Oregon Geology Fact Sheet

Tsunami Hazards in Oregon

What is a tsunami?

A tsunami is a series of ocean waves most often generated by disturbances of the sea floor during shallow, undersea earthquakes. Less commonly, landslides and volcanic eruptions can trigger a tsunami. In the deep water of the open ocean, tsunami waves can travel at speeds up to 800 km (500 miles) per hour and are imperceptible to ships because the wave height is typically less than a few feet.

As a tsunami approaches the coast it slows dramatically, but its height may multiply by a factor of 10 or more and have catastrophic consequences to people living at the coast. As a result, people on the beach, in low-lying areas of the coast, and near bay mouths or tidal flats face the greatest danger from tsunamis.

A tsunami can be triggered by earthquakes around the Pacific Ocean including undersea earthquakes with epicenters located only tens of miles offshore the Oregon coast. Over the last century, wave heights of tsunamis in the Pacific Ocean have reached up to 13.5 m (45 ft) above the shoreline near the earthquake source. In a few rare cases, local conditions amplified the height of a tsunami to over 30 m (100 ft).

What is the difference between a Cascadia (local) tsunami and a distant tsunami?

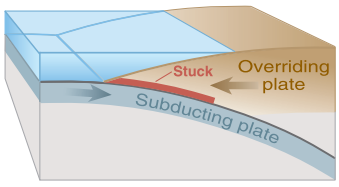
An earthquake on the Cascadia Subduction Zone, a 960-km-long (600 mile) earthquake fault zone that sits off the Pacific Northwest coast, can create a **Cascadia tsunami** that will reach the Oregon coast within 15 to 20 minutes. Massive earthquakes of magnitude 9 or greater that can last for several minutes have been generated on the fault zone. A destructive tsunami can follow moments later.

A **distant tsunami** produced by an earthquake far from Oregon will take 4 or more hours to travel cross the Pacific Ocean, usually allowing time for an official warning and evacuation, if necessary. A distant tsunami will be smaller in size and much less destructive, but it can still be very dangerous.

The December 26, 2004, Indian Ocean tsunami strikes Khao Lak, Thailand. A wall of water dwarfs a tourist and boats on the beach. (Photo source: John Jackie Knill – family photo/AP)

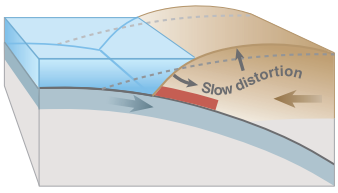
Destruction at Seaside, Oregon, due to the March 28, 1964, Alaska tsunami. Water lifted the car against the house, uprooted the tree, and washed in driftwood logs. Beach grass hanging in the tree branches indicates the maximum water depth at this location was 3.5 m (12 ft). This house was 1200 m (4000 ft) from the shore. (Photo source: Herb Schlappi)

Tsunami Generation



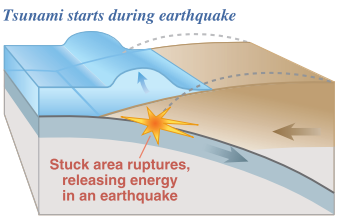
Vertical Slice Through a Subduction Zone

One of the many tectonic plates that make up Earth's outer shell descends, or "subducts," under an adjacent plate. This kind of boundary between plates is called a "subduction zone." When the plates move suddenly in an area where they are usually stuck, an earthquake happens.



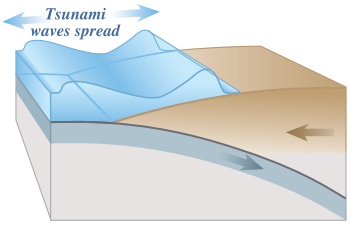
Between Earthquakes

Stuck to the subducting plate, the overriding plate gets squeezed. Its leading edge is dragged down, while an area behind bulges upward. This movement goes on for decades or centuries, slowly building up stress.



