

Tsunami Program Foundation

"Tsunami Warning, Education, and Research Act of 2017"
Authorizes Congress to fund the National Tsunami Hazard Mitigation Program states

National Weather Service administers & supports

Federal

- National Tsunami Warning Centers
- National Warning System

State

- Grant Funding to California
- Designate a Technical Advisory Panel
- Foster Development of Resilient Communities
- Develop Outreach Activities (Tsunami Education)

Together

- Develop Uniform Operational Procedures
- Planning; Alert & Warning; Mapping/Modeling

Community

Tsunami Warning Centers and Regional National Weather Service Forecast Offices

Warning Guidance

Mitigation

State Emergency Management Agencies, State Geological Surveys, and Academic Partners

Federal

State

Hazard Assessment

National Tsunami Hazard Mitigation Program

Coordinating Committee
Mapping and Modeling Subcommittee
Mitigation and Education Subcommittee
Warning Coordination Subcommittee



California Tsunami Preparedness, Mitigation & Response Program



Hazard Assessment & Understanding

- Inundation Modeling and Maps
- Evacuation Modeling and Maps
- Probabilistic Modeling and Maps
- Maritime Modeling and Maps


Preparedness, Mitigation & Recovery

- Evacuation Planning and “Playbooks”
- Maritime Education and Planning
- Tsunami Sign purchase and advice
- CA Tsunami Steering Committee
- Outreach Material provision
- Tsunami Preparedness Week
- Public Education
- Training and Exercise Support
- Live Code System Testing
- TsunamiReady® Program Support


Response

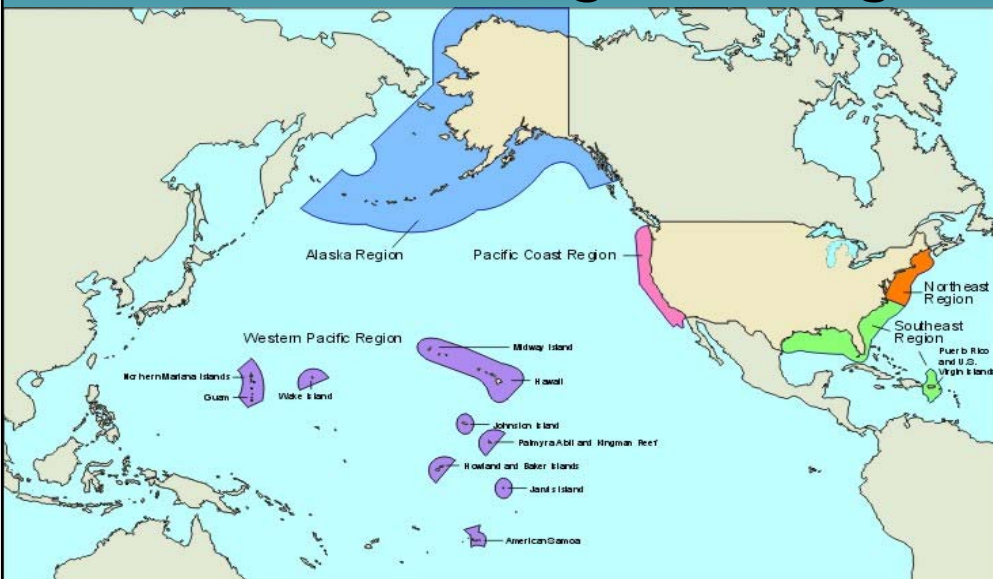
- 24/7 Duty Officer Program
- Real-Time / Post-Tsunami Field Teams
- Real-Time Observation Web-Camera Network
- Policy Analysis and Development





National Tsunami Hazard Mitigation Program





- U.S. Coastal States (AK, CA, HI, OR, WA, East Coast, Gulf Coast)
- Pacific territories/commonwealths (American Samoa, CNMI, Guam)
- Puerto Rico
- U.S. Virgin Islands
- National Oceanic and Atmospheric Administration (NOAA) (Chair)
- Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA)
- U.S. Geological Survey (USGS)



What is a Tsunami?

- A tsunami is a series of waves generated most often by an earthquake or coastal or undersea landslide.
- The entire California coastline is vulnerable to these events.
- Beaches, lagoons, bays, estuaries, tidal flats, and river mouths are some of the most dangerous places to be.



Tsunami facts....

