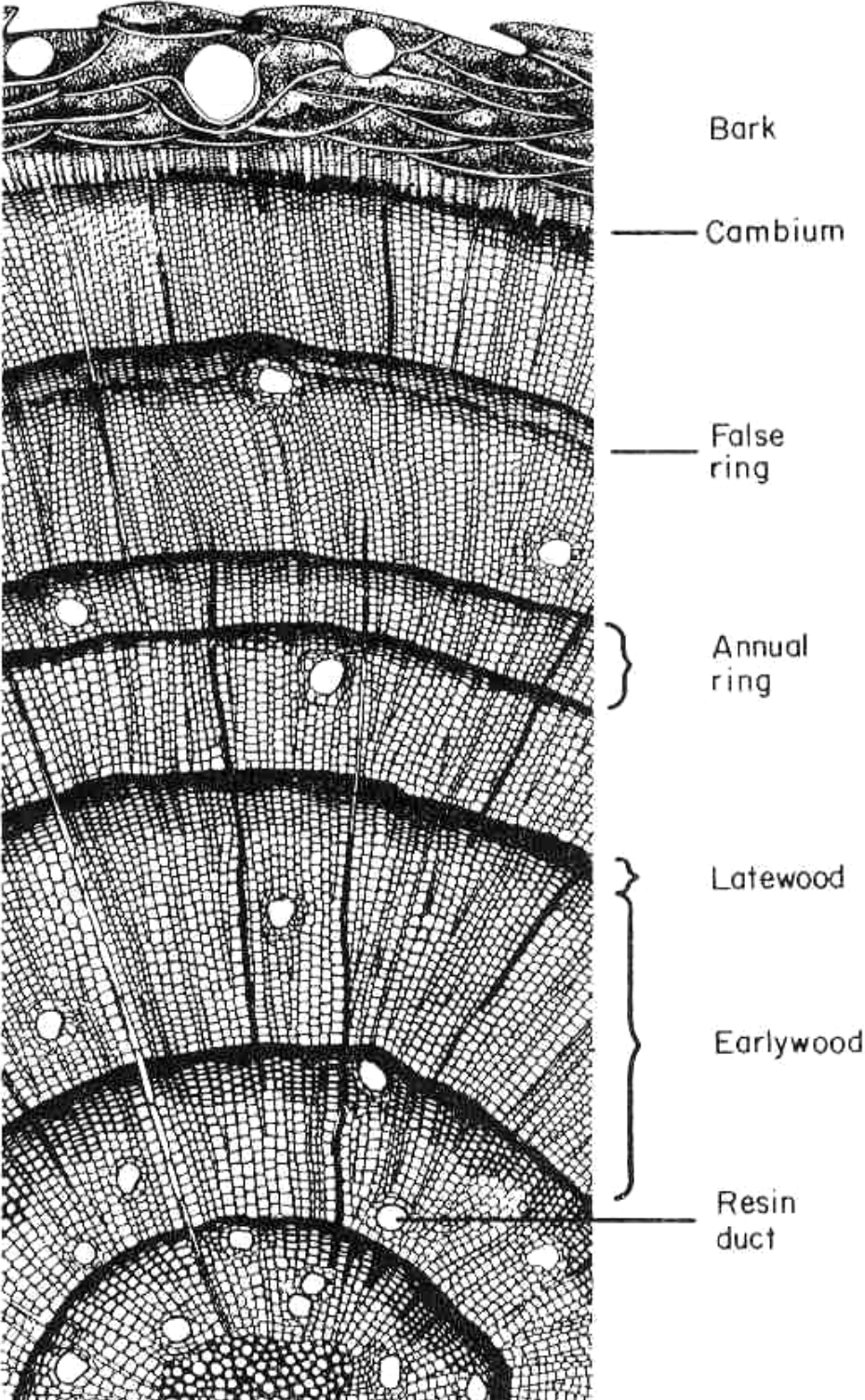
Trees grow in two ways. The stem grows taller and roots elongate beneath the ground, called *primary growth*. *Secondary growth* is the increase in diameter of the stem and the roots. Special cells at the tip of the roots and stems divide and produce new cells producing longer roots, new stems and leaves. These growing points are active during the spring and summer months. During late summer and fall, buds form to protect these delicate tissues from harsh winter conditions. The buds can be seen at the end of branches and at the tops of trees in the fall. In spring, with warm weather and spring rains, the buds will burst and begin to grow again.

Woody plants, including trees, are unique because they are able to add consecutive layers of tissues to the stem by secondary growth. In trees, there is a second set of special growth cells located between the bark and the stem wood. This layer of cells is the source of secondary growth. During spring and summer these cells divide and grow producing a new layer of bark cells and a set of wood cells. The wood cells are called *tracheids*. They have *lignified* or hardened cell walls and form the wood or support structure of the tree. Many tracheid cells are produced each year, resulting in the diameter growth of the stem.

*Rings* mark the annual growth of the tree. In temperate regions of the world, including Canada and the United States, tree growth is restricted to the spring and summer months. In spring, trees grow rapidly. Temperatures are warm and water and nutrients are available in the soil. The new tracheid cells are large and have stretched, thin cell walls that appear light in colour. This wood is called *earlywood* or *springwood*. Throughout the summer, water and nutrients become scarce and temperatures cool with the onset of autumn. The tracheids formed later in the year are narrower with thick cell walls that make them appear dark in colour. These cells indicate slow or declining growth rate and are called *latewood* or *summerwood*. Together, the earlywood and latewood form the *annual tree ring*. The boundaries between the end of one year's growth (dark latewood) and the next year's growth (light earlywood) are usually distinct and countable. It is the dark latewood that we see and describe as a *tree ring*.

Ring counts, from the bark to the central *pith* of a tree, determine tree age. We can also compare *ring-width patterns*, the sequence of wide and narrow rings within a tree. Ring widths can be compared between trees to match growth patterns to study the relationship between tree growth (ring widths) and the tree's environment over time. The study of tree rings in relation to time is called *dendrochronology*.

**Cell structure of a stem of a young pine tree.**



## B. What is Dendrochronology?

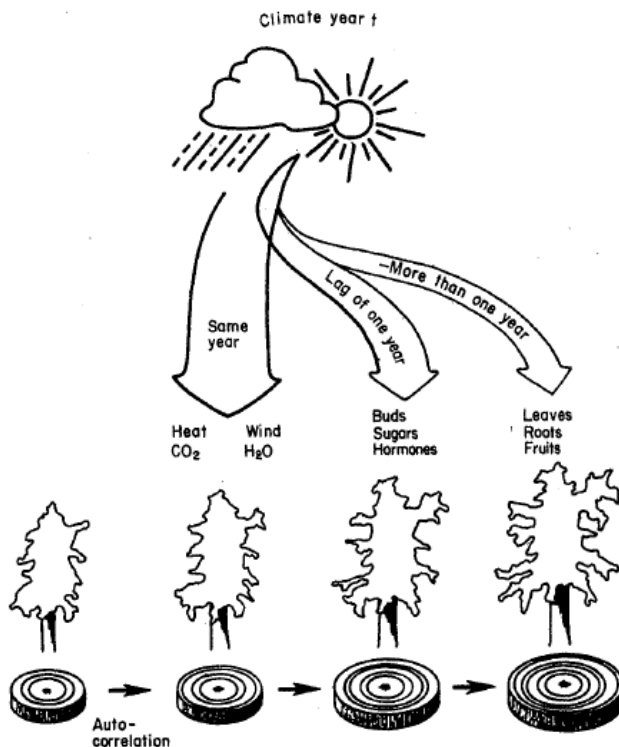
*Dendrochronology* is the study (*ology*) of tree rings (*dendro*) in relation to time (*chrono*). Tree rings are like natural history warehouses. They store information about climate, natural disturbances, and forest history in their rings. Dendrochronologists study tree rings to try to read and interpret that history.

We know that many factors affect tree growth and that these factors range from global to local influences. For example,

- Location on the plant affects seasonality and when trees grow.
- Location on each continent, including position relative to the oceans and mountains, affects the climatic conditions in which trees grow.
- Micro-site factors such as elevation, topography, moisture, nutrients, and light versus shade affect tree growth.

Differences in weather from one year to the next will also influence a tree's growth. Combined, these factors will determine the potential and actual growth of trees.

Within individual trees, the tree ring reflects growth processes and influences of the environment on these processes. Information about the conditions controlling tree growth are expressed in the anatomy of the tree-ring: the number and size of the cells, the thickness of the cell walls, the number of earlywood cells relative to latewood cells, and the total width of the ring (see the figure below). Trees growing together in a patch of forest, or in a broader region influenced by similar climate will respond to the same environmental conditions and will have common signals stored in their tree-ring patterns.



A tree is an integrator. It reacts to environmental factors and its reactions are recorded in the annual ring. The development of the tree ring is influenced by weather during the present growing season, weather during the previous growing season and the condition of the tree (from *Tree Rings and Climate* by H.C. Fritts, 1976)

## II. GROUP EXERCISES

### A. Brain-storming about tree-rings

1. How many children are X years old? Y years old?
2. How do you know how old you are?
3. What if you were a tree. How do you know your age?
4. Discussion of tree growth:
  - trees grow in two ways: stems grow taller and they increase in diameter
  - rings mark the annual growth of trees
  - in temperate parts of the world, trees grow only in spring and summer
  - in spring and early summer, while days are long, temperatures are warm, and water and nutrients are available from the soil, trees grow rapidly forming large, light coloured cells (springwood or earlywood)
  - in late summer and fall, when days are shorter, temperatures cool, and water and nutrients in the soil are scarce, tree growth slows. Cells are smaller with thick cell walls that are dark (summerwood or latewood)
  - together the earlywood and the latewood form the tree ring
  - the boundary between latewood of one year and the earlywood of the next year is usually a distinct line that we see and count as a tree ring
5. Can you say this word? *dendrochronology*
6. Who knows what it means? Dendrochronology is the scientific study of tree rings in relation to time. Tree rings are like natural history warehouses. They store information about climate, natural disturbances and forest history in their rings. Dendrochronologists study tree rings to try to read and interpret that history.

### B. Examining Tree Cookies

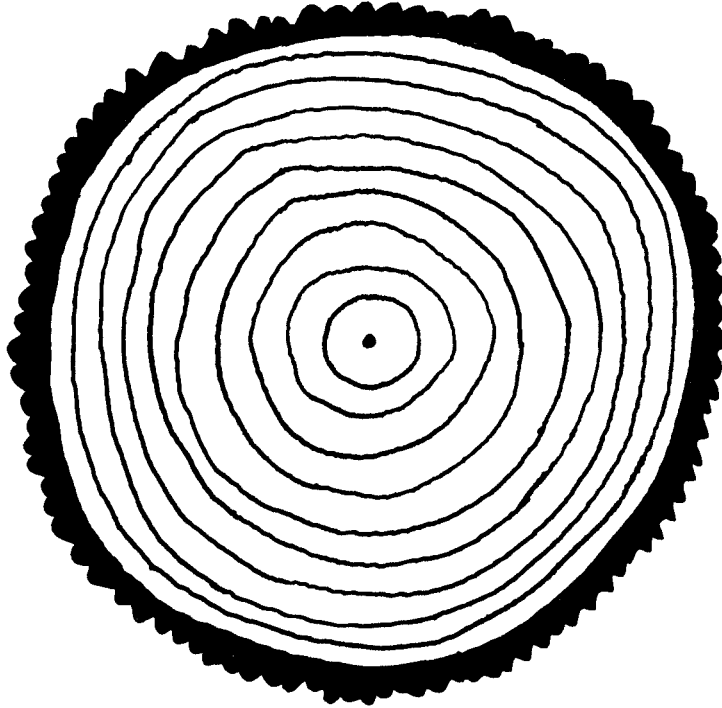
Compare your two tree cookies (aspen versus pine) using a magnifying glass:

- are they the same size?
- are they the same colour?
- is the bark similar or different?
- how old are the two trees?
- which one was growing more slowly? quickly? why?
- does the rate of tree growth change over time? why?

## C. Be a Dendrochronologist

### 1. Young Dendrochronologists

Consider this picture of a tree “cookie”. The tree rings of this cookie have been enlarged to make it easier to study the rings.



*Hint.* The spaces between the lines = earlywood and the line = latewood.  
Count the spaces to determine the age of the tree.

How old is this tree? \_\_\_\_\_ (Practice counting first!)

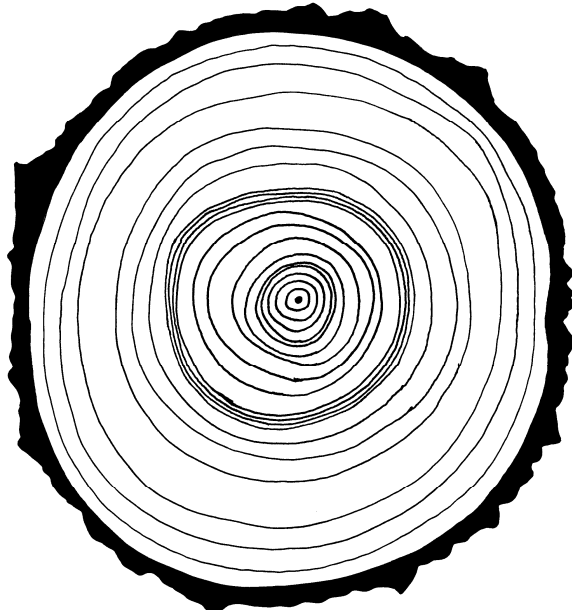
How old are you? \_\_\_\_\_

Start at the tree bark and count backwards to find the tree ring for your birthday.  
Mark an “x” in that tree ring. Count the rings from the center to the x.

How old was the tree when you were born? \_\_\_\_\_

## 2. Advanced Dendrochronologists

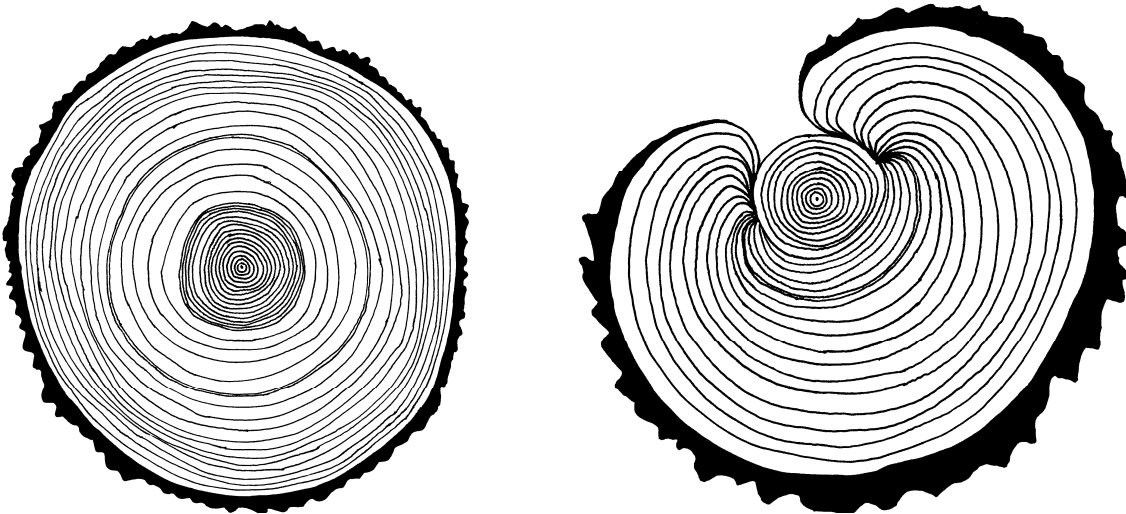
Consider this picture of a tree cookie. The tree rings of this cookie have been enlarged to make it easier for us to study the rings.



