



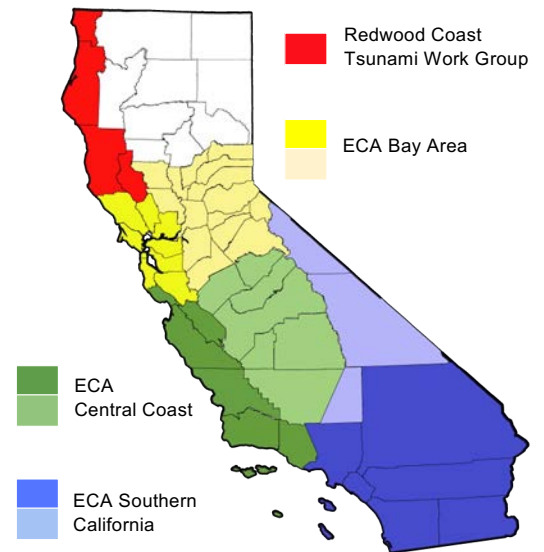
2024 California Tsunami Preparedness Webinar



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Earthquake Country Alliance

- 4000+ *Public-Private-Grassroots* leaders
- Subject matter expert *Committees* develop resources and programs
- *Regional Alliances* organize meetings and outreach activities
- California's Office of Emergency Services provides FEMA NEHRP funding for ECA earthquake mitigation activities
- USC's Statewide California Earthquake Center (SCEC.org) administers ECA



Join: EarthquakeCountry.org/join



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ECA Statewide Activities

Develop Messaging and Resources:

EarthquakeCountry.org
EarthquakeCountry.org/resources
Terremotos.org



Support Tsunami Preparedness Week:

TsunamiZone.org/california



March
23-31,
2024

Created and Coordinate
The Great California ShakeOut:

ShakeOut.org/california



Oct. 17,
2024

Webinars & other events

EarthquakeCountry.org/calendar

Today's Presenters

Nick Graehl

Engineering Geologist, California Geological Survey
California Tsunami Hazards

Yvette LaDuke

Earthquake, Tsunami, and Volcano Program Manager, California Office of Emergency Services
California Tsunami Program – Tsunami Preparedness and Alerts

Susan Clark

City and County of San Francisco, Department of Emergency Management
Tsunami Signage Project

California TSUNAMI HAZARDS

Nick Graehl | CGS
Yvette LaDuke | Cal OES

California Tsunami Program



March 21, 2024

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California Tsunami Program

"Planning for the Next Tsunami"

Coordinated with
20 coastal counties,
100 coastal cities,
other states, and
consulting partners.

Brought to you by the
California Tsunami Program



FEMA

AECOM



California Tsunami Program

3/21/2024

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Mitigation Benefits

The adoption of resilience strategies
could reduce losses by 80-90%



Information provided by the SAFRR Tsunami Scenario Working Group

tsunami.ca.gov

California Department of Conservation

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Tsunamis

Announcing Updated and New Tsunami Products

- OCTOBER 7, 2022**
New Tsunami Maps for California
We now have updated tsunami hazard area maps for all 20 of the state's coastal counties. The latest maps cover the counties of San Diego, Ventura, Santa Cruz, Marin, Sonoma, Napa, and Solano.
- MARCH 11, 2021**
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Appropriate for all ages, our updated multimedia guide is packed with videos, images, and maps. September is National Preparedness Month... this is a good time to determine if you live in, work in, or visit a Tsunami Hazard Area, and to prepare for a tsunami.
- JANUARY 31, 2022**
The Tonga Tsunami of January 15, 2022
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tsunami.ca.gov

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CGS Home

About the CGS

Earthquakes

Forest & Watershed Geology

Forest Biomass to Carbon-Negative Biofuels

Geologic Maps & Mapping

Geological Modeling

Landslides

Minerals

Tsunamis

Tsunami Maps & Data

Educational Materials & FAQ

Preparedness: What to do Before, During, and After a Tsunami

Tsunami Technical Reports

The 1992 Cape Mendocino Earthquake and Tsunami

The 2011 Tōhoku-oki Earthquake and Tsunami

The 2022 Tonga Tsunami

Tsunami Program Contact Information

Geologic Reviews

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California Tsunami Program 3/21/2024

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- Updated tsunami hazard maps were updated using the best currently available scientific information.
- Maps assist the public and local governments in identifying their tsunami hazard for evacuation planning.
- Use the "find address" box to see if the areas you work, live, visit, or commute are in a Tsunami Hazard Area.