During an Earthquake

An earthquake along a subduction zone happens when the leading edge of the overriding plate breaks free and springs seaward, raising the sea floor and the water above it. This uplift starts a tsunami. Meanwhile, the bulge behind the leading edge collapses, thinning the plate and lowering coastal areas.



Minutes Later

Part of the tsunami races toward nearby land, growing taller as it comes in to shore. Another part heads across the ocean toward distant shores.

(Source: U.S. Geological Survey Circular 1187)

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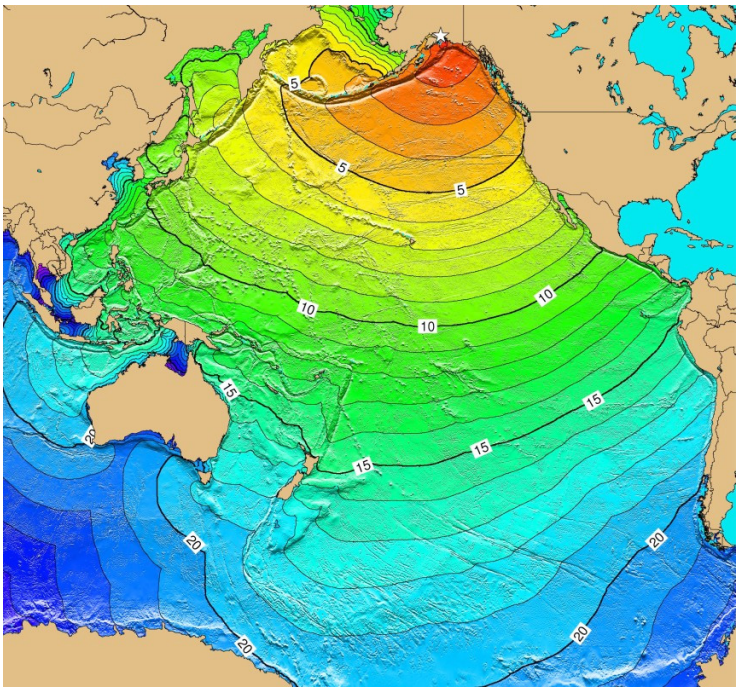


Tsunami travel time map for the March 28, 1964, Prince William Sound Alaska earthquake. Destructive waves reached the Oregon coast 4 hours after the earthquake occurred. (Source: National Geophysical Data Center, http://www.ngdc.noaa.gov/hazard/tsu_travel_time.shtml).

Have tsunamis hit the Oregon coast?

Yes. Tsunamis triggered by nearby earthquakes offshore Oregon as well as distant tsunamis caused by earthquakes across the Pacific Ocean have struck the Oregon coast. The last Cascadia tsunami, triggered by a Cascadia subduction zone earthquake, occurred in A.D. 1700, and left an indelible mark in Native Tribal legends. Damaging tsunamis from distant sources reached Oregon's shorelines as recently as 1960 and 1964.

Will a tsunami strike again?

Yes. Since 1854, 21 tsunamis produced by earthquakes around the Pacific Ocean basin have reached the Oregon coast. Wave heights of four of these distant tsunamis reached 1-5 m (3-16 ft), causing damage to coastal communities and in one event, five deaths. Geologists predict a 10-14 percent chance that a Cascadia tsunami will be triggered by a shallow, undersea earthquake offshore Oregon in the next 50 years. The forecast comes from evidence for large but infrequent earthquakes and tsunamis that have occurred at the Oregon coast every 500 years, on average.

Who is at risk?

Communities along the Pacific coast and along estuaries are at greatest risk. A nearby earthquake could drop the low-lying regions of the coast several feet below sea level. The highest tsunami waves could reach 25 m (80 ft) and severely flood coastal communities near beaches, bay mouths, and low-elevation coastal plains. Oregon's at-risk population is approximately 40,000 on the outer coast, excluding tourists and transient populations that could increase the number significantly.

