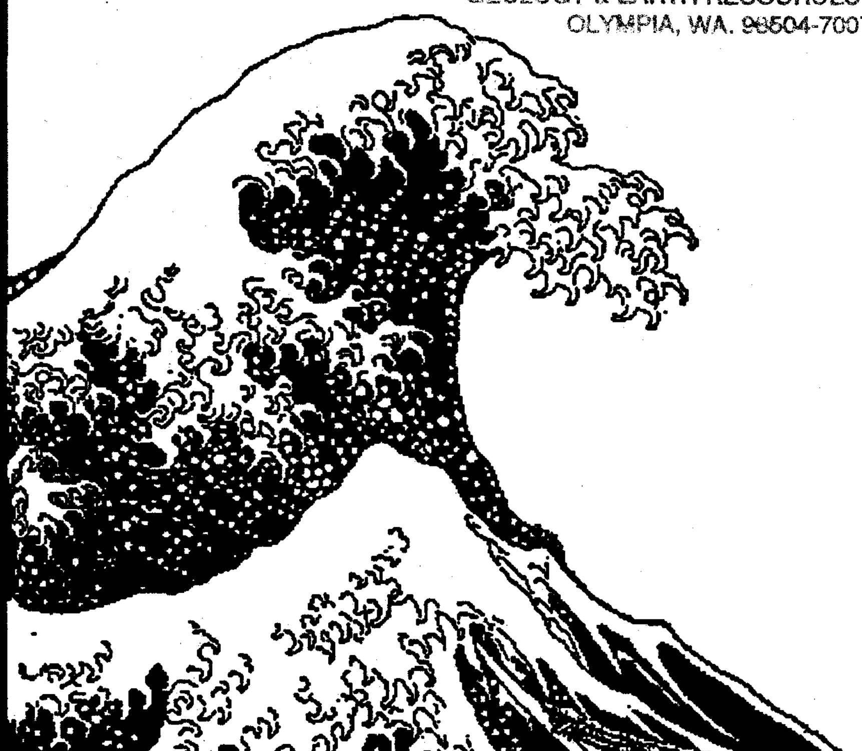
NATURAL RESOURCES

Tsunamis on the Pacific Coast of Washington State and Adjacent Areas— An Annotated Bibliography and Directory

compiled by
Connie J. Manson



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INTRODUCTION

The Pacific coast of Washington is at risk from giant, destructive waves called *tsunamis*. Most tsunamis are caused by large, rapid movements or changes in the sea floor that displace the water column above. Earthquakes are a common cause of tsunamis, but submarine landslides and volcanic eruptions can also generate these waves.

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from the area in which the earthquake (or other event) took place. Tsunamis that affect Washington could be generated by local events or produced thousands of miles away.

Tsunamis can move across the ocean at speeds as great as 600 miles per hour. If an earthquake in the Pacific Ocean that might cause a tsunami is detected, the Alaska Tsunami Warning Center calculates the danger to the northeast Pacific coast and notifies the communities at risk. If the earthquake is a long way from Washington, the warnings may give people a few hours to prepare and evacuate. However, if the earthquake occurs closer to Washington, there may be no time to send out hazard warnings.

The shape of the ocean bottom and coastline influences the height of the waves when they reach land, and heights of 50 feet are not uncommon. Enormous surges of water can also rush into bays and up rivers, pushing boats and driftwood, and even houses, inland.

Fortunately, tsunamis are rare events. The most recent significant tsunami to reach the Washington coast happened in 1964. However, historically, tsunamis have caused great damage. In 1946, a tsunami was initiated by an earthquake in the Aleutian Islands of Alaska; it reached Hawaii with waves as high as 55 feet and killed 173 people. The tsunami caused by the 1964 Alaska earthquake in Prince William Sound destroyed property in many areas along the coast from Alaska to California. In Washington alone, this tsunami caused $105,000 in damage.

The sequence of tsunami waves arrive at the shore over a long period. The first wave will be followed by others a few minutes or a few hours later. Commonly the later waves are larger. The first and second waves to strike Crescent City, California, in 1964 occurred at low tide and did little damage. The third and fourth waves, however, killed 11 people and caused $7.4 million in damage.

The Cascadia subduction zone west of Washington is thought to be capable of generating very large earthquakes (magnitudes of 8 or more). Recent studies show that about a dozen of these very large earthquakes have occurred in the last few thousand years. In 1964, the bridge over the Copalis River in Washington was destroyed by debris driven against the pilings by the tsunami from the Alaska quake. In 1992, scientists and engineers studying the site found evidence of previous tsunamis in the same area, possibly caused by subduction-zone earthquakes. Computer models indicate that such locally generated tsunami waves might range from 5 to 55 feet in height.

Because tsunamis are so destructive, we need to be prepared. This report has been put together to help local planners and emergency managers of the Pacific coast communities acquire information that will help them be ready in the event of a tsunami in their area.

The information in this booklet is presented in two parts. First is an annotated bibliography, which offers titles of books and other materials for general reference and about hazards in various areas along the Pacific coast. The second part is a directory of people and organizations concerned with tsunamis in the Pacific Northwest.

Note on Availability

Copies of items marked with an asterisk (*) are available free to planners, local officials, and emergency managers in the Pacific coast area. Contact the Division of Geology and Earth Resources (DGER) Library for more information.

The other materials are available for examination at the DGER offices in Olympia, Washington. Many are also available at public libraries.

Acknowledgments

This work benefitted greatly from reviews by Brian Atwater and Jerry Thorsen. The booklet was prepared at the Washington Department of Natural Resources, Division of Geology and Earth Resources, in cooperation with the Washington Department of Community, Trade, and Economic Development and the Federal Emergency Management Agency.

GENERAL WORKS ABOUT GEOLOGIC HAZARDS, EARTHQUAKES, AND TSUNAMIS

Alexander, David, 1993, Natural disasters: Chapman and Hall [New York, N.Y.], 632 p.

A thorough examination of the causes and actions of various geologic hazards, including earthquakes and tsunamis, their impacts on people and society, and the responses and preventive measures we can make.

****American Institute of Professional Geologists, 1993, The citizens' guide to geologic hazards—A guide to understanding geology hazards—Including asbestos, radon, swelling soils, earthquakes, volcanoes, landslides, subsidence, floods and coastal hazards: American Institute of Professional Geologists, 134 p.**

An excellent review of hazards from geologic materials (like asbestos and radon) and geologic processes (including earthquakes, landslides, and tsunamis). Clearly written, with good illustrations and current information.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

Bernard, E. N., editor, 1991, Tsunami hazard: Natural Hazards, v. 4, no. 2-3, p. 113-326.

Recent advances in tsunami research are published in this special issue of *Natural Hazards* (the proceedings of the 14th International Tsunami Symposium, 1989). The scientific reports are grouped into three areas of research: observations, physical processes, and hazard mitigation.

Bolt, B. A., 1988, Earthquakes: W. H. Freeman and Company, 282 p.

A standard work about the causes and effects of earthquakes.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

***Clague, J. J., 1991, Natural hazards. *In* Gabrielse, H.; Yorath, C. J., editors, Geology of the Cordilleran orogen in Canada: Geological Survey of Canada Geology of Canada 4; Geological Society of America DNAG Geology of North America, Vol. G-2, p. 803-815.**

A current overview of the earthquake, landslide, tsunami, and volcanic hazards in western Washington and British Columbia.

