

Avoiding Earthquake Surprises in the Pacific Northwest

This article is provided courtesy of the American Museum of Natural History.

How Vulnerable Is the Pacific Northwest?

Cascadia is a region in the Pacific Northwest. It includes southern British Columbia, Washington, Oregon, and northern California. This region is at risk of being hit by earthquakes. Until the mid-1980s, Earth scientists thought that the threat was limited to quakes of magnitude¹ 7 or below.

But more recently, Earth scientists discovered evidence that more intense earthquakes repeatedly struck the region over the past several thousand years. And they are likely to occur again. Earthquakes of magnitude 8 and 9 are considered “great” quakes. An earthquake of magnitude 8 releases about thirty times as much energy as a quake of magnitude 7. A quake of magnitude 9 is another thirty times larger.

Why the Pacific Northwest Is at Risk

Earth’s rigid outer shell is made up of vast rocky pieces called tectonic plates. These plates move as slowly as fingernails grow. They separate, collide, or grind against each other at plate boundaries. Where the plates grind together, pressure builds up and the rocks eventually break. This sends stored-up energy surging through Earth. This energy is what causes earthquakes.



Earth’s surface is broken into massive rocky plates called tectonic plates.

¹ Over the years, seismologists devised various magnitude scales as measures of earthquake size. The “moment magnitude” scale is used today.

Most earthquakes occur along certain plate boundaries called subduction zones. A subduction zone is where a more dense oceanic plate subducts, or sinks below, a continental plate. Decades ago, scientists recognized that a subduction zone runs along the Pacific coast. It lies between southern British Columbia and northern California. It's called the Cascadia subduction zone.

The two largest earthquakes since 1900 occurred along subduction zones. They were a Chilean earthquake of magnitude 9.5 in 1960, and an Alaskan earthquake of magnitude 9.2 in 1964. During each of these earthquakes, the continental plate lurched 20 meters toward the sea. This movement thinned the plate by stretching its rocks. The thinning lowered the coast enough for tides to drown coastal forests. Today, ghostly tree trunks provide natural clues that the huge earthquakes occurred.

Clues of Ancient Quakes

Earth scientists have found similar, much older remains of flooded forests in Cascadia. They were discovered along bays and river mouths on the coasts of British Columbia, Washington, Oregon, and northern California. Scientists also found other evidence of strong earthquakes in the same locations. These include sheets of sand that were deposited by floods from the sea and ground cracks that were filled with quicksand. Scientists concluded that earthquakes of magnitude 8 or larger have struck Cascadia repeatedly in the past several thousand years.

Teams of scientists worked together to determine the exact date and an approximate size for the most recent of these Cascadia earthquakes. First, American scientists discovered clues in some dead trees. The trees recorded sudden lowering of coastal land during this earthquake. Radiocarbon dating showed that they died between 1680 and 1720.

Japanese researchers were paying attention to these discoveries in North America. They knew that if the Cascadia earthquake was big enough, it would have started a tsunami in the Pacific Ocean. And they had been looking for the mysterious source of a tsunami that caused flooding and damage in Japan in January 1700. They proposed that a great Cascadia earthquake occurred in the evening of January 26, 1700. They estimated its size as magnitude 9.

To test this proposed date and size, American scientists returned to some of the earthquake-killed trees in Washington. By measuring thin and thick rings, they assigned dates to individual tree rings. They were able to narrow the time of the earthquake to the months between August 1699 and May 1700. This evidence supported the date proposed by Japanese researchers. The findings combined to give the 1700 Cascadia earthquake a place in history.



Scientists study dead trees in a tidal marsh along the Pacific coast of Washington. They provide evidence that a great earthquake occurred in January 1700.

Northwesterners Respond to the Risk

Earthquakes can't be prevented. However, people can take measures to minimize the damage they cause. In some cases, communities can strengthen structures that already exist. These include dams, bridges, water systems, schools, hospitals, and lifelines (electrical, gas, and water lines). They can also design and build earthquake-resistant structures in the future.