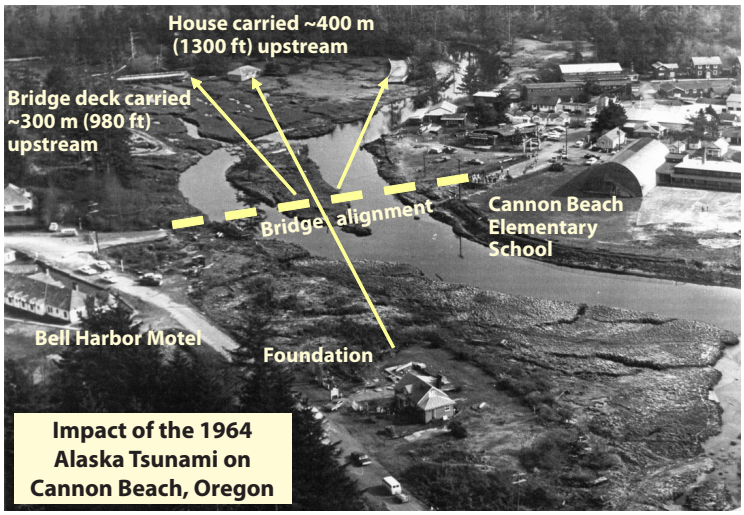
What should I do if an earthquake occurs while I'm at the coast?

Strong, local earthquakes may generate tsunamis. If shaking during the earthquake causes you to fall or have difficulty standing:

1. Drop, cover and hold. Brace yourself under a sturdy object and watch out for falling debris.
2. After the shaking stops, immediately move to high ground or inland.
   Do not wait for an official warning; a tsunami may arrive within minutes.
3. Stay away from the beach and low-lying coastal areas. Tsunami waves may continue to arrive for several hours.
4. Wait for the "All Clear" signal from emergency officials before returning to low-lying areas. Buildings, lifelines, and utilities must be inspected for damage to ensure public safety.
5. Be alert for aftershocks and stay tuned to local radio, NOAA weather radio, and television broadcasts for emergency information and recovery assistance.

Where do I evacuate?

Go to high ground, at least 15 m (50 ft) above sea level. If you are unable to get to high ground, go inland away from the ocean as far as possible. If you are unable to evacuate but are near a multi-story, reinforced concrete building, go to the third floor or higher. If you need assistance evacuating, tie a large white sheet or towel to the front door knob to notify officials that you need help. Tsunami evacuation maps for Oregon communities indicate the safest evacuation routes and assembly areas. Evacuation maps for some Oregon communities are available at: http://www.oregongeology.com/sub/earthquakes/Coastal/Tsubrochures.htm



Oblique aerial photograph of the lower Elk Creek valley (now Ecola Creek) that flows through downtown Cannon Beach, Oregon, after the 1964 Alaska tsunami. Decking from the old Elk Creek bridge was torn from its abutments and transported 300 m (980 ft) upstream. A foundation in the lower part of the photo marks the original position of a house that was carried 400 m (1300 ft) upstream and deposited between the bridge sections. (Photo source: Hillsboro Argus*, March 30, 1964)*

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What is the difference between a Tsunami WARNING and Tsunami WATCH?

When the West Coast/Alaska Tsunami Warning Center (http://wcatwc.arh.noaa.gov/) detects an earthquake with the potential to generate a tsunami in the Pacific Ocean, the Warning Center alerts communities at risk along the coasts of Oregon, Washington, California, British Columbia, and Alaska.

A **Tsunami Warning** means that a potentially destructive tsunami is imminent or expected. Warnings alert public officials and the public that widespread, dangerous coastal flooding accompanied by strong currents is possible and may continue for several hours after the arrival of the initial wave. Moving away from beaches and low-lying coastal areas may be appropriate. A **Tsunami Watch** alerts emergency officials and the public that a potentially destructive tsunami may later impact the Watch area. Be ready to respond if the Watch is upgraded to a Tsunami Warning.

What can I do to prepare for a tsunami?

