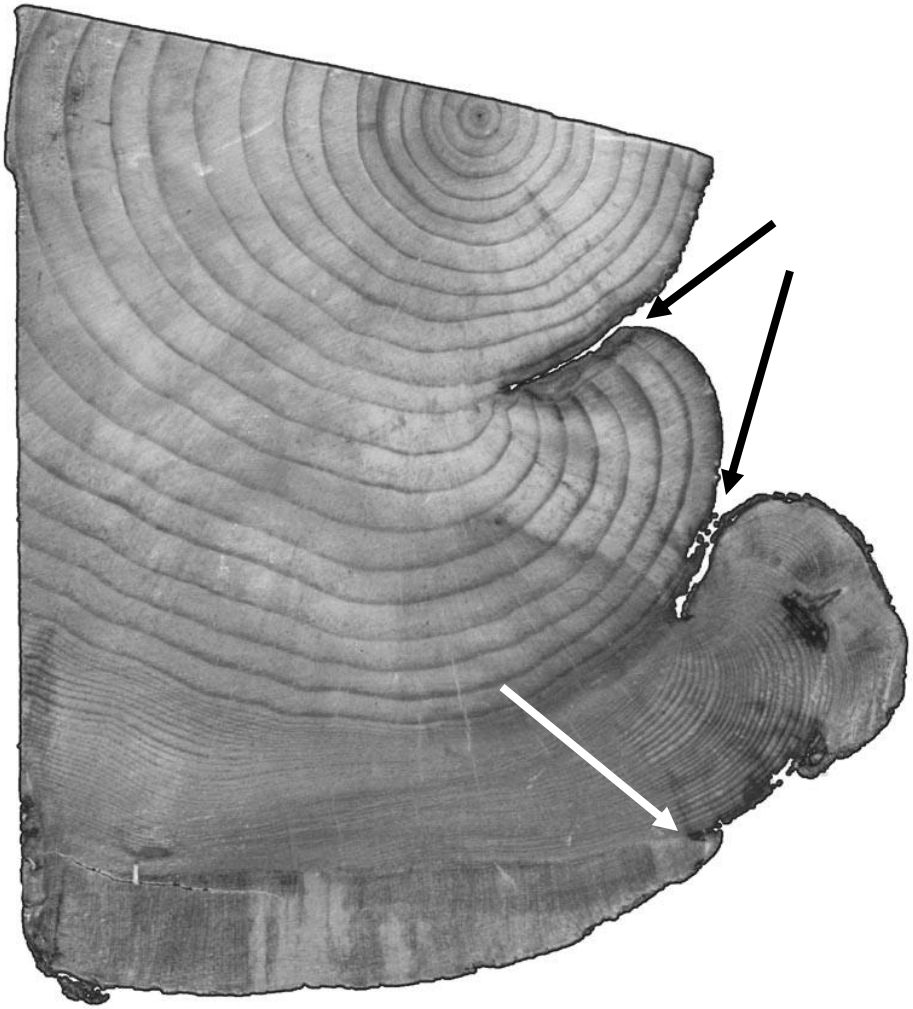
FireWorks Cookie Book

for

***FireWorks* featuring Ponderosa, Lodgepole, and Whitebark Pine Forests**



Contains:

1) Description of "real" tree cookies in your trunk

2) Description of all tree cookie photographs in the trunk

Fire Sciences Laboratory, Missoula, MT

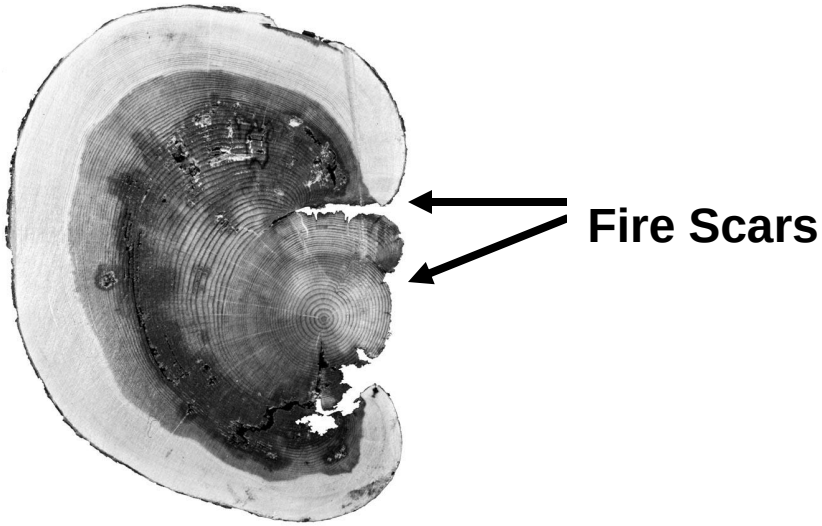
About Tree Cookies & Fire Scars

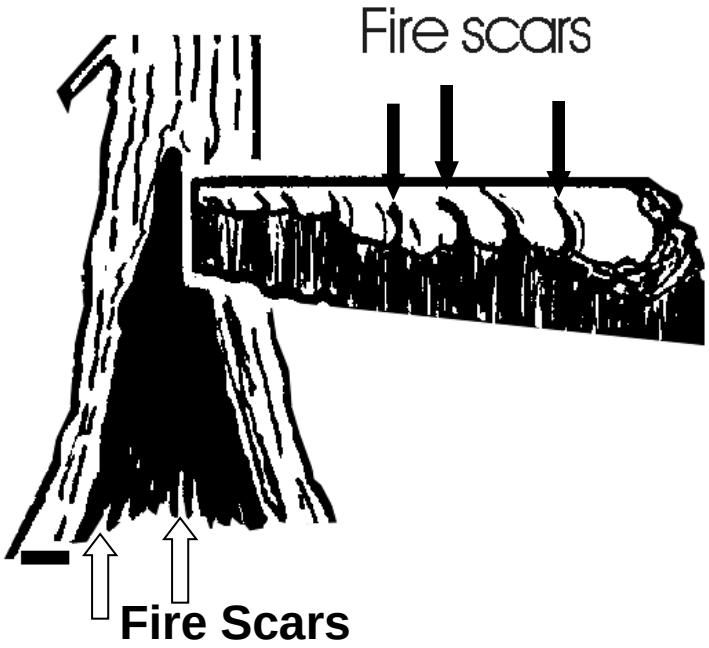
Tree rings and scars on trees tell the history of a forest. *Dendrochronology,* learning about forests and climate from tree growth rings, is a difficult but interesting science.

In *FireWorks,* we use cross-sections of fire-scarred trees to do dendrochronology (see Chapter 5). We call them "tree cookies." Some tree cookies are cut from stumps or fallen trees; these are complete cross sections, sometimes called "rounds," and actually look sort of like cookies (see photo at top). Other tree cookies are cut from living trees. How? A thin slice is removed from the center of the fire scar out to one side, leaving most of the tree bole undamaged (see diagram at right). Because little of the cambium is removed and pine trees produce a lot of pitch around damaged areas, pines are affected very little by this procedure.

Trees generally form one growth ring each year, so you can estimate a tree's age by counting its rings. When part of a tree's cambium is killed, a scar is formed. Surface fires often scar trees rather than killing them. Some trees have many fire scars. We can estimate how often surface fires occurred by counting the rings between scars.

For more information about dendrochronology, read *Tree Basics* by Alex Shigo, or visit the following Web sites: web.utk.edu/~grissino and www.ltrr.arizona.edu.





What's in this book?

Information about the Tree Cookies & Photos in Your *FireWorks* Trunk

This book contains one page describing each **real tree cookie** in your trunk, and also one page describing each **cookie photo** in your trunk.

Each page has information on the cookie's tree species and the location where the tree was growing. Each page has a data table that describes the tree's fire history-- how old it was when first scarred by fire, how many years occur between scars, and how many years occurred after the last scar. Not all data tables follow the same format, but they are all labeled so you can get the information you need. Some data tables show tree-ring counts made using two different methods-- first, counts made directly from a photo; then, counts made from the actual cookie by using a microscope or hand lens. Some tree cookie pages have a photograph of the cookie, with arrows that point to fire scars and other features. Some contain information about the tree that is unrelated to fire, such as what dark stains or streaks on the cookie mean.