*Hint.* The spaces between the lines = earlywood and the line = latewood.  
Count the spaces to determine the age of the tree.

1. How old is this tree? (different answers?)
2. Try this trick for keeping track of the tree rings: count backwards from the outer tree ring (2001) and use a pencil to mark dots at each decade (2000, 1990, 1980 etc.). The dots help you to keep track of years and help you double check your counts.
3. Formula for determining age:  $AGE = OUTERMOST\ YEAR - PITH\ YEAR + 1$
4. Remember, tree rings store information about the history of the forest. What stories can you read from the ring patterns?
  - a. *Are the rings closest to the pith wide or narrow compared with the rest of the rings?*
    - wide rings result when trees grow in “open” environments where resources including sunlight, water and nutrients are readily available. Open environments result after large disturbances (e.g. fire, avalanche, landslide, clearcuts)
    - narrow rings near the pith result when trees establish in environments where necessary resources are limiting (e.g. seedlings growing slowly in the shade)
  - b. *Can you find “marker” rings – rings that are very narrow or very wide?*
    - *narrow rings* = stressed-out trees = years when tree growth was limited perhaps by an extremely cold winter or summer drought
    - do you have a narrow ring? in which year? does it match the year for the person next to you?
    - *many narrow rings* in a row = prolonged cold or drought or insect attacks that remove the leaves and limit tree growth, but the tree later recovers
    - *wide rings* = years when all resources readily available and the tree grows allot

5. Consider these pictures of tree cookies. Again, the tree rings of this cookie have been enlarged to make it easier for us to study the rings. Their growth shows some unusual growth patterns.



c. *Can you see trends in the ring patterns?*

You can trace the life of the tree by examining the rings from the *pith toward the bark*. Look for times when the tree rings were relatively narrow or wide.

- the transition from narrow to wide rings is called a *release*. A release has at least five wide rings following more than five narrow rings. Releases occur when resources suddenly become available to trees (e.g. adding fertilizer, watering or rain during long droughts).
- the transition from wide to narrow rings is called a *suppression*. A suppression has at least five narrow rings following more than five wide rings.Suppressions are caused when resources are not available for trees (e.g. drought or competition when trees grow very close to each other)

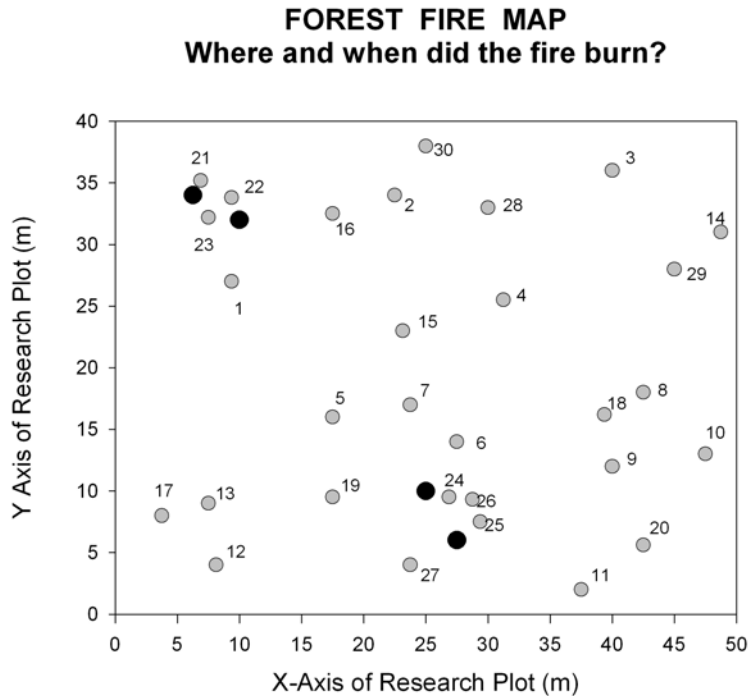
d. *Can you see anomalies in the tree rings? What might have caused this scar?*

- *scars* are caused by fires, animals, insects, people, and trees that fall and strike a neighbouring tree etc.
- assume ring next to the bark was formed in the year 1999:
  - which is the last year in which the tree has a complete ring? 1981
  - in which year does the trees growth become disrupted? 1982
  - in what year was the tree damaged? *between fall 1981 and spring 1982*



## D. Fire History Study

### Part 1. Tree Rings



Use your new skills as a dendrochronologist to determine the history of the patch of forest shown on this map. In this forest, there are some dead trees, some trees with charcoal on them and some trees with weird “cat-face” scars at the base of the stem. What do you think might have happened here? *Fire*

Our goal in this exercise is to determine *when* and *where* the fire burned. What kind of clues can we look for? In other words, how does a forest fire impact the trees? During a fire, some trees will die (negative effect). But many trees survive and actually benefit after the fire (positive effect). With some trees removed there is more space for the trees to grow and they may grow quickly. Often the ash from the fire adds nutrients to the soil, providing more essential minerals to the trees. With more space and more nutrients, new trees establish.

We can use dendrochronology to study the tree rings and look for clues of the fire. Some trees that survive the fire will have a scar – we will know the year of the fire if we can determine the year of the scar. Some new trees will begin to grow – we can determine when the fire burned from their age. Other trees survived the forest fire, do not have a scar, but they do release or grow quickly after the fire – using the extra resources not used by the trees that died. If we determine the year that they release, we have more evidence of when the fire burned. Finally, if we consider where the trees are located in the forest, we can figure out where the forest fire burned - what part of the forest burned and what part did not.

## Part 2. The Forest Fire Map

The map shows the location of 30 trees that were sampled in September of 2001. Each of you has a picture of a tree cookie from one of the trees. The tree rings of this cookie have been enlarged to make it easier to study the rings. Study your cookie to determine its *age* and to find *marker rings*, *fire scars*, or *releases*. Then we will add your data to our map and see if the clues tell us when and where the forest fire occurred.

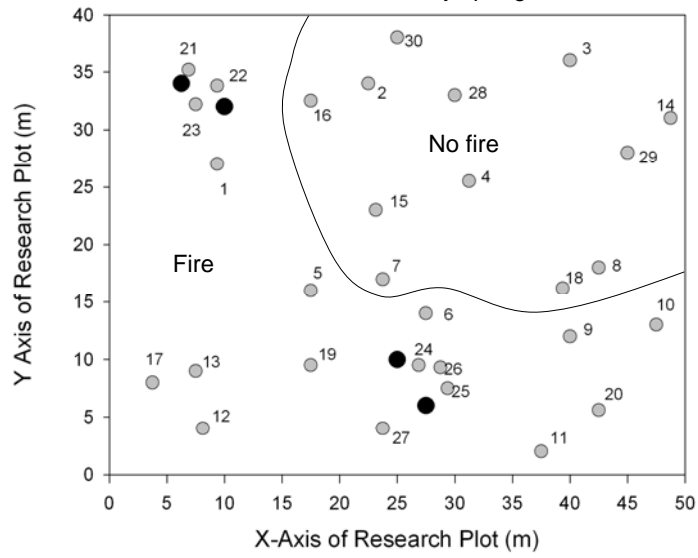
### Mapping the results:

1. Let's use marker rings to check the quality of our data. How many trees had a narrow marker ring? *All have a marker ring*  
What year was narrow? *1989* *Does everyone agree - double check you ring counts!!*
2. How many trees had a fire scar? *8 trees have a fire scar: # 1, 5, 6, 9, 10, 11, 12, 13*  
What year did the scar form (the first year with irregular rings)? *1984*  
For the fire-scarred trees, where are they located? One at a time, call out the sample number and add the fire scar dates to the map.
3. Did any of the trees release? *5 trees have a growth release: # 16, 17, 18, 19, 20*  
What year did they release? *1984*  
Why might trees release after a fire? *As some trees and other vegetation is killed by the fire, there is more space, sunlight and nutrients available for surviving trees. The survivors are able to take advantage of available resources and grow more quickly resulting in wider tree rings or released growth.*  
Where are the released trees located? One at a time, call out the sample number and add the release dates to the map.
6. If trees established after the fire, what is the year of their pith? *1984 or later*  
How old are they? *18 years old or younger when sampled in 2001*  
Are there trees that established in 1984? *7 trees: # 21, 22, 23, 24, 25, 26, 27*  
Where are they located? One at a time call out the sample number and add the establishment dates to the map. *Note, the new trees are in groups near large dead trees.*  
  
*So far - where do you think the forest fire may have burned?*
8. Are there trees without scars or releases? *10 trees: #2, 3, 4, 7, 8, 14, 15, 28, 29, 30*  
How old are they? *>18 years when sampled in 2001*  
Why don't they have any clues about forest fires in their rings? Do you think that the forest fire burned around them? *These trees were not within the boundary of the fire*  
Where are they located in the forest? One at a time, call out the sample number and add the establishment dates to the map.
9. Now determine the fire boundary. Review the clues and evidence: scars, releases, new trees indicate where the fire burned and trees that were not affected and include no evidence of fire indicate areas where fire did not burn.  
What season and year did the fire burn? *Either fall 1983 or early spring 1984 - allowing new seedlings to establish in the summer of 1984 immediately after the fire*

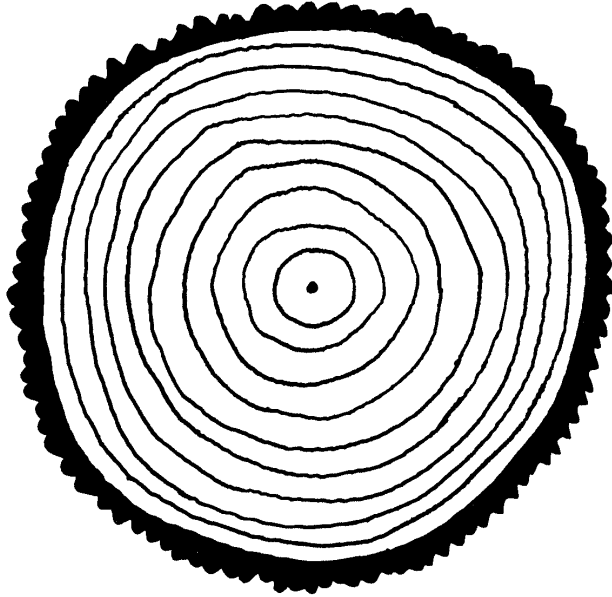
# FOREST FIRE MAP

## Where and when did the fire burn?

Fire = fall of 1983 or early spring 1984



## YOUNG DENDROCHRONOLOGISTS



How old is this tree?

\_\_\_\_\_

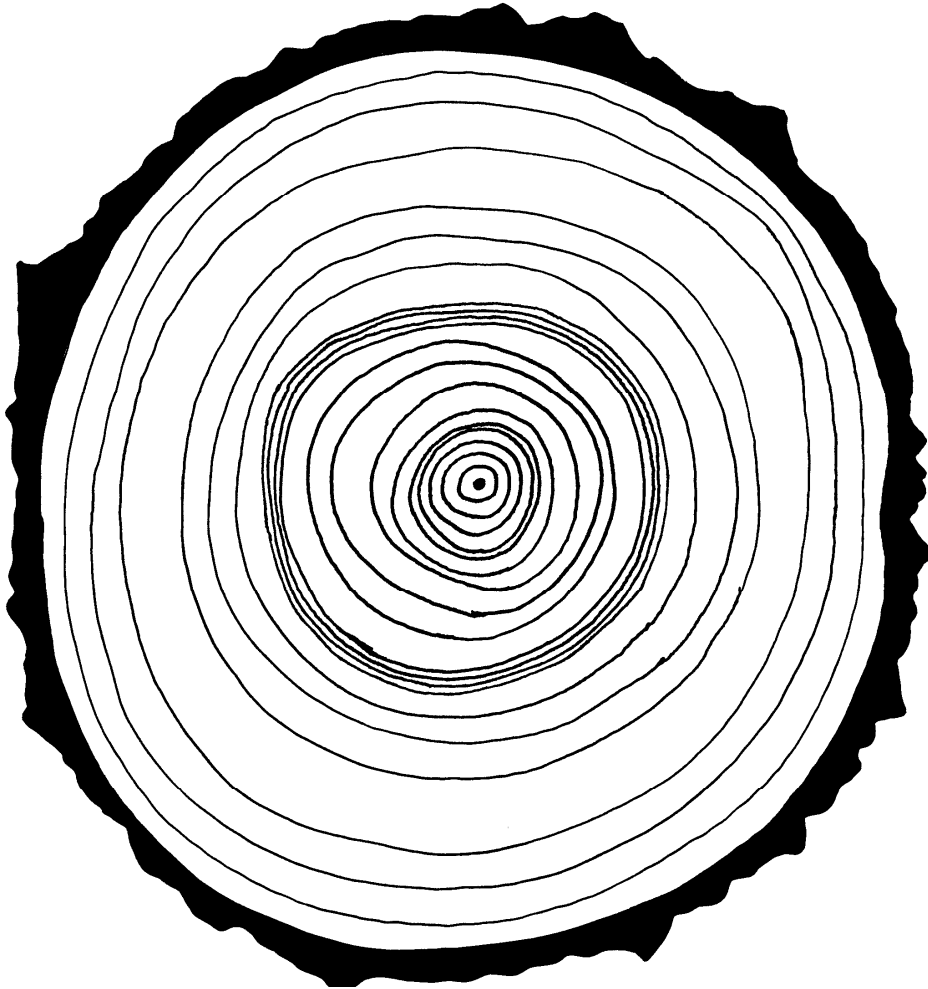
How old are you?