Until 1994, the Uniform Building Code² placed an area of Washington in a zone with the second highest hazard level (out of six). Most of the rest of Oregon and Washington was placed in a zone with a lower hazard level. The 1994 edition of the Uniform Building Code redrew the map for the Pacific Northwest. All parts of Oregon and Washington that are at risk of great earthquakes were upgraded to the higher-level hazard zone.

This revision of the code was an important first step toward meeting the great-earthquake threat in the Pacific Northwest. In the areas upgraded to the second highest level, new buildings are designed to withstand earthquakes fifty percent stronger than under the old code.

² The Uniform Building Code was replaced in 2000 by the International Building Code.

How Safe Are Other Parts of the United States?

People in other earthquake-prone states started asking questions about whether they were adequately prepared for future earthquakes. These states include Massachusetts, New York, South Carolina, Missouri, Indiana, Utah, California and Alaska. Many of the questions cannot be answered satisfactorily until we know more about past earthquakes. Deciphering the geologic past is one of the ways that Earth scientists help to protect people from loss of life and property.

This reading was adapted from a 1995 USGS Fact Sheet, "Averting Surprises in the Pacific Northwest," by Brian F. Atwater, Thomas S. Yelin, Craig S. Weaver, James W. Hendley, II.

Name: _____ Date: _____

1. Where is Cascadia located?

- A) in Alaska
- B) in Chile
- C) in the Pacific Northwest
- D) in the middle of the Pacific Ocean

2. What is the cause of earthquakes?

- A) the sudden breaking of the earth's rigid outer shell
- B) the stretching and thinning of the rocks that make up a tectonic plate
- C) the very slow movement of tectonic plates that are separating from each other
- D) the energy released when two tectonic plates grind together and then suddenly move

3. What evidence led scientists to conclude that Cascadia had been hit by large earthquakes many times in the past?

- A) the knowledge that the earth's outer shell is made up of tectonic plates
- B) the remains of forests in Cascadia that had died because of flooding
- C) the fact that Alaska had been hit by an earthquake of magnitude 9.2
- D) the revision of the Uniform Building Code in the Pacific Northwest

4. Based on the text, what may have led people to revise the Uniform Building Code in the Pacific Northwest?

- A) the need to prevent large earthquakes from happening in the Pacific Northwest region
- B) the fact that buildings in the Pacific Northwest had recently fallen down during earthquakes
- C) the desire to help scientists learn about buildings in areas that are likely to be hit by earthquakes
- D) the evidence that large earthquakes had struck the Pacific Northwest in the past

5. What is the main idea of this article?

- A) Scientists can tell where large earthquakes have occurred by studying dead forests along coastal land.
- B) Earthquakes can occur along subduction zones, where an oceanic tectonic plate sinks below a continental plate.
- C) Scientists have found evidence that the Pacific Northwest is at risk of being hit by major earthquakes.
- D) Changing the Uniform Building Code in the Pacific Northwest was an important step toward meeting the threat of large earthquakes.

6. Read these sentences from the text.

"Earthquakes can't be prevented. However, people can take **measures** to minimize the damage they cause. In some cases, communities can strengthen existing dams, bridges, water systems, schools, hospitals, and lifelines (electrical, gas, and water lines). They can also design and build earthquake-resistant structures."

What does the word "**measures**" most nearly mean in this sentence?

- A) questions
- B) amounts
- C) actions
- D) lessons

7. Choose the answer that best completes the second sentence below.

Scientists used to think that Cascadia would only be struck by earthquakes of magnitude 7 or below. _____, they found more recent evidence of bigger earthquakes in the region.