- A tsunami has many waves or surges
- The first wave is almost never the largest
- The danger period can last 24 hours or more! (like the March 2011 tsunami in Calif.)
- Cannot be Surfied – No Face & Usually Debris-Filled

The March 11, 2011 Tohoku Tsunami

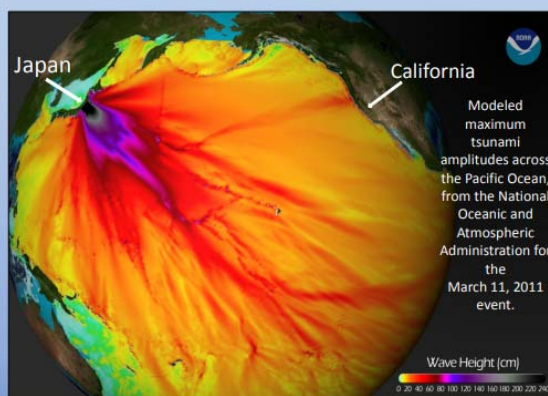
In Japan and California

Tsunami in Japan: A magnitude 9.0 earthquake off of northeastern Honshu Island caused a massive tsunami that first arrived on shore within 20-30 minutes after the earthquake. The tsunami measured 30-feet high at the coast along the Sendai Plain with a maximum run-up to an elevation of 130 feet at Aomori Bay located further to the north.



IMPACTS IN JAPAN: Although 300,000 people successfully evacuated, tragically over 18,000 people were killed or remain missing in Japan because of the tsunami. The Fukushima Daiichi Nuclear Power Plant suffered a catastrophic meltdown causing long-term radiation problems. The World Bank estimates the earthquake and tsunami was the costliest natural disaster in world history at \$235B.

RECOVERY IN JAPAN: After several years, communities have started to rebuild using coastal setbacks, raised land, and other engineered, protective measures. Significant segments of the impacted population have moved to other regions and will likely not return. Large portions of the Fukushima Prefecture may not be repopulated because of the nuclear disaster.



Tsunami in California: Ten hours after the tsunami was generated in Japan, the trans-Pacific tsunami reached the California coast. The largest tsunami wave heights were eight feet in Crescent City. Although only very localized on-land flooding occurred, strong coastal currents in and around harbors and bays were significant.



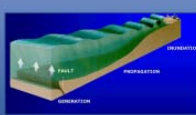
IMPACTS IN CALIFORNIA: One person was killed and 27 harbors sustained a total of \$100M in damages. In particular, all docks in Crescent City and Santa Cruz harbors were damaged or destroyed by several strong tsunami surges that arrived over the next 24+ hours. A major disaster declaration was issued in the state by President Obama.



RECOVERY IN CALIFORNIA: Sedimentation, environmental issues, and damage inside several harbors delayed rebuilding efforts by several years. Larger piers and stronger docks were required in harbors like Crescent City and Santa Cruz to make them more "tsunami resilient" in future events.

What is a Tsunami?

- Tsunamis are long ocean waves which are typically caused by a displacement of the ocean floor, commonly initiated by large earthquakes in the rock beneath the sea floor.
- Tsunamis grow in height near shore because the water shallows.
- Tsunamis form a series of waves which can be very large in the near-source region (like in 2011 in Japan) and potentially large and damaging thousands of miles away (like in 2011 in California).
- Dangerous conditions can include swift moving flooding, strong currents and large eddies, and viscous sediment-laden water. They cannot be surfed.