Here are some ideas for counting tree rings accurately:

•Use a pointer to keep track of "where you are" as you count. You can use a straight pin for this. You can also use a pencil, but its point will not be fine enough to track narrow tree rings. If you're working with a real cookie (as opposed to a photo), hold the pointer firmly in place when you re-adjust the hand lens. Hold the lens close to the tree cookie and place your eye close to the lens. Be sure to use bright light.

•Some cookies are entire tree "rounds," with fire scars showing on both sides of the central scar. Count in only one direction from the center. If you count every scar on the round, you will count twice as many fires as really occurred! Choose the side to count according to where rings are most prominent and widest (therefore easiest to work with). It may be interesting to count both sides and compare the results. They are seldom identical.

•Some rings are too small or too damaged to count. If you can't count them accurately, just count the ones you can see clearly. Then record the number with ">," meaning "more than" that many rings are in the cookie. If you use these counts in calculations, explain that you are using an minimum, or "conservative estimate," and explain why you are uncertain.

If you have binocular microscopes in the classroom, let students use them to examine the real tree cookies.

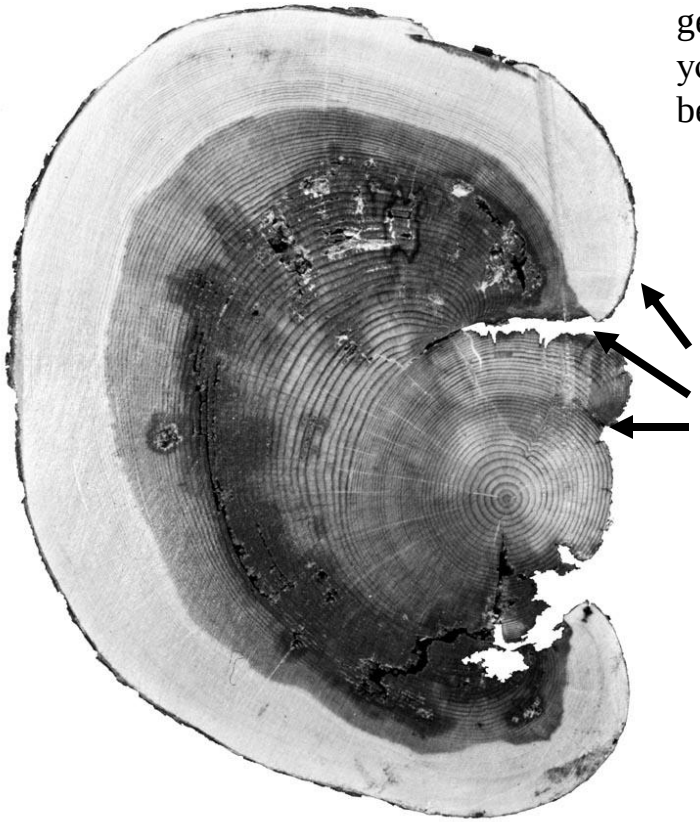
Tree Cookie 101

Lodgepole pine

This tree cookie came from a lodgepole pine forest in the Gash Creek drainage, Bitterroot National Forest, western Montana.

Dark stains in the cookie's center and holes in the wood show that the tree's heartwood was decayed. The dark stains are from pitch, produced by the tree to slow the spread of decay fungi from heartwood to sapwood.

Because the wood near the fire scars has decayed, it is hard to count the tree rings between the two fire scars. It may be easiest to count from the ring next to the second (more recent) fire scar back to the tree's pith; you'll get about 40 years. Then count from the pith out to the area of the first scar; you'll get about 20. Subtract that time from the first number to get the interval between fires.

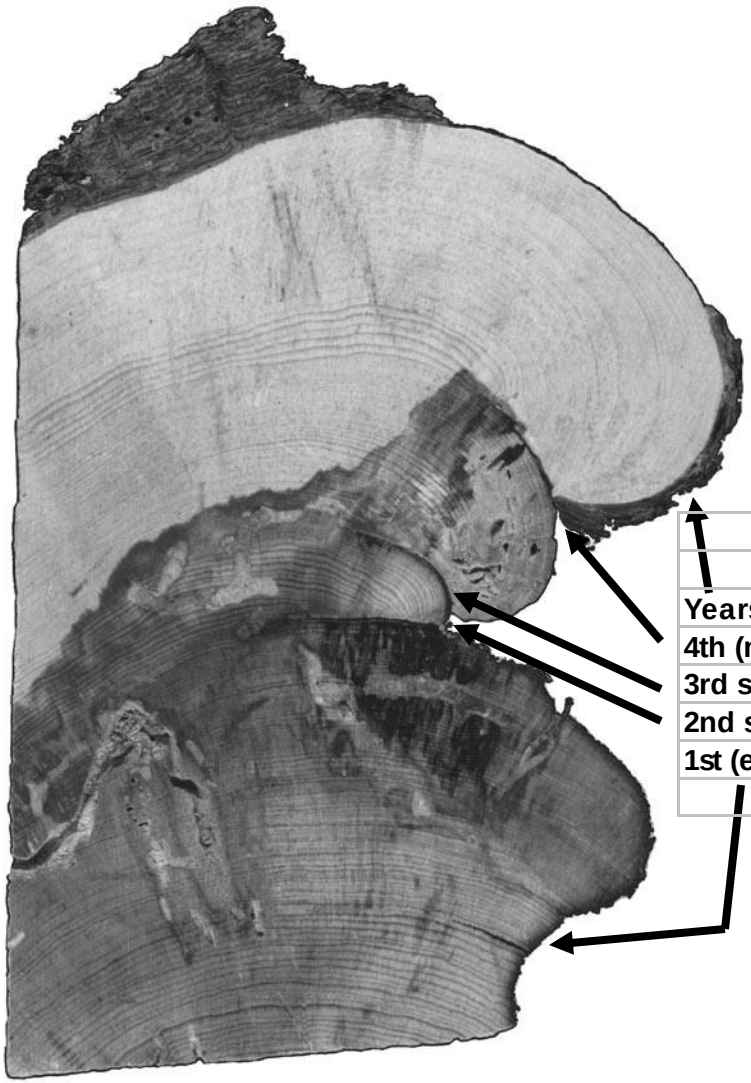


History	Ring Count from Photo		Ring Count from Cookie
Years after most recent scar	>75	years since last fire	>75
2nd (most recent) scar	19	years between fires	19
1st (earliest) scar	23	age when first scarred	23

This is a photograph of "real" cookie #76.

Tree Cookie 102

Ponderosa pine



This tree cookie was collected in 1986 from the Greenough Creek drainage in the Lolo National Forest, western Montana. A small piece of the thick bark characteristic of ponderosa pine is still attached. Dark stains in the cookie's center and holes in the wood show that the center of this tree was decayed when the cookie was cut.

Many rings near the center of the cookie are hard to count. Just count as many as you can; then you at least know the *minimum* number of years between fires. That's what ">23" and ">46" mean in the table below. When the rings were counted with a hand lens on the original cookie, as recorded in the right-hand column, a few more were visible.