- A) Therefore
- B) However
- C) Indeed
- D) For example

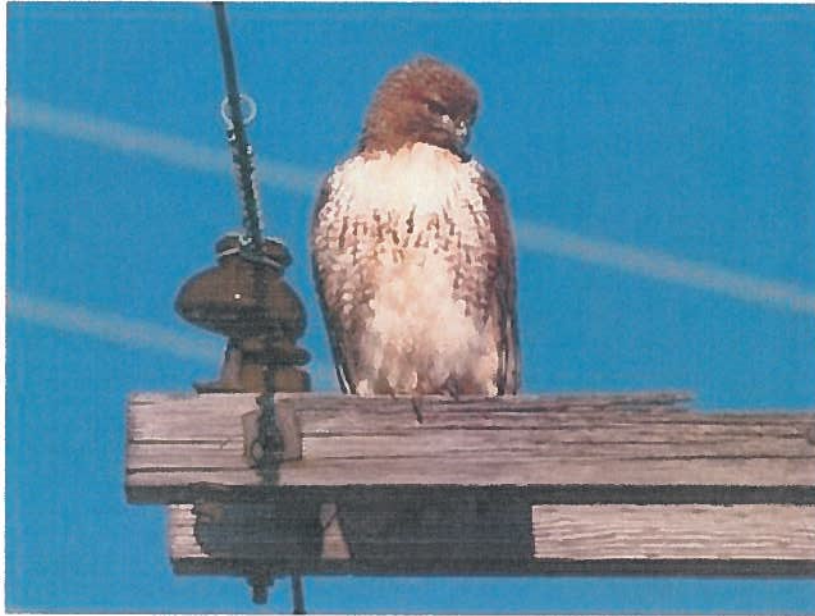
8. What did the drowned forests in Cascadia show scientists about the size of past earthquakes in the region?

9. In 1994, the Uniform Building Code was revised to include new requirements for how strong buildings in parts of the Pacific Northwest had to be. How did this change in the Uniform Building Code help people in the Pacific Northwest prepare for future earthquakes?

10. The last paragraph of the article states that it is hard to know whether we are prepared for future earthquakes until we know more about past earthquakes. It says that by studying the earth's past, scientists can help protect people from loss of life and property. How can knowing more about past earthquakes help people better prepare for future earthquakes? Use evidence from the text to support your answer.

Sandwich Money

by ReadWorks



I flip grilled cheese sandwiches for a living.

Seriously. No joke. Everything I pay for- the posters on my bedroom walls, the repairs for the bicycle I take to work, my new red sneakers with the little white outlines of an elephant on the sides-all of it is sandwich money. I think this is kind of funny. Everything I do and own is all made of grease and bread and little rubbery slices of salty, fake-looking, inexplicably delicious cheese. Some people think of money when they hear the clink and whoosh a cash register makes when the drawer pops open, but I think of money when I hear the sound of a spatula scraping against a flattop grill.

Don't get me wrong, I don't make nearly as much money as I do sandwiches. But my rent is cheap, and I make just enough to save a few bucks here and there after paying for necessary things: groceries, my phone bill, the occasional lipstick in the perfect shade of red. Sometimes I even find I have the dough saved up for some unnecessary thing. It's nice to know I have the financial wiggle room to just go for it when I see something, unexpectedly, that I really want.

Like the hawk.

A city doesn't have to be really big to be dense, but my city is both. This makes it hard to get around and be anywhere on time. Fortunately for some, it also makes it hard to get caught. People do a lot of stupid things almost or completely in plain view and no one notices, even though everyone is walking by them. There are just too many things going on and too many folks passing along for much of anything to stand out.

I was on my way home from the diner one afternoon, biking down the street like a croquet ball, dodging dog walkers and kids on tricycles. I got a flat jumping a curb. I pulled off the street before I fell off and walked a few blocks. I was in a weird hybrid of a neighborhood: part Koreatown, part mostly-empty warehouse district, with only the vestiges of industry left. I'd biked through that part of

town hundreds of times and never stopped to look, because I'm either on my way to work the grill or heading home to wash the grill off of me—both priorities over walking this funny part of town.

