



Mount St Helens National Volcanic Monument – Teacher’s Corner 2016
Gifford Pinchot National Forest
USDA Forest Service

Geographic Jigsaw Puzzles

Outdoor Activity

Teacher Information:

Time Commitment: 2 Hours and 15 minutes
Location: Hummocks Trail
Group Size: Not recommended for groups larger than 30

Materials Needed:

Pencil, clipboard or notebook to write on, download copies of the ‘Geographic Jigsaw Puzzles’ worksheet for students and copies of ‘Geographic Jigsaw Puzzles *Answer Sheets*’ for chaperones.

Materials Provided:

A storage box mounted behind the trailhead bulletin board contains basalt, andesite and dacite rock samples, and visual aids. Return these items to the storage box when you conclude the trailhead activities.

Student worksheet stop locations are marked with wooden posts with white puzzle pieces along the trailside. Note: some of the wood posts have other colored shapes on them which designate stop locations for other educational activities.

Purpose:

The purpose of the activity is to identify geological features such as hummocks and rock formations in order to determine how the landslide moved during the May 18, 1980 eruption. Students will also examine topographic features created by the landslide and evaluate how they have influenced plant and animal colonization.

Goal:

- 1) Students will make observations and analyze facts to identify landslide features, determine how the landslide moved and what may have influenced its movement, and explain how topographical features affected plant and animal re-colonization.

Objectives:

- 1) Students will be able to describe the characteristics of the May 18, 1980 landslide event and its deposits.
- 2) Students will be able to identify and describe how landscape features influenced the movement of the landslide.
- 3) Students will be able to identify and describe how landscape features influenced the re-colonization of plant and animal communities.
- 4) Students will not get off the trail because they understand that it is prohibited in order to protect fragile plant life within an on-going research area.

Required Vocabulary:

- 1) **Landslide:** The sliding or flowage of unsorted masses of rock and other material moving under the force of gravity
- 2) **Hummock:** large mounds of rock deposited by a landslide.
- 3) **Slide Block:** Enormous sections or segments of earth that slide downward during a landslide. Three large slide blocks fell from Mount St. Helens on May 18, 1980.
- 4) **Lateral Blast:** At Mount St. Helens this includes two components: 1) a large explosion directed out of the side of a volcano and a turbulent mixture of hot gas, ash, and rock that flow over the ground at high speeds under the influence of gravity.
- 5) **Basalt:** a volcanic rock characteristically dark gray to black in color, containing 45 to 54% silica, and is generally rich in iron and magnesium. Shield volcanoes like Kilauea in Hawaii typically erupt basalt lava.
- 6) **Andesite:** a volcanic rock characteristically dark to medium gray in color, containing 54 to 62% silica, rich in aluminum and moderate amounts of calcium and sodium.
- 7) **Dacite:** a volcanic rock usually light gray in color, containing 62 to 69% silica, includes aluminum and moderate amounts of sodium and potassium. Dacite erupted explosively from Mount St. Helens on May 18, 1980.
- 8) **Viscosity:** the resistance of any liquid to flow.
- 9) **Erosion:** The process in which soil and rock are removed from the Earth's surface by natural processes such as wind and water, and then transported and deposited to new locations.
- 10) **Terrace:** Step-like flat areas along the sides of river valleys. Terraces are the remains of flood plains that existed at a time when a river was flowing at a higher elevation, before it down cut and created a new floodplain at a lower elevation.
- 11) **Habitat:** a place or type of place where an organism, population or community live.
- 12) **Wetland:** Lands where saturation with water is the dominant factor determining the nature of soil development and the types of plants and animals living in the soil and on its surface.