\_\_\_\_\_

**Start at the tree bark and count backwards to find the tree ring for your birthday. Mark an “x” in that tree ring. Count the rings from the center to the x.**

How old was the tree when you were born? \_\_\_\_\_

## ADVANCED DENDROCHRONOLOGISTS

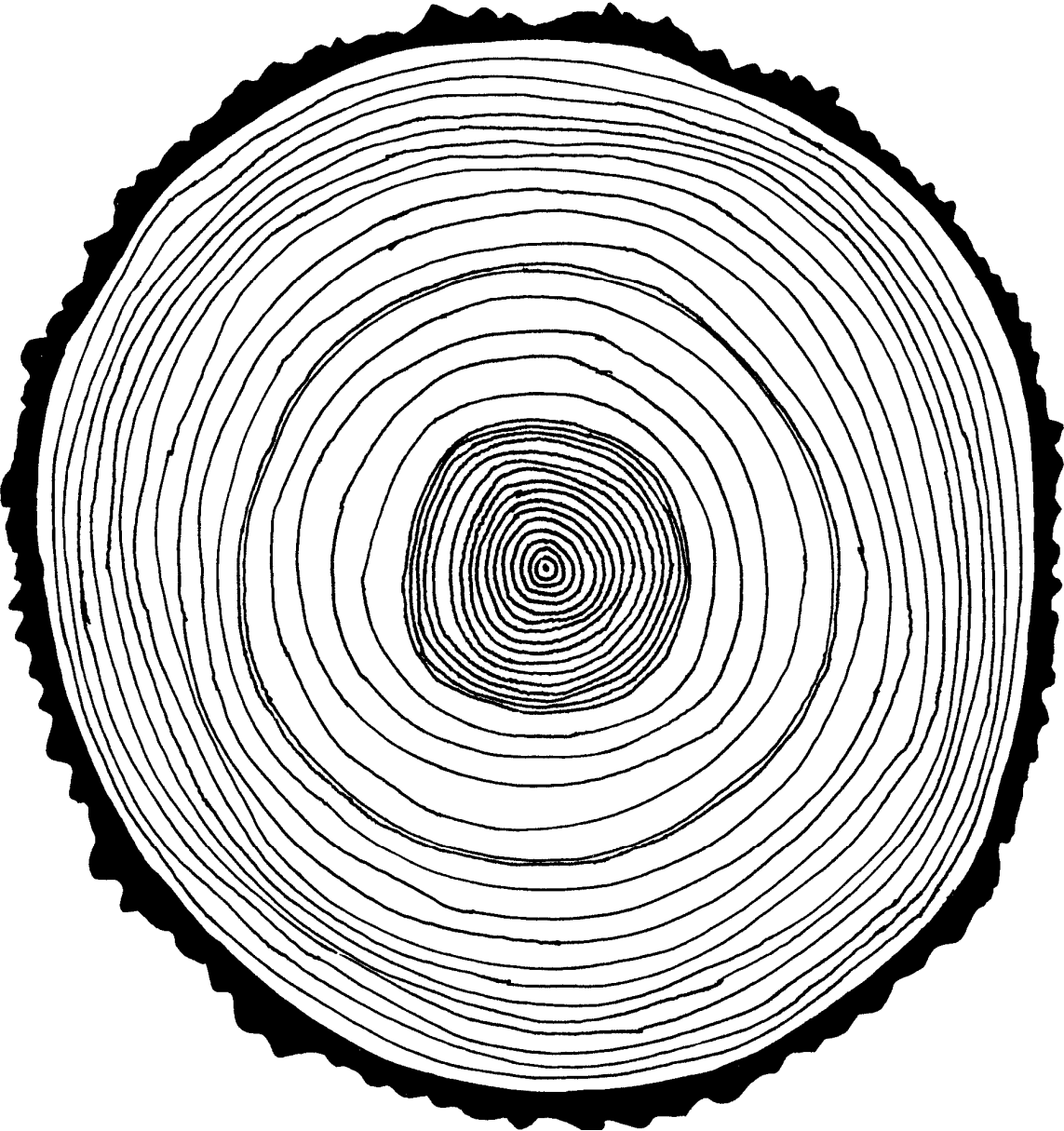


1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?

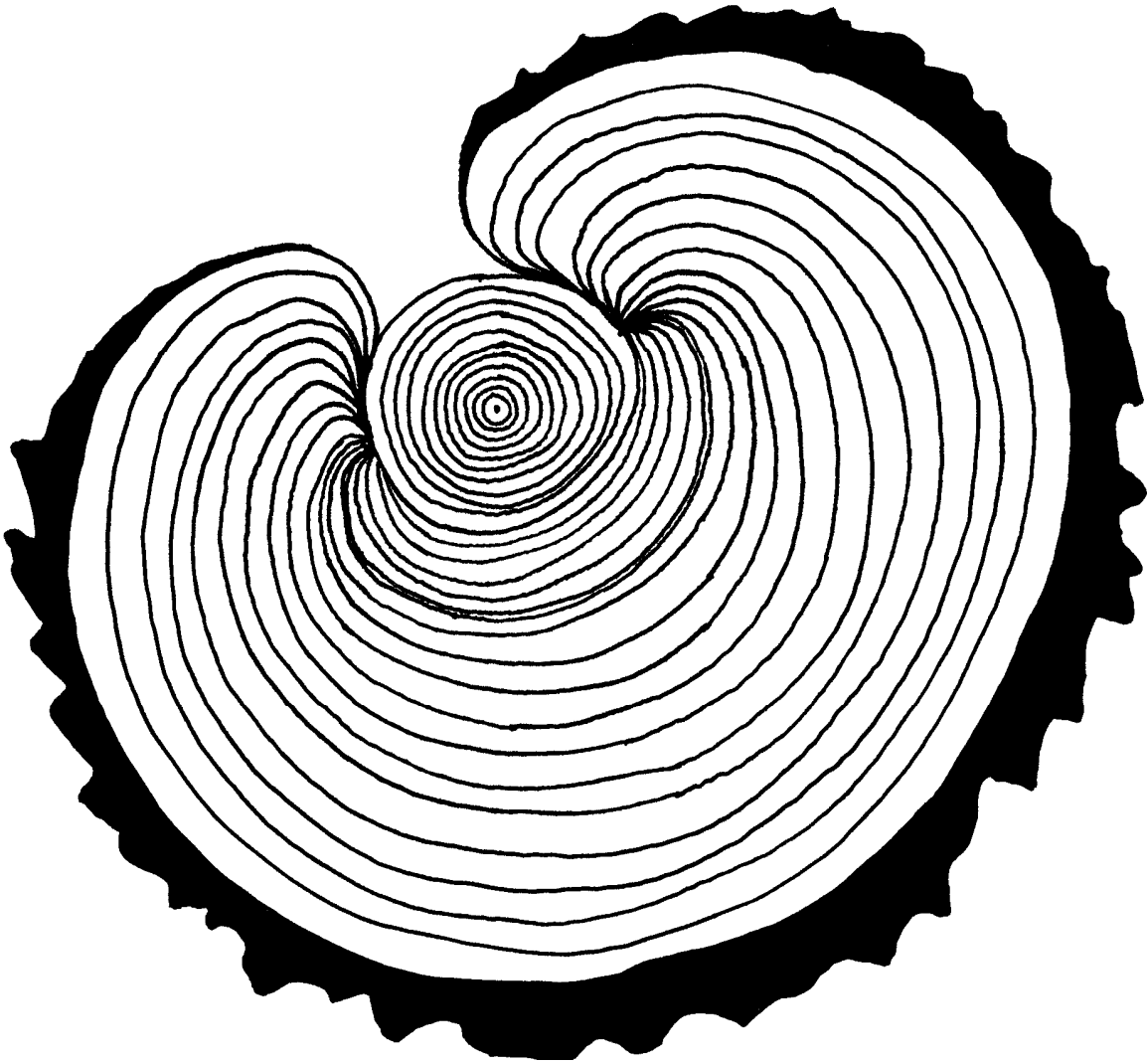
2. How old is your tree?

3. Does your tree have a “marker” or very narrow ring or rings? If yes, in what years?

**GROWTH RELEASE**

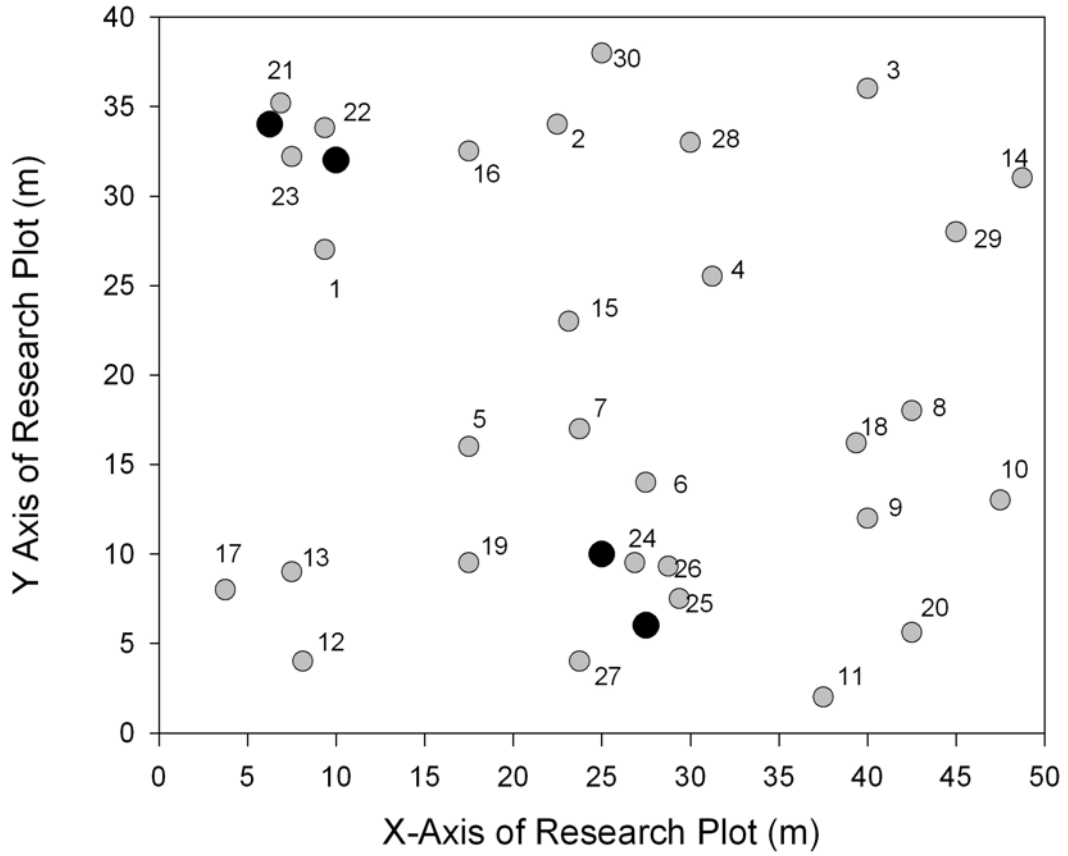


# FIRE SCAR



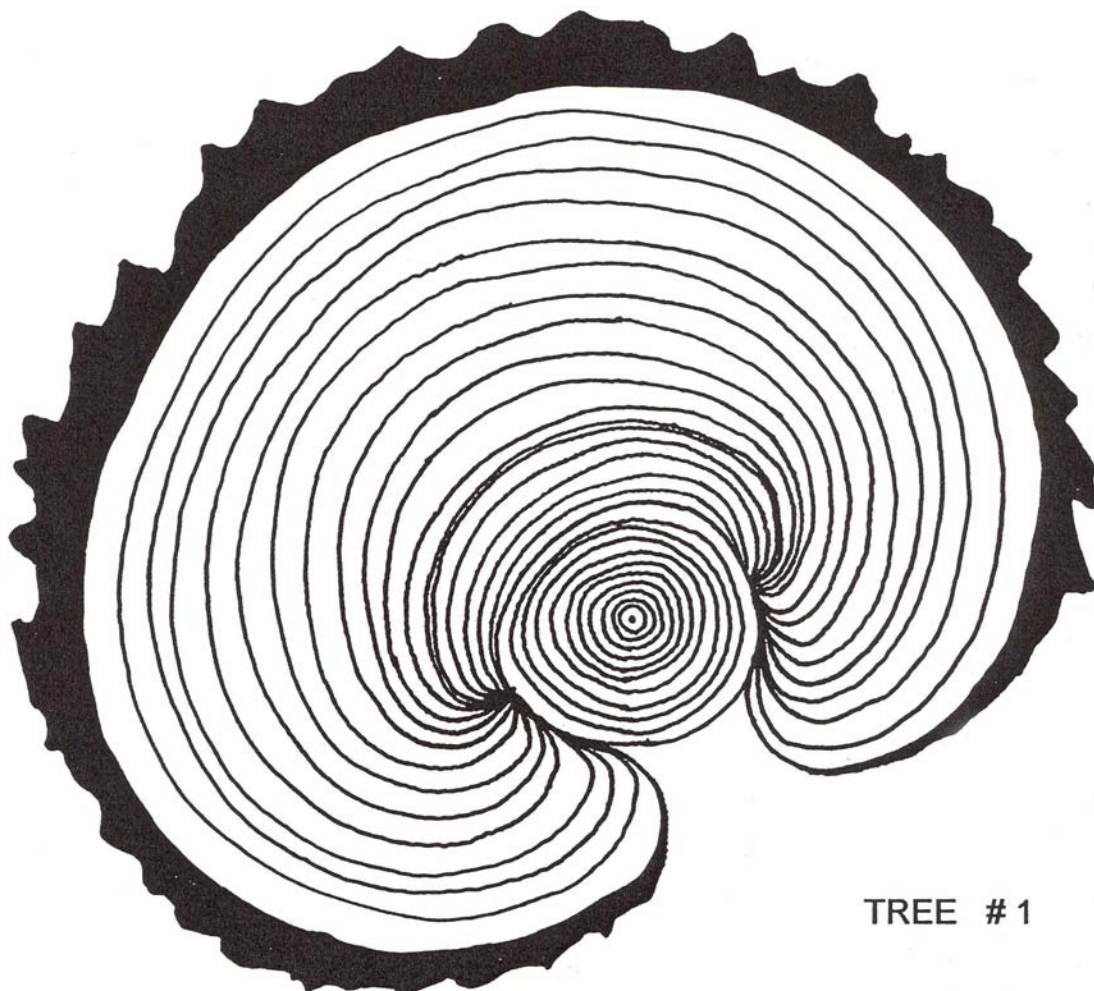
# FOREST FIRE MAP

## Where and when did the fire burn?



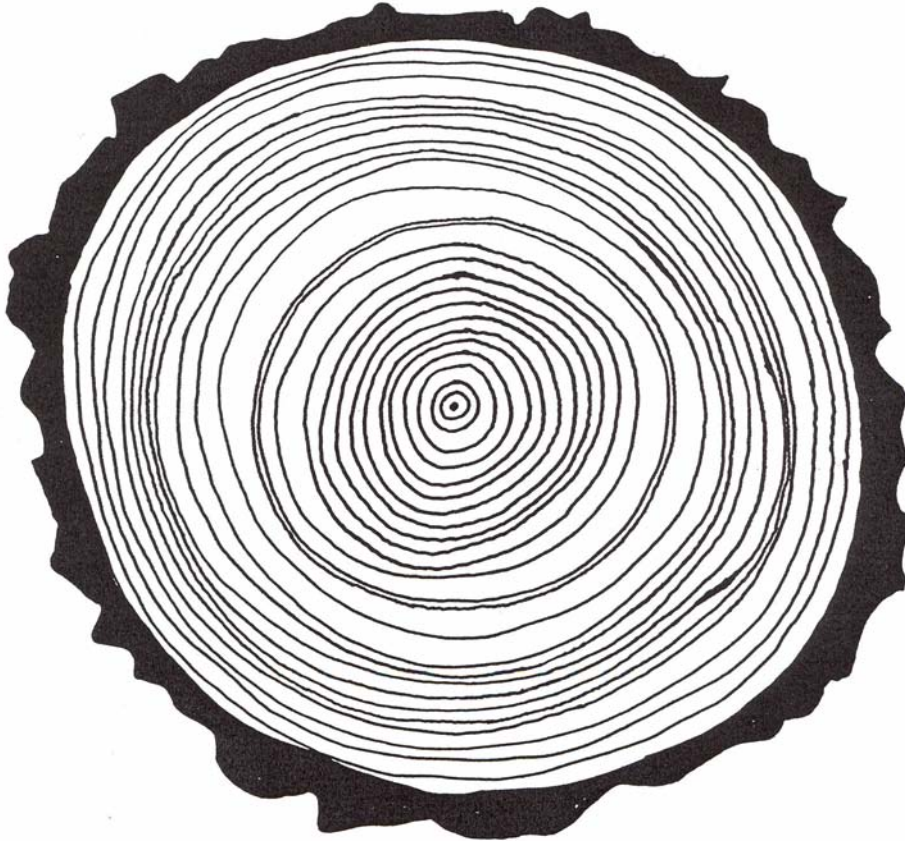
**Note: Black dots mark the location of dead trees and grey dots are living trees.**





