Key for Identification of Pollen Types for Square Lake Pollen Slides

Figures from Knapp 2000

1a. Pollen grains have walls with bladder-like extensions (Figure 1), either wing-like or encircled with a rough surface (Figure 2) 2

2a. Pollen grain has bladders ..... pine

2b. Pollen grain is encircled by a rough surface ..... western hemlock

1b. Pollen grains do not have any bladder like extensions or are not encircled by a rough surface 3

3a. Pollen grain is large in size, has a smooth surface (Figure 3), and does not have any pores (Figure 4) or furrows (Figure 5) ..... Douglas-fir

3b. Pollen grain has either pores or furrows 4

4a. Pollen grain has three furrows (Figure 5) ..... oak

4b. Pollen grain has one or more pores 5

5a. Pollen grain has one pore (Figure 4) ..... grass

5b. Pollen grain has five pores (rarely four pores) ..... alder

Figure 1. Pollen grain with bladders

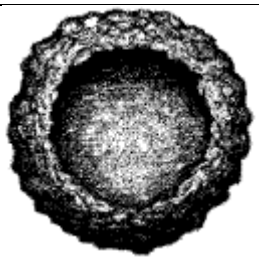


Figure 2. Pollen grain encircled by a rough surface

Figure 3. Pollen grain with no pores or furrows.

Figure 4. Pollen grain with one pore.

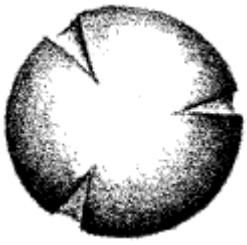
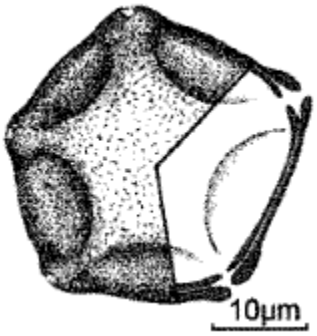


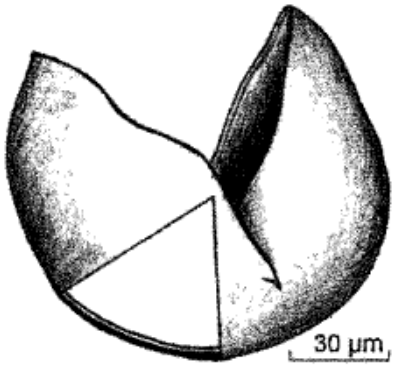
Figure 5. Pollen grain with three furrows

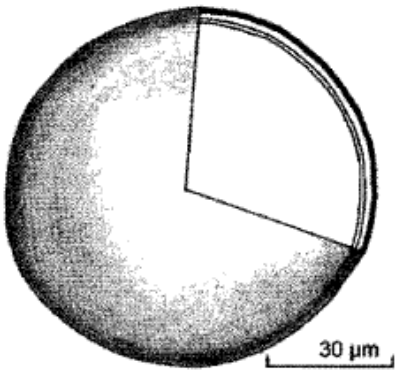
Pollen Grain Descriptions

Alder (*Alnus rubra*)



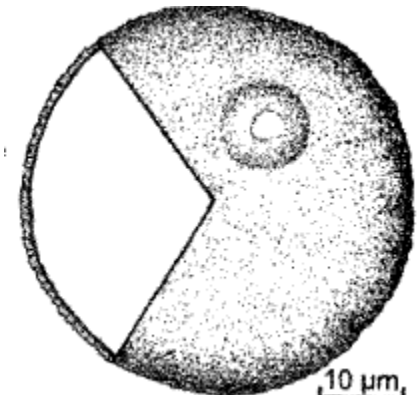
This alder has almost exclusively a 5-pored pollen (rarely 4 or 6 pored) and in angular shape. Pores are roughly evenly spaced around the outside of the grain in one plane (all pores around the widest point of the grain).