Geographic Jigsaw Puzzles

Outdoor Activity

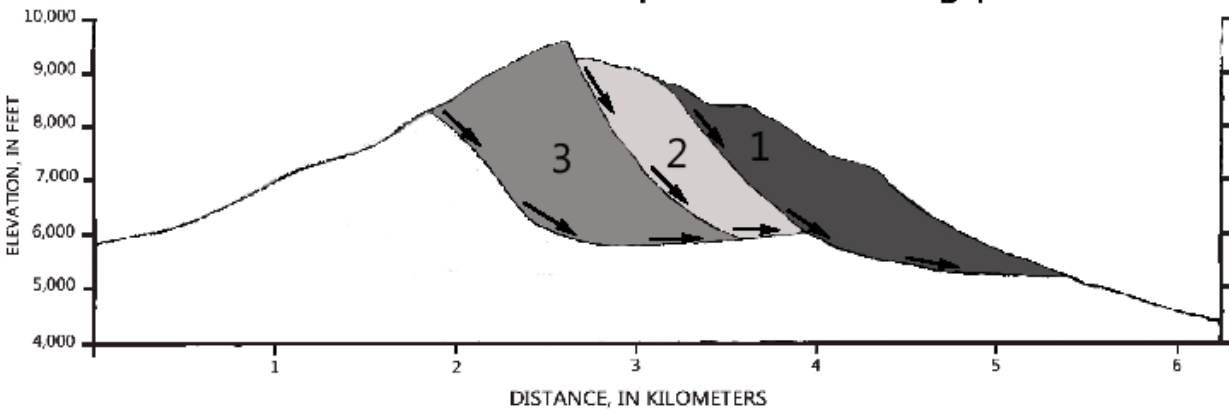
Directions:

Begin at the trailhead by a bulletin board. Stop at the wood post with **WHITE PUZZLE PIECES**. At each stop read the facts listed below and observe landscape features to answer the questions.

Fact:

1. From March 20, 1980 until May 18, 1980 rising magma pushed the north side of Mount St. Helens out sideways 300 to 450 feet. This swollen mountainside was called the “bulge”.
2. The May 18, 1980 eruption began when a huge **landslide** fell from the bulging north side of Mount St. Helens. Three enormous slabs of rock, called **slide blocks** fell downward in quick succession.

Mount St. Helens collapsed in three big pieces.



3. **Slide Block I** is dominated by dark gray andesite lava rocks and black or red basalt lava rocks from the north flank of the volcano. It also contains minor amounts of light gray dacite rocks from the summit.
4. **Slide Block II** is dominated by light gray dacite rocks from the former summit.
5. Moments after **Slide Block I** came to rest, **Slide Block II** pushed it out of the way like a gigantic snow plow. Due to this violent collision, slide block I is largely found along the sides of the valley, while slide block II dominates the center of the valley.
6. The large mounds of rock on the valley floor, called **hummocks**, are enormous pieces of the volcano carried down in slide blocks I & II. Clearly defined rock layers visible in some hummocks reveals that they came down as an intact piece. Scientists have identified 675 hummocks and understand approximately where they would fit back inside the crater.
7. **Slide Block III** was dominated by tan dacite lava rocks from the interior of the volcano. This slide block was violently shoved outward by a lateral blast, pushing the landslide 13 ½ miles down valley (4 miles past slide blocks I and II). Few intact hummocks from this slide block are found west of the hummocks trail—they were broken apart and mixed together during their turbulent journey.

Geographic Jigsaw Puzzles Worksheet

Name: _____

STOP 1:

1) Turn slowly a full revolution and observe the color of the rocks as you turn. Use your observation skills and the fact sheet to determine which slide block these rocks came from. Circle your answer.

- a. Slide Block I
- b. Slide Block II

STOP 2:

2) The landslide began on the north side of the volcano, but traveled only $5\frac{1}{2}$ miles *north*. However, the landslide traveled $13\frac{1}{2}$ miles *westward*. Circle the answer that best explains why this happened.

- a. Johnston Ridge blocked or prevented most of the landslide from traveling further north.
- b. The landslide was deflected westward by Johnston Ridge.
- c. The Toutle River Valley funneled the landslide westward.
- d. All of the above.