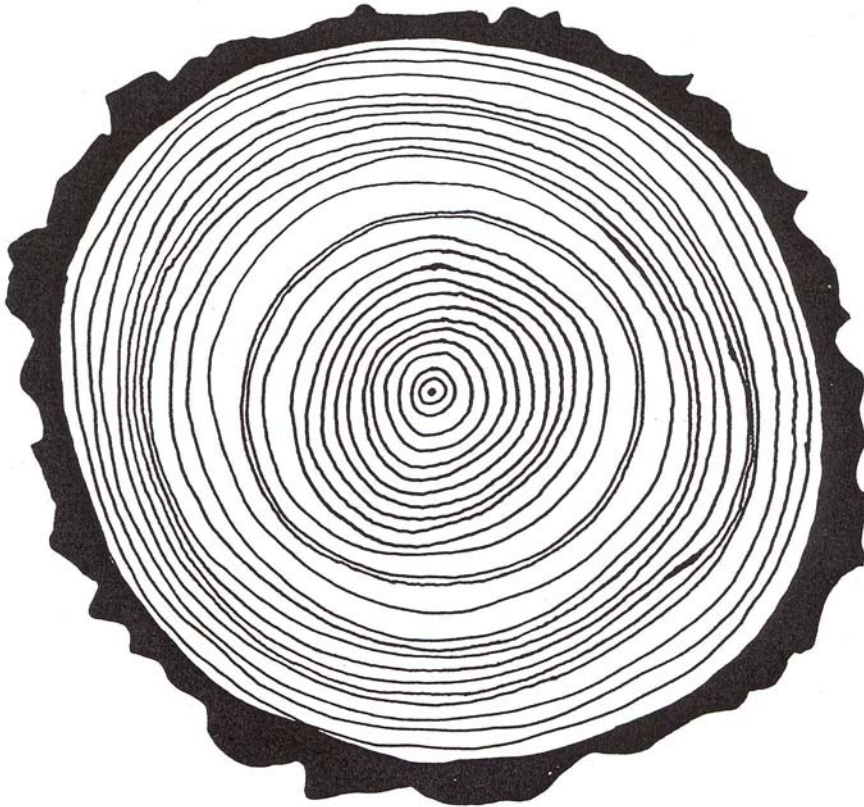
TREE # 1

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



**TREE # 2**

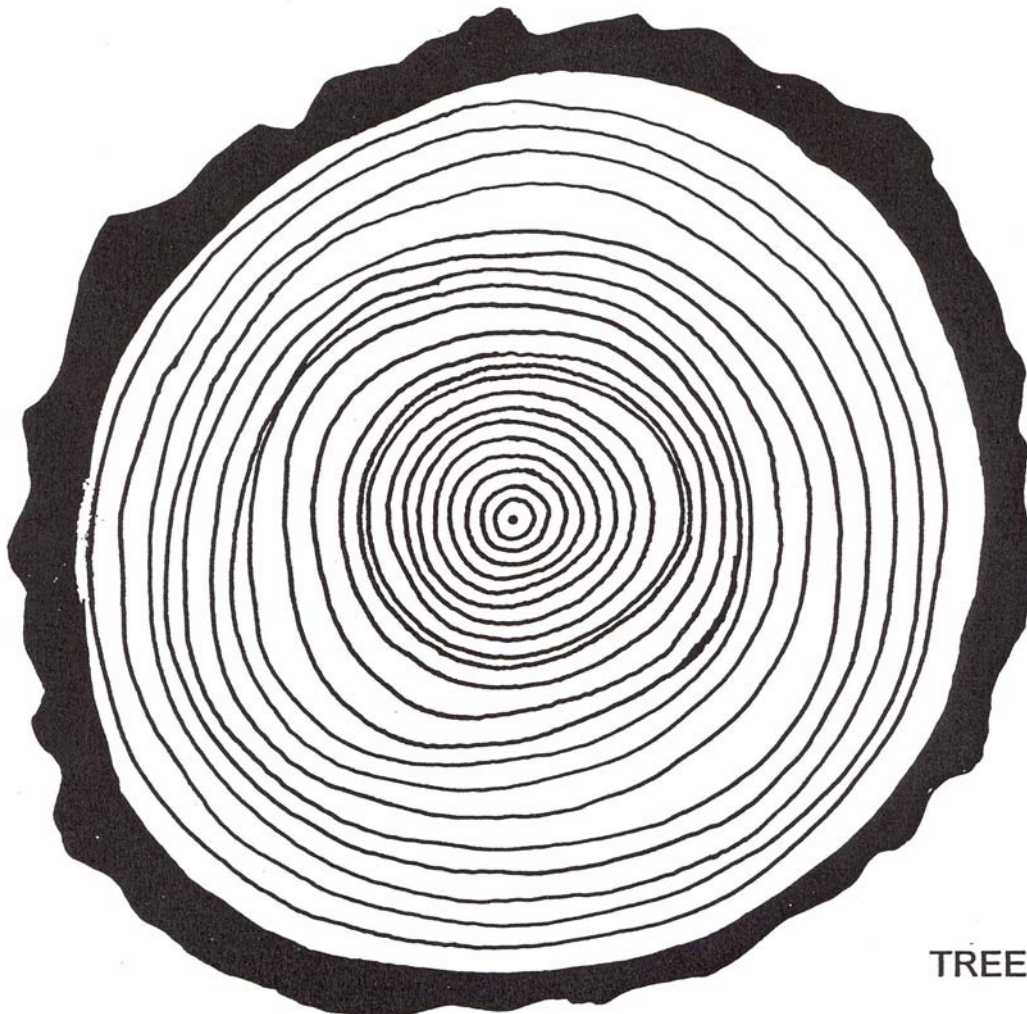
- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



### TREE # 3

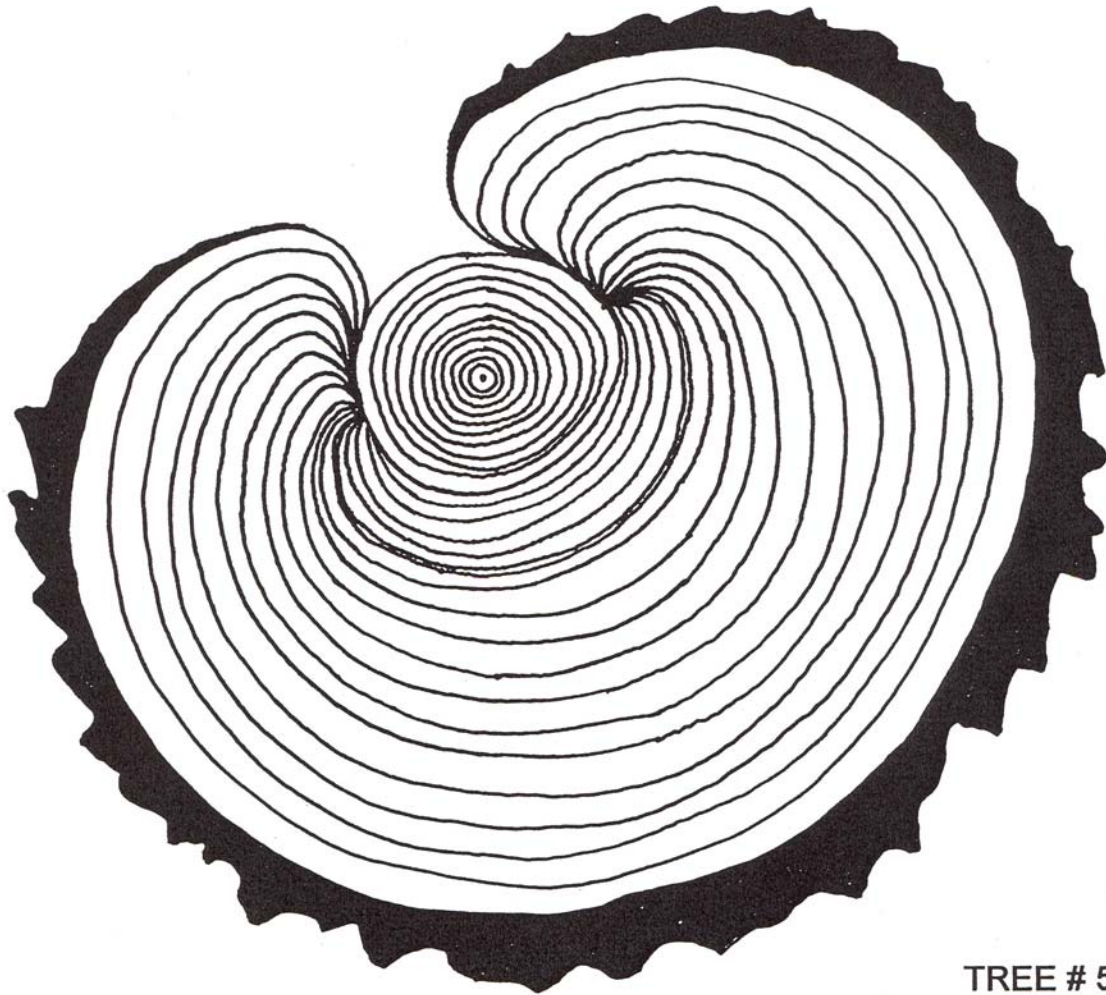
1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?