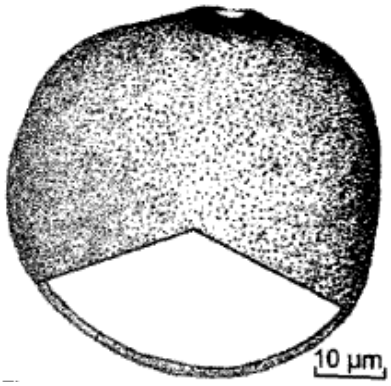




Douglas fir (*Pseudotsuga menziesii*)

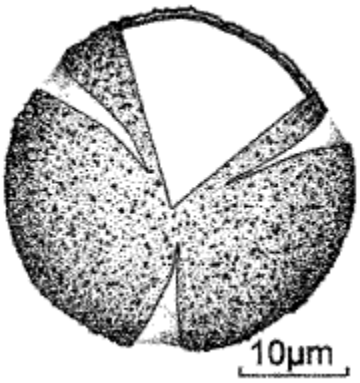
Large spheroidal grain that has a smooth exine. This grain is often torn apart or folded in processed samples





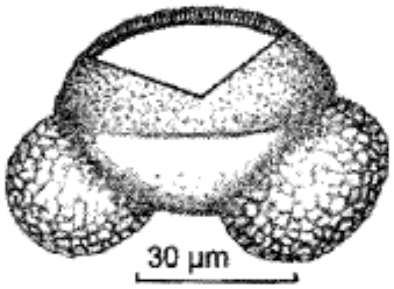
Grass (Poaceae)

Pollen grain is spheroidal. Surface is smooth. There is only one large pore found on this grain.



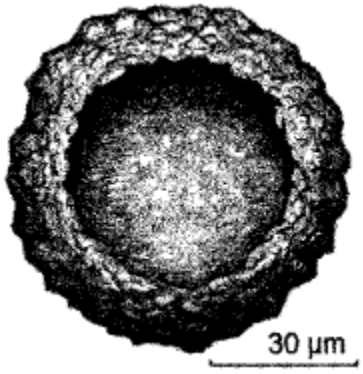
Oak (*Quercus*)

Overall shape of this pollen grain is circular. The exine of this species of oak is coarsely verrucate. This gain has three furrows evenly spaced.



Pine (*Pinus*)

Pollen grain has air bladders on either side of the grain. Exine surface granular or indistinctly verrucate on the distal and lateral faces of body. Bladders coarsely reticulate with indistinctly parallel ridges on the distal faces.



Western hemlock (*Tsuga heterophylla*)

Grain essentially circular. Sometimes in the center of the grain there is an indentation (an artifact of preservation). Exine is separated from the inner wall layers and developed into a covering that surrounds the entire grain.

Counting Pollen

You and one or two partners will be assigned a pollen slide. Record its number and age below. Focus the slide under the 4X objective, then under 10X (or 20X). Count and record (in the chart below) the number of each type of pollen that you see in the field of view. Move to another field and repeat the process. Continue until you have counted five fields. Now, have your partner count five fields. If there are three of you, each of you should count four fields.

Determine the total number of grains counted of each type and enter in the Type total column. Then, add together the Type totals to determine the Pollen Total (this should be more than 100 pollen grains). Then, determine the percentages of each pollen type by dividing each Type Total by the Pollen Total and multiplying by 100. Enter this in the gray column.