Preparing for a Tsunami

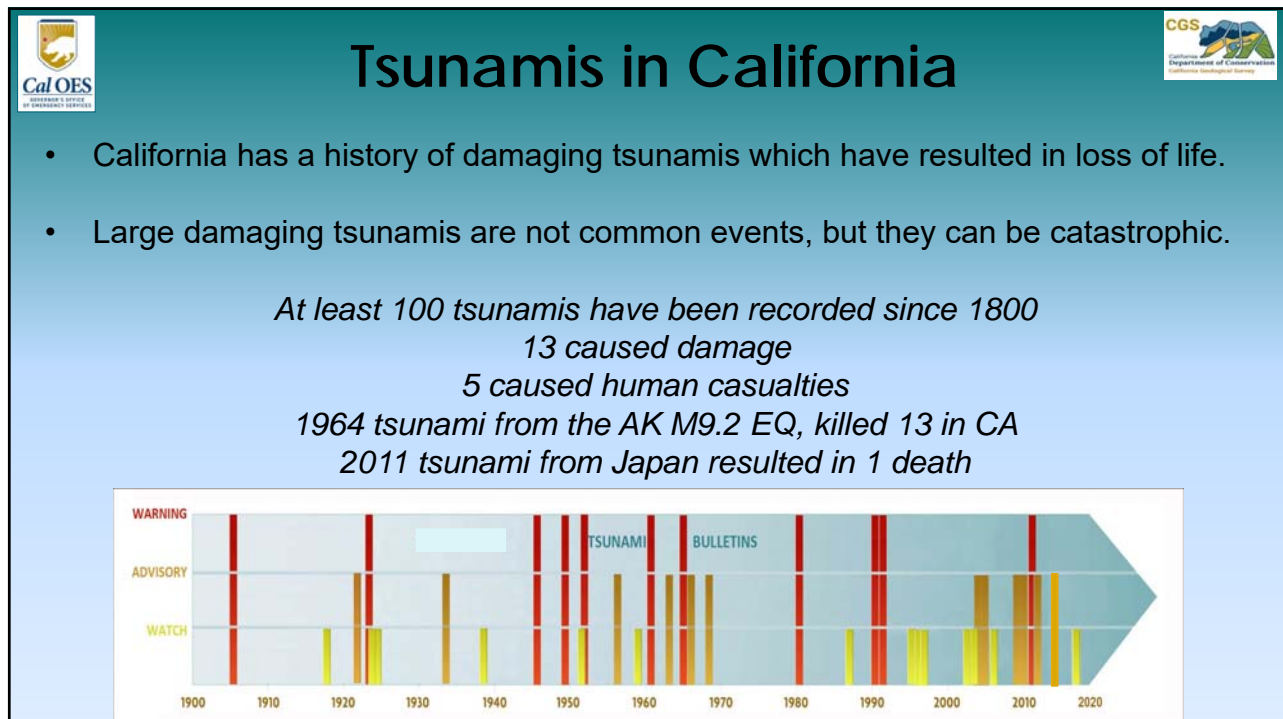
- First, review information about the tsunami risk to coastal areas where you live, work, or visit.
- Become familiar with your local evacuation plan and practice evacuating to become familiar with your evacuation route.
- For local events, watch for "natural warning signs" like feeling a large earthquake, hearing abnormal ocean rise, or seeing the water recede, and get to high ground immediately. Any one sign could be an indication of tsunami danger.
- Follow the instructions of the local emergency managers.

For More Information

www.tsunami.ca.gov
www.tsunamizone.org




All photos by Rick Wilson or staff. This website contains the tsunami safety information from the United States, which is not intended to be used for any other purpose. The information is provided for informational purposes only. The National Oceanic and Atmospheric Administration (NOAA) is the primary source of information for the United States.



TSUNAMIS IN CALIFORNIA

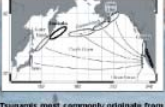
TSUNAMI BASICS

WHAT



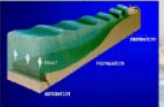
A tsunami is a series of waves or surges that can have enough force to destroy buildings and harm people. Tsunamis can last for hours, and the first wave is typically not the largest.

WHERE




Tsunamis most commonly originate from large earthquakes along subduction zones around the rim of the Pacific Ocean.

HOW




Tsunamis are typically generated by earthquakes along subduction zones and other submarine faults where significant vertical movement of the sea floor results in a rise of the ocean surface.

FEEL




If you are at the beach or near the coast and you **FEEL** strong earthquake shaking that lasts for more than 20 seconds, or...

SEE AND HEAR



... If you **SEE** the tide go out or a large frothy wave coming ashore, or you **HEAR** a roaring wave coming or a warning siren sounding, you should...

RESPOND




... **RESPOND** by moving quickly to high ground or far enough inland to get away from a potential tsunami.

KNOW WHAT TO DO


NOTABLE CALIFORNIA TSUNAMIS

1700




Supported by written records of a tsunami hitting Japan and geologic evidence in California, a magnitude 9 earthquake along the Cascadia Subduction Zone likely caused a 50-foot tsunami along California's north coast.

1812




A local earthquake triggered a tsunami near Santa Barbara that so frightened people in coastal villages that they retreated up the hill closer to the local mission.

1946




A tsunami generated in the Aleutian Islands caused tsunami flooding in parts of California, including a surge in Half Moon Bay that flooded over 1,000-foot Island.

1964



A magnitude 9.2 earthquake in Alaska caused a tsunami 20-foot high that flooded 29 city blocks in Crescent City and killed 12 people statewide.