3) Observe the rocks along each side of the trail at this stop. Use your observation skills and the fact sheet to determine which slide block these rocks came from. Circle your answer.

- a. Slide Block I
- b. Slide Block II

STOP 3:


4) Look at the hummock that is half light-tan and half blackish-red. Based on the color, name the type of rocks that might be found on each side of this hummock?

- a). _____
- b). _____

5) Face Mount St. Helens and look at the hummocks in the canyon on each side of the Toutle River. Circle the answer that best explains which slide blocks these rocks came from.

- a. Slide Block I
- b. Slide Block II

6) What evidence did you use to support this answer?

STOP 4: 

7) Face the canyon, then turn right and look down the canyon. Note the multi-colored hummocks and hummocks with bands of color on the sides of the canyon walls. Use your fact sheet to determine which types of hummocks are visible in the canyon walls. Circle “T” for true or “F” for false.

T or F The colorful rocks are intact hummocks from Slide Blocks I and II.

T or F The colorful rocks are fragments of hummocks broken apart in slide block III.

8) The North Fork of the Toutle River lies 165 feet below you. It was completely buried beneath slide blocks I, II and III. A new river formed after the eruption and carved out most of this canyon between 1980 and 1985. Circle the answer that best describes which factors may have contributed to the rapid creation of this canyon.

- a. The Pacific Northwest’s climate produces abundant rain and snowfall.
- b. The eruption destroyed vegetation that normally helps reduce erosion rates.
- c. Ash and loose rock within the landslide deposit is highly erodible.
- d. Answers A and B.
- e. All of the above.

STOP 5:



9) Seasonal weather changes affect the amount of water in the river and its ability to erode, transport and deposit the landslide deposit. Find the series of step-like flat areas along each side of the river. Circle "T" for true or "F" for false for the answer that best describes how the flat terraces formed.

T or F The flat terraces reveal different levels the North Fork of the Toutle River once flowed as it eroded this canyon.

10) The elevation of the North Fork of the Toutle River at this site before the eruption was 2,173 feet above sea level. The current elevation of the river is 2,319 feet. How many feet of rock must the Toutle River erode to reach the pre-eruption elevation? Show your work

11) The North Fork of the Toutle River drains into the Cowlitz River, which in turn drains into the Columbia River. Since 1980, 13% of the landslide deposit has eroded away. Circle the answer that best describes how sediment eroded from this canyon might impact areas down river.

- a. Sediment fills river channels, which increases flooding hazards.
- b. Sediment creates shipping hazards in the Columbia River adversely affecting economies.
- c. Sediment degrades habitat for salmon, steelhead and other fish.
- d. Answers A and B.
- e. All of the above.

12) You passed ponds with lush plant growth along the trail. Circle the answer that best explains why there so little plant life on either side of the river?

- a. There are few nutrients available for plants in the rock and ash along the river.
- b. The river channel continuously shifts eroding ash, rock, and colonizing plants.
- c. Sediment carried in the milky water prevents plants from establishing.

STOP 6:



13) The landslide created 118 ponds similar too this one. The ponds formed when water collected within depressions, or when large chunks of glacial ice carried in the landslide later melted. Beaver colonized this pond over a decade ago. How did the beaver’s dam-building activities change habitat here? Circle “T” for true or “F” for false

- T or F It drowned trees and plants unable to tolerate excessively wet conditions.
- T or F It created new habitat for some species of amphibians, waterfowl, aquatic plants and plankton.
- T or F It reduced the amount of breeding habitat for some species of amphibians and birds.

14) Observe habitat features visible from this site. Circle the answer that summarizes how ponds influenced the surrounding landscape.

- a. The diameter of red alders trees decreases with distance from ponds, indicating that forests developed along the edges of ponds and spread outward.
- b. Habitat for water-dependent plant species like cattails expanded with the development of ponds and reduction of stream-based aquatic plants.
- c. Answers A and B.