Dudley, W. C.; Lee, Min, 1988, Tsunami!: University of Hawaii Press, 132 p.

In 1946, a series of tsunami waves struck the Hawaiian Islands without warning, leaving 159 persons dead and millions of dollars in damage. A few years later, the Pacific Tsunami Warning System was established. This volume gives eyewitness accounts of the 1946, 1952, 1957, and 1960 tsunamis, and clear descriptions of the causes, actions and effects of tsunami waves.

Recommended for high school and public libraries.

Gere, J. M.; Shah, H. C., 1984, Terra non firma—Understanding and preparing for earthquakes: W. H. Freeman and Company, 203 p.

A standard work about the causes and effects of earthquakes.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

****Hays, W. W., editor, 1981, Facing geologic and hydrologic hazards—Earth-science considerations: U.S. Geological Survey Professional Paper 1240-B, 109 p.**

Basic information about the geologic hazards of earthquakes, floods, ground failures, and volcanic eruptions with suggested actions that planners and decision-makers can take to reduce losses from geologic and hydrologic hazards.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

****Hunt, Joe, 1992, Tsunami warning!: Intergovernmental Oceanographic Commission, 32 p.**

An illustrated children's book about tsunamis, suitable for 2nd to 4th grade.

Recommended for school and public libraries.

****Lampton, Christopher, 1992, Tidal wave: Millbrook Press [Brookfield, Conn.], 63 p.**

A basic work about tsunamis, suitable for 4th to 8th grade. Current work, well illustrated.

Recommended for school and public libraries.

McCredie, Scott, 1994, Tsunamis—The wrath of Poseidon; When nightmare waves appear out of nowhere to smash the land: Smithsonian, v. 24, no. 12, p. 28-39.

Current article about tsunami hazards, damage, and generation. Clearly written and well illustrated.

Recommended for local planners, emergency managers, public libraries, and high school libraries.

McCulloch, D. S., 1985, Evaluating tsunami potential. *In* Ziony, J. I., editor, Evaluating earthquake hazards in the Los Angeles region—An earth-science perspective: U.S. Geological Survey Professional Paper 1360, p. 375-413.

Excellent technical overview. Descriptions and illustrations of tsunami-wave propagation and runup are especially useful.

Recommended for engineers, local planners, and college libraries.

Nance, J. J., 1988, On shaky ground: William Morrow and Company, Inc., 416 p.

A popular work about earthquake hazards of the U.S., with emphasis on the Pacific Northwest.

Recommended for public libraries.

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*Copies are available free to planners, local officials, and emergency managers in the Pacific Coast area from the Division of Geology and Earth Resources Library.

**Copies are available free to planners, local officials, and emergency managers in the Pacific Coast area from the Division of Geology and Earth Resources Library while grant funds are available.

Nelson, J. B., 1980, Catalog of tsunami photographs: U.S. National Oceanic and Atmospheric Administration Key to Geophysical Records Documentation 13, 52 p.

These photographs of earthquakes, tsunami waves, and resulting damage cover nine events occurring during the period 1946 to 1975, including the tsunami damage along the Pacific coast caused by the 1964 Alaska earthquake. The photographs are a unique form of data that record a natural phenomenon extremely difficult to reduce to a written report. Copies of the individual photographs are available for sale; ordering information is included.

***Nichols, D. R.; Buchanan-Banks, J. M., 1974, Seismic hazards and land-use planning: U.S. Geological Survey Circular 690, 33 p.**

Describes the hazards caused by earthquakes, including tsunamis, ground shaking, and earthquake-induced landslides and their application to land-use planning. Includes a list of the principal sources of geologic and seismic data. Although dated, this is still a useful report.

Recommended for local planners and public libraries.

***Pararas-Carayannis, George, 1988, Tsunami warning system in the Pacific—An example of international cooperation. *In* El-Sabh, M. I.; Murty, T. S., editors, Natural and man-made hazards; Proceedings of the international symposium held at Rimouski, Quebec, 1986: D. Reidel Publishing Co., p. 773-780.**

Prior to 1960, the U.S., Japan, and other countries around the Pacific Ocean maintained their own independent tsunami warning systems. The great destruction of the 1964 Alaska earthquake focused attention on the need for an international system. This brief report describes the international system.

Recommended for local planners and emergency managers.

***Preuss, Jane, 1984, Comprehensive planning in tsunami prone areas. *In* Proceedings of the 8th World Conference on Earthquake Engineering: Prentice-Hall, Inc., v. 7, p. 793-800.**

An excellent summary of land-use planning in tsunami-prone areas.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

***Sokolowski, T. J., 1991, Improvements in the Tsunami Warning Center in Alaska: Earthquake Spectra, v. 7, no. 3, Aug. 1991, p. 461-481.**

Describes the Alaska Tsunami Warning Center's highly automated tsunami warning system. The Center analyzes data from potential tsunamigenic earthquakes in real-time and disseminates critical information to affected coastal populations via satellite and high-speed teletypewriter communication systems. These upgraded systems provide timely and effective tsunami warning services for coastal populations in Alaska and the west coasts of Canada and the U.S.

Steinbrugge, K. V., 1982, Earthquakes, volcanoes, and tsunamis—An anatomy of hazards: Skandia America Group [New York, N.Y.], 392 p.

A thorough examination of earthquakes, volcanoes, and tsunamis, with emphasis on their insurance risk.

Tiedemann, Herbert, 1992, Earthquakes and volcanic eruptions—A handbook on risk assessment: Swiss Reinsurance Company [Zurich], 951 p.

An exhaustive examination of earthquakes, volcanoes, and tsunamis, with emphasis on their insurance risk. Current work, with recent examples.

U.S. National Oceanic and Atmospheric Administration, 1986, Tsunamis slide set: U.S. National Oceanic and Atmospheric Administration World Data Center-A, 20 photographic slides, in folder with 4 p. text.

These 35mm slides of tsunami waves and their resulting damage cover seven events occurring during the period 1946 to 1975, including the tsunami damage in Prince William Sound caused by the 1964 Alaska earthquake. The photographs are a unique form of data that record a natural phenomenon extremely difficult to reduce to a written report. Copies of the slide set are available for sale; ordering information is included.

GENERAL WORKS ABOUT THE GEOLOGY AND GEOLOGIC HAZARDS OF WASHINGTON

Cope, Vern, 1994, The Washington earthquake handbook—An easy-to-understand information and survival manual: Vern Cope [Portland, Ore.], 145 p.

A good, general review of earthquake and tsunami hazards in Washington. Very good sections on earthquake preparedness and emergency information.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

***Lasmanis, Raymond, 1991, The geology of Washington: Rocks and Minerals, v. 66, no. 4, p. 262-277.**

A good, brief, current overview of Washington's extremely diverse geology. Includes a discussion of the earthquake hazards of the Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and high school libraries.

***Noson, L. L.; Qamar, A. I.; Thorsen, G. W., 1988, Washington State earthquake hazards: Washington Division of Geology and Earth Resources Information Circular 85, 77 p.**

An excellent, thorough discussion of earthquake and tsunami hazards in Washington.

Highly recommended for local planners, emergency managers, public libraries, and high school and college libraries.