The flat, flapping tire on my front wheel forced me to take a tour, though. I thought I had some tools in my bag, but realized I'd left them on my kitchen table. So, oh well, I'd have to find a bike shop. They are everywhere, except, as I found, in Koreatown. There were so many people, tripping over colorful merchandise spilling from the occasional garage-door store, stepping in and out of Asian bakeries and grocery stores. I don't think the crowds of people lasted for more than a few blocks, but they were long blocks. I crawled.

Right up to the end of the busiest stretch, people knocked one another off the curb with elbows and packages. I stepped up and down from the street to the sidewalk and tried not to clip anyone with my pedals. Pretty suddenly, though, everyone evaporated, in as short a moment as it took for me to cross a street. The street got bigger and traffic went from mainly folks on foot to folks in cars. The sidewalk opened up and turned into a sort of chopped up, run-down block of concrete buildings and neon signs. It felt lonely.

Loneliness has an unexpected magnetism. Forlorn places draw artistic eyes all the time; I locked my sad bike against a signpost thinking of that Edward Hopper painting of an empty, all-night diner. My eyes aren't artistic but I still wanted to see a little bit more of this place, so I pushed open the door of a store that looked, from its few tiny windows, like a kitchen supply and bulk fabric store hybrid.

It looked like a garage on the inside, except with really bright fluorescent lights. It also looked like a mess. Shelves full of soaps and shampoos filled up the front-end of the store, and pots and pans flanked the front wall. Toward the back, the room took a turn. The space was shaped like an L, and I headed toward the elbow through an aisle lined with bulk spices and oils and, oddly, bath towels.

Price tags hopped from their products and stuck to my sweater, the aisles were so tight. I stooped in the back to look at chopsticks, cookbooks and tea, and DVDs and washcloths and measuring cups. In the short-end of the L, glass tanks, the sort of tanks you'd keep mice or goldfish or hermit crabs in, filled up shelves, some of the bigger ones hanging over the edge. It made me a little nervous that one of them might fall over and smash onto the floor, scattering glass everywhere.

Most of the tanks housed wiggling piles of hamsters or mice. I tapped the glass on a cage with a tarantula, and knelt down when the spider jumped back into a corner. A couple of empty shelves, a long tank with a few stiff lizards...and then, on the bottom shelf of the opposite wall, a bird—no pet store bird, either.

Is this even legal? I thought. One of the store employees approached me, and for a moment I was afraid I'd thought out loud.

"Can I help you?" The girl was young. She spoke to me while she twirled her hair, and some of it snapped as it got caught in her rings.

"Oh, I'm just looking...what's this?" I pointed to the hawk. Its head was tucked into its body, like it was hiding from everything, and its eyes were half closed.

"It's a hawk."

"Where- what's its story?"

"It's for sale." She paused and looked at me. "I mean, it was for sale, and we sold it, but it's back and for sale again."

"Um...I...where did it come from?"

"I don't know. I just got hired."

"Well...who bought it? Why did they return it?" The store smelled like cat food and miso soup. I was still crouched on the ground next to the hawk's cage, and when I shifted my knees, it opened its eyes and moved a talon. Just one.

"I wasn't hired yet when it was first sold. I don't know where it came from before that." The salesgirl stared at me. I looked at her. She still hadn't answered my question, really. She was terrible at her job. "But the guy who returned it, I was here for that. I don't know, some rich dude bought it and built a nest box on the roof of his apartment for the thing."

I pictured a sandbox-size nesting box. The hawk moved its whole foot, kicking up some of the wood chip litter in its cage.

"But the bird didn't want to live there, I guess. It was building a nest in a tree next to the building. It would come to the roof to eat, and whenever this guy was up there just hanging out, it would fly around him. I don't know. This is what the guy told me."

"So he just...he didn't want the bird because...it wouldn't live in the box he built?"

The girl nudged the hawk's cage with her shoe. It hopped backwards, but didn't make a noise. "I guess. That's what he told me. He said having a pet that didn't want an owner was stupid. So he just brought it back."

"So...it's pretty tame, then?" I stood up and my knees cracked.