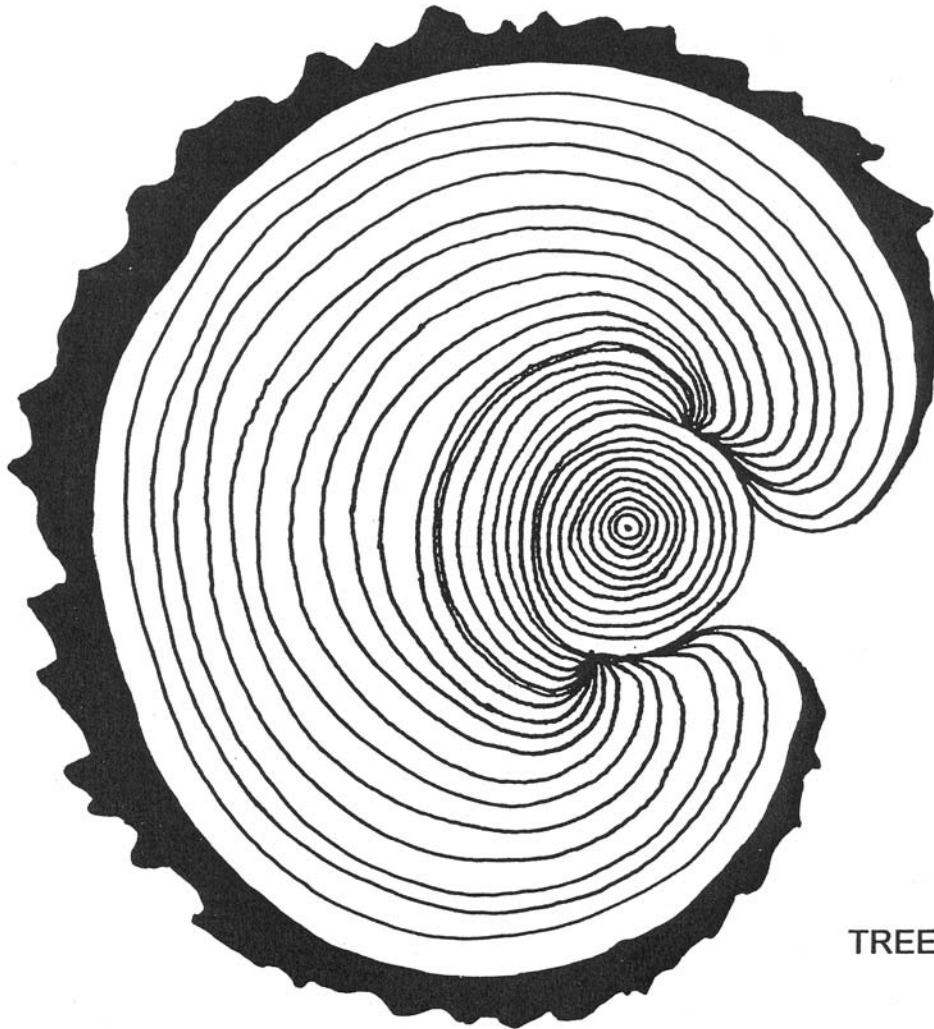
TREE # 4

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



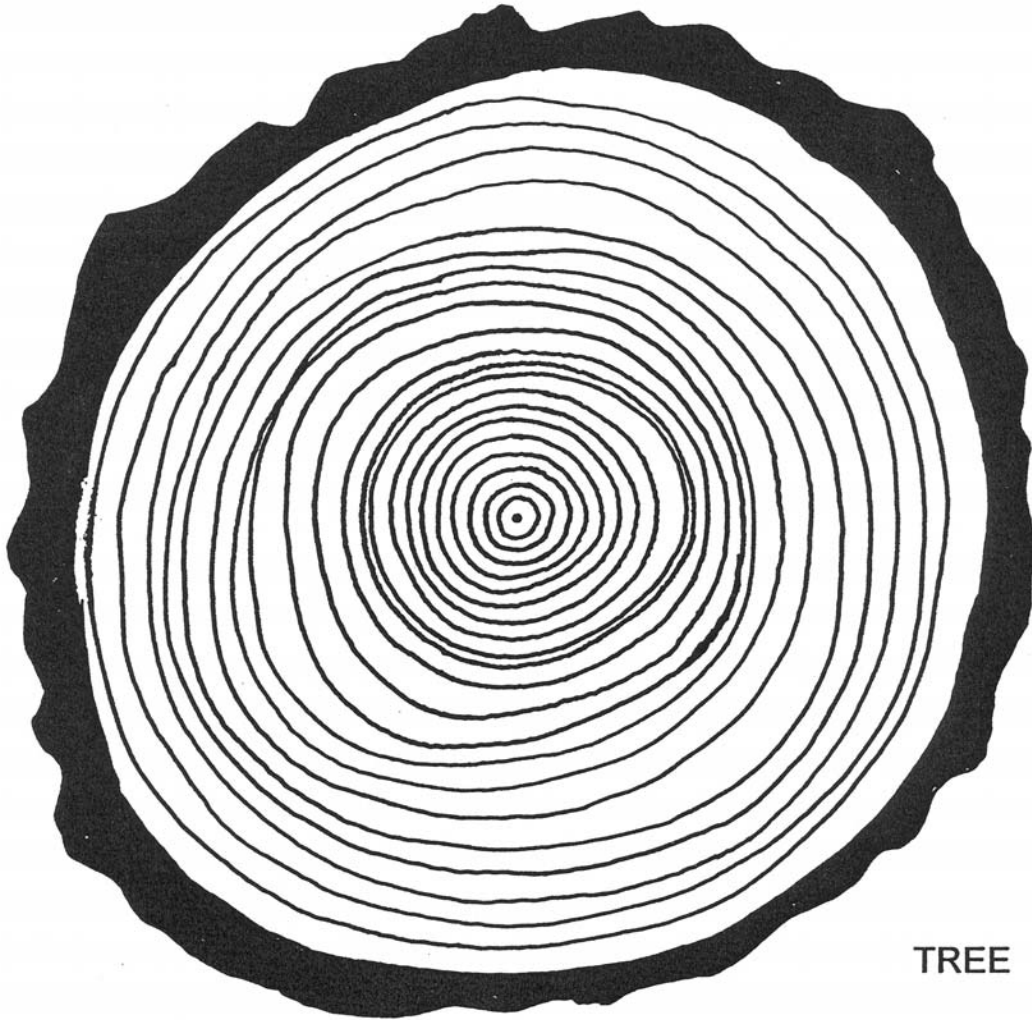
TREE # 5

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
  
2. How old is your tree?
  
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
  
4. Does your tree have a fire scar?  
If yes, in what year?
  
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



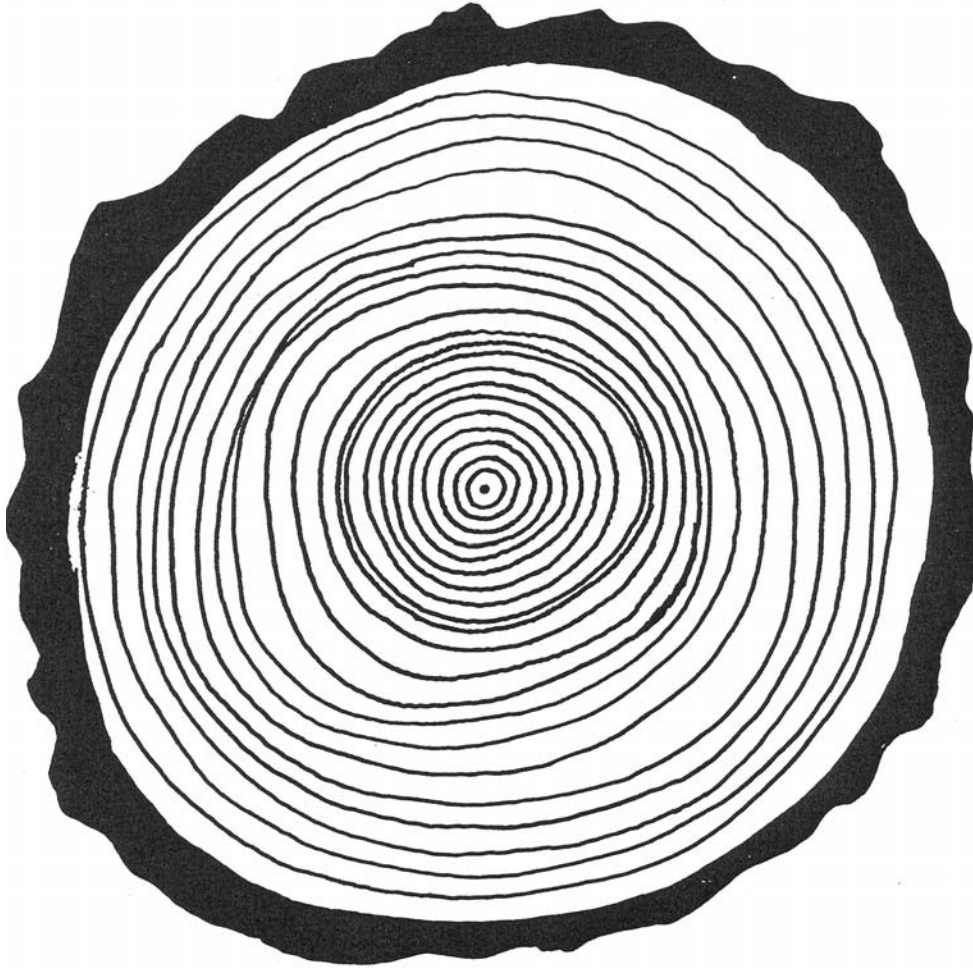
TREE #6

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



TREE #7

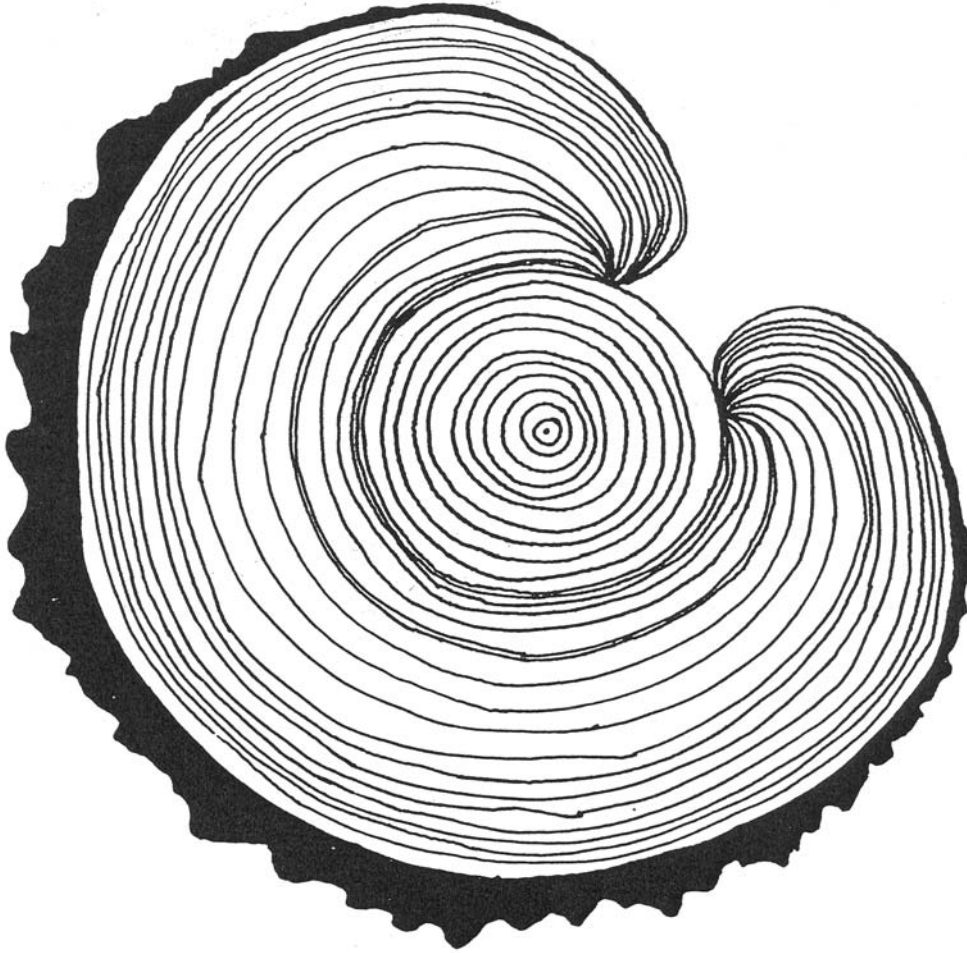
1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
  
2. How old is your tree?
  
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
  
4. Does your tree have a fire scar?  
If yes, in what year?
  
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



**TREE # 8**

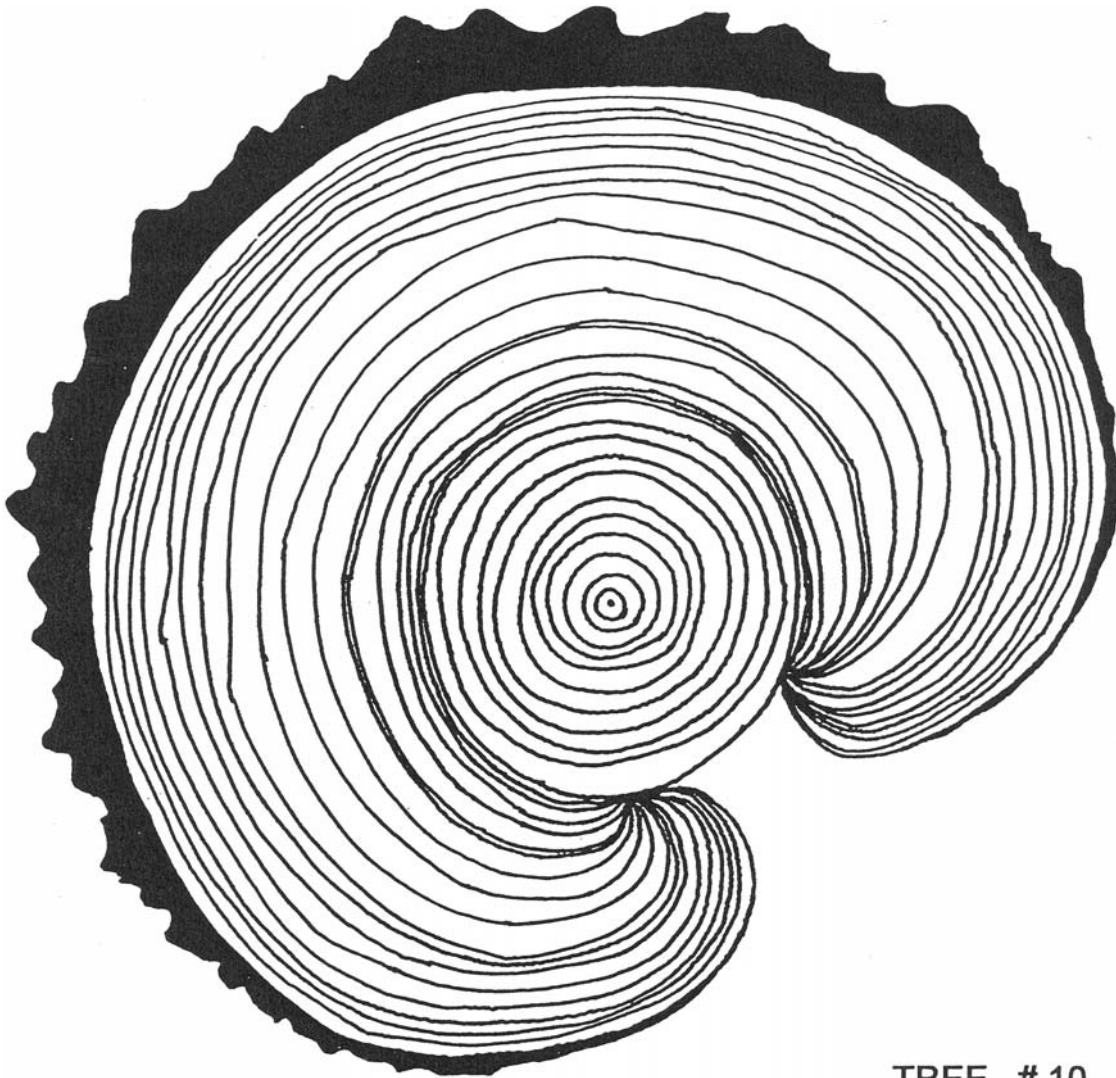
- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**





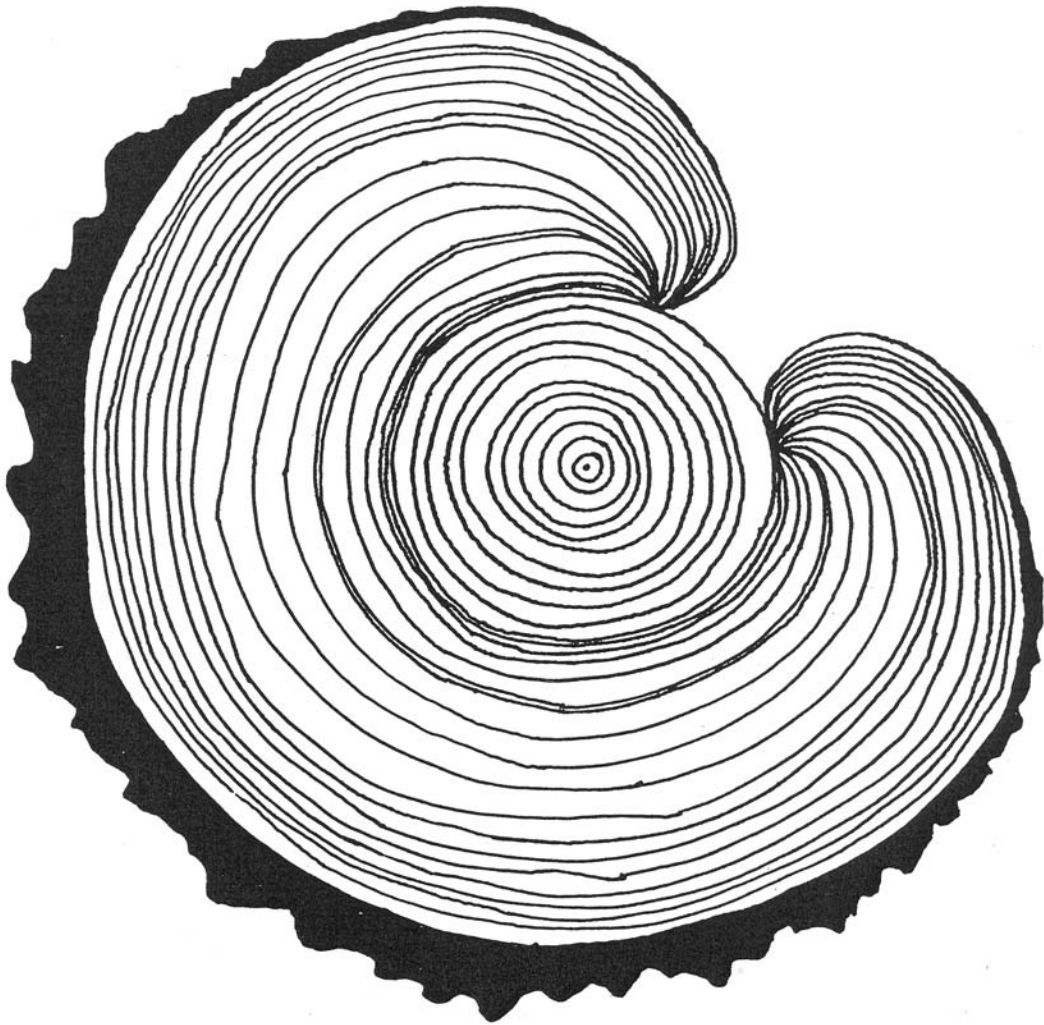
**TREE # 9**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