History	Ring Count from Photo		Ring Count from Cookie
Years after most recent scar	>65	years since last fire	68
4th (most recent) scar	>46	third fire interval	57
3rd scar	>23	second fire interval	28
2nd scar	73	first fire interval	73
1st (earliest) scar	24	Can't tell when first scarred	24
		because pith isn't present	

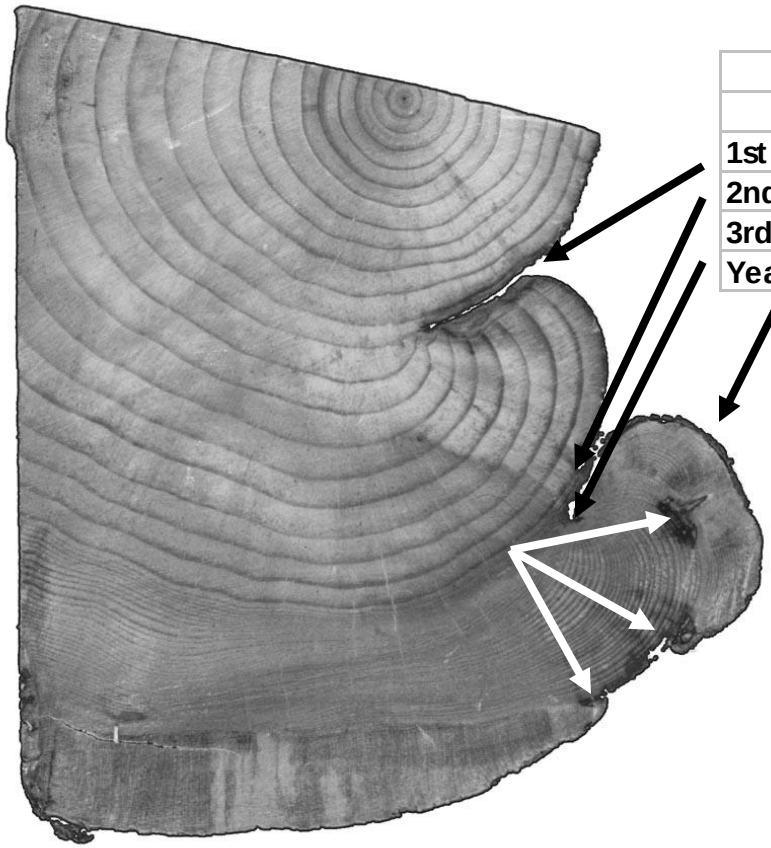
This is a photograph of "real" cookie #62.

Tree Cookie 103

Lodgepole pine

This tree cookie was cut in 1978 from a tree killed by mountain pine beetles in Glacier National Park, Montana.

This cookie has some surprises that are hard to spot. The tree must have grown very fast during its first few years, because the rings are huge– some nearly 1 cm wide. After the tree was scarred by the second fire, however, it grew very slowly. On the photo, you may be able to spot a third fire scar, about 10 years after the second one. Then something scarred the tree about 30 years before the cookie was cut (marked with white arrows). Could that have been another fire?



History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	13	age when first scarred	24
2nd scar	9	first fire interval	9
3rd (final?) scar	10	second interval	10
Years after 3rd scar	>80	years since 3rd fire scar	87

This is a photograph of “real” cookie #61.

Tree Cookie 104

Ponderosa pine

This tree cookie was cut in the Flathead River valley, Montana. Much of the thick bark characteristic of ponderosa pine is still attached to the outside edge of the cookie.

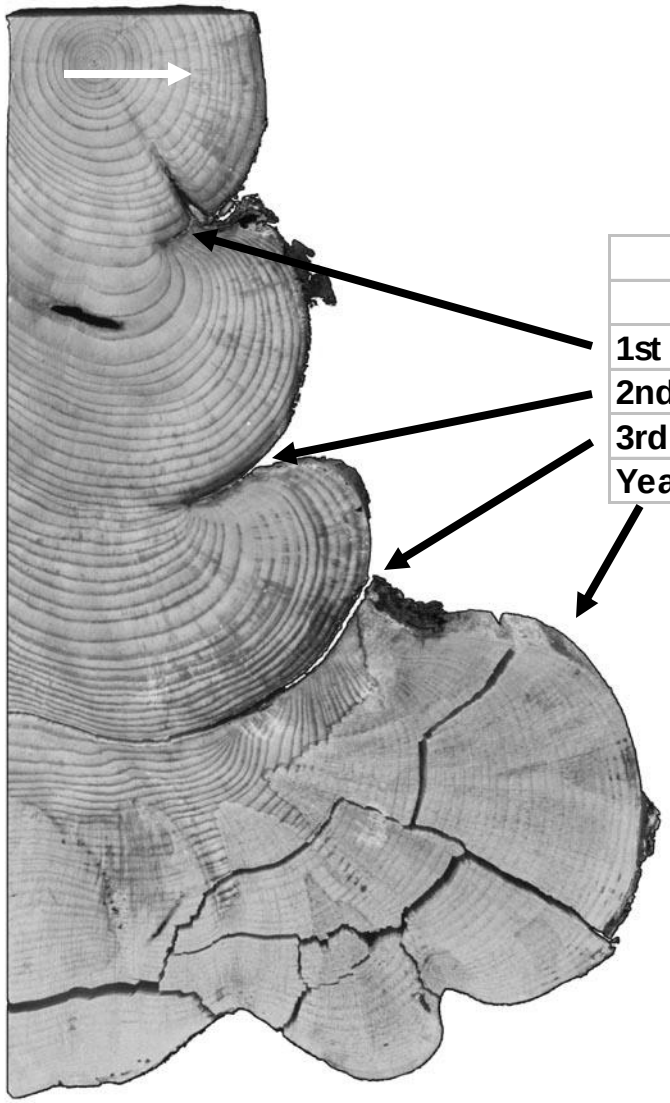
This cookie has some dark areas in the older wood. They tell us that the tree had decay in its heartwood. The tree surrounded the decay with pitch so its sapwood would not rot.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	58	Can't tell age when first	58
		scarred because pith not present	
2nd scar	23	first fire interval	23
3rd scar	11	second fire interval	11
4th scar	10	third fire interval	11
5th (most recent) scar	28	most recent fire interval	28
Years after final scar	100	years since last fire scar	103

This is a photograph of “real” cookie #4.

Tree Cookie 105

Lodgepole pine



This tree cookie was cut from a tree in Glacier National Park, Montana.

This cookie has a lot of pitch around its fire scars. It probably responded to every surface fire by producing pitch near the wound. That kept fungi from entering at the wound and rotting the sapwood. This cookie also has grayish-blue streaking in the unfinished wood near its outside edge, marked by a white arrow. The streaks mark areas infected by blue-stain fungus, which is introduced to pine trees by mountain pine beetles; they carry parts of the fungus around on their heads!

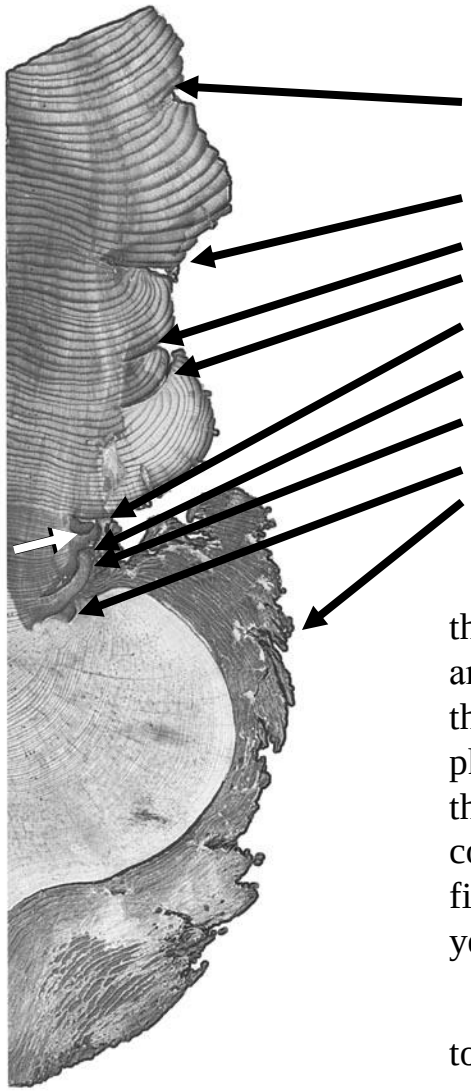
History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	20	age when first scarred	21
2nd scar	18	first fire interval	18
3rd scar	22	second fire interval	22
Years after 2nd scar	51	years since final fire scar	51

This is a photograph of “real” cookie #60.