2006

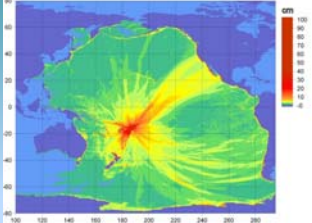


Strong water currents generated by a tsunami originating from the Kuril Islands caused \$20-million worth of damage in Crescent City's small boat harbor.

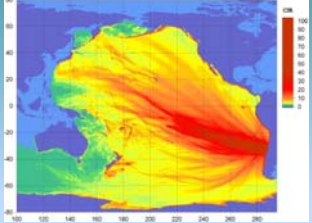
Recent Tsunamis

Six Tsunamis in Ten Years

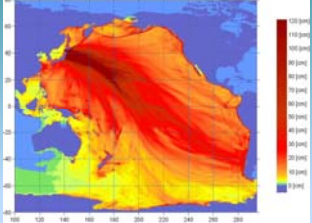
Samoa Sept 2009



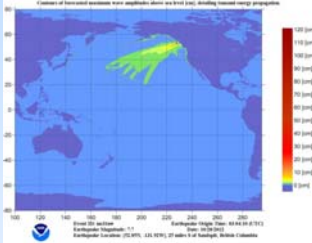
Chile Feb 2010



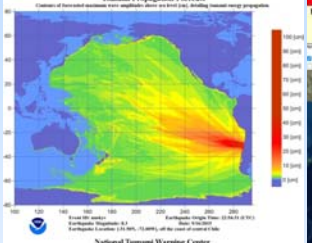
Japan March 2011




BC Canada Oct 2012



Chile Sept 2015



Alaska Jan 2018





1964 Alaska Tsunami



- March 28, 1964
- 9.2 Mw Earthquake and Ensuing Tsunami
- 139 deaths and \$400 million in property loss
- Earthquake - 15 deaths; Tsunami - 124 deaths
- 106 in Alaska, **13 in California** and 5 in Oregon
 - Del Norte County = 12 deaths
 - Marin County = 1 death
- Damaged Harbors, Flooded Homes and Businesses



2011 North Coast California



- March 11, 2011 – Small group of friends went down to the coast near the mouth of the Klamath River. It was later in the day, hours after the first tsunami wave had arrived.
- They thought that the waves would be smaller and they went to take pictures.
- A large wave came in knocked them down and took one person out to sea. They were not able to rescue him.
- One month later his body was recovered 330 miles to the north in Oregon.