15) Some hummock ponds are seasonal in nature—full in the spring and then gradually dry up by fall. How would the ecosystem at this site change if the aquatic habitat disappears?

STOP 7:



16) The deciduous trees are Sitka and red alders. Alders grow rapidly due to their ability to produce their own nitrogen with the help of bacteria in their roots. Circle "T" for true or "F" for false

- T or F Shade from alder forests adversely affects some plant species, and create habitat for other plants species.

- T or F Alder forests can alter temperatures, affect the availability of moisture, and increase nutrient levels by creating organic matter.

Teacher Answer Sheet

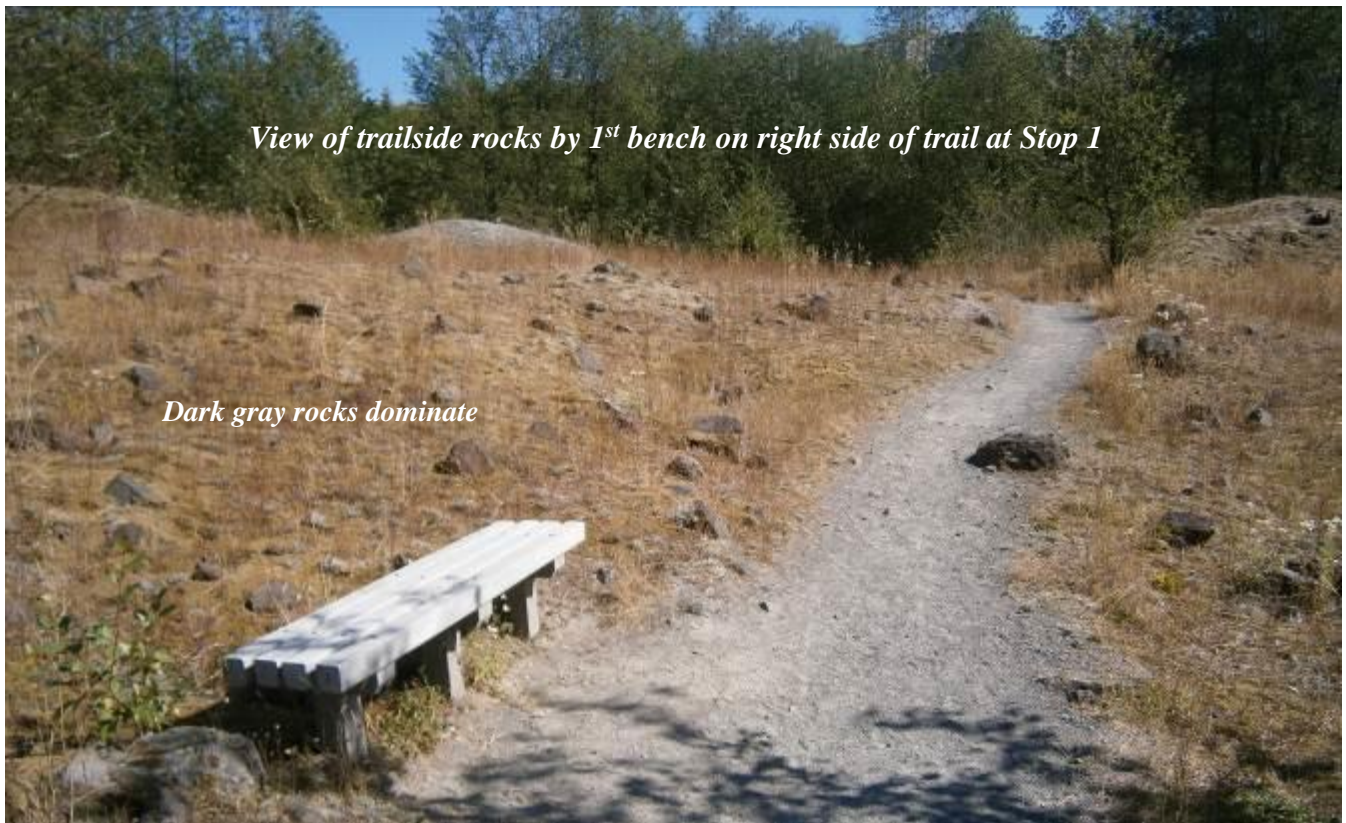
Outdoor Activity

STOP 1:



1) Turn slowly a full revolution and observe the color of the rocks as you turn. Use your observation skills and the fact sheet to determine which slide block these rocks came from. Circle your answer.