Age of sample as indicated on the slide _____

Table 1. Team pollen data

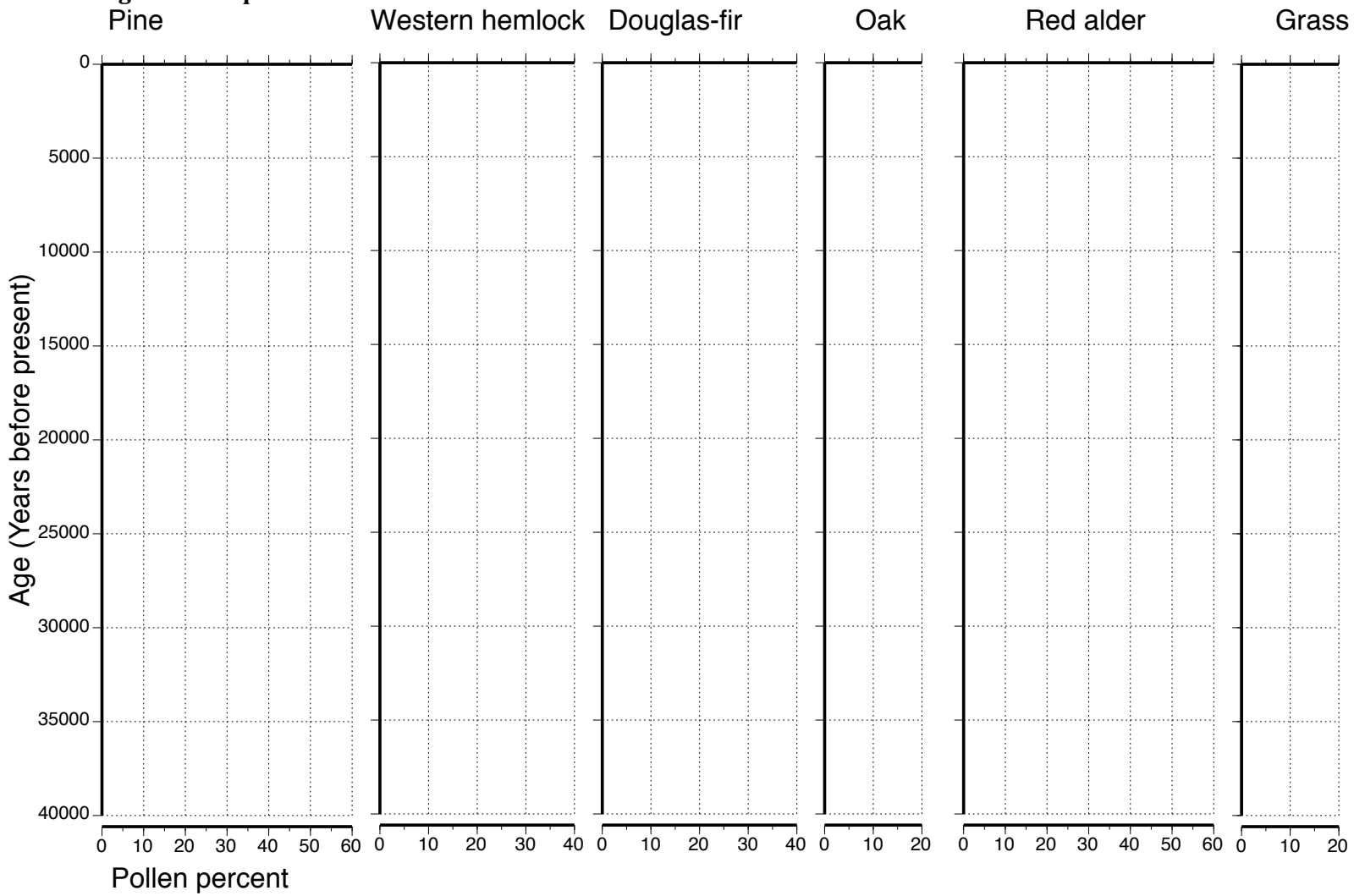
Pollen type	Number of grains counted	Type Total	Percent
Pine			
Western hemlock			
Douglas-fir			
Alder			
Oak			
Grass			
	Pollen Total (count at least 100 grains)		

Table 2. Class pollen data (pollen percentages). Obtain the data for the other depths in the core from your classmates.

Pollen type	Present	5,000 yrs BP*	10,000 yrs BP	15,000 yrs BP	20,000 yrs BP	25,000 yrs BP	30,000 yrs BP	35,000 yrs BP	40,000 yrs BP
Pine									
Western hemlock									
Douglas-fir									
Oak									
Alder									
Grass									

***yrs BP=years before present**

Pollen diagram for Square Lake



Environmental preferences of the six species used in the pollen diagram of Square Lake.

Douglas-fir

The native range of Douglas-fir extends across much of western North America. There are coastal and interior varieties of Douglas-fir. The coastal region of the Pacific Northwest has a maritime climate that is dominated by mild, wet winters and cool, relatively dry summers, a long frost-free season and narrow diurnal fluctuations of temperature (6 to 8 °C). Precipitation occurs mostly in the form of rain and is highly concentrated in the winter months. Climate in both the Cascade and Sierra Nevada Ranges tend to be more severe.

Douglas-fir grows in association with a wide range of vegetation types. Douglas-fir commonly establish after wildfire. In western Oregon, stands of Douglas-fir have stand age cohorts that indicate the time of a forest fire. After fire, seedlings and re-sprouting of red alder compete with seedlings of Douglas-fir.