WORKS ABOUT EARTHQUAKE AND TSUNAMI HAZARDS ON THE PACIFIC COAST OF WASHINGTON

***Atwater, B. F., 1987, Evidence for great Holocene earthquakes along the outer coast of Washington State: Science, v. 236, no. 4804, May 22, 1987, p. 942-944.**

This brief account describes geologic evidence for great earthquakes along the Pacific coast of Washington State: repeated episodes of the rapid subsidence of vegetated coastal areas topped with what appear to be tsunami-generated sand layers.

One of the early, seminal studies giving evidence of great earthquakes along the Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

***Atwater, B. F., 1992, Geologic evidence for earthquakes during the past 2000 years along the Copalis River, southern coastal Washington: Journal of Geophysical Research, v. 97, no. B2, p. 1901-1919.**

A more thorough examination of the evidence for several prehistoric earthquakes in recent deposits (less than 2000 years old) in the Copalis River estuary, WA. Deposits show submergence and a landward surge of sandy water implying a subsidence and tsunami about 300 and 1400–1900 years ago. The deposits are explained by thrust earthquakes, two occurring 1400–1900 years ago and another 300 years ago. Evidence that sand intrusion occurred at one or more times in the past 2000 years and earthquake-induced, vented sand volcanoes occurred 900–1300 years ago is also presented. There is a thorough discussion of possible sources of the earthquakes that caused the intrusion and sand volcanoes. A note added as proof states that the author's interpretation of recent drilling data is that the venting of sand did not result from the shaking and consequent liquefaction of a hypothetical sand body at depth.

Recommended for local planners, emergency managers, public libraries, and college libraries.

Berkman, S. C.; Symons, J. M., 1960?, The tsunami of May 22, 1960 as recorded at tide stations: U.S. Coast and Geodetic Survey, 69 p.

Gives tide gage readings for this tsunami from around the Pacific Ocean, including the stations at Neah Bay, Friday Harbor, and Echo Bay.

***Bourgeois, Joanne; Reinhart, M. A., 1988, Potentially damaging waves associated with earthquakes, coastal Washington. *In* Hays, W. W., editor, Workshop on "Evaluation of earthquake hazards and risk in the Puget Sound and Portland areas"; Proceedings of conference XLII: U.S. Geological Survey Open-File Report 88-541, p. 96-99.**

The authors examined the ways sand layers could be deposited in Willapa Bay in order to test Atwater's 1987 postulation that they were caused by a tsunami.

***Bourgeois, Joanne; Reinhart, M. A., 1989, Sedimentological analysis of postulated tsunami-generated deposits from great-subduction earthquakes along Washington's outer coast. *In* Jacobson, M. L., compiler, National Earthquake Hazards Reduction Program, summaries of technical reports Volume XXIX: U.S. Geological Survey Open-File Report 90-54, p. 119-122.**

Further examinations of the ways sand layers could be deposited in Willapa Bay.

***Gonzalez, F. I.; Bernard, E. N.; Milburn, H. B.; Castel, D.; Thomas J.; Hemsley, J. M., 1987, The Pacific tsunami observation program (PacTOP). *In* Bernard, E. N., editor, Proceedings of the International Tsunami Symposium: U.S. National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory Contribution 1041, p. 3-19.**

PacTOP is a cooperative effort by NOAA and the U.S. Army Corps of Engineers to establish a network to monitor tsunamis generated by earthquakes in the Aleutian trench of Alaska. Station locations, instrument characteristics, and data collection procedures are described.

****Good, J. W.; Ridlington, S. S., editors, 1992, Coastal natural hazards—Science, engineering, and public policy: Oregon Sea Grant Program, 162 p.**

Excellent papers about coastal hazards from earthquakes, tsunamis, landslides, and erosion, as well as papers about coastal engineering and public policy. Focuses on the Pacific coast of Oregon, with applications to the entire Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and college libraries.

***Heaton, T. H.; Hartzell, S. H., 1986, Source characteristics of hypothetical subduction earthquakes in the northwestern United States: Bulletin of the Seismological Society of America, v. 76, no. 3, June 1986, p. 675-708.**

An estimation of the seismic hazard associated with the subduction of the Juan de Fuca and Gorda plates beneath North America. In this paper, the results of previous studies are extended to estimate the nature of shallow subduction earthquakes that could be postulated if the Cascadia subduction zone is assumed to have strong seismic coupling. Key issues addressed are (1) the dimensions and geometry of hypothetical Cascadia subduction earthquakes; (2) plausible repeat time; (3) identification of analogous historic earthquakes; and (4) estimation of possible tsunami amplitudes.

One of the early, seminal studies giving evidence of great earthquakes along the Cascadia subduction zone.

Recommended for local planners and college libraries.

***Heaton, T. H.; Hartzell, S. H., 1987, Earthquake hazards on the Cascadia subduction zone: Science, v. 236, no. 4798, Apr. 10, 1987, p. 162-168.**

An overview of the potential seismic hazard from large subduction earthquakes on the Cascadia subduction zone. If large subduction earthquakes occur in the Pacific Northwest, relatively strong shaking can be expected over a large region. Such earthquakes may also be accompanied by large local tsunamis.

One of the early, seminal studies giving evidence of great earthquakes along the Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

Heaton, T. H.; Kanamori, Hiroo, 1984, Seismic potential associated with subduction in the northwestern United States: Seismological Society of America Bulletin, v. 74, no. 3, p. 933-941.

One of the early, seminal studies discussing the possibility of great earthquakes along the Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

*Heaton, T. H.; Snavely, P. D., Jr., 1985, Possible tsunami along the northwestern coast of the United States inferred from Indian traditions: Seismological Society of America Bulletin, v. 75, no. 5, p. 1455-1460.

Judge James Swan was an early traveler and a renowned student of native culture; several accounts of his experiences with Pacific coast tribes were published in the mid-1800s. This paper briefly discusses Swan's 1868 account of the Makah's tradition of a great flood at Neah Bay, and the possibility that it was a tsunami.

Recommended for local planners, emergency managers, public libraries, and high school and college libraries.

*Hebenstreit, G. T.; Murty, T. S., 1987, Preliminary studies of local tsunami hazards in the Washington–British Columbia coast—Summary. *In* Bernard, E. N., editor, Proceedings of the International Tsunami Symposium: U.S. National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory Contribution 1041, p. 242-246.

Brief discussion of tsunami hazards in the Cascadia subduction zone area.

Recommended for local planners, emergency managers, and college libraries.

Hebenstreit, G. T.; Murty, T. S., 1989, Tsunami amplitudes from local earthquakes in the Pacific Northwest region of North America; Part 1—The outer coast: Marine Geodesy, v. 13, no. 2, p. 101-146.

A computer model of the maximum size of tsunamis generated by earthquakes along the Pacific coasts of British Columbia, Washington, and Oregon. The results showed that large tsunami amplitudes can occur on the outer coast.

Recommended for local planners, emergency managers, and college libraries.

*Hebenstreit, G. T.; Preuss, Jane, 1988, Loss estimation methodology—Projecting the risk from a tsunami generated by a Juan de Fuca plate earthquake. *In* Jacobson, M. L., compiler, National Earthquake Hazards Reduction Program, summaries of technical reports Volume XXVII: U.S. Geological Survey Open-File Report 88-673, p. 467-469.