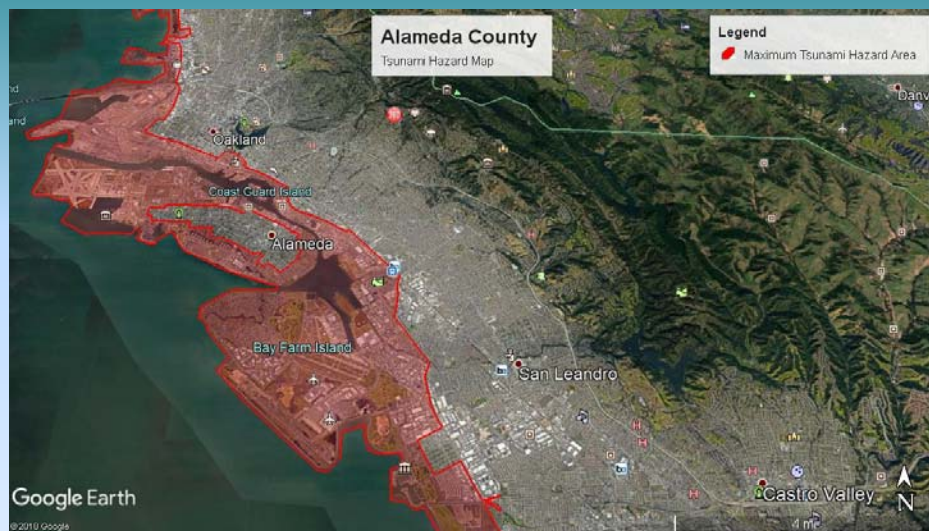
2011 Santa Cruz

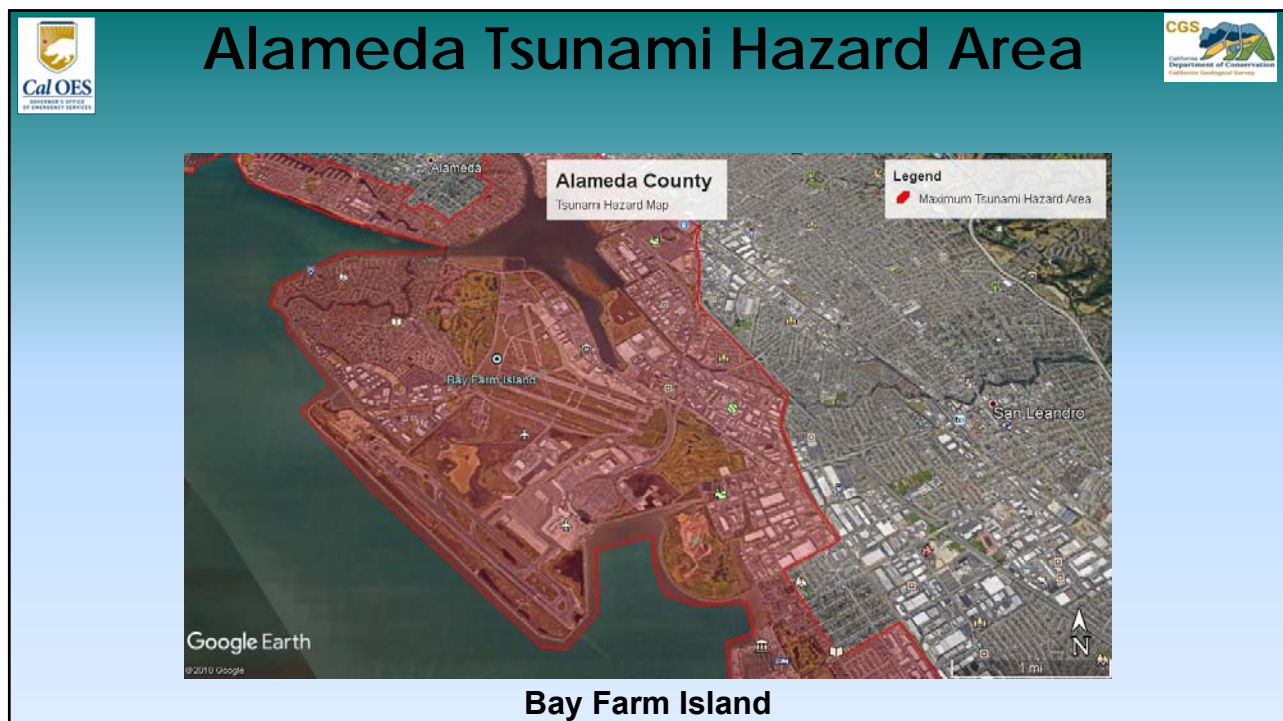


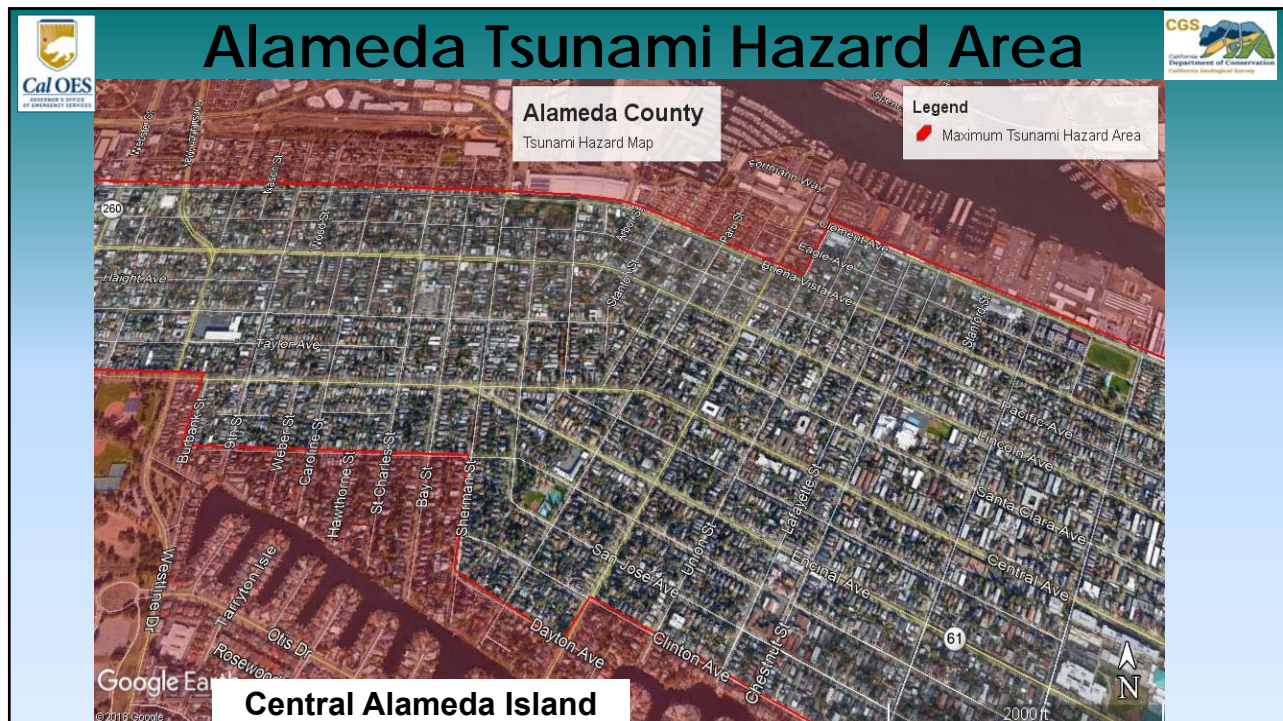