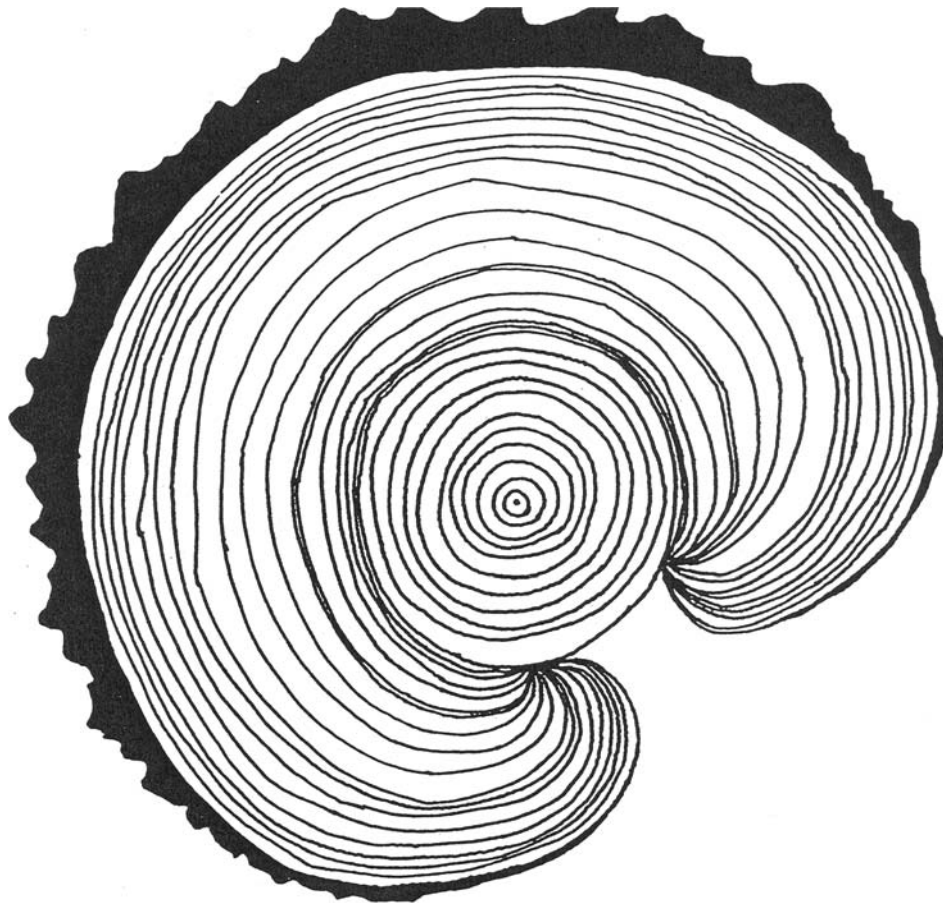
TREE # 10

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



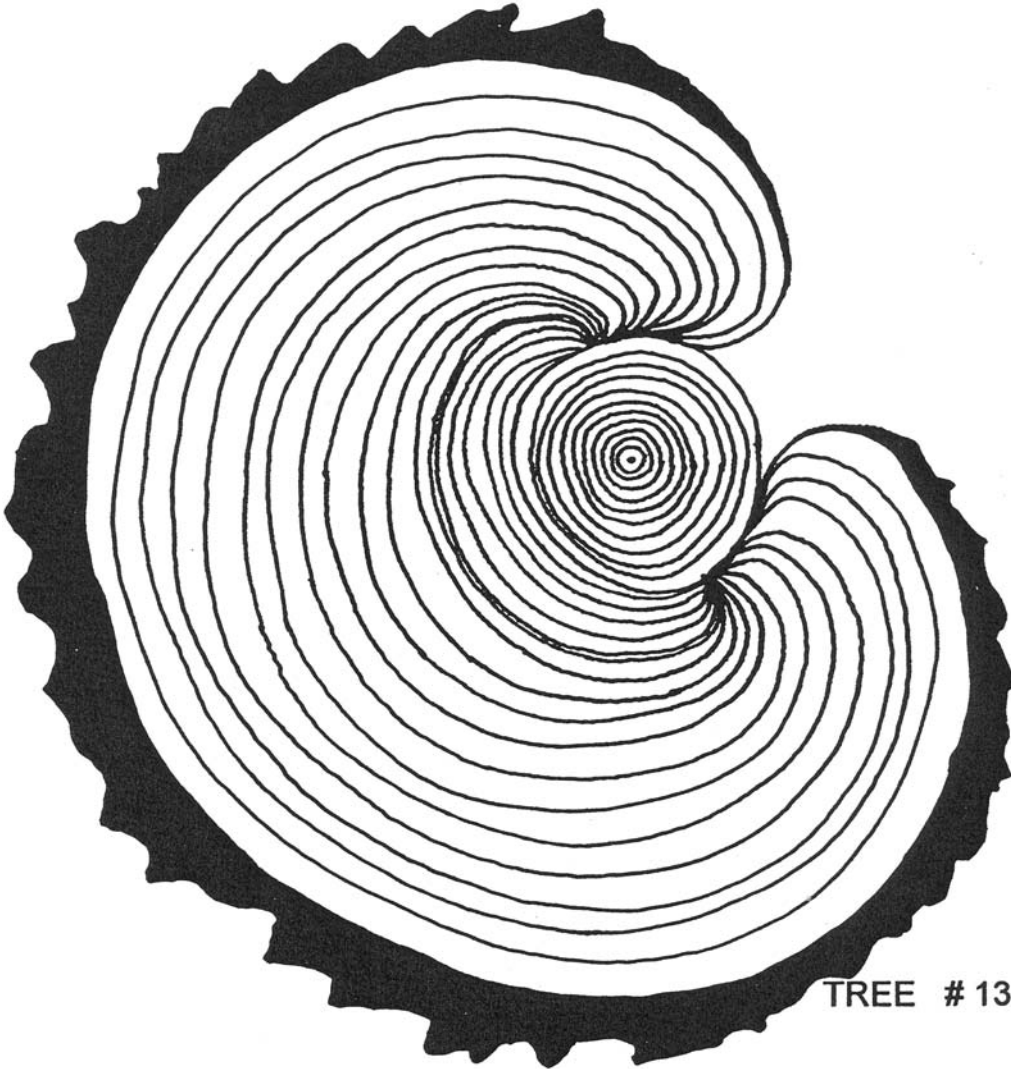
TREE # 11

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



**TREE # 12**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



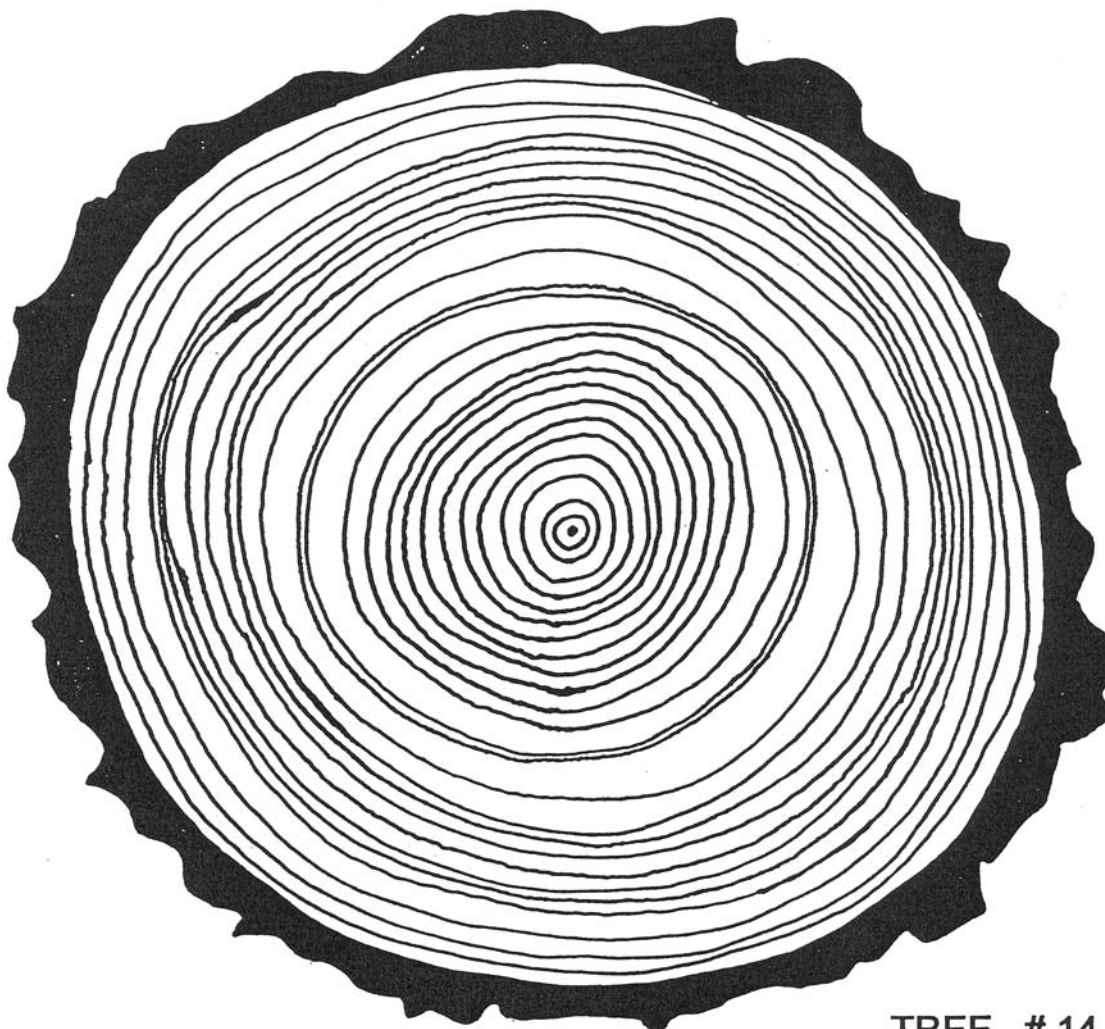
**1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**

**2. How old is your tree?**

**3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**

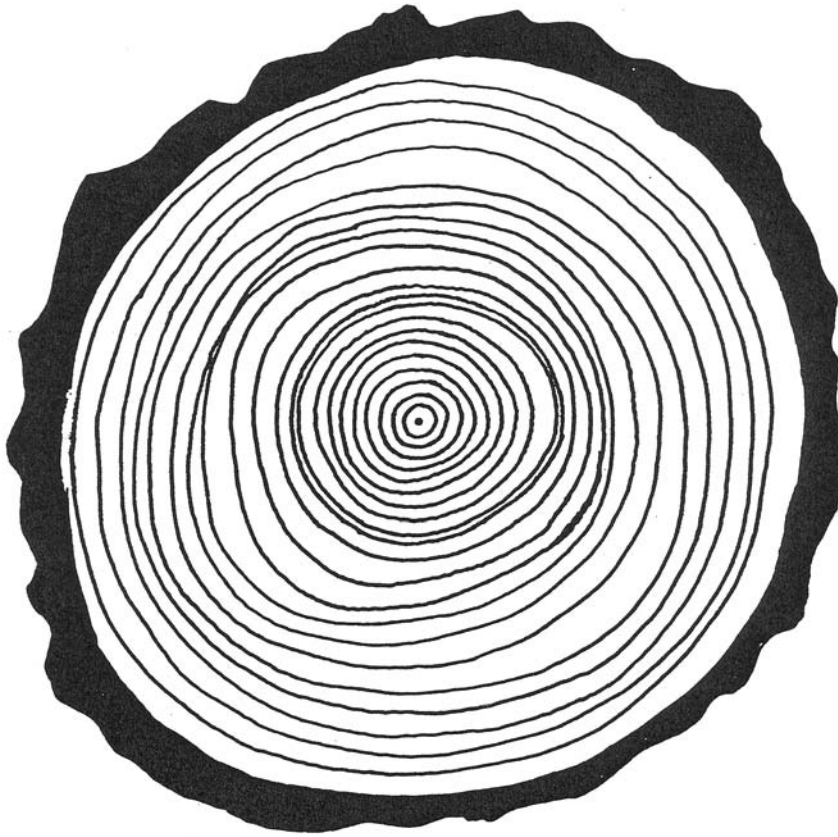
**4. Does your tree have a fire scar?  
If yes, in what year?**

**5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



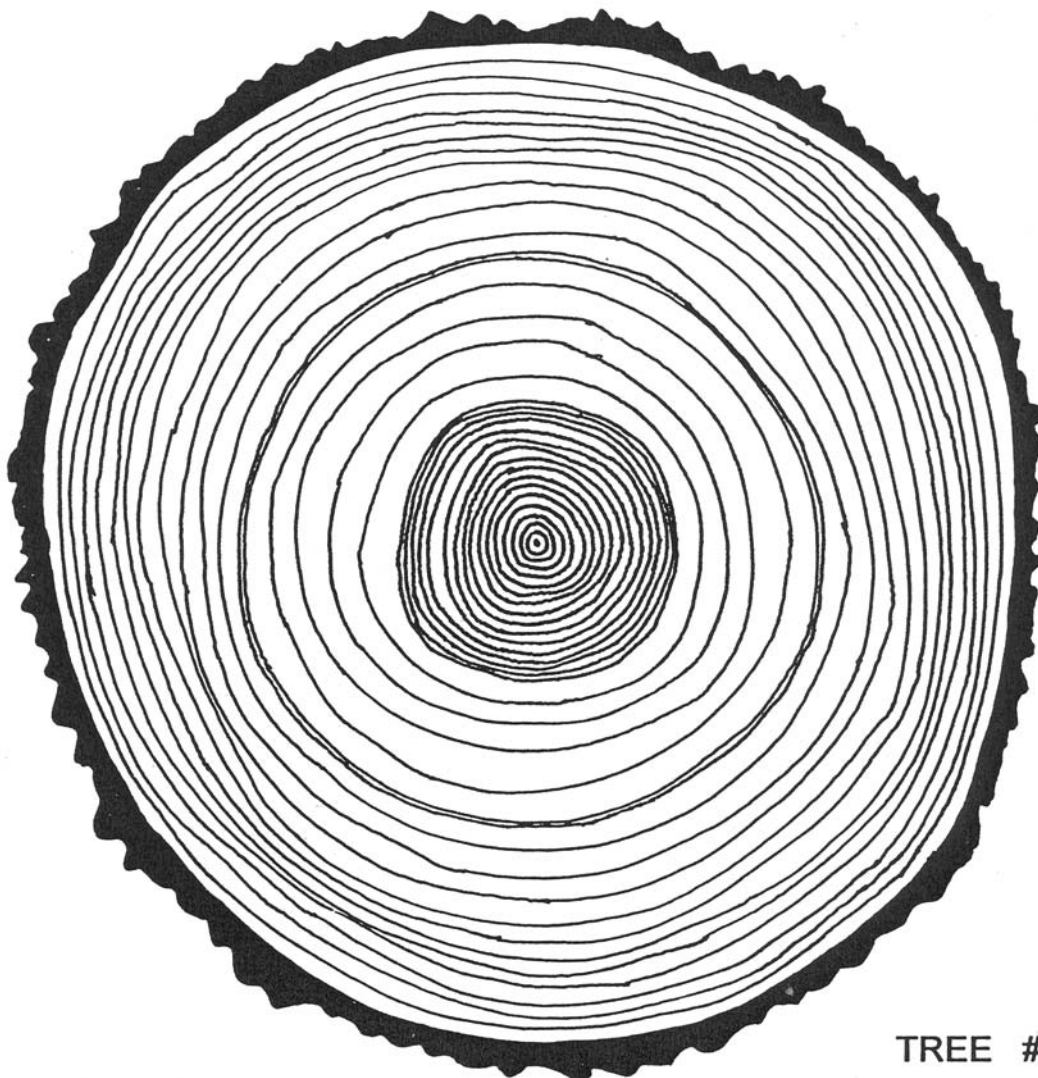
TREE # 14

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



**TREE # 15**

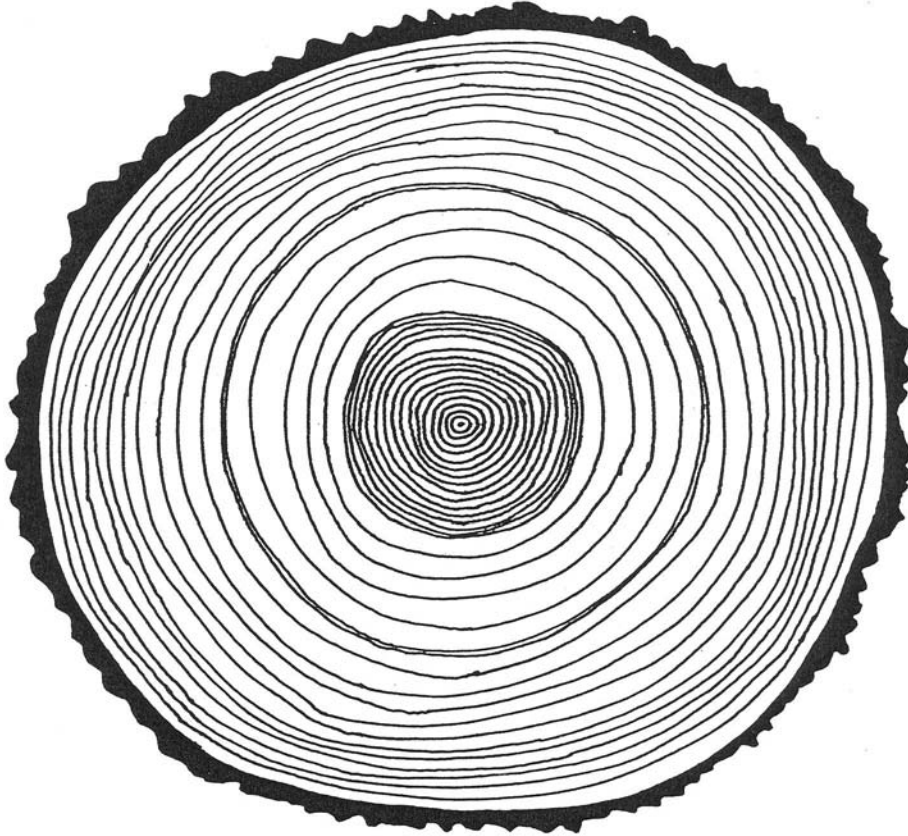
- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