Tree Cookie 106

Ponderosa pine

This is a photograph of a ponderosa pine cookie collected in the Blue Mountains of Oregon. Notice that it still has a lot of thick bark, which is characteristic of old ponderosa pines.



History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	10	Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	14	first fire interval	14
3rd scar	15	second fire interval	15
4th scar	7	third fire interval	7
5th scar	18	fourth fire interval	18
6th scar	>26	fifth fire interval	30
7th scar	>10	sixth fire interval	11
8th (most recent) scar	>10	seventh fire interval	12
Years after 8th scar	>60	years since final fire scar	Not recorded

Many rings on this cookie are hard to count. Just count as many as you can; then you at least know the *minimum* number of years between fires. That's what ">26" and ">10" mean in the table above. When the rings were counted with a microscope on the original cookie, as recorded in the right-hand column, a few more were visible. On the photo, you may just barely be able to spot a fire scar between the 5th and 6th ones listed in the table. This scar is very hard to see on the photo, but it can be identified on the real cookie with a hand lens. It is marked on the photo with a white arrow. In reality, then, the fifth fire interval was not just one 30-year period, but was broken into a 6-year and 24-year period.

This tree cookie has a lot of pitch around its fire scars. It probably responded to every surface fire by producing pitch near the wound. That kept fungi from entering the wound and rotting the sapwood.

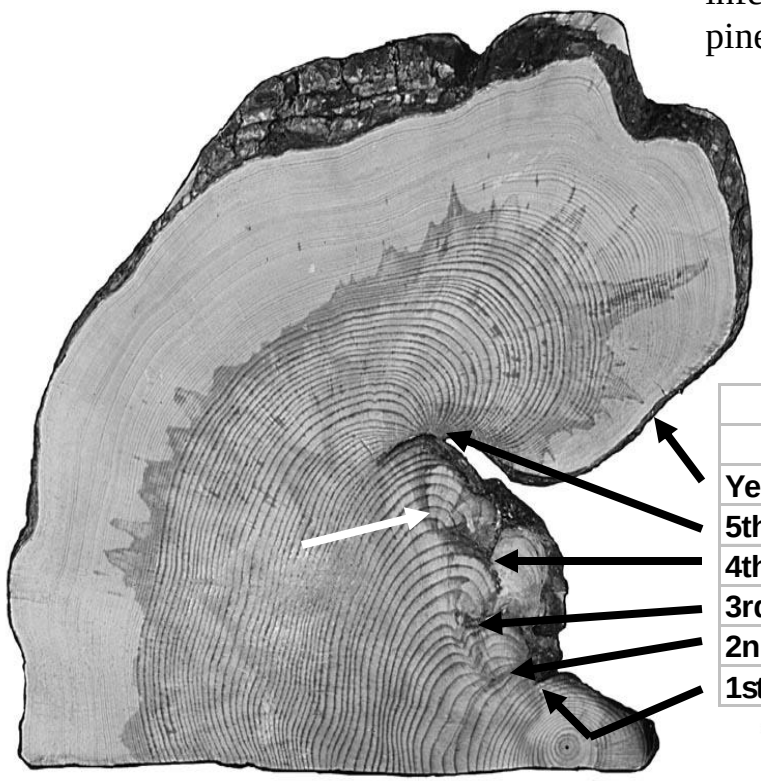
Tree Cookie 107

Lodgepole pine

This tree cookie was collected in the Flathead River drainage, western Montana. It seems to have thick bark near its top, but it doesn't really; it looks that way because of the angle used to take the picture. The bark is really quite thin, typical of lodgepole pine.

This cookie has a lot of pitch around its fire scars. It probably responded to every surface fire by producing pitch near the wound; that kept fungi from entering at the wound and rotting the sapwood.

This cookie also has a few grayish-blue streaks in the area between fire scars, marked here with a white arrow. These streaks mark areas infected by blue-stain fungus, which is introduced to pine trees by mountain pine beetles. The beetles carry parts of the fungus around on their heads!



This is a photograph of "real" cookie #6.

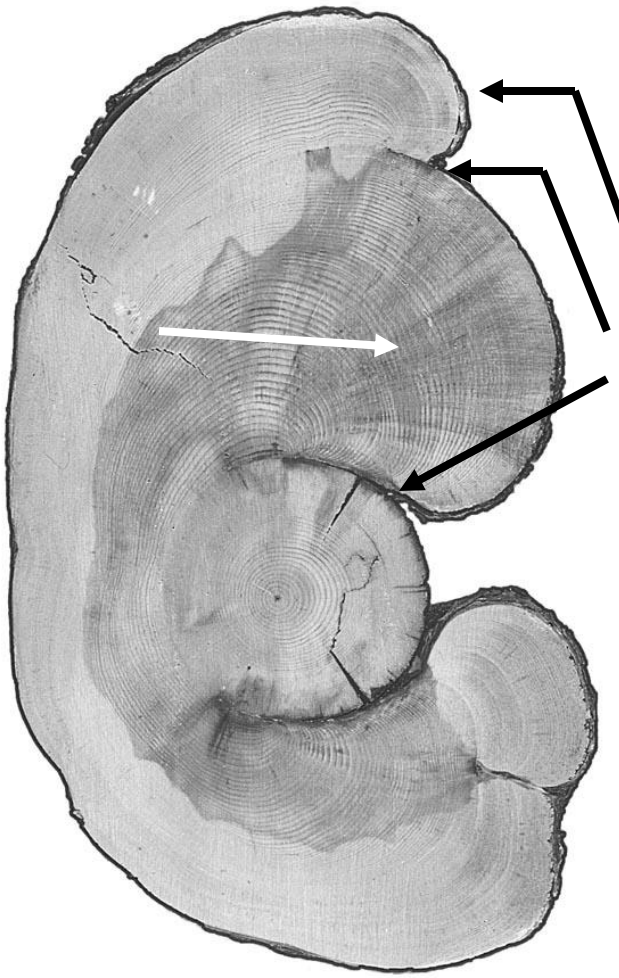
History	Ring Count from Photo		Ring Count from Cookie
Years after 5th scar	>85	years since final fire scar	100
5th (most recent) scar	11	fourth fire interval	11
4th scar	7	third fire interval	7
3rd scar	7	second fire interval	7
2nd scar	4	first fire interval	4
1st (earliest) scar	17	age when first scarred	17

Tree Cookie 108

Lodgepole pine

This tree cookie was collected in the Beaverhead National Forest, Montana.

This cookie has some pitch in its center. The tree used pitch to slow the growth of fungi from heartwood into sapwood. The cookie also has grayish-blue streaking in the area between fire scars; the streaks, marked by a white arrow on this photo, look like rays coming in from the bark. They mark areas infected by blue-stain fungus, which is introduced to pine trees by mountain pine beetles. The beetles carry parts of the fungus around on their heads!