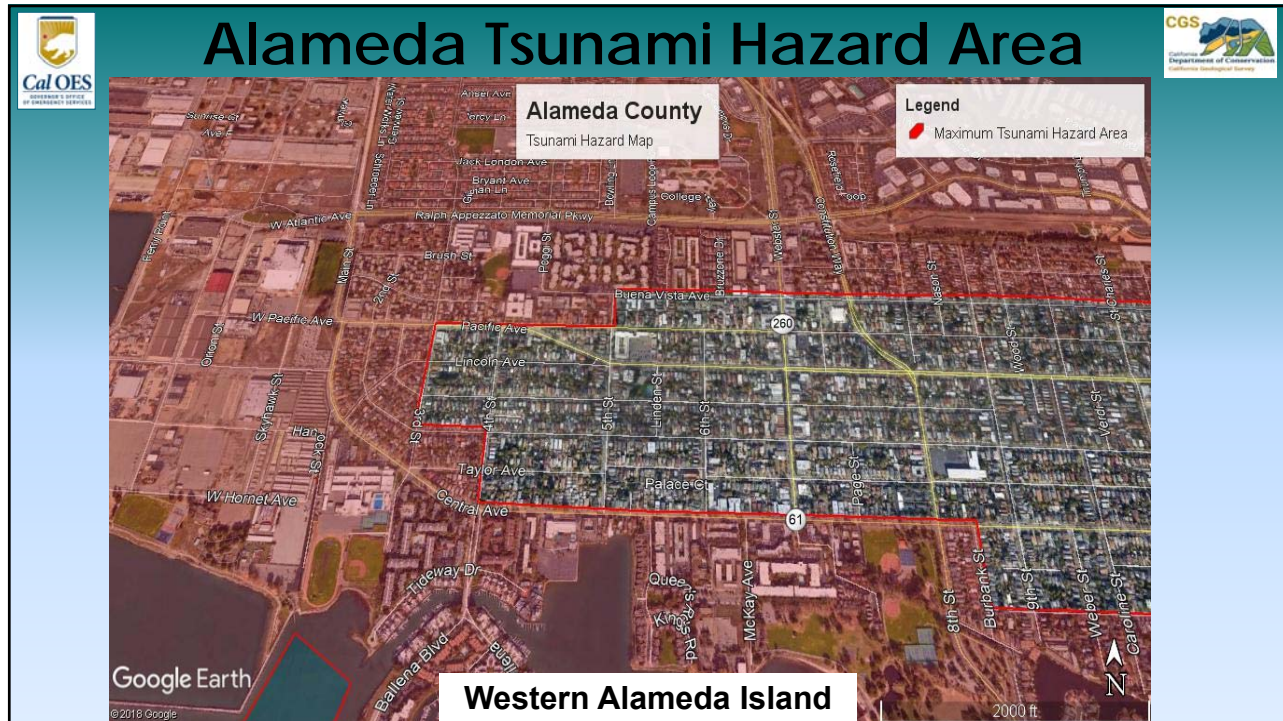
Santa Cruz Harbor, March 11, 2011 - video at 11AM (about 3 hours after first arrival of tsunami) within Santa Cruz Harbor