A brief discussion of the risks to coastal communities from tsunamis.

Recommended for local planners, emergency managers, and college libraries.

Hogan, D. W.; Whipple, W. W.; Lundy, C., 1964, Tsunami of 27 and 28 March, 1964, State of Washington coastline: U.S. Army Corps of Engineers [Seattle, Wash.], unpublished file report, 29 p.

Original Corps of Engineers field data of waves heights along the Washington coast from the 1964 tsunami.

Recommended for local planners, emergency managers, and college libraries.

Houston, J. R., 1979, State-of-the-art for assessing earthquake hazards in the United States; Report 15, Tsunamis, seiches, and landslide-induced water waves: U.S. Army Engineer Waterways Experiment Station Miscellaneous Paper S-73-1, 88 p.

An assessment of the hydrodynamic consequences from tsunamis, seiches, and landslide-induced water waves in the U.S. Focuses on distantly generated tsunamis. (Hazards from locally generated earthquakes on the Cascadia subduction zone were not yet recognized when this report was written).

Recommended for local planners, emergency managers, and college libraries.

Houston, J. R.; Garcia, A. W., 1978, Type 16 flood insurance study—Tsunami predictions for the west coast of the continental United States: U.S. Army Engineer Waterways Experiment Station Technical Report H-78-26, 69 p.

Runup estimates were calculated for most of the U.S. Pacific Coast for distantly generated tsunamis.

Recommended for local planners, emergency managers, and college libraries.

Hull, A. G., 1987, Buried lowland soils from Willapa Bay, southwest Washington—Further evidence for recurrence of large earthquake during the last 5000 years [abstract]: Eos (American Geophysical Union Transactions), v. 68, no. 44, p. 1468-1469.

Examination of eight buried soil layers at Willapa Bay suggests subsidence from subduction zone earthquakes

Lander, J. F., 1987, Impact of tsunamis on the U.S. and associated territories. *In* Bernard, E. N., editor, Proceedings of the International Tsunami Symposium: U.S. National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory Contribution 1041, p. 49-58.

A preview and summary of Lander and Lockridge, 1989.

Lander, J. F., 1989, Observations of tsunamis on the west coast of the United States. *In* Raufaste, N. J., editor, Wind and seismic effects—Proceedings of the 21st Joint Meeting of the U.S.–Japan Cooperative Program in Natural Resources, Panel on Wind and Seismic Effects: U.S. National Institute of Standards and Technology Special Publication, p. 247-254.

An overview of the tsunami hazards and response along the Pacific coasts of the U.S. Recommended for local planners and emergency managers.

Lander, J. F.; Lockridge, P. A., 1989, United States tsunamis (including United States possessions), 1690–1988: U.S. National Oceanic and Atmospheric Administration Publication 41-2, 265 p.

This exhaustive catalog documents tsunamis that have struck the U.S. and its territorial possessions since 1690. It gives a scientific description of tsunamis and then describes the various tsunamis by region and year. Much of the material is based on local, historical, and eyewitness accounts.

Recommended for college and large public libraries.

Larsen, L. H., 1979, Tsunamis hazard along Washington's coast. *In* Wilcox, F. W., Jr., editor, Natural hazards in Washington's coastal zone—An anthology of recent articles: Washington Department of Emergency Services, p. 35-38.

A brief overview of tsunami hazards on the Pacific coast of Washington. Hazards from earthquakes on the Cascadia subduction zone were not yet recognized when this report was written.

***Lockridge, P. A., 1988, Historical tsunamis in the Pacific Basin. *In* El-Sabh, M. I.; Murty, T. S., editors, Natural and man-made hazards; Proceedings of the international symposium held at Rimouski, Quebec, 1986: D. Reidel Publishing Co., p. 171-181.**

A brief, well-illustrated review of tsunami hazards around the Pacific Ocean in the last 100 years.

Recommended for local planners, emergency managers, and college libraries.

Lockridge, P. A.; Smith, R. H., 1984, Tsunamis in the Pacific Basin, 1900–1983: U.S. National Geophysical Data Center, 1 sheet, scale 1:17,000,000.

Map showing tsunamis around the Pacific Ocean, coded to indicate the type and magnitude of the tsunami-generating source and the size of the run-up. The accompanying tables give the date, location, source region, casualties, and damage of the tsunamis.

Recommended for local planners, emergency managers, and college libraries.

Lockwood, Millington; Elms, J. D.; Lockridge, P. A.; Moore, G. W.; Nishenko, S. P.; Simkin, Tom; Newhall, C. G., 1990, Natural hazards map of the Circum-Pacific region—Pacific Basin sheet: U.S. Geological Survey Circum-Pacific Map Series CP-35, 1 sheet, scale 1:17,000,000, with 31 p. text.

Map showing hazards from tsunamis, earthquakes, volcanoes, and storms for the Circum-Pacific region.

Recommended for local planners, emergency managers, and college libraries.

Murty, T. S.; Kowalik, Z., 1987, Future tsunamis in the Pacific Ocean [abstract]. *In* Bernard, E. N., editor, Proceedings of the International Tsunami Symposium: U.S. National Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory Contribution 1041, p. 139.

A very brief description of a research project to do computer simulations of a tsunami generated in the Aleutian Islands, simulated to strike Grays Harbor.

***Ng, Max; LeBlond, P. H.; Murty, T. S., 1990, Numerical simulation of tsunami amplitudes on the coast of British Columbia due to local earthquakes: Science of Tsunami Hazards, v. 8, no. 2, p. 97-127.**

Thorough, detailed report of computer simulations of tsunamis along the Pacific Coast, the Strait of Juan de Fuca, and Puget Sound.

Recommended for engineers and for college libraries.

***Ng, M. K.-F.; LeBlond, P. H.; Murty, T. S., 1990, Simulation of tsunamis from great earthquakes on the Cascadia subduction zone: Science, v. 250, no. 4985, p. 1248-1251.**

A computer model of a tsunami generated by a hypothetical earthquake of magnitude 8.5 off Washington and British Columbia. The calculations quantify the tsunami risk and identify the factors that would determine flooding levels along the adjacent coast, in the Strait of Georgia, and Puget Sound.

Recommended for local planners, emergency managers, public libraries, and college libraries.

***Peterson, C. D.; Priest, George, 1992, Catastrophic coastal hazards in the Cascadia margin U.S. Pacific Northwest. *In* Good, J. W.; Ridlington, S. S., editors, Coastal natural hazards—Science, engineering, and public policy: Oregon Sea Grant Program, p. 33-37.**

The Pacific beaches of Washington and Oregon are far more dynamic than previously assumed. They are at risk from the effects of a great subduction zone earthquake (subsidence, liquefaction, and tsunami inundation), as well as beach erosion by storms. Site-specific information is needed for catastrophic hazard mitigation.

Recommended for local planners, emergency managers, public libraries, and college libraries.

***Preuss, Jane, 1986, Tsunami and flood hazard preparedness and mitigation program for Aberdeen. *In* Hays, W. W.; Gori, P. L., editors, Proceedings of conference XXXIII, "Earthquake hazards in the Puget Sound, Washington area,": U.S. Geological Survey Open-File Report 86-253, p. 139-156.**

An early and brief report on Preuss's study of hazard mitigation and planning for flood and tsunami hazards in Aberdeen, WA.