History	Ring Count from Photo		Ring Count from Cookie
Years after last scar	>46	years since final fire	61
2nd (most recent) scar	67	first & only fire interval	67
1st scar	48	age when first scarred	49

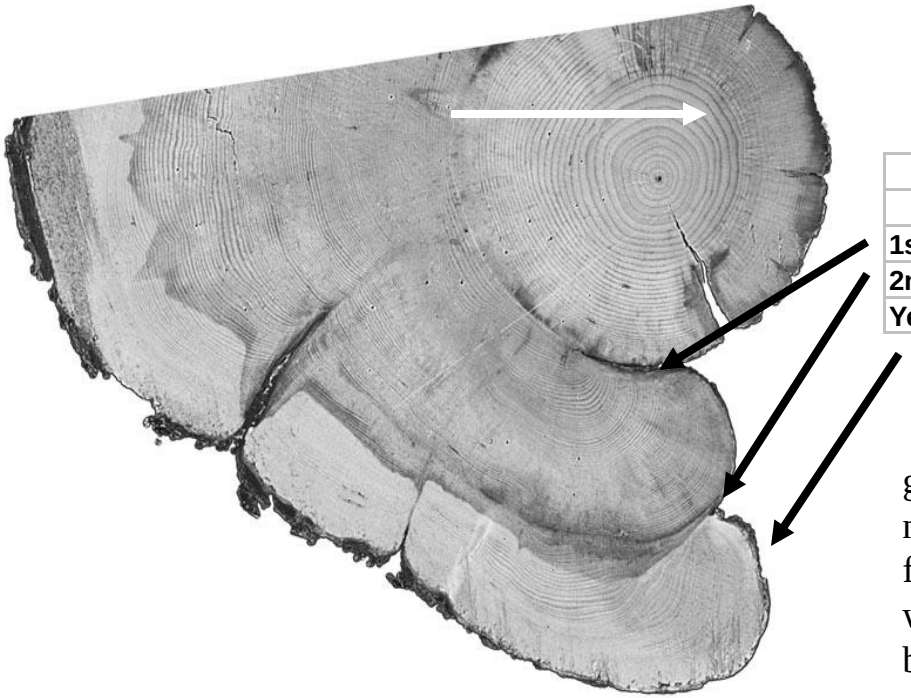
This is a photograph of “real” cookie #38.

Tree Cookie 109

Lodgepole pine

This tree cookie was collected in the Beaverhead National Forest, Montana.

This cookie has some very narrow rings, so it is hard to count them and determine the tree's fire history. You can make a "conservative estimate" of the years between fires by counting the number of rings in a single centimeter, then multiplying by the number of centimeters between the tree rings made in fire years. This estimate is "conservative" because the hard-to-count rings are even narrower than the ones you counted, so even more would occur in a centimeter.



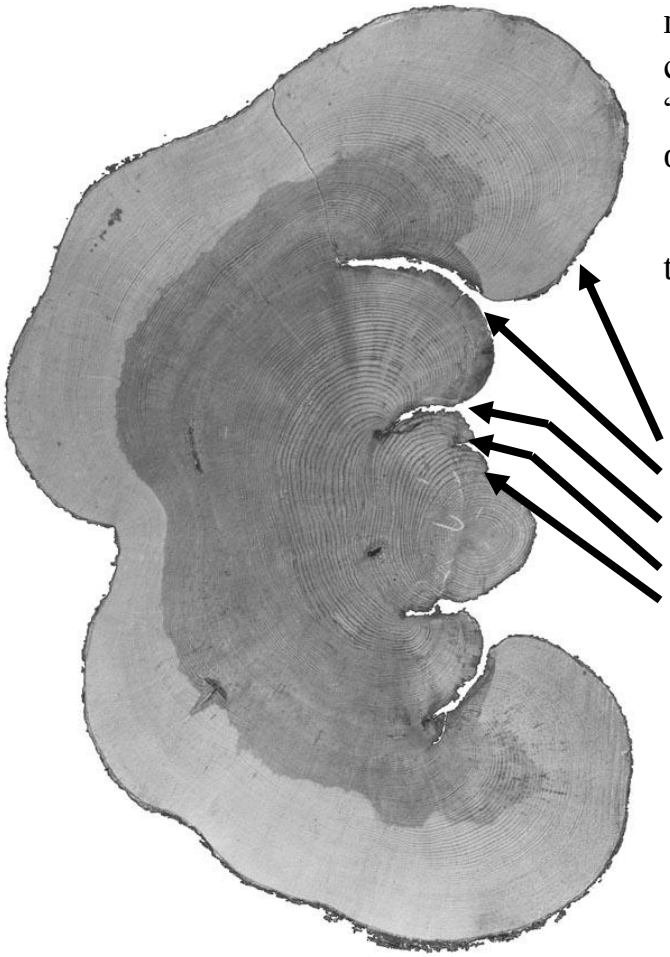
History	Ring Count from Photo		Ring Count from Cookie
1st scar	>40	age when first scarred	about 53
2nd (most recent) scar	>50	only fire interval	about 87
Years after last scar	>46	years since final fire	about 80

This tree cookie has pitch in its center. It also has grayish-blue streaking around the pith, marked by a white arrow near the front of the scar. The streaks look like rays coming in from the scar. They mark areas infected by blue-stain fungus, which is introduced to pine trees by mountain pine beetles. The beetles carry parts of the fungus around on their heads!

This is a photograph of "real" cookie #40.

Tree Cookie 110

Lodgepole pine



This tree cookie was collected in a high-elevation meadow with a few trees in the Galena area, south-central Montana.

This cookie has some areas with narrow rings, so it is hard to count all of them to determine the tree's fire history. You can obtain a "conservative estimate" in one of two ways: (1) Count the rings you *can* see and write down ">" before the number you count; or (2) count the number of rings in a single centimeter, then multiply by the number of centimeters where you can't count the rings. This estimate is "conservative" because the hard-to-count rings are even narrower than the ones you counted, so even more would occur in a centimeter.

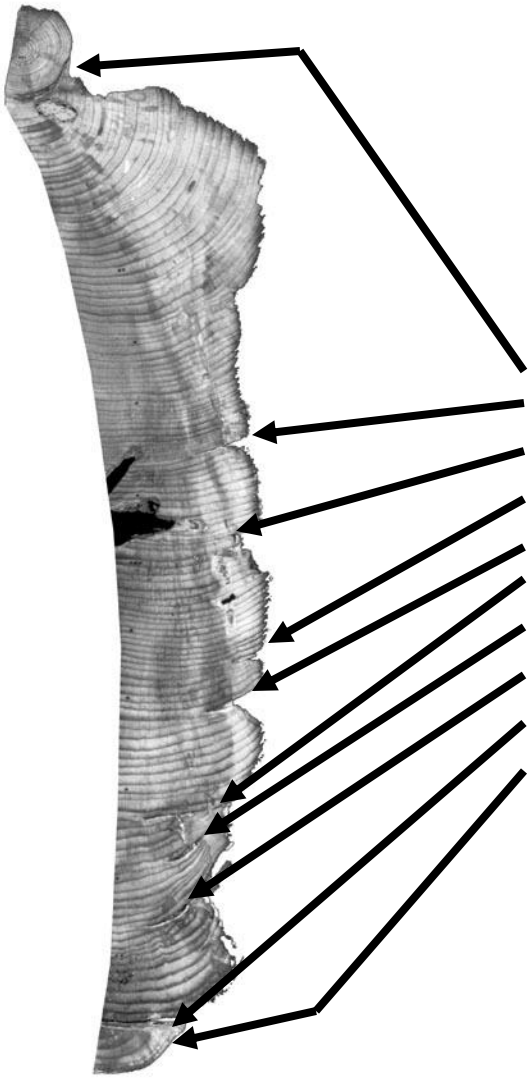
This tree cookie has pitch in its center, showing where the tree sealed off decay in the heartwood to protect its sapwood from decay.

History	Ring Count from Photo		Ring Count from Cookie
Years after last scar	>120	years since final fire	137
4th (most recent) scar	>48	third fire interval	65
3rd scar	11	second fire interval	11
2nd scar	6	first fire interval	6
1st scar	>22	age when first scarred	29

This is a photograph of "real" cookie #54.