- a. Slide Block I
- b. Slide Block II



The rocks on each side of the trail are mostly dark gray indicating they came from slide block I

STOP 2:



2) The landslide began on the north side of the volcano, but traveled only 5½ miles *north*. However, the landslide traveled 13½ miles *westward*. Circle the answer that best explains why this happened.

- a. Johnston Ridge prevented or blocked the landslide from traveling further northward.
- b. The landslide was deflected westward by Johnston Ridge.
- c. The Toutle River Valley funneled the landslide westward.
- d. All of the above.



3) Observe the rocks along each side of the trail at this stop. Use your observation skills and the fact sheet to determine which slide block these rocks came from. Circle your answer.

a. Slide Block I

b. Slide Block II



STOP 3:

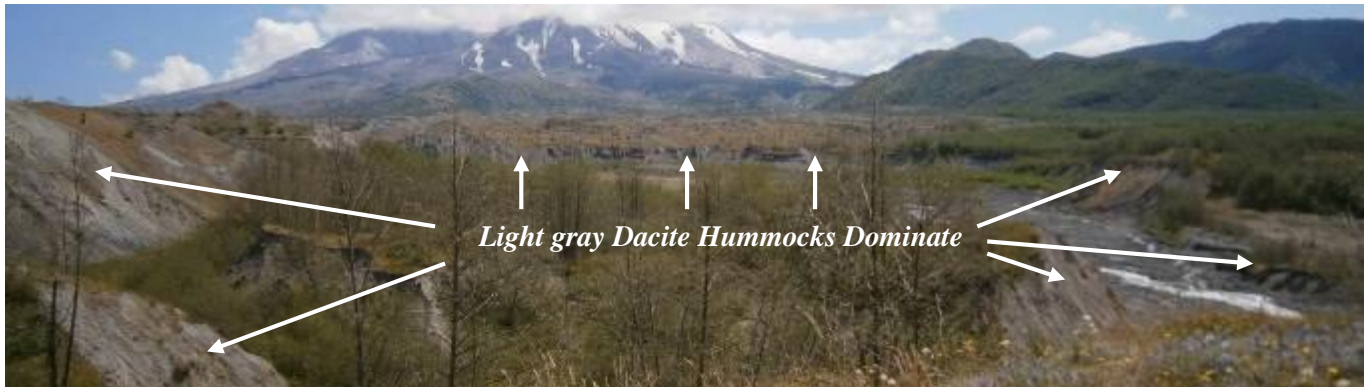



- 4) Look at the hummock that is half light-tan and half blackish-red. Based on the color, name the type of rocks that might be found on each side of this hummock.
- The two-toned nature of the hummock reveals intact strata layers from inside the volcano. The tan color is a dacite rock formation.
 - The black and red coloration indicates that this side of the hummock is an andesite or basalt lava flow (The red coloration reveals that the lava had a high water content, and as it cooled, it oxidized or rusted.).



- 5) Face Mount St. Helens and look at the hummocks in the canyon on each side of the Toutle River. Circle the answer that best explains which slide blocks these rocks came from.
- Slide Block I
 - Slide Block II
- 6) What evidence did you use to support this answer?

The dominant hummock color is light gray. Light gray hummocks dominate slide block II. Dark gray andesite and black or red basalt hummocks dominated slide block I.



STOP 4: 



8) Face the canyon, then turn right and look down the canyon. Note the multi-colored hummocks and hummocks with bands of color on the sides of the canyon walls. Use your fact sheet to determine which types of hummocks are visible in the canyon walls. Circle "T" for true or "F" for false.