Western hemlock

Western hemlock is a low-elevation tree species that is adapted to a mild (no extreme temperature fluctuations) and humid climate where summer drought is not very intense. Western hemlock has thin bark that does not provide protection from fire. Western hemlock is not able to survive in areas that have frequent fires and long warm dry summers. Therefore, it is common in coastal forests from northern California to southeast Alaska and in the western Cascade Range. Western hemlock is a late-successional tree species. It is shade tolerant. Unlike Douglas-fir, western hemlock seedlings are able to persist in the deep shade of other trees. A forest of Douglas-fir will transition to western hemlock if no fire returns within the life-span of the Douglas-fir trees (which may be 500 years or more).

Oregon white oak

Oregon white oak has a north-south distribution from southern British Columbia to central southern California. Oregon white oak can grow in a wide range of climates ranging from cool, humid conditions near the coast to the dry environments in inland valleys and foothill woodlands.

Oregon white oak can be found in association of a variety of vegetation types. It can be found in pure, closed-canopy stand; in a mixture with conifers or broad-leaved trees; and as scattered single trees or groves on farmlands, woodlands, and prairies. These trees can grow to great sizes. The Willamette Valley used to be dominated by oak prairie savanna. which has been lost to agriculture and urban development.

Red alder

Red alder can be found throughout the west-side of the Cascade Range and in the Coast Ranges, and from southern California to southeastern Alaska. It is a lowland species of humid to very-humid environments.

Red alder grows in both pure and mixed forest stand conditions. Pure stands are usually confined to stream bottoms and lower slopes with areas of plenty of available water. Within forests, red alder is a major component of many forest types. Red alder trees become established after disturbances (i.e. fire, floods, volcanic eruptions, wind storms, etc.). Red alder has a symbiotic relationship with nitrogen-fixing cyanobacteria that grows on its root system. This species, therefore, greatly increases nutrient availability in forest soils.

Grass

Grass occurs in a broad range of environmental conditions. Grass needs sunlight, so when forests become too dense and shade the forest bottom grass gives way to other vegetation types—grass is not common in shaded understories. Therefore, abundant grass occurs in prairies that are too dry and burn too frequently to support trees, or in subalpine meadows above the tree line. Grass prefers some summer rainfall—if summers become too hot and dry, shrubs will replace grass.

Lodgepole pine

Lodgepole pine is found scattered in forests throughout the western United States and north into Canada. This pine species can grow under a wide variety of climatic conditions. In some places, this tree species may experience winter temperature as low as -40 °C. Summer high temperatures may be as much as 38 °C in some places. In contrast to many other conifer tree species, lodgepole pine seedlings are not easily injured by frost. Precipitation may be as little as 250 mm per year, whereas it receives more than 500 mm along the northern coast of its range. Interior locations receive much of its annual precipitation in the form of snowfall.

Most lodgepole pine forests are early-successional, establishing after forest fires. Lodgepole pine is easily killed by fire, but quickly reseeds itself with seeds dispersing from the cone. These trees can grow extensively in pure stands and in association with many other western conifer species. In Washington and southwestern Canada, lodgepole pine was the first species to become established after the ice sheets.

Exploring Paleoecological Data Using Web-Mapping Tools.

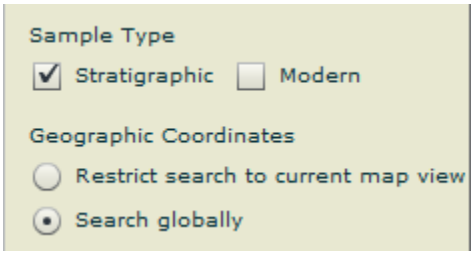
A very large community of scientists studies the environments of the past several thousand years, and many of these scientists study fossils of plants and animals. The pollen record you studied in previous days is an example of a fossil record. Data sharing is an important activity of scientists. For example, the results from your own study can be compared to other studies nearby. Mapping tools such as the NEOTOMA EXPLORER are one way scientist can share their data and findings with the scientific community and other interested people. Mapping and data sharing tools, such as this, are becoming common in all areas of our lives.

- Go to the NEOTOMA DATABASE and launch the NEOTOMA EXPLORER

http://neotomadb.org

- Use the roll bar on the mouse to zoom out to so you can see the entire world.