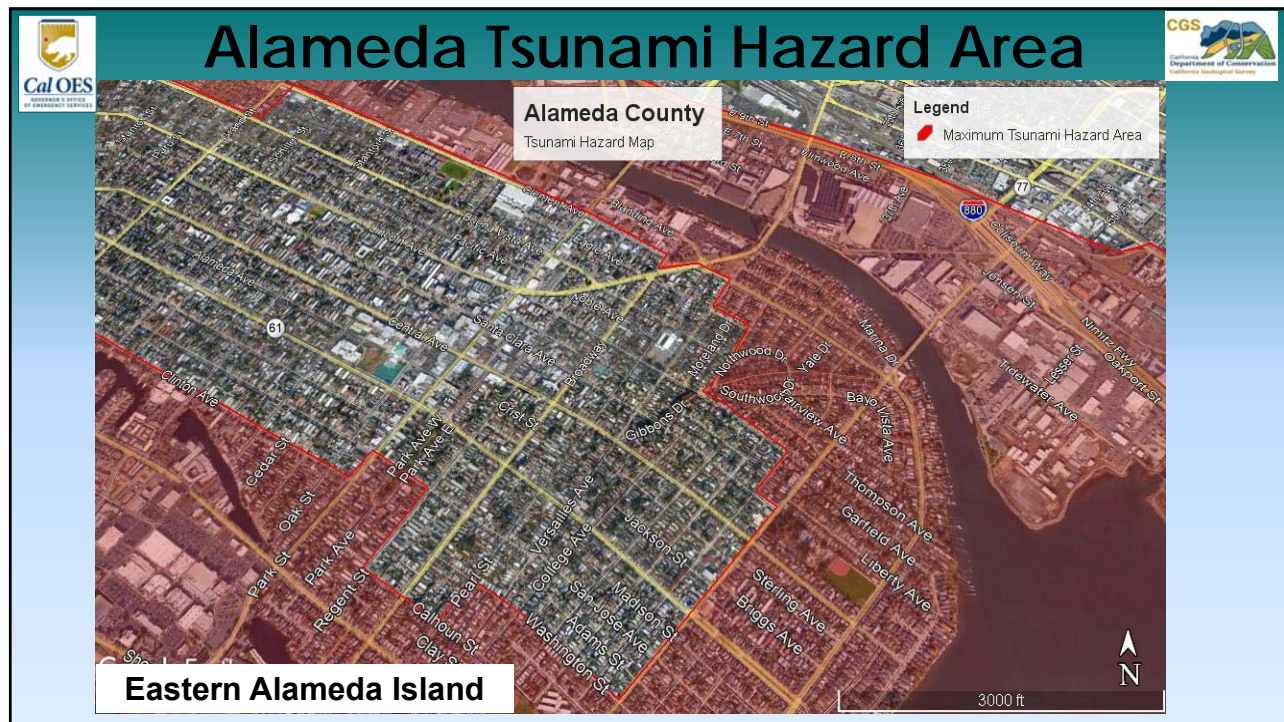


Alameda Tsunami Hazard Area










Local Tsunami Threat


Natural Warning Signs

- **Feel** – Strong Earth Shaking
- **See** – Water Receding Exposing Sea Floor
- **Hear** – Loud Ocean Roar





If one or more Natural Warning Sign Occurs – Go Immediately to High Ground or Inland and Stay There

You May Only Have **Minutes** before a Tsunami Arrives.