Tree Cookie 111

Ponderosa pine



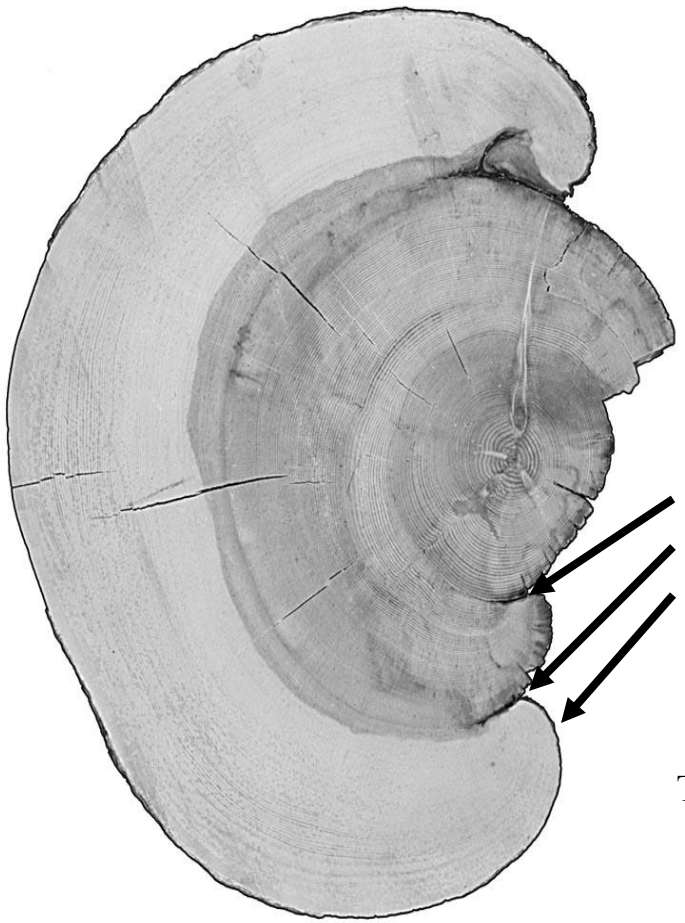
This is a photograph of a ponderosa pine cookie collected in the Blue Mountains of Oregon. There is no bark left on the outside edge of the cookie (at the bottom in this photo). In fact, the outside edge is a fire scar that was never covered by later wood.

This cookie has one fire scar that can't be seen on the photograph. It occurs between the 2nd and 3rd fire scars that you *can* see. That interval is not really 14 years, as marked below; it is one 6-year interval and one 8-year interval.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	17	age when first scarred	Not recorded
2nd scar	65	first fire interval	66
3rd scar	14	second fire interval	6, then 8
4th scar	19	third fire interval	19
5th scar	6	fourth fire interval	6
6th scar	11	fifth fire interval	11
7th scar	6	sixth fire interval	6
8th scar	7	seventh fire interval	7
9th scar	11	eighth fire interval	11
Years after 9th scar	7	years since 9th scar	8

Tree Cookie 112

Lodgepole pine



This tree cookie was collected in the Beaverhead National Forest, Montana.

This cookie has some areas with narrow rings, so it is hard to count all of them to determine the tree's fire history. You can obtain a "conservative estimate" in one of two ways: (1) Count the rings you *can* see and write down ">" before the number you count; or (2) count the number of rings in a single centimeter, then multiply by the number of centimeters where you can't count the rings. These estimates are "conservative" because the hard-to-count rings are even narrower than the ones you counted, so even more would occur in a centimeter.

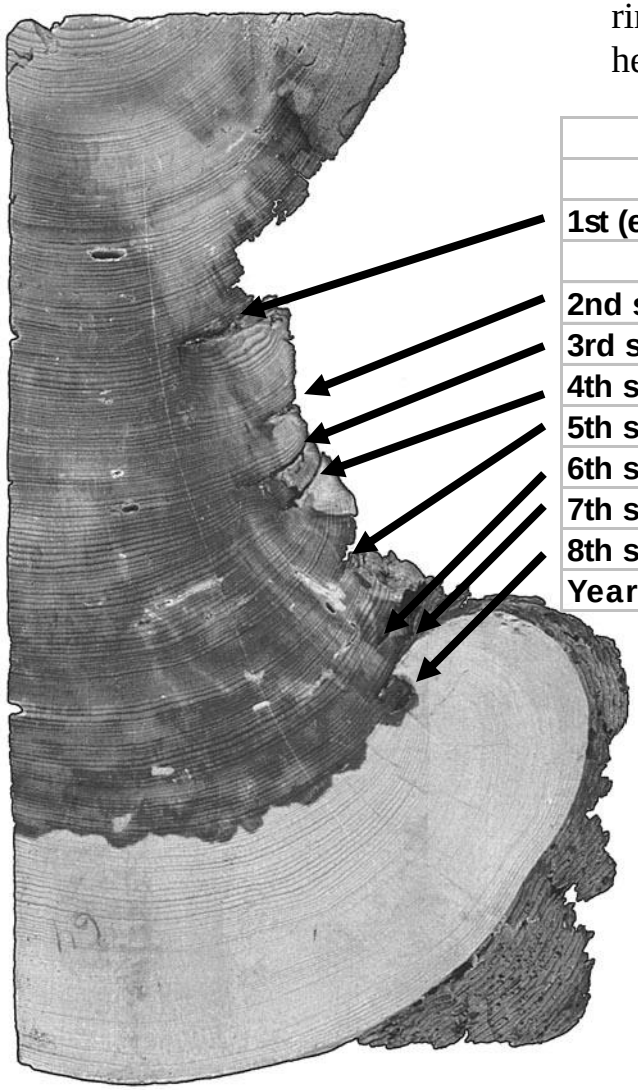
This tree cookie is darker in the center than near the outside. The dark wood has a lot of pitch in it. Trees use pitch to seal off decay in the heartwood, protecting the sapwood from decay.

History	Ring Count from Photo		Ring Count from Cookie
1st scar	41	age when first scarred	45
2nd scar	>60	only fire interval	68
Years after last scar	>108	years since final fire	137

This is a photograph of "real" tree cookie #45.

Tree Cookie 113

Ponderosa pine



This tree cookie was collected in the Salmon River drainage, Idaho. A small area on the cookie still has the thick bark characteristic of old ponderosa pines. This cookie has dark wood from its center through most of the growth rings with fire scars. The dark wood tells us that the tree had decay in its heartwood. The tree surrounded the decay with pitch to protect its sapwood.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	>80	Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	25	first fire interval	25
3rd scar	>14	second fire interval	22
4th scar	11	third fire interval	12
5th scar	>29	fourth fire interval	34
6th scar	22	fifth fire interval	22
7th scar	8	sixth fire interval	10
8th scar	6	seventh fire interval	6
Years after final scar	>54	years since last fire	>80

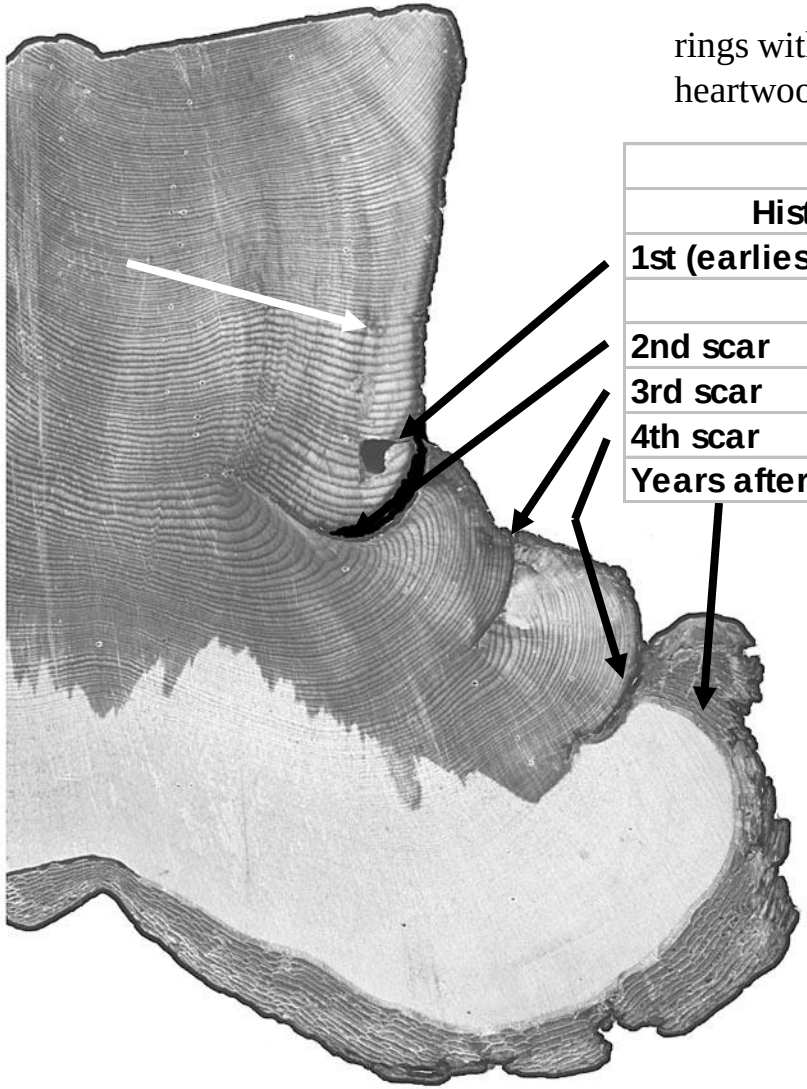
Many rings near the center of this cookie are hard to count. Just count as many as you can; then you at least know the *minimum* number of years between fires. That's what ">14" and ">29" mean in the table above. When the rings were counted with a hand lens on the original cookie, as recorded in the right-hand column, a few more were visible.