California Tsunami Maps and Data

Welcome to the Tsunami Hazard Area Map Application

How to use this map

Locate where you live, work, or visit. If you are in the yellow hazard area after feeling an earthquake that lasts a long

County-Specific Page Links

- Alameda [2021]
- Contra Costa [2021]
- Del Norte [2021]
- Humboldt [2021]
- Los Angeles [2021]
- Marin **UPDATED 2022**
- Mendocino [2021]
- Monterey [2021]
- Napa **UPDATED 2022**
- Orange [2021]
- San Diego **UPDATED 2022**
- San Francisco [2021]
- San Luis Obispo [2021]
- San Mateo [2021]
- Santa Barbara [2021]
- Santa Clara [2021]
- Santa Cruz **UPDATED 2022**
- Solano **UPDATED 2022**
- Sonoma **UPDATED 2022**
- Ventura **UPDATED 2022**

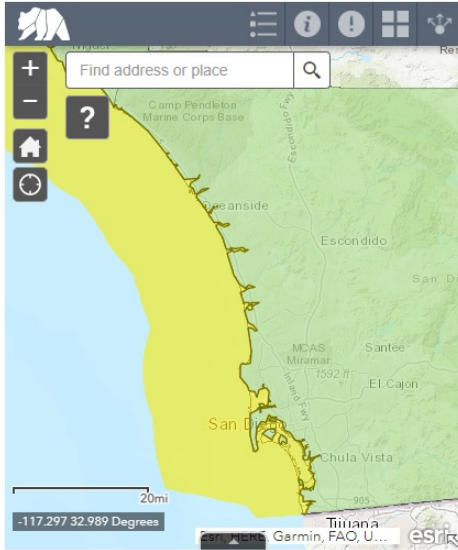
tsunami.ca.gov/map

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San Diego County Tsunami Hazard Areas

Explore your area of interest in the map below. You may also [OPEN THE MAP IN A NEW WINDOW](#)



What to do Before, During, and After a Tsunami in San Diego County

- [San Diego County Emergency Services Website](#)
- Make sure everyone in your home is prepared. Register your cell phone number and email address with **AlertSanDiego**, the County's emergency mass notification system. Emergency responders use AlertSanDiego to send evacuation and important incident information during an emergency in your area.
- [Ready.gov: Tsunamis](#) summarizes how to Prepare NOW, Survive DURING, and Be Safe AFTER.
- [TsunamiZone.org](#) offers suggestions and resources for your family or organization to "know your zone" and to learn how to be safe.
- [The Earthquake Country Alliance](#) develops resources and organizes activities to improve earthquake and tsunami preparedness, mitigation and resiliency. The ECA offers a host of free booklets and other materials in multiple languages.

Each County Tsunami Hazard Map has its own web page with additional local resources listed.

tsunami.ca.gov/map



tsunami.ca.gov

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Tsunamis

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CALIFORNIA TSUNAMI PREPAREDNESS GUIDE

California Geological Survey (CGS) Tsunami Website

Intro | What is a tsunami? | Where do tsunamis occur? | Recent Damaging Tsunami Events in California | Flood Model vs Hazard Area | California Tsunami Hazard Maps | Maritime Response | Get Prepared | Credits & Resources

Hazard Area → **Outside Hazard Area**

If you are in the yellow hazard area, evacuate by foot immediately to a green area after feeling an earthquake that lasts a long time.

Use the "Find address or place" feature on the map to locate where you work, live, or visit to see if you are in a Tsunami Hazard Area (shaded yellow color).