Recommended for local planners, emergency managers, public libraries, and college libraries.

***Preuss, Jane, 1987, Coastal high hazard mitigation—Comprehensive planning for areas vulnerable to tsunamis. *In* Association of State Floodplain Managers, Realistic approaches to better floodplain management; 11th annual conference, Proceedings: University of Colorado Natural Hazards Information Center Special Publication 18, p. 317-322.**

In coastal areas vulnerable to tsunamis, a risk-based urban planning approach balances the needs of industrial and resort waterfront activities with safety and preparedness requirements. This short report gives examples from Alaskan and Mexican cities damaged by tsunamis, with applications to Washington coastal towns.

Recommended for local planners, emergency managers, public libraries, and college libraries.

*Preuss, Jane, 1988, Coastal effects of a great subduction earthquake—Regional land use implications. *In* Hays, W. W., editor, Workshop on "Evaluation of earthquake hazards and risk in the Puget Sound and Portland areas"; Proceedings of Conference XLII: U.S. Geological Survey Open-File Report 88-541, p. 234-245.

The Pacific coast of Washington is at risk from tsunamis generated by subduction zone earthquakes. The first step in hazard-based land use planning for these areas is a scientifically based method for hazard delineation. Land-use planning decisions can then be based on vulnerabilities to distinct and definable risks. Preuss discusses the earthquake and tsunami risk for various Pacific coast communities and the land use planning implications.

Recommended for local planners, emergency managers, public libraries, and college libraries.

*Preuss, Jane; Hebenstreit, G. T., 1989, The tsunami threat in the Pacific Northwest under today's land use conditions. *In* Hays, W. W., editor; Huey, Linda, compiler, Proceedings of Conference XLVIII, 3rd annual workshop on "Earthquake Hazards in the Puget Sound, Portland area": U.S. Geological Survey Open-File Report 89-465, p. 114-121.

The authors briefly describe a project to provide estimates of the risk that a tsunami will strike the coast of Washington or Oregon. The project, conducted jointly by the Science Applications International Corporation and Urban Regional Research, develops a methodology for defining the characteristics of coastal tsunami risks and for projecting the vulnerability of the geographic area.

Recommended for local planners and emergency managers.

*Preuss, Jane; Hebenstreit, G. T., 1991, Integrated hazard assessment for a coastal community—Grays Harbor: U.S. Geological Survey Open-File Report 91-441-M, 36 p.

In this case study of an earthquake-generated tsunami at Grays Harbor, the authors develop and apply a methodology for an integrated hazard assessment. The tsunami is treated not as the sole threat, but as the initiator of a suite of interrelated hazards. Only through such an integrated approach can relatively accurate loss estimates and subsequent mitigation efforts be conducted with accuracy and effectiveness. A thorough report on the authors' long-term project,

Highly recommended for local planners, emergency managers, public libraries, and college libraries.

**Reinhart, M. A., 1991, Sedimentological analysis of postulated tsunami-generated deposits from Cascadia great-subduction earthquakes along southern coastal Washington: University of Washington Master of Science unpublished report, 77 p., plus appendixes.

Thorough technical analysis of the stratigraphy of shoreline sediments that could indicate tsunami-related flooding in the past 1000 years at Willapa Bay.

Recommended for college libraries and for engineers and geologists.

Reinhart, M. A.; Bourgeois, Joanne, 1987, Distribution of anomalous sand at Willapa Bay, Washington—Evidence for large-scale landward-directed processes [abstract]: Eos (American Geophysical Union Transactions), v. 68, no. 44, p. 1469.

Additional evidence for possible tsunami-related flooding in the past 1000 years at Willapa Bay.

*Reinhart, M. A.; Bourgeois, Joanne, 1989, Tsunami favored over storm or seiche for sand deposit overlying buried Holocene peat, Willapa Bay, WA [abstract]: Eos (American Geophysical Union Transactions), v. 70, no. 43, p. 1331.

Additional evidence for possible tsunami-related flooding in the past 1000 years at Willapa Bay.

*Saxena, N. K.; Murty, T. S., 1988, Tsunami research—A review and new concepts. *In* El-Sabh, M. I.; Murty, T. S., editors, Natural and man-made hazards; Proceedings of the international symposium held at Rimouski, Quebec, 1986: D. Reidel Publishing Co., p. 163-170.

An overall review of tsunami research, principally in the detection and measurement of tsunami waves in the deep ocean. Improvements in the travel-time charts used by the Tsunami Warning Centers are suggested. Potential tsunamis caused by earthquakes on the Juan de Fuca plate, and other areas, are discussed.

Schatz, C. E., 1965, Source and characteristics of the tsunami observed along the coast of the Pacific Northwest on March 28, 1964: Oregon State University Master of Science thesis, 39 p.

The mechanism and effects of the 1964 tsunami along the Pacific Coast.

Recommended for local planners, emergency managers, and college libraries.

*Sokolowski, T. J.; Fuller, G. W.; Blackford, M. E.; Jorgensen, W. J., 1983, The Alaska Tsunami Warning Center's automatic earthquake processing system. *In* Bernard, E. N., editor, Proceedings—Tsunami Symposium: U.S. National Oceanic and Atmospheric Administration, p. 131-147.

A review of the Alaska Tsunami Warning Center's computerized earthquake and tsunami warning systems.

Recommended for local planners, emergency managers, and college libraries.

*Thorsen, G. W., 1988, Overview of earthquake-induced water waves in Washington and Oregon: Washington Geologic Newsletter, v. 16, no. 4, p. 9-18.

An excellent article about the historic damage and the potential hazard from tsunamis in Washington and Oregon.

Highly recommended for local planners, emergency managers, public libraries, and high school and college libraries.

Urban Regional Research, 1988, Planning for risk—Comprehensive planning for tsunami hazard areas: National Science Foundation, 246 p.

A thorough examination of land-use planning in tsunami risk areas. Includes chapters on risk assessment, risk reduction, and implementation. Gives examples from tsunamis experiences in Alaska and Mexico, and others areas (including Grays Harbor).

Highly recommended for local planners, emergency managers, public libraries, and college libraries.

***Washington Highways, 1964, Tidal wave rips coast, highways: Washington Highways, v. 11, no. 5, p. 2-3.**

Report of the damage along the Washington coast from the 1964 tsunami.

Recommended for local planners, emergency managers, public libraries, high school libraries, and college libraries.

***Witten, Don, 1984, Tsunami—A wave like no others: NOAA, v. 14, no. 2, p. 14-17.**

A general discussion of the Tsunami Warning System.

WORKS ABOUT TSUNAMI HAZARDS IN PUGET SOUND

Atwater, B. F.; Moore, A. L., 1992, A tsunami about 1000 years ago in Puget Sound, Washington: Science, v. 258, no. 5088, p. 1614-1617.

One of six reports in this issue of Science that discuss the paleoseismic evidence for an earthquake about 1100 years ago on what is now called the Seattle fault. This article describes sand layers in Seattle and on Whidbey Island that may have been deposited by a tsunami generated by that earthquake.

Chleborad, A. F.; Schuster, R. L., 1990, Ground failure associated with the Puget Sound region earthquakes of April 13, 1949, and April 29, 1965: U.S. Geological Survey Open-File Report 90-687, 136 p., 5 pl.