Setup Search Parameters



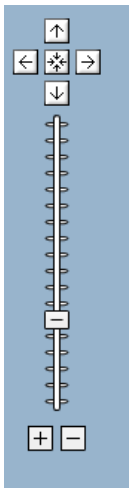
- In the **Search window,** select only **Pollen**.
- For Sample Type, check **Stratigraphic**
    - Note: This limits the search to sites where fossil data were collected. Modern samples will only show where "modern" fossil data are located--for pollen, this is done so we can calibrate the different types of pollen occur in different kinds of vegetation.
- For Geographic Coordinates choose to **Search globally**.
- Click the **Search** button. The viewer may take a minute to draw.

Geographic Pattern and Distribution

1. On the next page, describe the general pattern of pollen data. Where is it and are areas that do not have collection site. (See the example on the next page.)

For example: Looking at the map in a global scale, pollen collection sites in North America appear to be located through most of the continent. If you zoom into to North America, there are areas in Idaho, Nevada, southern Oregon, and Western Texas, as well as British Columbia that seem to have few to no pollen sites.

- Zoom into Oregon and Washington using the roller bar of the Zoom tool on the map. You want to be able to clearly see the individual point symbols on the map.



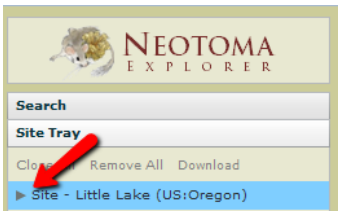
You can move the map north/south and east west by clicking on the map with the left mouse button and dragging the image to a new location.

2. Describe the general geographic distribution of pollen collection sites in Oregon and Washington.

Pollen Cores

- Hover over the pollen site closest to Eugene. A dialogue box will open with the name and description of the site.

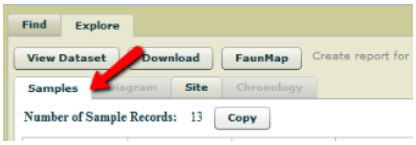
3. What is the site name and where is it located (physiography)?



- Click the site map symbol. The site is added to the Site Tray.

- Expand the Site Tray by clicking the triangle.

- Click LITTLE_Core91A_geochronologic and click the Samples tab.



This attribute table (data table) shows the location (depths) of each radiocarbon sample throughout the core.

The table shows the different depths samples, the thickness of the sediment sample, and the age of the sediment at each particular location in the core.

4. What is the time frame represented in this core (youngest to oldest)?

- In the Site Tray, click LITTLE_Core91A_pollen → Click the Samples tab.
  This attribute table has detailed information about the age, and different pollen and spore types that were identified and counted at a particular sample depth.

At a depth of 30 cm, the chronology (Chron) is 243 years before present and the pollen count for *Abies* (subalpine fir) was three (three pollen grains were counted).

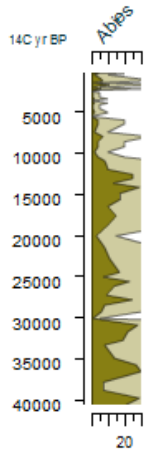
Samples | Diagram | Site | Chronology

Number of Sample Records: 84 Copy

Name	Gro	Element	Units	Contex	Modif									
AnalysisUnitNam														
Depth						30	50	60	120	150	180	210	230	250
Thickness						1	1	1	1	1	1	1	1	1
Sample Name														
Sample ID						30551	30553	30555	30557	30559	30561	30563	30565	3056
Chron:Worona a		Age	Radio			243	406	487	974	1217	1461	1704	1866	2029
Chron:Worona a		Age You	Radio											
Chron:Worona a		Age Old	Radio											
Abies	TRS	pollen	NISP			3	13	7	23	29	3	43	15	6
Acer circinatum	TRS	pollen	NISP					1						
Acer macrophyllu	TRS	pollen	NISP			1		4	2	4	2	5	5	3
Alnus rubra-type	TRS	pollen	NISP			91	124	140	92	166	74	103	82	255
Alnus viridis-type	TRS	pollen	NISP			12	3		14	1		1	6	2
Amaranthaceae	UPH	pollen	NISP			5					3	1		

- Scroll down to *Pseudotsuga* (Douglas-fir).