T or F The colorful rocks are intact hummocks from Slide Blocks I and II.

T or F The colorful rocks are fragments of hummocks broken apart in slide block III.

7) The North Fork of the Toutle River lies 165 feet below you. It was completely buried beneath slide blocks I, II and III. A new river formed after the eruption and carved out most of this canyon between

1980 and 1985. Circle the answer that best describes which factors may have contributed to the rapid creation of this canyon.

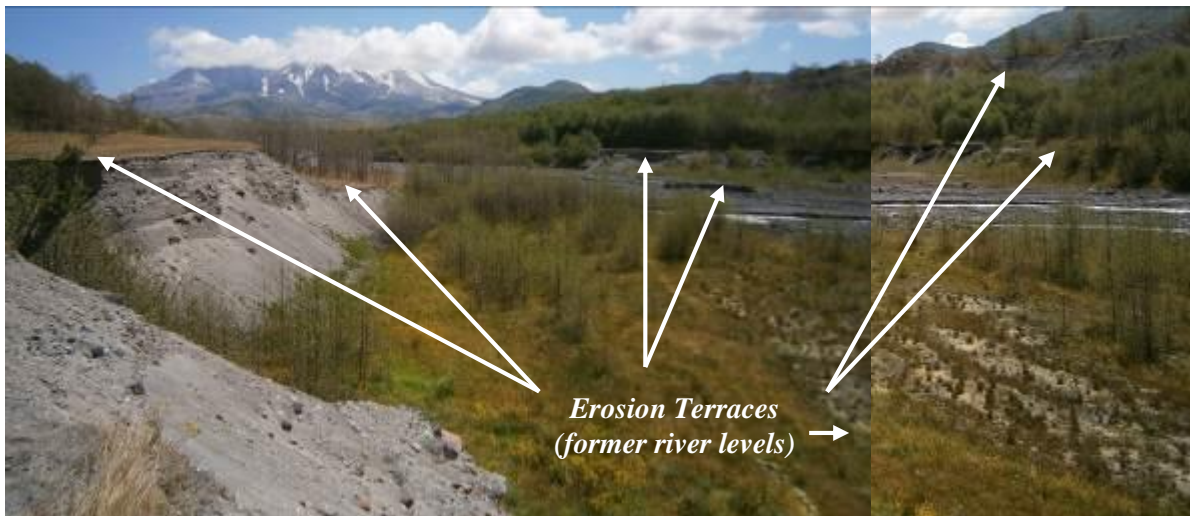
- a. The Pacific Northwest's climate produces abundant rain and snowfall.
- b. The eruption destroyed almost all vegetation that helps reduce erosion rates.
- c. Ash and loose rock within the landslide deposit is highly erodible.
- d. Answers A and B.

e. All of the above.

STOP 5: 

9) Seasonal weather changes affect the amount of water in the river and its ability to erode, transport and deposit the landslide deposit. Find the series of step-like flat areas along each side of the river. Circle "T" for true or "F" for false for the answer that best describes how the flat terraces formed.

T or F The terraces reveal different levels the North Fork of the Toutle River once flowed as it eroded this canyon.



10) The elevation of the North Fork of the Toutle River at this site before the eruption was 2,173 feet above sea level. The current elevation of the river is 2,319 feet. How many feet of rock must the Toutle River erode to reach the pre-eruption elevation? Show your work

$$\begin{array}{r} 2319 \\ - \underline{2173} \\ \hline 146 \text{ feet} \end{array}$$

11) The North Fork of the Toutle River drains into the Cowlitz River, which in turn drains into the Columbia River. Since 1980, 13% of the landslide deposit has eroded away. Circle the answer that best describes how sediment eroded from this canyon might impact areas down river.