Find address or place: Example: Arcata, CA, USA

- Use this map to plan a safe evacuation route outside of the hazard area (to the green area).
- If available in your area, a clickable black-outlined box will link you to a detailed community-specific map that you can download and/or print.

CGS Information Warehouse: Tsunami Hazard Area Map

Find address or place:

Welcome to the Tsunami Hazard Area Map Application

How to use this map

Locate where you live, work, or visit. If you are in the yellow hazard area after feeling an earthquake that lasts a long time, or you receive an official evacuation notification, evacuate by foot immediately to a green area.

Hazard Area → **Outside Hazard Area**

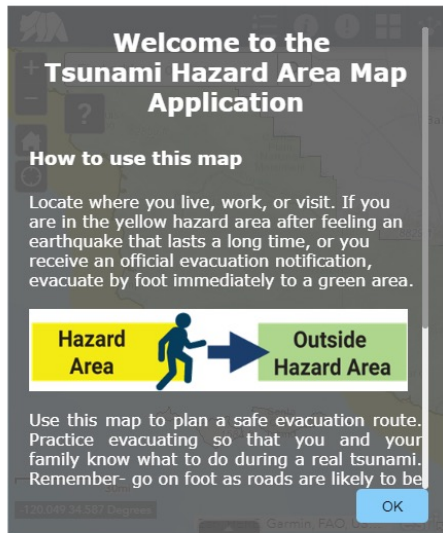
Use this map to plan a safe evacuation route. Practice evacuating so that you and your family know what to do during a real tsunami. Remember- go on foot as roads are likely to be impassable.

OK

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Santa Barbara County Tsunami Hazard Areas

Explore your area of interest in the map below. You may also [OPEN THE MAP IN A NEW WINDOW](#)



Welcome to the Tsunami Hazard Area Map Application

How to use this map

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Use this map to plan a safe evacuation route. Practice evacuating so that you and your family know what to do during a real tsunami. Remember- go on foot as roads are likely to be

OK

What to do Before, During, and After a Tsunami in Santa Barbara County

- **Santa Barbara County Emergency Preparedness Website** Be prepared! Sign up for emergency alerts at www.Readysbc.org.
- **Ready.gov: Tsunamis** summarizes how to Prepare NOW, Survive DURING, and Be Safe AFTER.
- **TsunamiZone.org** offers suggestions and resources for your family or organization to "know your zone" and to learn how to be safe.
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tsunami.ca.gov/map



Historic California Tsunamis

More than 150 tsunamis have been recorded along the California coastline since 1800

*1964 tsunami from a M9.2 earthquake from Alaska
12 lives lost in California*

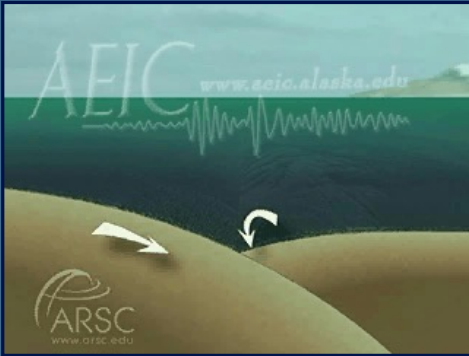
2011 tsunami from a M9.1 earthquake offshore from Japan caused more than \$100 million in damage to CA, there was one fatality

2022 tsunami from Tonga volcanic eruption caused ~\$11.5 million in damage in CA

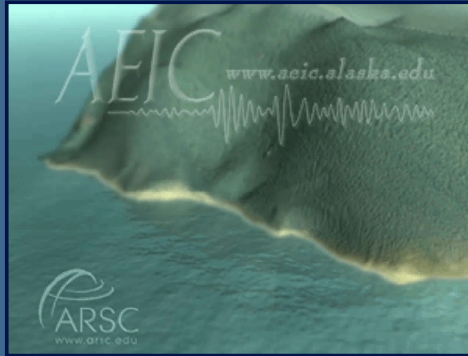
How are tsunamis generated?

~85% of tsunamis are caused by earthquakes below the ocean floor.

