



The cold and wild winter ocean beats and breaks against the banks, pulls up beach grass clumps, drags the sand into offshore depths, down, exposing rocks and old spruce roots in the grey clay ground. The ocean takes what it wants and throws back the rest to sit and to rot and to be picked at by birds. The waves roll in big now, pushed along by winds that howl across the open Pacific. The night is filled with their deep thunderous sounds. The big waves remind me: an anniversary is upon us. Three hundred years ago this month, on January 26, 1700, giant waves rose up, engulfing houses and trees and people along the Oregon coast, dragging them out into the cold nighttime sea. Three hundred years ago, tsunamis crashed through our hometown.

What we know of Oregon coast tsunamis is limited by our comparatively brief tenure here - since European peoples first reoccupied this coast, no waves have loomed as large as those that arrived 300 years ago. Still, small tsunamis have recently visited our shores, giving us hints of what has come before. Many locals still recall the events of 1964, when an earthquake centered in southern Alaska's Prince William Sound sent a wave down the Pacific coast. Reaching a maximum height of over 200 feet in Alaska, these waves were only around 10 feet high when they arrived on the Oregon coast. When the Alaska tsunami arrived in Cannon Beach, it rushed inland up Ecola Creek, taking out the town's main bridge and tumbling trailers. Then, having reached far upstream, the wave lost momentum and fanned out into the trees, returning as a seaward current of water coursing through the forest. My grandparents' house, located in the north end of town, was knocked from its foundation by rushing water and hurtling logs. Family legend informs us that the neighbor's house was tossed into the broad lateral branches of a spruce tree on my grandparents' property. When the waters receded, the neighbor who owned this house approached my grandfather, asking permission to climb into the tree so that he could retrieve some of his belongings. My grandfather, a cautious man by nature, visions of personal liability litigation dancing in his head, ultimately consented. In time, houses were pulled down from trees, and placed - with much labor and complaint - back onto their foundations. We were comparatively lucky this time. Surging across the Pacific from its Alaskan epicenter, this same wave drowned people in Alaska, as well as Newport and the northern California coast, caused significant damage in such far-flung locations as Hawaii and Japan, and was detectable as far away as Chile and Antarctica. Small tribal villages on the British Columbia and Alaska coasts, places occupied for centuries, containing small remnant populations of elderly epidemic survivors and young fishermen, were wiped away; their homes and docks destroyed; these people drifted off to places such as Vancouver and Seattle. It marked the end, the final blow, for more than one tribe. Here and there on our coast, one can still see weathered gray logs perched in improbably high places, sitting right where the tsunami placed them in 1964. Young trees grow back densely near the shoreline, where waves swept their predecessors clean.

Tsunamis are by no means rare in the seismically active Pacific basin. Usually, there are about two tsunamis per year in the Pacific Ocean, while waves that are large enough to be detectable around the entire Pacific occur only every 10 to 12 years. These giant waves are created by the rapid displacement of large amounts of water - most often they are generated by earthquakes, but they can also result from other disturbances: volcanic eruptions, meteor impacts, or the large landslides - above or below the water's surface - that sometimes follow earthquakes. These waves pulse outward at tremendous speeds, a rushing lateral shockwave that is detectable from the ocean's surface to its floor. In the open sea, these waves can often reach speeds of 600 miles per hour. Tsunamis have extremely long wavelengths; sometimes, in the open ocean, over a hundred miles separates the crest of each successive wave, while they may be only a few inches or feet in height. To ships at sea, they often are not detectable (the Japanese, in particular, have many ominous tales of fisherman returning to a destroyed home port, not having noticed the wave passing beneath their boats at sea). When these waves enter shallows, however, the wave's energy becomes increasingly focussed - the wavelength rapidly decreases, the wave slows, and its height begins to increase. The resulting surge of water can arrive as a large breaking wave, or in more subtle forms - as a standing wave, or simply as a very rapid rise in the water level. Tsunamis commonly arrive in rapid succession after an earthquake. Numerous waves may crash into the shore, continuously, for several hours after the initial tsunami, and often the first wave is not the biggest. The size that these waves reach is a matter of the severity of the earthquake (or other disturbance), the contours of the nearshore sea floor, the distance between the wave's origin and the point of landfall, the tide, and a number of other factors that coastal residents might simply summarize under the heading 'dumb luck'. Waves of up to 50 feet can result from earthquakes far across the Pacific, while waves of over 100 feet are not uncommon in locations near an earthquake's epicenter. (For reference, Haystack Rock is 235 feet high.) Still, they can be much much bigger. Waves of 500 feet can be detected archaeologically in portions of the Pacific. And, in 1958, following a large landslide, Lituya Bay, Alaska was struck by a wave that was 1,722 feet high. We can only guess how large tsunamis have become in the past; we can only imagine what it must be like to witness these monster waves.