- a. Sediment fills other river channels, increasing flood hazards in downstream communities
- b. Sediment creates shipping hazards in the Columbia River adversely affecting economies.
- c. Sediment degrades habitat for salmon, steelhead and other fish.
- d. Answers A and B.

e. All of the above.

12) You passed ponds with lush plant growth along the trail. Circle the answer that best explains why there so little plant life on either side of the river?

- a. There are few nutrients available for plants in the rock and ash along the river.
- b. The river channel continuously shifts eroding ash, rock, and colonizing plants.
- c. Sediment carried in the milky water prevents plants from establishing.

STOP 6:



13) The landslide created 118 ponds similar too this one. The ponds formed when water collected within depressions, or when large chunks of glacial ice carried in the landslide later melted. Beaver colonized this pond over a decade ago. How did the beaver’s dam-building activities change habitat here?
Circle “T” for true or “F” for false

T or F It drowned trees and plants unable to tolerate excessively wet conditions.

T or F It created new habitat for some species of amphibians, waterfowl, aquatic plants and plankton.

T or F The pond’s increased surface area reduced breeding habitat for wetland dependent bird species.

14) Observe habitat features visible from this site. Circle the answer that summarizes how ponds influenced the surrounding landscape.

a. The diameter of red alders trees decreases with distance from ponds, indicating that forests developed along the edges of ponds and spread outward.


b. Habitat for water-dependent plant species like cattails expanded with the development of ponds and reduction of stream-based aquatic plants.

c. Answers A and B.

15) Some hummock ponds are seasonal in nature—full in the spring and then gradually dry up by fall. How would the ecosystem at this site change if the aquatic habitat disappears?

Entire communities of plants and animals can be dramatically impacted when ponds dry up. Aquatic plants like willows, sedges, rushes, tules, and cattails in shallow water areas are stressed as water levels decline, or may even die out altogether. Amphibian egg masses, tadpoles and immature frogs or toads are particularly vulnerable to declining water levels in shallow areas. During drought years it is not uncommon to have 100% mortality rates for some species. Bird nests within mats of cattail, become vulnerable to predators like snakes and weasels. When the pond dries up, drought tolerant grasses take advantage of the conditions and spread out. If this wetting and drying cycle occurs over

several years, major shifts in the composition of plant communities can occur. For example, water-loving cattails might be replaced by drought tolerant grasses, or the water-loving Red-winged Blackbird, might be replaced by the Western Meadow Lark, which feed on insects like grasshoppers, beetles, and seeds.

STOP 7: 

16) The deciduous trees are Sitka and red alders. Alders grow rapidly due to their ability to produce their own nitrogen with the help of bacteria in their roots. Circle "T" for true or "F" for false

- T or F Shade from alder forests adversely affects some plant species, and create habitat for other plants species.

- T or F Alder forests can alter temperatures, affect the availability of moisture, and increase nutrient levels by creating organic matter.

Instructional Sequence for Geographic Jigsaw Puzzles

In the parking lot by the trailhead:

- 1) A storage box is mounted to the backside of the bulletin board at the trailhead. Open the storage box behind the trailhead bulletin board and use the rocks and pictures in the parking lot.
- 2) Display the light gray dacite, dark gray andesite, and black basalt rocks in a row (the dark gray andesite rock should be in the middle). Ask the group to make observations about differences and similarities in the rocks.
- 3) The differences in the color of lava are due to different amounts of silica. Silica is the building block of basic rock-forming minerals like quartz and feldspar. The amount of silica affects how a volcano erupts and the types of rocks produced. Mount St. Helens makes B.A.D. rocks—Basalt, andesite and dacite. Review each rock sample.

→ **Basalt**

- Least amount of silica: 48-52%
- Black colored rocks due to dark-colored minerals like Iron and Magnesium
- Red-colored rocks indicate the lava was exposed to oxygen as it cooled and oxidized
- Low viscosity—thinnest, runniest lava
- Flows like honey or fountains upward if it contains lots of gas bubbles
- Erupts from Hawaiian volcanoes, but less often at Mount St. Helens or in the Cascade Range

→ **Andesite**

- Silica: 52-62%, most commonly erupted lava in Cascades
- The rocks dark gray color is due to fewer dark-colored minerals like Iron and Magnesium
- Medium viscosity—between basalt and dacite.
- It can flow like basalt, but not as far, or explode like dacite.