You did a very good job if you were able to spot the most recent fire scar on this tree cookie. It is right near the edge of the dark, pitchy wood and it was completely covered by wood that grew over its edges in the years after the fire.

This is a photograph of "real" cookie #20.

Tree Cookie 114

Ponderosa pine



This tree cookie was collected in the Flathead River drainage, western Montana. The cookie still has the thick bark characteristic of old ponderosa pines.

This cookie has dark wood from its center through the growth rings with fire scars. The dark wood tells us that the tree had decay in its heartwood. It surrounded the decay with pitch so its sapwood would not rot.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	>90	Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	10	first fire interval	11
3rd scar	44	second fire interval	44
4th scar	36	third fire interval	38
Years after final scar	>80	years since last fire	>120

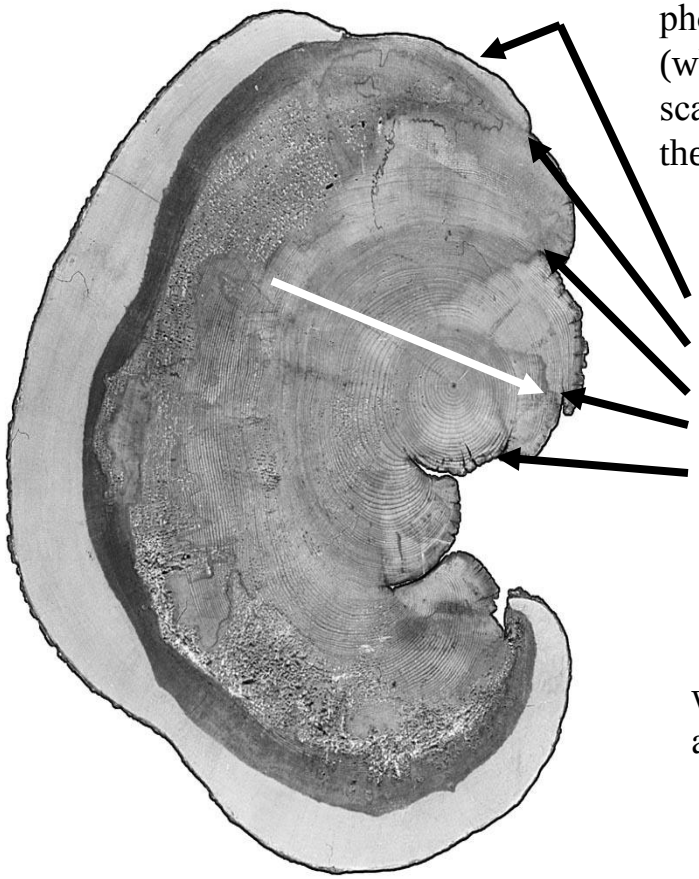
This tree cookie has one fire scar that can't be seen on the photograph. It is only noticeable because the rings right after the fire are a little wider than those before. It is marked on the photo below with a white arrow.

In some parts of the cookie, especially the sapwood, the rings are too narrow to see on the photo. For these sections, you can make a "conservative estimate" of the number of rings. See the directions for Tree Cookie #112.

This is a photograph of "real" cookie #2.

Tree Cookie 115

Lodgepole pine



This tree cookie has dark, rotten wood from its center all the way to its sapwood. This means that the tree had advanced decay in its heartwood. It surrounded the decay with pitch to slow the spread of fungi into the sapwood.

This cookie has a fire scar that occurs on one side of the tree but not the other. It is marked with two arrows (both white & black) on the photo here. The tree's rings are easier to count on the left side of the scar (when you hold it with the scar facing you) than the right side, but the 2nd scar isn't visible on the left side. You could count the rings on both sides of the scar, to see how close the numbers are.

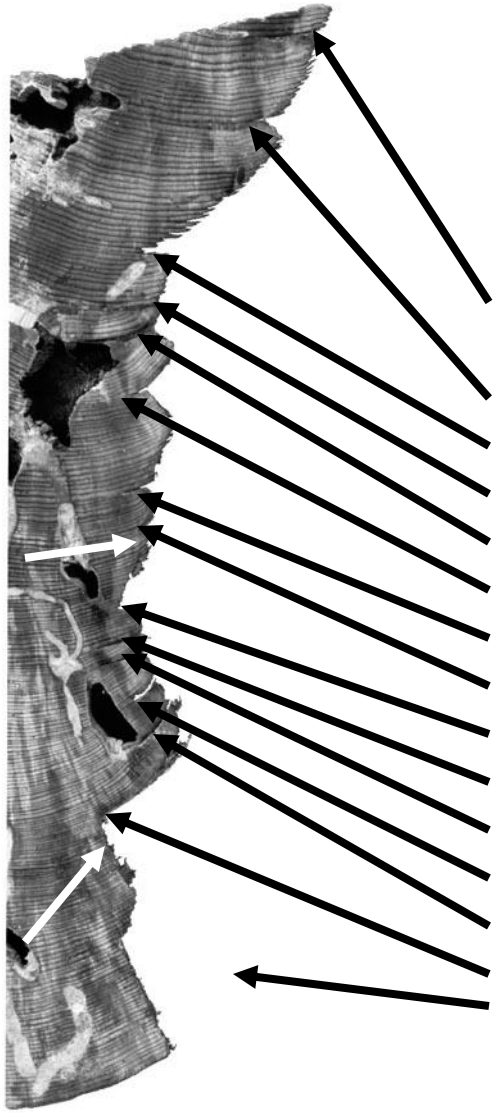
History	Ring Count from Photo		Ring Count from Cookie
Years after final scar	>50	years since last fire	>120
4th scar	>60	third fire interval	71
3rd scar	>15	second fire interval	17
2nd scar	>30	first fire interval	32
1st (earliest) scar	22	age when first scarred	22

In many parts of this cookie, the rings are too narrow or the wood is too rotten for counting rings accurately. For these sections, make a "conservative estimate." See the directions for Tree Cookie #112.

This is a photograph of "real" cookie #31.