A thorough examination of the various landslides, liquefaction, and other ground failures associated with the 1949 and 1965 earthquakes. The 1949 earthquake probably triggered a landslide at the Tacoma Narrows that caused an 8-foot high tsunami in Puget Sound.

Dinkelman, Lisa; Holmes, M. L., 1993, Wild waves—Tsunamis in Puget Sound [abstract]. ***In*** **University of Washington Quaternary Research Center, Large earthquakes and active faults in the Puget Sound region: University of Washington Quaternary Research Center, [1 p., unpaginated].**

A brief description of a computer model of the underwater movement caused by earthquake on the Seattle fault 1100 years ago. This model was then used to generate a numerical simulation of the resulting tsunami and to estimate the potential wave heights and wave-train periods along several locations on Puget Sound.

Garcia, A. W.; Houston, J. R., 1975, Type 16 flood insurance study—Tsunami predictions for Monterey and San Francisco Bays and Puget Sound: U.S. Army Engineer Waterways Experiment Station, Technical Report H-75-17, 1 v.

A thorough study conducted to determine 100- and 500-year runup due to tsunamis of distant origin for the Strait of Juan de Fuca, Puget Sound, and areas of the California coast.

Holmes, M. L.; Dinkelman, Lisa, 1993, Modeling paleotsunamis in Puget Sound, Washington [abstract]: Geological Society of America Abstracts with Programs, v. 25, no. 6, p. A-289 -A-290.

A brief description of a computer model to assess the potential of damaging tsunamis or seiches from earthquakes on the Seattle fault or from other earthquakes in the Puget Lowland.

Lander, J. F.; Lockridge, P. A., 1989, United States tsunamis (including United States possessions), 1690–1988: U.S. National Oceanic and Atmospheric Administration Publication 41-2, 265 p.

This exhaustive catalog documents tsunamis that have struck the U.S. and its territorial possessions since 1690. It gives a scientific description of tsunamis and then describes the various tsunamis by region and year. Much of the material is based on local, historical, and eyewitness accounts.

Recommended for college and large public libraries.

Moore, A. L., 1993, Evidence for a tsunami in Puget Sound [abstract]. ***In*** **University of Washington Quaternary Research Center, Large earthquakes and active faults in the Puget Sound region: University of Washington Quaternary Research Center, [1 p., unpaginated].**

A brief report on the sand layers in Seattle and on Whidbey Island that may have been deposited by a tsunami generated by the earthquake 1100 years ago on the Seattle fault.

Murty, T. S.; Hebenstreit, G. T., 1989, Tsunami amplitudes from local earthquakes in the Pacific Northwest region of North America, Part 2—Strait of Georgia, Juan de Fuca Strait, and Puget Sound: Marine Geodesy, v. 13, no. 3, p. 189-209.

A computer model of the maximum size of tsunamis generated by earthquakes along the Strait of Georgia, Strait of Juan de Fuca, and in Puget Sound (GFP model). The results showed that whereas large tsunami amplitudes can occur on the outer coast, inside the GFP system, unless the earthquake occurs in the system itself, no major tsunami will result.

Recommended for local planners, emergency managers, and college libraries.

***Ng, Max; LeBlond, P. H.; Murty, T. S., 1990, Numerical simulation of tsunami amplitudes on the coast of British Columbia due to local earthquakes: Science of Tsunami Hazards, v. 8, no. 2, p. 97-127.**

Thorough, detailed report of computer simulations of tsunamis along the Pacific Coast, the Strait of Juan de Fuca, and Puget Sound.

Recommended for engineers and for college libraries.

***Ng, M. K.-F.; LeBlond, P. H.; Murty, T. S., 1990, Simulation of tsunamis from great earthquakes on the Cascadia subduction zone: Science, v. 250, no. 4985, p. 1248-1251.**

A computer model of a tsunami generated by a hypothetical earthquake of magnitude 8.5 off Washington and British Columbia. The calculations quantify the tsunami risk and identify the factors that would determine flooding levels along the adjacent coast, in the Strait of Georgia, and Puget Sound.

Recommended for local planners, emergency managers, public libraries, and college libraries.

***Thorsen, G. W., 1988, Overview of earthquake-induced water waves in Washington and Oregon: Washington Geologic Newsletter, v. 16, no. 4, p. 9-18.**

An excellent article about the historic damage and the potential hazard from tsunamis in Washington and Oregon.

Highly recommended for local planners, emergency managers, public libraries, and high school and college libraries.

WORKS ABOUT TSUNAMI HAZARDS IN THE STRAIT OF JUAN DE FUCA

Garcia, A. W.; Houston, J. R., 1975, Type 16 flood insurance study—Tsunami predictions for Monterey and San Francisco Bays and Puget Sound: U.S. Army Engineer Waterways Experiment Station, Technical Report H-75-17, 1 v.

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Lander, J. F.; Lockridge, P. A., 1989, United States tsunamis (including United States possessions), 1690–1988: U.S. National Oceanic and Atmospheric Administration Publication 41-2, 265 p.

This exhaustive catalog documents tsunamis that have struck the U.S. and its territorial possessions since 1690. It gives a scientific description of tsunamis and then describes the various tsunamis by region and year. Much of the material is based on local, historical, and eyewitness accounts.

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Murty, T. S.; Hebenstreit, G. T., 1989, Tsunami amplitudes from local earthquakes in the Pacific Northwest region of North America, Part 2—Strait of Georgia, Juan de Fuca Strait, and Puget Sound: Marine Geodesy, v. 13, no. 3, p. 189-209.

A computer model of the maximum size of tsunamis generated by earthquakes along the Strait of Georgia, Strait of Juan de Fuca, and in Puget Sound (GFP model). The results showed that whereas large tsunami amplitudes can occur on the outer coast, inside the GFP system, unless the earthquake occurs in the system itself, no major tsunami will result.

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An excellent article about the historic damage and the potential hazard from tsunamis in Washington and Oregon.

Highly recommended for local planners, emergency managers, public libraries, and high school and college libraries.

WORKS ABOUT TSUNAMI HAZARDS IN OTHER PARTS OF THE CASCADIA SUBDUCTION ZONE

Ansevin, Andrea; Good, J. W., 1993, A strategy for improving coastal natural hazards management—Oregon's policy working group approach. *In* Magoon, O. T.; Wilson, W. S.; Converse, Hugh; Tobin, L. T., editors, Coastal zone '93; Proceedings of the 8th symposium on coastal and ocean management: American Society of Civil Engineers, v. 3, p. 2829-2841.

The population of Oregon's coastal areas is increasing rapidly while, at the same time, the awareness of the great natural hazards along the coast is growing. In response, Oregon has embarked on an ambitious coastal hazards policy review and improvement effort. This paper describes the coastal natural hazards in Oregon, how the present coastal policies are working, and how problems with the current framework are being addressed.

***Barlow, D. P., 1993, Tsunami—Annotated bibliography; Version 2: British Columbia Ministry of Environment, Lands and Parks, Floodplain Management Branch, 36 p.**

An impressive, very thorough annotated bibliography about tsunami hazards in British Columbia, tsunami modelling, flood insurance, floodplain management, and coastal zone management

Recommended for local planners, emergency managers, and college libraries.