→ **Dacite**

- Most silica: 62-68%
- Light gray colored due to abundance of silica.
- High viscosity--thickest lava. If it contains few gas bubbles, it flows like peanut butter
- If thick lava contains lots of gas, the bubbles become trapped, pressurize and explode.
- Mount St. Helens frequently erupts dacite lava, both explosively and non-explosively
- Light gray dacite often decays to a tan/orange color due to heat and water (hydrothermal).

4) Review the read aloud the “landslide facts” and state that this information will be critical to answering all questions on the worksheet.

→ **Read Aloud Case Fact 1 from Worksheet**

- Emphasize that when Mount St. Helens awoke in 1980 that the rising magma pushed the north side of Mount St. Helens out **sideways**.
- Show the March 20, 1980 picture and April 27, 1980 bulge picture side by side.
- Explain that the swollen, unstable side of the mountain was called the bulge.

→ **Read Aloud Case Fact 2 from Worksheet**

- The May 18, 1980 eruption began when a huge **landslide** fell from the bulging north side of Mount St. Helens.
- Show the graphic entitled “*Mount St. Helens collapsed in three big pieces*” and explain that the landslide came down in three enormous slabs of rock, called **slide blocks**, which fell downward in quick succession.
- Show the first set of Gary Rosenquist pictures and identify slide block 1.

→ **Read Aloud Case Fact 3 from Worksheet**

- Show the andesite and basalt rock samples and explain that **Slide Block I** is dominated by **dark gray andesite lava rocks** and **black or red basalt lava rocks** from the north flank of the volcano. It also contains minor amounts of light gray dacite rocks from the summit.

- Explain that most of **Slide Block I** struck Johnston Ridge, was deflected westward and traveled 8-miles down the Toutle River valley.

→ **Read Aloud Case Fact 4, 5 and 6 from Worksheet**

- Show the light gray dacite rock sample and explain that **Slide Block II** is dominated by light gray and tan dacite lava rocks from the interior of the volcano and light gray dacite rocks from the former summit.
- Moments after **Slide Block I** came to rest, **Slide Block II** pushed it out of the way like a gigantic snow plow. Due to this violent collision, slide block I is largely found along the sides of the valley, while side block II dominates the center of the valley.
- The large mounds of rock here on the valley floor are called **hummocks**. They are enormous pieces of the volcano carried down in slide blocks I & II. Clearly defined rock layers visible in some hummocks reveals that they came down as an intact piece. Scientists have identified 675 hummocks and understand approximately where they would fit back inside the crater.

→ **Read Aloud Case Fact 7 from Worksheet**

- Show the tan dacite rock sample and explain that **Slide Block III** is dominated by tan/orange dacite lava rocks from the interior of the volcano.
- **Slide Block III** was violently shoved outward by a lateral blast, pushing the landslide 13 ½ miles down valley (4 miles past slide blocks I and II). Few intact hummocks from this slide block are found west of the hummocks trail: they were broken apart and mixed together during their turbulent journey.
- Slide block 3 traveled over slide blocks 1 and 2 and rushed 13 ½ miles down the valley.

5) Inform the students that you will lead the way because there are specific points along the trail marked with wooden posts entitled “student stop”. The posts may have several different colored shapes or symbols on them, but they only need to stop at the posts with WHITE PUZZLE PIECES on them. At each stop they will observe geographic features and review the “landslide facts” to complete answers to questions on their worksheets.

6) Inform the students that they will be hiking within a research area. Off trail travel, the collection of rocks, plants, and wood, and disturbing research sites (removing tags, pipes or flagging marking boundaries) is strictly prohibited (\$100 fine).