TREE # 16

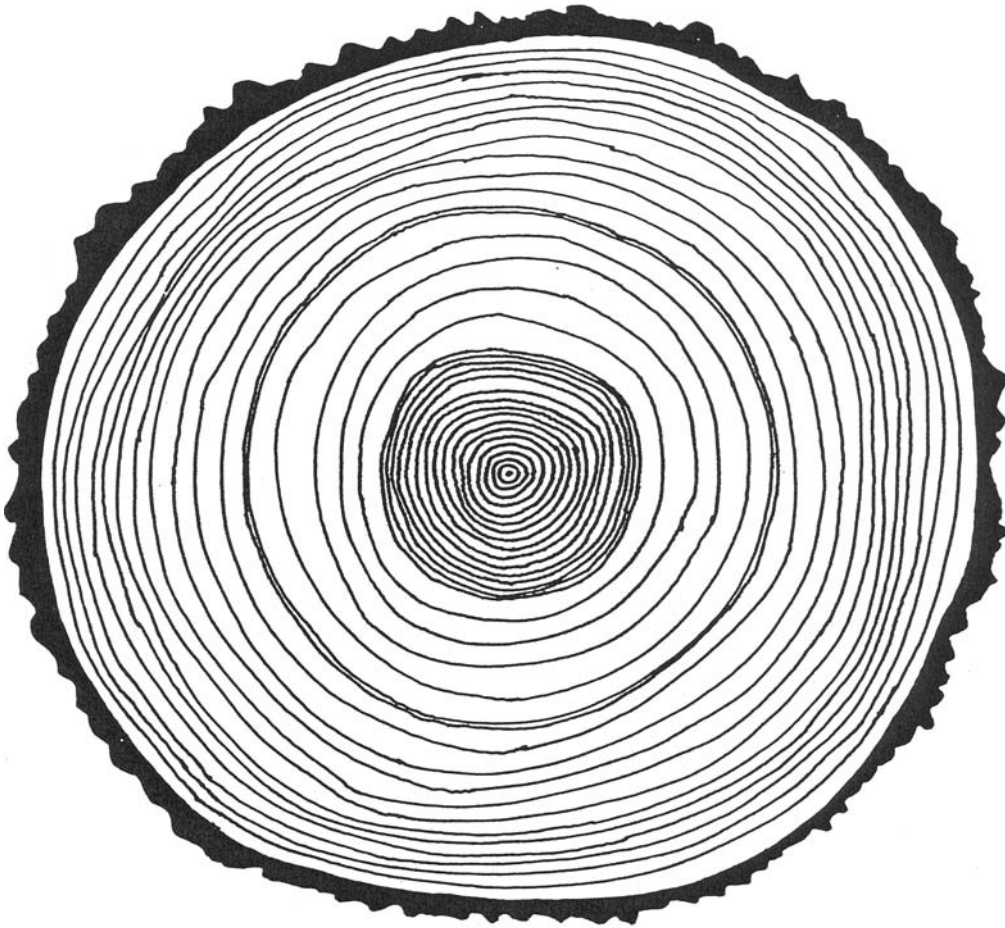
1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?





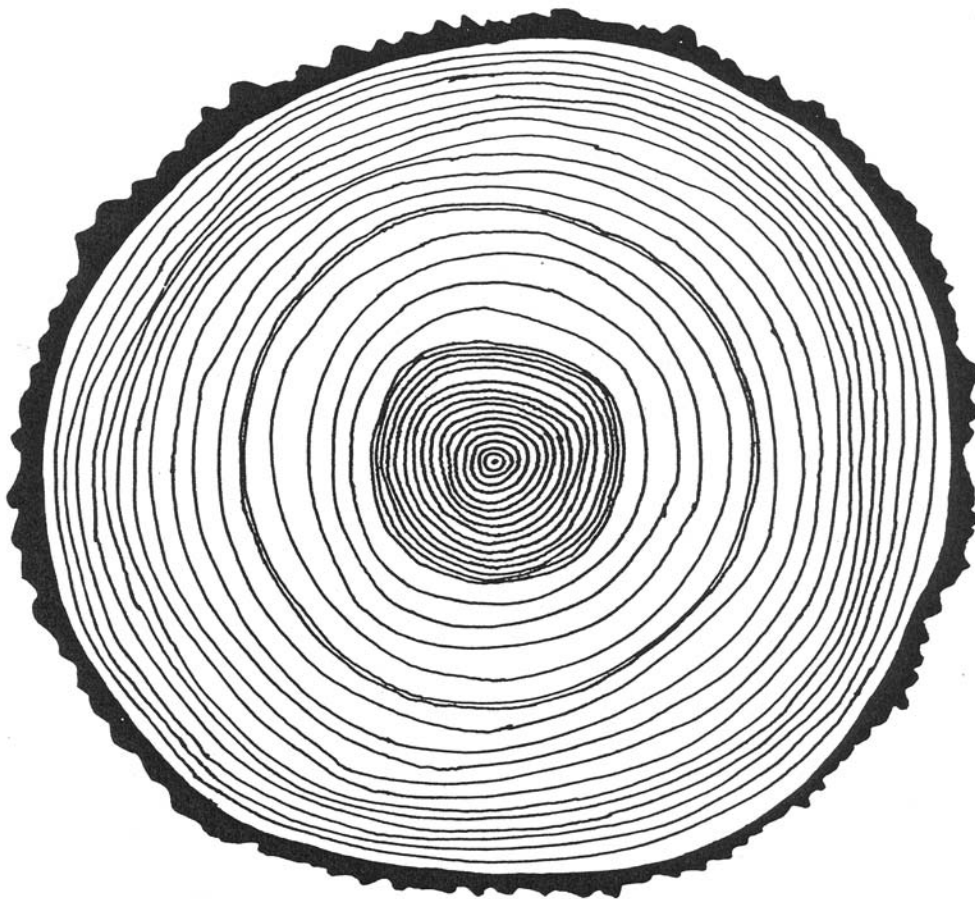
**TREE # 17**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



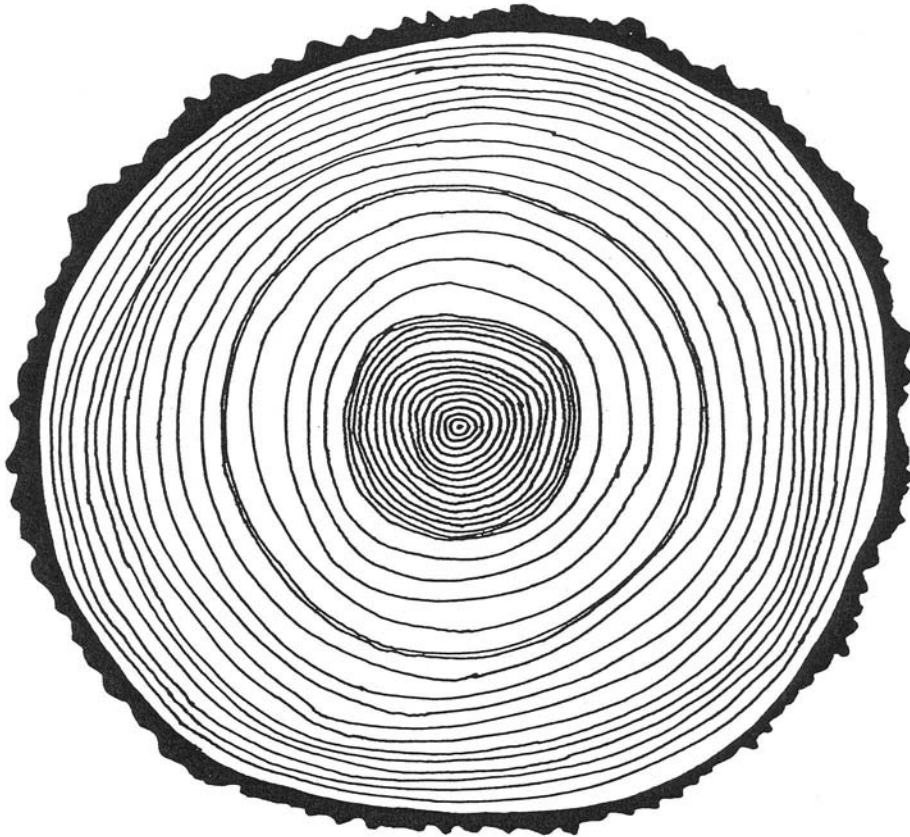
**TREE # 18**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



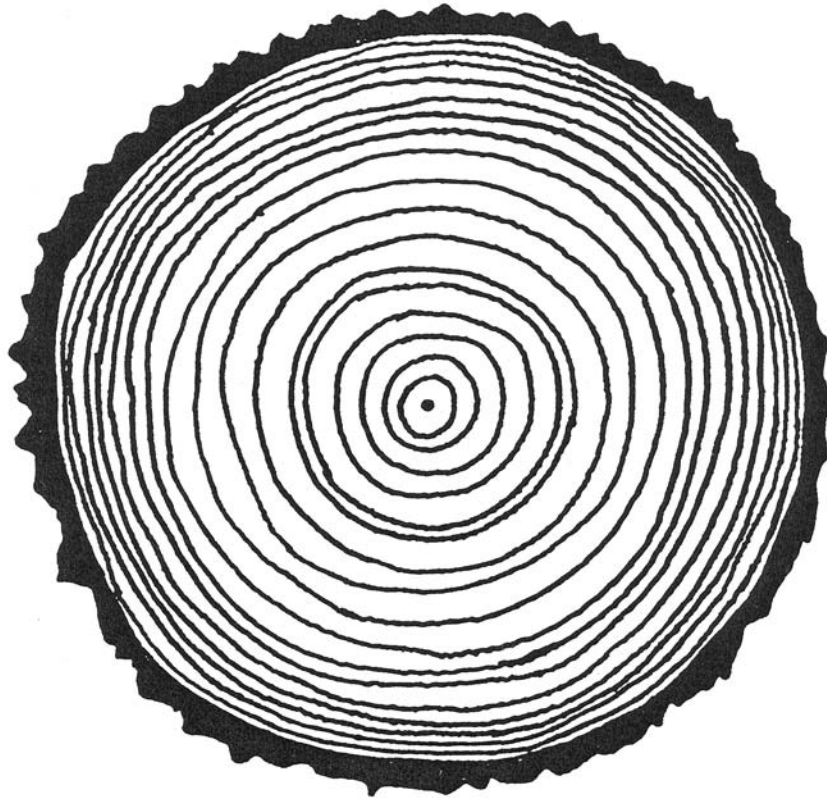
**TREE # 19**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



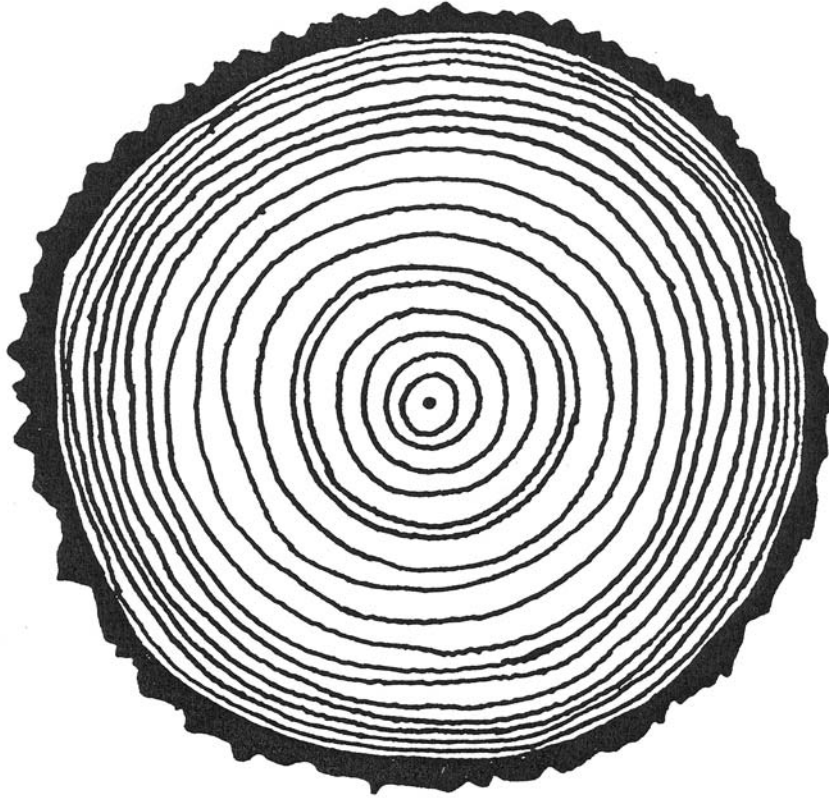
**TREE # 20**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
- 2. How old is your tree?**
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
- 4. Does your tree have a fire scar?  
If yes, in what year?**
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



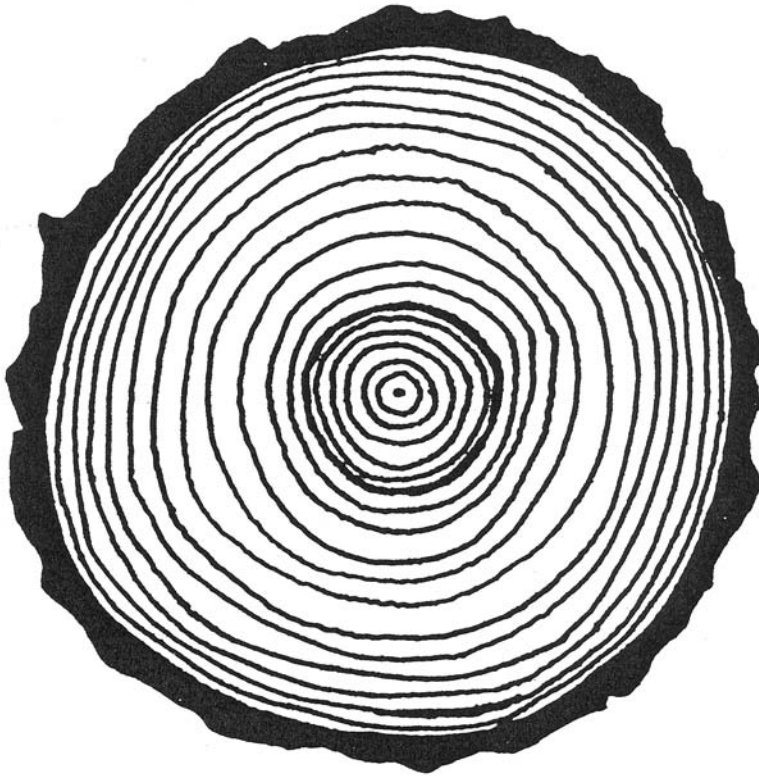
**TREE # 21**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