*Barlow, D. P., 1993, Tsunami hazards—A background to regulation: British Columbia Ministry of Environment, Lands and Parks, Floodplain Management Branch, 48 p.

An overview of information about Pacific coast tsunamis and the means of limiting damage, as a background towards development of tsunami flood damage reduction policy and development of controls for the British Columbia coast.

Highly recommended for local planners and emergency managers.

Berkman, S. C.; Symons, J. M., 1960?, The tsunami of May 22, 1960 as recorded at tide stations: U.S. Coast and Geodetic Survey, 69 p.

Gives tide gage readings for this tsunami from around the Pacific Ocean, including the stations at Neah Bay, Friday Harbor, and Echo Bay.

*Clague, J. J., 1991, Natural hazards. *In* Gabrielse, H.; Yorath, C. J., editors, Geology of the Cordilleran orogen in Canada: Geological Survey of Canada Geology of Canada 4; Geological Society of America DNAG Geology of North America, Vol. G-2, p. 803-815.

A current overview of the earthquake, landslide, tsunami, and volcanic hazards in western Washington and British Columbia.

Darienzo, M. E.; Peterson, C. D., 1987, Episodic tectonic subsidence recorded in late-Holocene salt-marshes, northwest Oregon [abstract]: Eos (American Geophysical Union Transactions), v. 68, no. 44, p. 1469.

Four cycles of marsh subsidence and sand deposits were found at Netarts Bay.

*Darienzo, M. E.; Peterson, C. D., 1990, Episodic tectonic subsidence of late Holocene salt marshes, northern Oregon central Cascadia margin: Tectonics, v. 9, no. 1, p. 1-22.

Six events of marsh burial in the last several thousand years are recorded in subsurface deposits in Netarts Bay, OR. Five of these include tsunami deposits or tidal mud flat deposits.

Recommended for local planners, emergency managers, and college libraries.

**Good, J. W.; Ridlington, S. S., editors, 1992, Coastal natural hazards—Science, engineering, and public policy: Oregon Sea Grant Program, 162 p.

Excellent papers about coastal hazards from earthquakes, tsunamis, landslides, and erosion, as well as papers about coastal engineering and public policy. Focuses on the Pacific coast of Oregon, with applications to the entire Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and college libraries.

Grant, W. C.; McLaren, D. D., 1987, Evidence for Holocene subduction earthquakes along the northern Oregon coast [abstract]: Eos (American Geophysical Union Transactions), v. 68, no. 44, p. 1239.

A buried marsh near Lincoln City, OR, probably records sudden subsidence, perhaps caused by a subduction zone earthquake, and a sand layer, perhaps caused by an associated tsunami.

Hebenstreit, G. T.; Murty, T. S., 1989, Tsunami amplitudes from local earthquakes in the Pacific Northwest region of North America; Part 1—The outer coast: Marine Geodesy, v. 13, no. 2, p. 101-146.

A computer model of the maximum size of tsunamis generated by earthquakes along the Pacific coasts of British Columbia, Washington, and Oregon. The results showed that large tsunami amplitudes can occur on the outer coast.

Recommended for local planners, emergency managers, and college libraries.

Lander, J. F.; Lockridge, P. A., 1989, United States tsunamis (including United States possessions), 1690–1988: U.S. National Oceanic and Atmospheric Administration Publication 41-2, 265 p.

This exhaustive catalog documents tsunamis that have struck the U.S. and its territorial possessions since 1690. It gives a scientific description of tsunamis and then describes the various tsunamis by region and year. Much of the material is based on local, historical, and eyewitness accounts.

Recommended for college and large public libraries.

Murty, T. S.; Boilard, Lise, 1969, The tsunami in Alberni Inlet caused by the Alaska earthquake of March 1964. *In* Adams, W. M., editor, Tsunamis in the Pacific Ocean; Proceedings of the International Symposium on Tsunamis and Tsunami Research: East-West Center Press [Honolulu, Hawaii], p. 165-187.

The tsunami generated by the March 1964 Alaska earthquake caused severe damage on the west coast of Canada, especially at the head of Alberni Inlet. This report calculates the local resonance and the frequencies of natural oscillation of the Alberni Inlet and Trevor Channel.

Murty, T. S.; Crean, P. B., 1986, Numerical simulation of the tsunami of June 23, 1946 in British Columbia, Canada: Science of Tsunami Hazards, v. 4, no. 1, p. 15-24.

Computer model reconstruction of the tsunami that occurred on Vancouver Island in 1946. The numerically simulated results on the amplitudes of the tsunami waves and the travel times are in good agreement with the few available observations.

Recommended for local planners and emergency managers.

Murty, T. S.; Wigen, S. O.; Chawla, R., 1975, Some features of tsunamis on the Pacific coast of South and North America: Environment Canada Marine Sciences Directorate Manuscript Report Series 36, 37 p.

A comparison of the resonance characteristics of some inlets on the coasts of Chile, British Columbia, and Alaska showed that secondary inundations are highest for Vancouver Island and that tsunami forerunners are more common than is generally believed.

Nelson, A. R.; Atwater, B. F.; Grant, W. C., 1987, Estuarine record of Holocene subduction earthquakes in coastal Oregon and Washington, USA [abstract]: International Union for Quaternary Research, Congress, 12th, Programme with Abstracts, p. 231.

A brief early report on evidence for Cascadia subduction zone earthquakes and tsunamis on the Pacific coasts of Oregon and Washington.

Ng, Max K.-F.; LeBlond, P. H.; Murty, T. S., 1992, Tsunami threat to the Pacific coast of Canada due to local earthquakes: Natural Hazards, v. 5, no. 2, p. 205-210.

Computer modeling for tsunami hazard from a hypothetical earthquake on the northern Cascadia subduction zone.

Recommended for local planners and emergency managers.

Obee, Bruce, 1989, Tsunami!: Canadian Geographic, v. 109, no. 1, p. 46-53.

A popular report about tsunamis in British Columbia

Recommended for local planners, emergency managers, high school libraries, and public libraries.

Oppenheimer, D. H.; Beroza, G.; Carver, G. A.; Dengler, L. A.; Eaton, J. P.; Gee, L.; Gonzalez, F.; Jayko, A. S.; Li, W. H.; Lisowski, Michael; and others, 1993, The Cape Mendocino, California, earthquakes of April 1992—Subduction at the triple junction: Science, v. 261, no. 5120, p. 433-438.

In 1992, there was an earthquake (magnitude 7.1) at Cape Mendocino, California, at the intersection of three tectonic plates at the southern end of the Cascadia subduction zone. The earthquake produced coastal uplift and a small tsunami. This earthquake has important implications for the seismic hazard of the Cascadia subduction zone region.

Recommended for local planners and emergency managers.

Pattullo, J. G.; Burt, W. V.; Burdwell, G. B., 1968, Tsunami on the Oregon coast from an earthquake near Japan: Ore Bin, v. 30, no. 9, p. 182-184.

Brief report on a small tsunami on the Oregon coast in 1968 and on the tsunami warning system.

Peterson, C. D., 1989, Megathrust and upper-plate paleoseismicity of the southern Cascadia margin. *In* Hays, W. W., editor; Huey, Linda, compiler, Proceedings of Conference XLVIII, 3rd annual workshop on "Earthquake Hazards in the Puget Sound, Portland area": U.S. Geological Survey Open-File Report 89-465, p. 33-34.