Earthquakes Near the Ocean






DROP! COVER! HOLD ON!
Protect Yourself During Earthquakes



GO TO HIGH GROUND OR INLAND!
The Shaking is Your Tsunami Warning



STAY THERE!
Tsunami Waves May Arrive for Hours



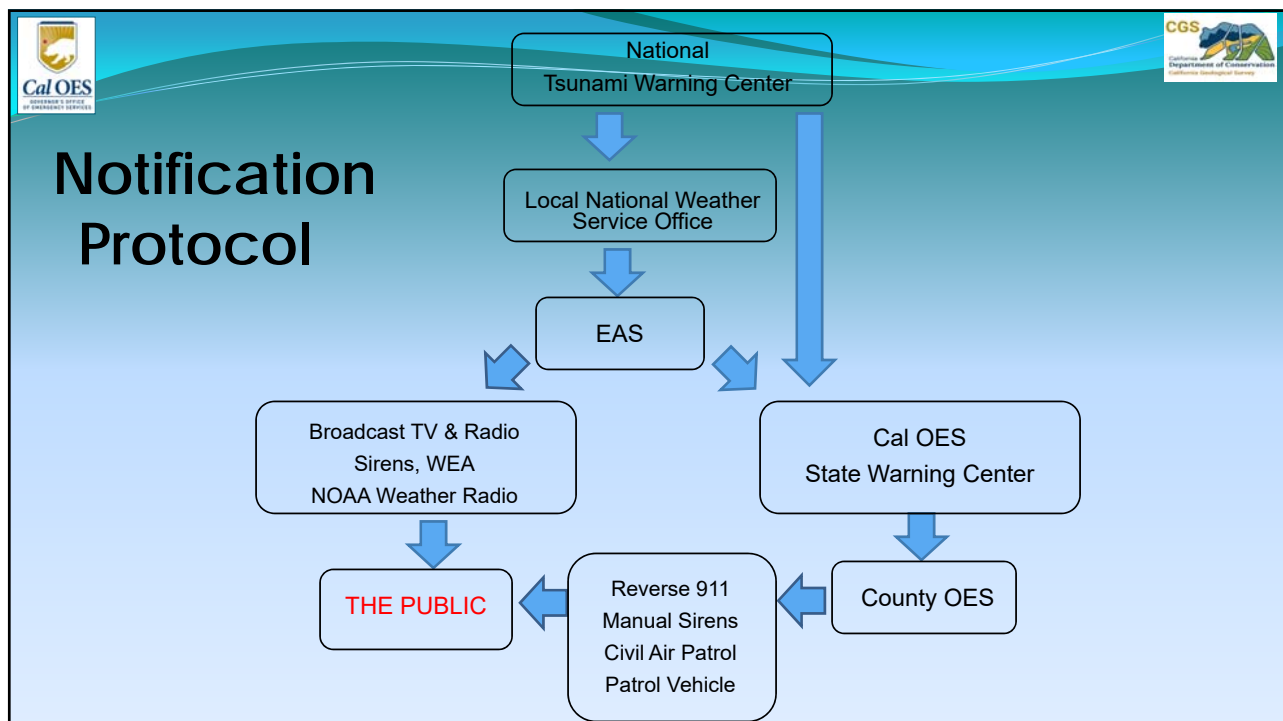
Tsunami Alert and Response







NOAA — TSUNAMI




Deep Ocean Assessment and Reporting of Tsunami (DART) Buoy







Official NOAA Alert Bulletins



[Tsunami.ca.gov](https://tsunami.ca.gov)

- 
Tsunami WARNING (>3 feet)
 Widespread inundation is imminent or occurring
 Full Evacuation Suggested, Move to Higher Ground
- 
Tsunami ADVISORY (1 foot to 3 feet)
 Strong currents are imminent or occurring
 Move Away From Shore, Harbors, Marinas
- 
Tsunami WATCH
 Potential Tsunami - May Impact Your Area
 Stay Alert For More Info, May be upgraded to
 Warning/Advisory






Official NOAA Alert Bulletins


- 
Tsunami INFORMATION STATEMENT
 Minor Waves at Most
 No Action Suggested
- 
Tsunami THREAT
International only – Not for domestic U.S. coastlines
 Dangerous coastal flooding and/or powerful currents
 Get more information, follow instructions from
 national and local authorities



Text:
NWS_NTWC
To:
40404



Where Are You?





Are You In The Zone?
TsunamiZone.org

- Do you Live, Work or Play in a Tsunami Zone?
- Do you Know What to do if You are Near the Ocean and you Feel Strong Shaking?




Tsunami Program Resources





Key Tsunami Resources



tsunami.ca.gov
California (CA) Tsunami Program

- Mapped tsunami inundation areas
- Preparedness information
- Key tsunami facts

myhazards.caloes.ca.gov
CA Office of Emergency Services

- Type in your address to identify hazards at that location
- Preparedness information

rctwg.humboldt.edu
Redwood Coast Tsunami Work Group

- CA North Coast tsunami zones
- Educational resources
- Preparedness information

ready.gov/tsunamis
Federal Emergency Management Agency (FEMA)


- Tsunami preparedness information
- Get involved, volunteer opportunities


tsunamizone.org
Tsunami campaigns and resources

- Register your tsunami preparedness activities
- Educational materials

tsunami.gov
National Weather Service
Tsunami Warning Centers

- Tsunami alert and warning information
- National and international tsunami information







Thank you!





THE EXTRAORDINARY VOYAGE
OF KAMOME:
A Tsunami Boat Comes Home

かもめの素晴らしい旅
帰って来たボート

高田 節子

WRITTEN BY LORI DENGLE AND AMYA MILLER WITH ILLUSTRATIONS BY AMY UYEKI

www.TsunamiZone.org

www.tsunami.ca.gov

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