- Practice a family strategy to respond to emergencies. Include a family meeting place, an evacuation plan, and how to survive on your own in the event of an earthquake and tsunami.
- Know how to get to high ground to escape a tsunami. Be familiar with local earthquake and tsunami emergency response plans.
- Be prepared to survive on your own for at least 3 days. Roads, bridges, utilities, and other lifelines may be damaged by the earthquake and tsunami. Do not expect relief from areas outside your community for several days or longer.
- Assemble an emergency supply kit and keep it ready to use in case an evacuation is ordered.
- Take a first-aid course and learn survival skills. Being aware of the danger and being prepared for emergency is the best strategy to survive a potential disaster.

What is the State of Oregon doing to minimize the effects of a tsunami in Oregon?

Almost 230,000 people from 11 nations were lost during the 2004 Indian Ocean tsunami, making it one of the deadliest natural disasters in human history. The startling global impact of this event instigated a reexamination of tsunami hazards along the Oregon coast. The Oregon Department of Geology and Mineral Industries (DOGAMI) is working closely with Oregon Emergency Management and other government agencies, universities, and research partners to develop the next generation of tsunami evacuation maps for the entire Oregon coast.

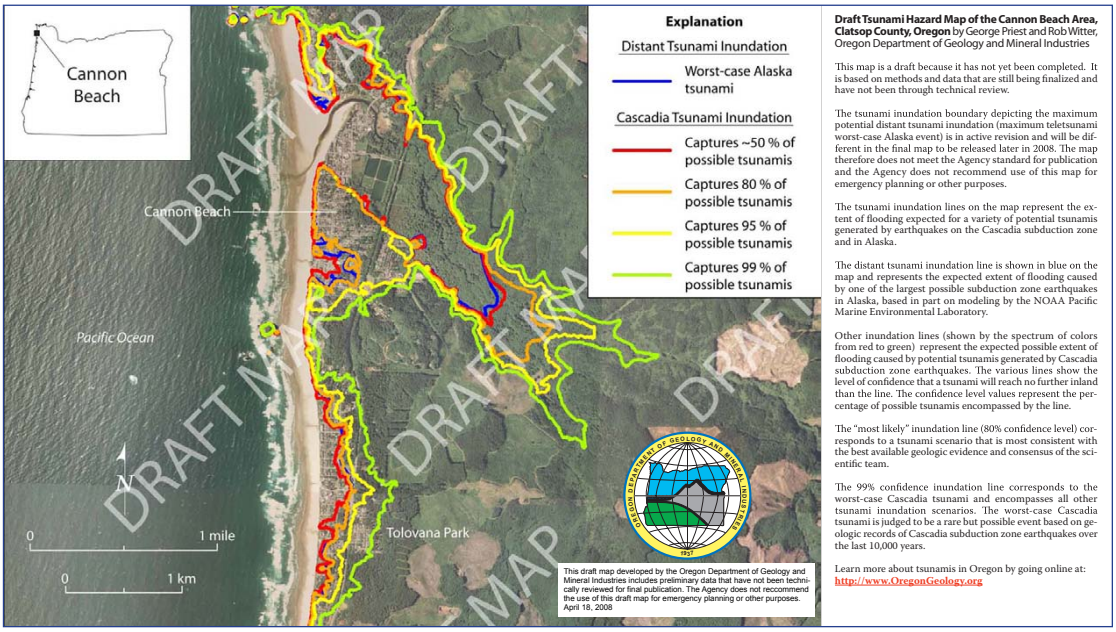
The new evacuation maps will be derived from computer simulations of tsunamis developed from our understanding of how undersea earthquakes produce tsunamis and from lessons learned from the devastating 2004 Indian Ocean tsunami. Our goals are to communicate the full range of tsunami hazards to the public and to reduce the loss of life and property in the event of a future tsunami through mapping, mitigation, and education outreach.

New models of how shallow earthquakes deform the seafloor informed by a better understanding of the structure of the Earth's crust and the geologic record of how often such earthquakes and tsunamis occur in Oregon suggest that prior tsunami hazard assessments may underestimate the true hazard.

New tsunami simulations indicate the largest waves may run up to elevations twice as high as earlier models predicted and flooding may inundate hundreds of yards further up coastal valleys. As a result, the evacuation zone for some coastal communities may need to be revised and likely will result in a larger evacuation area.