A brief report about evidence for subsidence on the southern Cascadia subduction zone.

Peterson, C. D.; Darienzo, M. E.; Clough, C. M.; Baptista, A. M., 1991, Paleo-tsunami evidence in northern Oregon bays of the central Cascadia margin—Final technical progress report: Oregon Department of Geology and Mineral Industries, 31 p.

A compilation of available evidence of paleo-tsunami deposits from 10 Oregon bays in the central Cascadia margin.

*Peterson, C. D.; Priest, George, 1992, Catastrophic coastal hazards in the Cascadia margin U.S. Pacific Northwest. *In* Good, J. W.; Ridlington, S. S., editors, Coastal natural hazards—Science, engineering, and public policy: Oregon Sea Grant Program, p. 33-37.

The Pacific beaches of Washington and Oregon are far more dynamic than previously assumed. They are at risk from the effects of a great subduction zone earthquake (subsidence, liquefaction, and tsunami inundation), as well as beach erosion by storms. Site-specific information is needed for catastrophic hazard mitigation.

Recommended for local planners, emergency managers, public libraries, and college libraries.

Rogers, G. C., 1988, An assessment of the megathrust potential of the Cascadia subduction zone: Canadian Journal of Earth Sciences, v. 25, no. 6, p. 844-852.

An important paper describing the tectonic setting of the Cascadia subduction zone

Recommended for local planners, emergency managers, and college libraries.

*Saxena, N. K.; Murty, T. S., 1988, Tsunami research—A review and new concepts. *In* El-Sabh, M. I.; Murty, T. S., editors, Natural and man-made hazards; Proceedings of the international symposium held at Rimouski, Quebec, 1986: D. Reidel Publishing Co., p. 163-170.

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The mechanism and effects of the 1964 tsunami, along the Pacific Coast.

Recommended for local planners, emergency managers, and college libraries.

Thomson, R. E., 1976, The physical oceanography of the B.C. coast—Part 10; Tidal waves (tsunamis): Pacific Yachting, Jan. 1976, p. 34-36, 69-72.

A brief article about tsunamis on the British Columbia coast.

Recommended for local planners, emergency managers, public libraries, and high school libraries.

*Thorsen, G. W., 1988, Overview of earthquake-induced water waves in Washington and Oregon: Washington Geologic Newsletter, v. 16, no. 4, p. 9-18.

An excellent article about the historic damage and the potential hazard from tsunamis in Washington and Oregon.

Highly recommended for local planners, emergency managers, public libraries, and high school and college libraries.

White, W. R. H., 1966, The Alaska earthquake—Its effect in Canada: Canadian Geographical Journal, v. 72, no. 6, p. 210-219.

A contemporary report on the effects of the tsunami generated by the 1964 Alaska earthquake on the British Columbia coast.

WORKS ABOUT TSUNAMI HAZARDS OUTSIDE OF THE CASCADIA SUBDUCTION ZONE

Boyce, J. A., 1985, Tsunami hazard mitigation—The Alaskan experience since 1964: University of Washington Master of Arts thesis, 109 p.

The majority of the damage and more than 90 percent of the deaths in the 1964 Alaska earthquake were due to the tsunamis. This master's thesis (in geography) evaluates the steps taken by state and local government since 1964 to prepare Alaska's coastal communities for the next tsunami.

Highly recommended for local planners, emergency managers, public libraries, and college libraries.

Carte, G. W., 1981, Tsunami hazard and community preparedness in Alaska: U.S. National Oceanic and Atmospheric Administration Technical Memorandum NWS AR-29, 20 p.

An evaluation of the tsunami hazard for the Alaskan coast, the effectiveness of the Alaska Tsunami Warning System, and the level of tsunami preparedness in individual Alaska coastal communities.

Recommended for local planners, emergency managers, public libraries, and college libraries.

Kanamori, Hiroo; Kikuchi, Masayuki, 1993, The 1992 Nicaragua earthquakes—A slow tsunami earthquake associated with subducted sediments: Nature, v. 361, no. 6414, p. 714-716.

The 1992 Nicaragua earthquake generated tsunamis disproportionately large for its surface wave magnitude. The tsunami generation is better explained by examining the moment magnitude, which was 7.6. The authors conclude that this was a slow thrust earthquake on a subduction interface. This has implications for tsunamis on the Cascadia subduction zone.

Recommended for local planners, emergency managers, public libraries, and college libraries.

Kowalik, Z.; Murty, T. S., 1989, On some future tsunamis in the Pacific Ocean: Natural Hazards, v. 1, no. 4, p. 349-369.

Computer modeling of tsunamis generated by earthquakes in the Aleutian Islands and by a major eruption of the St. Augustine volcano in Cook Inlet, Alaska.

Tsunami Directory: Individuals and Organizations Involved with Tsunami Hazards on the Pacific Coast of Washington

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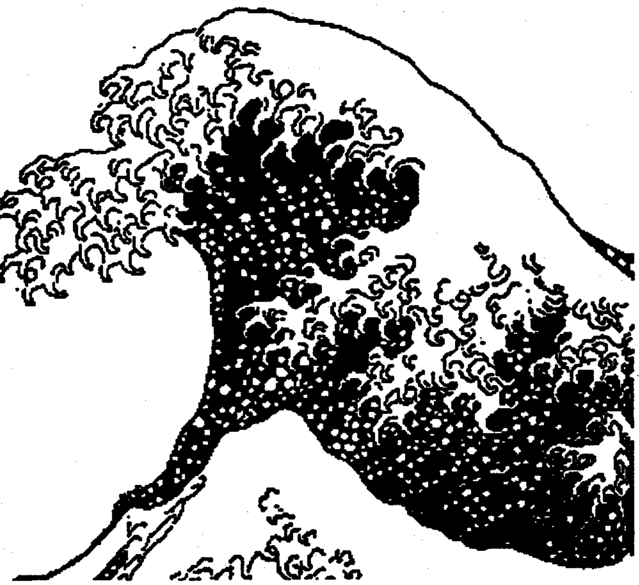
HOW TO SURVIVE A TSUNAMI



To Prepare for a Distantly Generated Tsunami:

- When you hear that an earthquake has occurred in the Pacific Basin, stay tuned to your radio and stand by for a tsunami bulletin.
- If you hear a tsunami warning, prepare to evacuate to high ground. Your local emergency agency will inform you where to go and when.
- If your home could be threatened, take important papers and valuables with you.
- Move pesticides and other dangerous goods from low lying areas.
- Take a battery powered radio with you.

To Survive a Locally Generated Tsunami:

- Your surest warning of the danger of a locally generated tsunami is a local earthquake. On the coast, if you feel an earthquake—even a small one—expect a tsunami. When the shaking stops, immediately get as far from the shore as possible.
- Some tsunamis are preceded by a sudden drop in sea level—an unexpected extreme low tide. If you notice this, immediately get as far from the shore as possible.
- Seek protection: get to the upper stories of sturdy buildings or towers, or get behind rows of natural sand dunes.

Remember:

- After the first wave, expect a second wave in 5 to 90 minutes or more. Additional waves would arrive at regular intervals. Leave the area if you can.
- Don't go back to watch.