**TREE # 22**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



**TREE # 23**

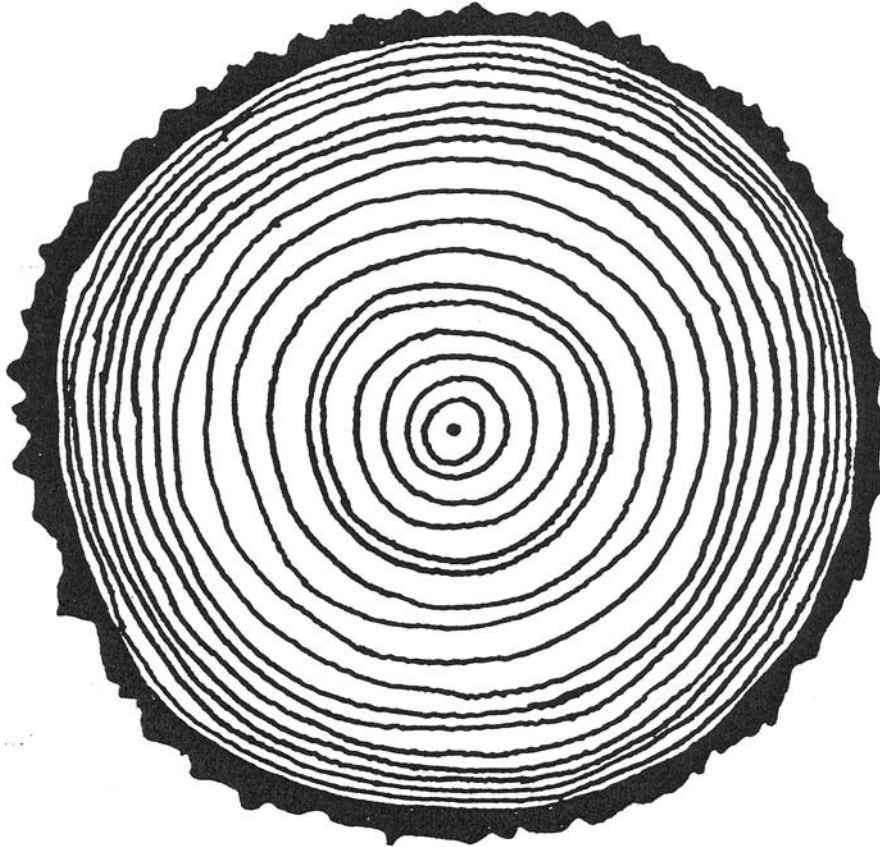
- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



TREE # 24

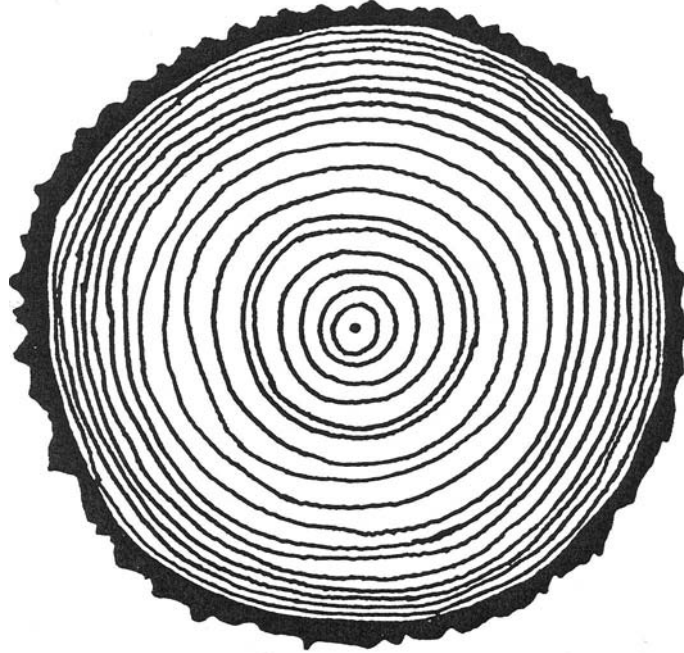
1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?





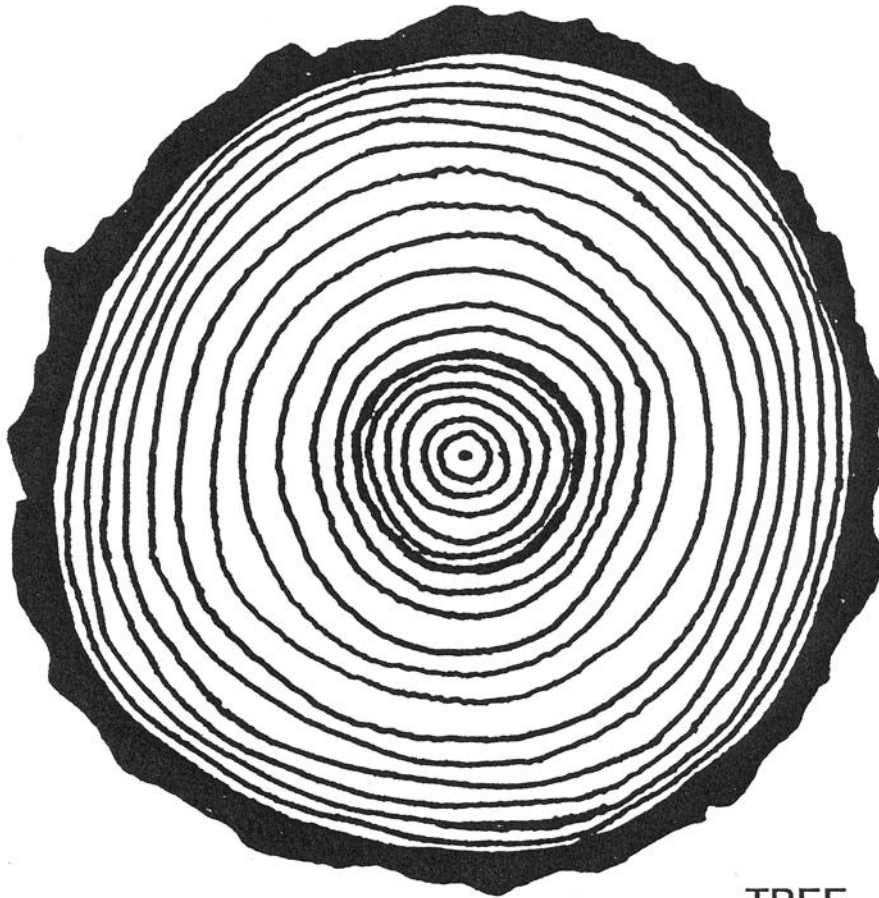
TREE # 25

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
  
2. How old is your tree?
  
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
  
4. Does your tree have a fire scar?  
If yes, in what year?
  
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



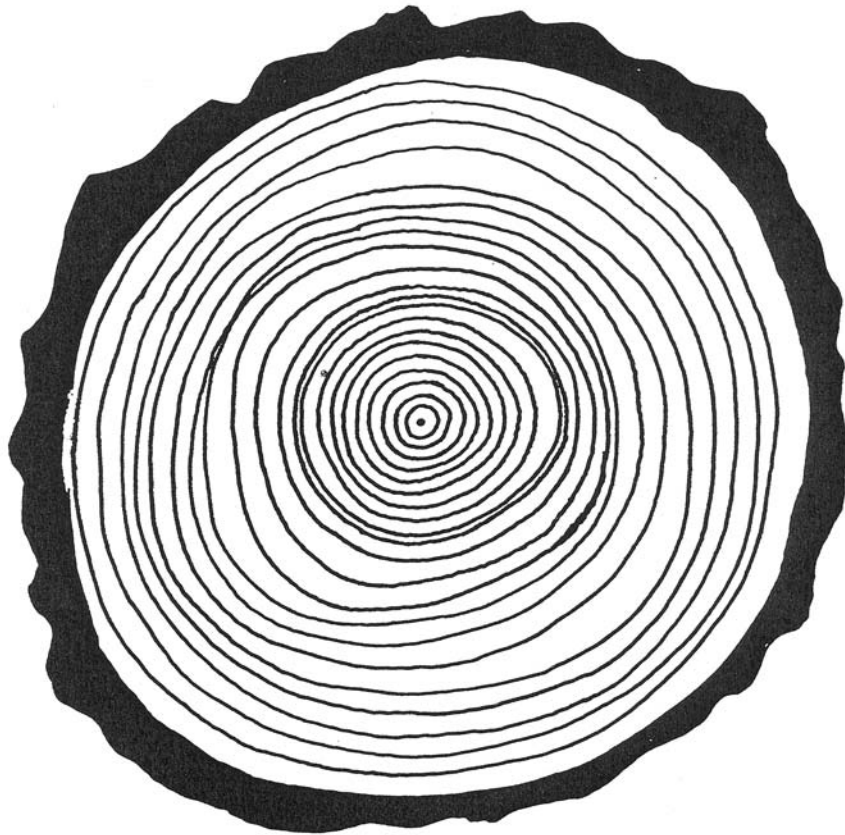
TREE # 26

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
  
2. How old is your tree?
  
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
  
4. Does your tree have a fire scar?  
If yes, in what year?
  
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



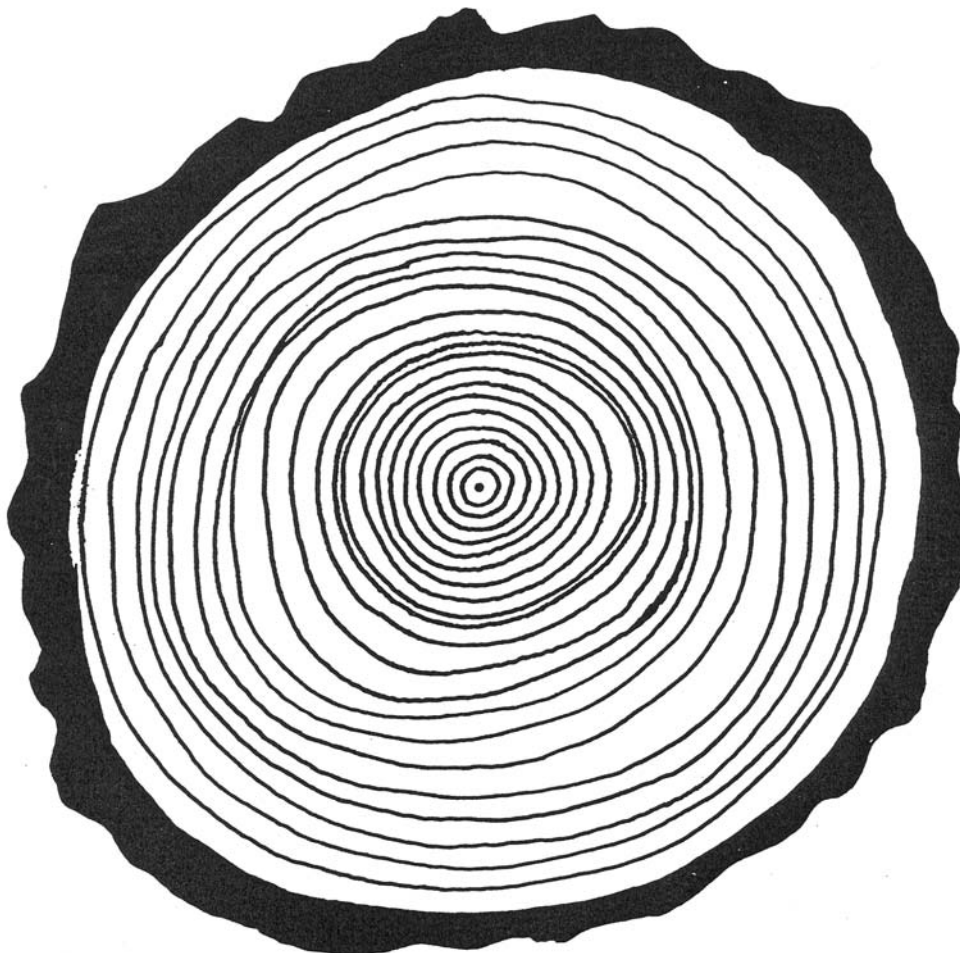
TREE # 27

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
2. How old is your tree?
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
4. Does your tree have a fire scar?  
If yes, in what year?
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



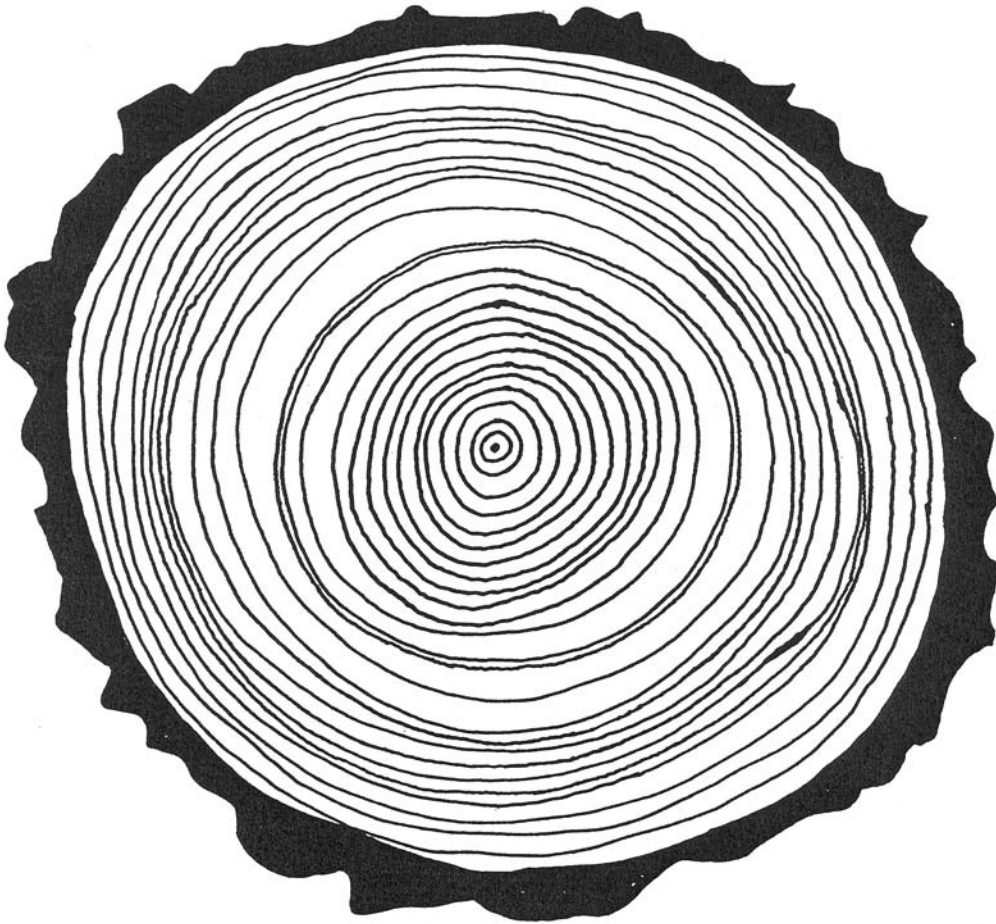
**TREE # 28**

- 1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**
  
- 2. How old is your tree?**
  
- 3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**
  
- 4. Does your tree have a fire scar?  
If yes, in what year?**
  
- 5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**



TREE # 29

1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?
  
2. How old is your tree?
  
3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?
  
4. Does your tree have a fire scar?  
If yes, in what year?
  
5. Did your tree “release” or start to grow quickly?  
If yes, in what year?



**TREE # 30**

**1. If the outer-most ring grew in 2001, what is the year of the first ring, the ring closest to the “pith” or center of the tree?**

**2. How old is your tree?**

**3. Does your tree have a “marker ring” or very narrow ring?  
If yes, in what year?**

**4. Does your tree have a fire scar?  
If yes, in what year?**

**5. Did your tree “release” or start to grow quickly?  
If yes, in what year?**