"Yeah. Just not totally. I mean, it's still a wild animal. But this guy was able to lure it with some food. I guess it had been trained before. But I don't know where. I don't know how we got it here."

"Huh." I felt butterflies in my stomach, disturbing the peace with a little bit of sadness. "How much is it?"

The salesgirl tapped the cage again. "70 bucks."

Inside the tank, the hawk took a couple of steps, one forward, and one back. It looked bored. It looked sad. It looked like it was in a glass box that was way too small, so it looked huge and uncomfortable.

"Okay. I'll buy him."

What was I, crazy? I lived in a tiny apartment. I had a roommate. But my apartment had windows, and my roommate was rarely home. At the time, the most important thing was that I didn't care whether or not the bird nested on my roof. I wouldn't be offended if it wanted to build a nest in a tree instead. I had 70 dollars, and I gave it to the girl as we walked up to the counter, my bird now making faces from a perch on my arm.

* * * *

I can't say exactly what made me do that. Grilled cheese money burned a hole in pocket, and I bought a bird of prey at a funny variety store on a lonely block in Koreatown. My bike still had a flat, and I had a bird on a rope holding fast to my forearm, so I left it locked to a post outside the shop overnight, walking four miles to my house in the twilight, and later, under the streetlights.

When I got home, I brought the hawk inside, opened a window, and it promptly flew out and hid in the gnarled old maple growing in the lot next door. I didn't even have to tell my roommate about it. It nested in that tree, and only when I was up on the roof watching sunsets or throwing water balloons at the sidewalk below, did it fly over and remind me that it was mine.

It sounds cheesy, but I'd given him freedom, paid for in full by grease and bread and the sound of a spatula scraping a flattop grill.

Name: _____ Date: _____

1. What does the narrator buy in the story?

- A. a tarantula
- B. a hawk
- C. a hamster
- D. a sandwich

2. A key point in the story is when the narrator sees the variety store and decides to go in. How does she end up in the store?

- A. She reads an advertisement for the store in the newspaper and wants to see the available pets.
- B. The store is a famous attraction in that neighborhood, and she wants to visit it.
- C. She walks past the store on her way to work at the sandwich grill.
- D. She was walking past the store after she got a flat tire and was interested to go inside.

3. The man who previously owned the hawk returned the bird because he thought it was too independent. What evidence from the story supports this conclusion?

- A. "So he just...he didn't want the bird because...it wouldn't live in the box he built?"
- B. "Some rich dude bought it and built a nest box on the roof of his apartment for the thing."
- C. "It would come to the roof to eat, and whenever this guy was up there just hanging out, it would fly around him."
- D. "I mean, it's still a wild animal. But this guy was able to lure it with some food."

4. How can the narrator best be described?

- A. careful
- B. lazy
- C. impulsive
- D. understanding

5. What is this story mostly about?

- A. a girl's experiences making sandwiches
- B. a bike that gets a flat tire
- C. how a girl ends up buying a hawk
- D. a hawk that wants to be free

6. Read the following sentences:

"Huh." I felt **butterflies in my stomach, disturbing the peace with a little bit of sadness**. "How much is it?"

The salesgirl tapped the cage again. "70 bucks."

Inside the tank, the hawk took a couple of steps, one forward, and one back. It looked bored.

Why does the author write the narrator felt "**butterflies in [her] stomach, disturbing the peace with a little bit of sadness**"?

- A. to indicate the narrator is afraid of the hawk
- B. to indicate the narrator feels sorry for the hawk
- C. to indicate the narrator does not care about the hawk
- D. to indicate the narrator is bored with the hawk

7. Choose the answer that best completes the sentence below.

The narrator does not make a lot of money; _____, she splurges to buy a hawk.

- A. however
- B. as a result
- C. ultimately
- D. especially

8. What does the narrator say she gives the hawk?

9. How does the narrator describe the hawk in the cage?

10. Why might the narrator have bought the hawk? Support your answer with information from the story.