Tree Cookie 116

Ponderosa pine

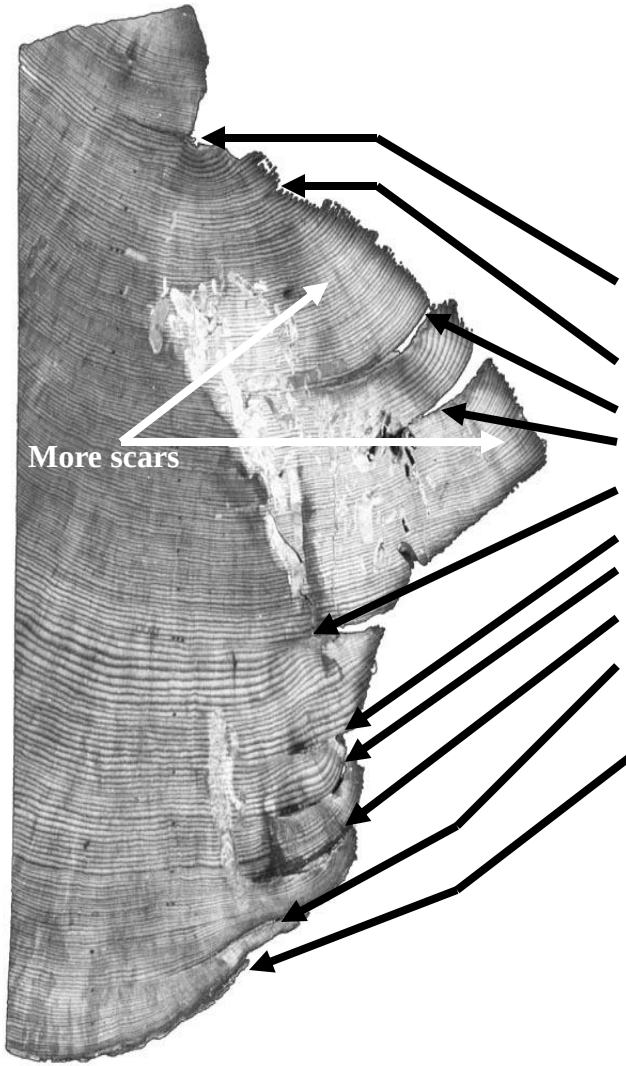


This tree cookie was collected in the Blue Mountains of Oregon. It is full of dark wood and spots of decay. The dark wood tells us that the tree filled fire-scarred wood with pitch to slow the movement of decay fungi from fire-caused wounds into the sapwood. This tree cookie has at least two fire scars that can't be seen on the photograph. One is between scars 8 and 9, another right after the final fire scar recorded in the table below. Both are marked on the photo here with white arrows.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar		Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	14	first fire interval	15
3rd scar	24	second fire interval	24
4th scar	11	third fire interval	11
5th scar	7	fourth fire interval	7
6th scar	>9	fifth fire interval	10
7th scar	22	sixth fire interval	22
8th scar	10	seventh fire interval	10
9th scar	20	eighth fire interval	7, then 14
10th scar	8	ninth fire interval	8
11th scar	6	tenth fire interval	7
12th scar	18	eleventh fire interval	18
13th scar	16	twelfth fire interval	17
14th scar	13	thirteenth fire interval	13
Years after 14th scar	60	years since 14th scar	Not recorded

Tree Cookie 117

Ponderosa pine

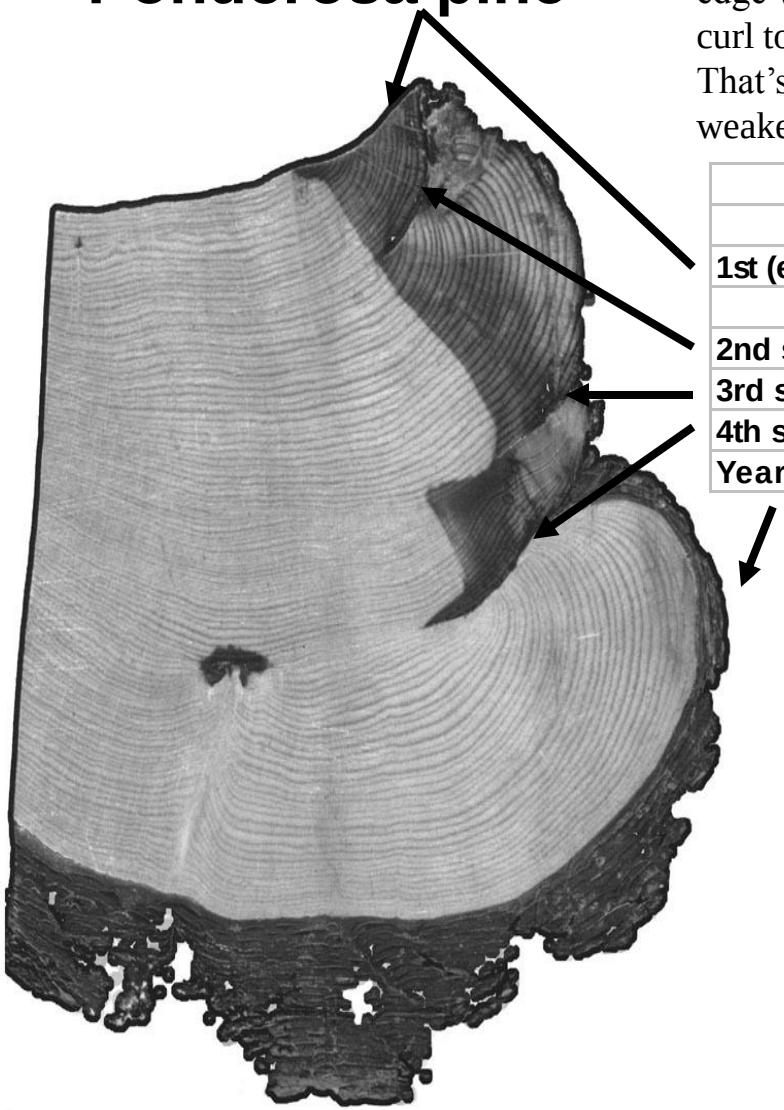


This tree cookie was collected in the Blue Mountains of Oregon. It is full of dark wood and decayed areas. The dark wood tells us that the tree filled fire-scarred wood with pitch to slow the movement of decay fungi from fire-caused wounds into the sapwood. This tree cookie has several fire scars that can't be seen on the photograph. Researchers used a microscope to find them. Three occur between scars 2 and 3. Two others occur between scars 4 and 5. The general areas where they occur are marked by white arrows.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	>50	Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	18	first fire interval	18
3rd scar	47	second fire interval	25, then 11, then 13
4th scar	15	third fire interval	17
5th scar	47	fourth fire interval	20, then 29
6th scar	19	fifth fire interval	19
7th scar	10	sixth fire interval	10
8th scar	14	seventh fire interval	15
9th scar	25	eighth fire interval	25
Years after 9th scar	21	years since last fire scar	Not recorded

Tree Cookie 118

Ponderosa pine



We don't have information on when or where this cookie was collected. In fact, this isn't the whole cookie! If you look carefully at the edge where the oldest wood is found, you'll notice that the growth rings curl toward the inside as if they were the wood formed around a fire scar. That's because this is a fire scar. The cookie broke off right along the weakened wood of the scar.

History	Ring Count from Photo		Ring Count from Cookie
1st (earliest) scar	0	Can't tell age when first	Not recorded
		scarred because pith not present	
2nd scar	20	first fire interval	20
3rd scar	29	second fire interval	29
4th scar	>27	third fire interval	34
Years after last scar	37	years since last fire scar	37

Some rings in this cookie, especially around the 4th fire scar, are hard to count. Just count as many as you can; then you at least know the *minimum* number of years between fires. That's what ">27" means in the table above. When the rings were counted with a microscope on the original cookie, as recorded in the right-hand column, a few more were visible.

This cookie has is dark wood along its fire-scarred edge. This tells us that the tree filled fire-scarred wood with pitch to slow the movement of decay fungi from fire-caused wounds into the sapwood.

Tree Cookie 119

Whitebark pine

This cookie was collected near Hamilton, western Montana. You can't count the tree rings on the photo because they are very narrow. We included it in this collection so you could see how whitebark pine differs from ponderosa pine and lodgepole pine. Whitebark pine has thin bark-- even thinner than that of lodgepole pine. Whitebark pine grows in very cold, dry places; often they are at high elevations where the winters are long and the summer growing seasons are very brief. That's why the growth rings are narrow. The tree was more than 300 years old when cut. It has scars from at least three surface fires (marked on the photo with white arrows).

This cookie is filled with dark pitch, except near the outer edge. It also has many holes, showing that there is a lot of decay in its heartwood. The tree filled its fire-scarred wood with pitch to slow the movement of decay fungi from fire-caused wounds into the sapwood.

This is a photo of "real" cookie #75.