Locally, historically, the largest tsunamis appear to have been caused by earthquakes along a long belt referred to by geologists as the "Cascadia subduction zone." This line demarcates the seam in the Earth's crust where two tectonic plates meet. Here, the "Juan de Fuca plate," underlying our offshore waters, slides under the much larger "North American plate" along an offshore north-south line, running from northern Vancouver Island in British Columbia to Cape Mendocino in California. The heavier oceanic plate slips below our continent, but it doesn't do this smoothly. It does so in plunging fits and starts, building up pressure and then releasing this tension with a rapid forward slide. When this happens, there is often a large earthquake. And, as was the case in January of 1700, when this last happened, there is a tsunami. Sometimes, during these events, the land also rises or falls relative to the sea, rapidly and permanently perching beaches high above the high tide line, or submerging forests below the sea. Some of the trunks and tree roots exposed on our beach by this winter's waves outline where whole forests were submerged, killed by the saltwater, and buried below the accumulating beach sand when the land dropped, 300 years ago. Up and down our coast, north and south of us, the roots and stumps of similar coastal forests lie buried in beach sand and bay mud. These large subduction zone earthquakes and tsunamis occur every 200 to 600 years, but arrive at an average interval of roughly 300 years. Which makes this 300 year anniversary so very interesting. Which, according to Michael Burgess' Guide to the Real Oregon Coast, makes "last week the safest time to visit the Oregon Coast for the next few decades."

European people have not yet seen these big waves, have not experienced the awesome force of a subduction zone earthquake and tsunami on this coast. Our history here is too brief, the timing of our rapid reoccupation too serendipitous. Despite this, we can pinpoint the last major tsunami to the night of January 26th, 1700. This is done on the basis of archaeological evidence, as well as the meticulous records of the Japanese, whose east coast was battered by 10-foot high tsunamis in the two days following this earthquake.

The Native peoples that lived on this coast when Europeans first arrived were direct descendants of the survivors. While they did not record their history with reference to specific calendar dates, they spoke clearly of the tsunami that struck 300 years ago this year, and of other tsunamis from times more distant. Many mentioned huge waves that arrived two or three or four generations before the first whites arrived, coming at night, sweeping through their villages. On Vancouver Island's west coast, for example, indigenous people still speak of this last major tsunami: "they simply had no time to get ahold of their canoes, no time to get awake, no one ever knew what happened, a big wave smashed into the beach." In one community, only the family that lived in a longhouse on a hill, perched above the rest of the village, was not overtaken by the waves and "did not drift out to sea with the others" - the tribe largely consisted of this family's descendants when whites arrived. Legends from up and down the Oregon coast describe the ocean going far inland after earthquakes of unknown antiquity, "sweeping everything away clean." Others speak of the ocean ebbing away, as often happens before a tsunami, giving certain people an early warning and the opportunity to go to high peaks; members of several tribes still can point to peaks to which their ancestors retreated for safety. Legends suggest that some people were able to ride out rapidly rising waters in large cedar canoes, but were separated from the others, drifting to faraway places. Tsunamis, we can gather from these tales, were a widely understood, terrifying aspect of everyday life.

Archaeological evidence lends support to many of these tales. Slowly, from the sediments and debris of former village sites along this coast, a coherent picture emerges: whole villages were demolished by these subduction zone earthquakes and tsunamis. Many were permanently abandoned. Layers of debris, marking hundreds of years of human occupation, cease abruptly at the same moment that earthquakes and tsunamis rearranged the local landscape. Some villages were permanently submerged with water as the land abruptly dropped relative to the sea. In a number of nearby places, including the western margins of Nehalem Bay, village sites were submerged into the intertidal zone; soon thereafter, nearby, other villages seem to be established anew. The timing of these events, these rapid relocations, appear to correspond with the timing of subduction zone quakes and the tsunamis that followed. With an empathetic imagination, we might envision the personal stories, the awesome human drama, associated with the events that made these signatures in the soil.

Our people have never seen this kind of destruction on this coast. As imagination is required to envision the tsunamis of the past, a little imagination is required to envision events yet to come. With our burgeoning, unprecedented population, a subduction zone quake and tsunami could result in a natural disaster with few modern parallels. (By all means, if you feel a major quake, head for the hills.) Now, confronted with growing evidence of the timing and severity of past tsunamis, some communities are contemplating their response. And how does one respond to the immanent but unpredictable threat of oceanic destruction on a Biblical scale? The City of Cannon Beach and a few other coastal towns have built tsunami alert systems, tied in to a network of seismic and oceanic monitoring stations around the Pacific. The reassuring sound of a very agitated cow, played over Cannon Beach loudspeakers every month or so, lets us know that this system is still functioning and can - with adequate forewarning - alert us of approaching waves. (A cow, it was determined, sounds much less intimidating to the average tourist than the siren that would sound if This Were An Actual Emergency.) The City has also posted blue signs to evacuation routes of unknown merit, featuring a stick figure-ish individual about to be swept away by a large curling wave. Other towns may soon follow these examples. History provides them with a valuable lesson: three hundred years ago, tsunamis crashed through our hometown. Tsunamis will come again. It could be tomorrow or another three hundred years into the future - the distinction is not significant in geologic time. By looking at where the waves have hit, and how high they have been, we might be better prepared. We might, unlike many of the people who lived here on that January night, 300 years ago, be able to get to high ground before the giant waves return again.

The verbal account of the 1700 tsunami comes from Arima, St. Claire, Clamhouse, Edgar, Jones, and Thomas (1991). Between Ports Alberni and Renfrew: Notes on West Coast Peoples. (Canadian Ethnology Service Mercury Series Paper #121). Ottawa: Canadian Museum of Civilization. Michael Burgess is quoted from his 1998 Left Coast Group book, Uncle Mike's Guide to the Real Oregon Coast, which includes an illuminating section on tsunami watching that I would quote in full here if space permitted. A number of very good tsunami sites are available on the internet. Start, perhaps, with the West Coast and Alaska Tsunami Warning Center at <http://wcatwc.gov/> and explore from there.

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