DOGAMI is working with local and state emergency officials and community leaders to heighten public awareness of revised tsunami hazards, to increase efforts to prepare for tsunamis, and to focus on community resilience and post-tsunami recovery.

The Oregon Department of Geology and Mineral Industries, together with Oregon Emergency Management and other partners, is developing new, computer simulation based, tsunami hazard maps for the entire Oregon coast. This draft map (04-18-08) of the Cannon Beach area shows the extent of flooding expected for a variety of potential tsunamis generated by earthquakes on the Cascadia subduction zone and in Alaska. Visit http://www.oregongeology.org to see a larger version of this map.



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Prepare an Emergency Supply Kit

Assemble an emergency kit that contains personal supplies for at least 3 days. Keep the kit compact, light weight and accessible in the event you must evacuate immediately on foot. At a minimum, an emergency supply kit should contain:

- Local map showing safe evacuation routes to high ground
- First-aid supplies, prescriptions and non-prescription medication
- Water bottle and filtration or treatment supplies capable of providing 1 gallon per person per day
- Non-perishable food (ready-to-eat meals, canned food, baby food, energy bars)
- Cooking and eating utensils, can opener, Sterno® or other heat source
- Matches in water-proof container or lighter
- Shelter (tent), sleeping bags, blankets
- Portable radio, NOAA weather radio, flashlight, and extra batteries
- Rain gear, sturdy footwear, extra clothing
- Personal hygiene items (toilet paper, soap, toothbrush)
- Tools and supplies (pocket knife, shut-off wrench, duct tape, gloves, whistles, plastic bags)
- Cash

Remember

- Tsunamis can occur at any time day or night.
- When at the beach, if you experience a strong earthquake, see a sudden rise or fall in sea level, or hear a load roar like a jet aircraft, a tsunami may be approaching. Do not wait – move to high ground or inland as quickly as possible.
- Evacuate on foot if possible and follow evacuation route signs and instructions from emergency officials.
- Never go to the coast to watch a tsunami. Tsunamis travel faster than a person can run.
- Never attempt to surf a tsunami wave. Most tsunamis advance onshore as breaking waves and lack a clean smooth face. Often the wave behaves like a rapidly rising tide or wall of water that may be full of debris.
- Do not return to the beach after the first wave, additional larger waves may follow. Wait for emergency officials to issue the "All Clear" signal before returning to low-lying areas.
- Stay tuned to your radio, marine radio or NOAA Weather Radio after an earthquake or tsunami. Bulletins will be updated regularly through local emergency management agencies and the National Weather Service.
- Call 9-1-1 only for life-threatening emergencies.

Resources

Oregon Department of Geology and Mineral Industries, tsunami evacuation maps for selected Oregon coastal communities
http://www.oregongeology.com/sub/earthquakes/Coastal/Tsubrochures.htm

Surviving a Tsunami: Lessons from Chile, Hawaii and Japan, U.S. Geological Survey Circular 1187
http://pubs.usgs.gov/circ/c1187/

Sobreviviendo a un Tsunami: Lecciones de Chile, Hawai y Japón
http://pubs.usgs.gov/circ/c1218/

Tsunami, the Great Waves, UNESCO-IOC Brochure 2006-2
http://ioc3.unesco.org/itic/files/great_waves_en_2006_small.pdf

American Red Cross
http://www.redcross.org/

Ready.gov, general preparedness information
http://www.ready.gov

West Coast/Alaska Tsunami Warning Center
http://wcatwc.arh.noaa.gov/Products/msgdefs.htm

Oregon Emergency Management
http://www.oregon.gov/OOHS/OEM/

TsunamiReady, National Weather Service
http://www.tsunamiready.noaa.gov/

National Tsunami Hazard Mitigation Program
http://nthmp.tsunami.gov/

International Tsunami Information Center
http://ioc3.unesco.org/itic/

Also contact your local fire department or city or county emergency management office.

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