5. What was the total number of *Pseudotsuga* grains counted at a depth of 30 cm? What was the total number of *Pseudotsuga* grains counted at a depth of 1800 cm (last column in table)?



- Now click on the Diagram tab. Set the **Primary axis** to Radiocarbon years BP and click **Draw**.

The pollen graphs show the abundance of the pollen over the time record (14C = radiocarbon date) of the cored sample. The gray color in this graph shows a 5X exaggeration so that you can discern the low abundance types.

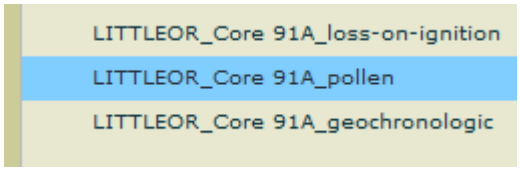
You can see from the graph that *Abies* is generally less frequent since the Holocene – about 10,000 years ago. The Holocene is the warming period after the last glacial period. Today, tree species in this genus are located at higher elevations, such as in the Cascade Range, or in drier locations, such as in eastern Oregon.

6. Look at the pollen graph for *Pseudotsuga*. This is the State Tree of Oregon and is very common today. Look at the age range between about 25,000 to 14,000 years BP. Was *Pseudotsuga* in Oregon at that time?

7. Look at the all the graphs. Which species are more abundant around 18,000 years before present, at the Last Glacial Maximum?

8. Which species seem to be absent or very rare at the Last Glacial Maximum?

Data Analysis



- Make sure you are viewing the pollen data for Little Lake.

Your task will be to calculate the percent of five species of pollen for three different time periods: The most current time, a time closest to 10,000 years and a time closest to 18,000 years. For Little Lake these will be Chron: 243, 9,845, and 17,618.

- Use the Data Analysis Sheet to record the total number of grains of the five listed species for all three years.
- Next, calculate the percentage for each species. Use the Pollen Total at the top of each column to find the total number of pollen grains that were counted in each

sample (three per lake). Only pollen that has the group description TRSH (trees and shrubs) and UPHE (upland herbs) were used to calculate the total pollen sum.

For example: in Little Lake there were 13 grains of *Tsuga heterophylla* found in the youngest section (age 243). There were a total of 254 pollen grains counted in that sample.

Therefore: to calculate the percent of *Tsuga heterophylla* in the year 243 you will use the following formula: (species grains/ pollen total) times 100) or ((13/254) * 100)
Answer: 5.1% of the pollen are *Tsuga* in the sample aged 243 years before present.

9. Use the table below to collect the information and calculate the percent for each.

	~ 243 Yrs pollen sum=254		**~ 9845 Yrs pollen sum=309**		**~ 17,618 Yrs pollen sum=347**	
POLLEN SPECIES	GRAIN COUNT	PERCENT	GRAIN COUNT	PERCENT	GRAIN COUNT	PERCENT
***Tsuga heterophylla* (western hemlock)**						
***Alnus rubra* (red alder)**						
***Pseudotsuga* (Douglas fir)**						
***Quercus* (oak)**						
***Pinus contorta* (lodgepole pine)**						

Extend the Exploration

- Compare the pollen record at Little Lake to the pollen records at Battleground Lake and Carp Lake.

10. To find a specific site, go to the Search window and type in the Site Name and choose Search. We have limited your seach to these sites becaue they all have pollen records that extent from the present to at least 18,000 years before the present. Carp Lake is from a much drier climate, and is located at the border of pine forest and sagebrush shrubland (*Artemisia*). Battleground Lake is located north of Portland in a vegetation type somewhat similar to Little Lake—the climate is similar to that at

Little Lake. View the pollen diagram, using an age scale, for each site. Make a list of the species that are abundant at each site.

Complete this table of most common five pollen types at three lakes at three different times in the past.

	Little Lake	Battleground Lake	Carp Lake
Present			
10,000 years ago			
18,000 years ago			

11. What general inference (an inference refers to reasonable conclusions or possible hypotheses drawn from a small sampling of data) can you state regarding warmer and colder climates and the type of vegetation that would be present at these sites at times in the past? You may need to review the vegetation types of western Oregon or find information on the species represented by each pollen type.