~15% of tsunamis comes from landslides, volcanic eruptions, meteors, and meteotsunamis (weather), and other significant water disruptions.



Earthquakes



Landslides



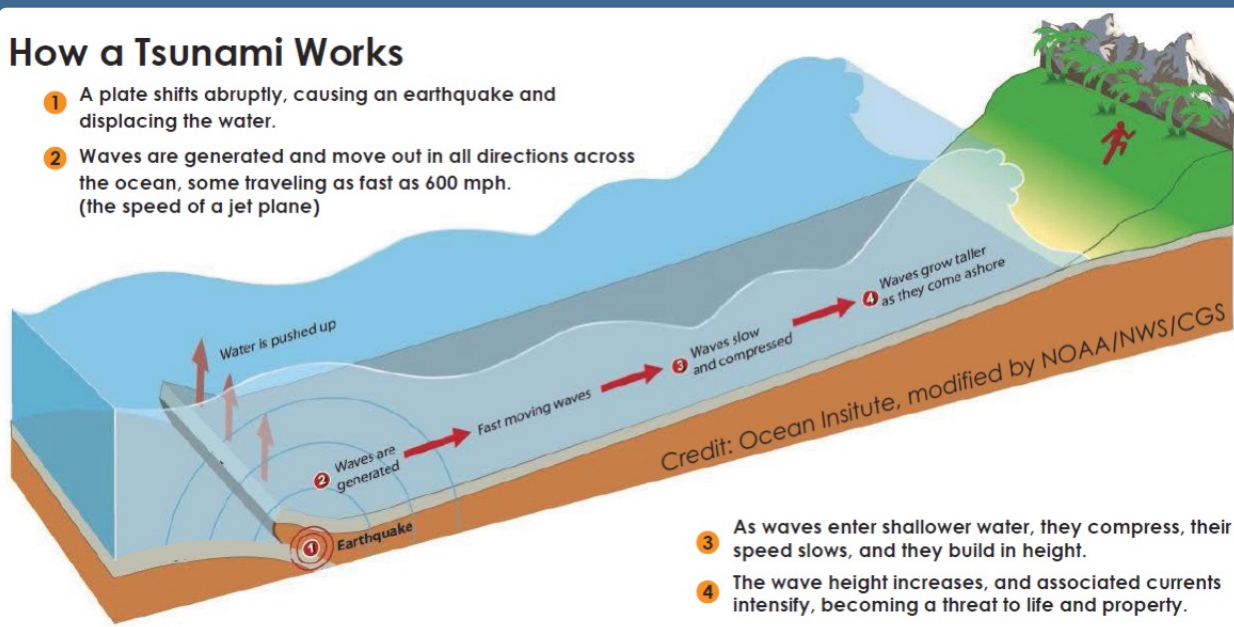
Meteotsunami

How are tsunamis generated?

Most tsunamis are caused by earthquakes below the ocean floor

How a Tsunami Works

- 1 A plate shifts abruptly, causing an earthquake and displacing the water.
- 2 Waves are generated and move out in all directions across the ocean, some traveling as fast as 600 mph. (the speed of a jet plane)



- 3 As waves enter shallower water, they compress, their speed slows, and they build in height.
- 4 The wave height increases, and associated currents intensify, becoming a threat to life and property.

How is a tsunami different from regular waves?

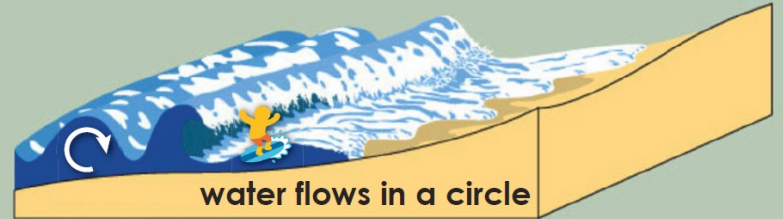
Tsunami Waves

- dangerous, unpredictable, and no face to surf
- waves flood the land like a wall of water



Regular Waves

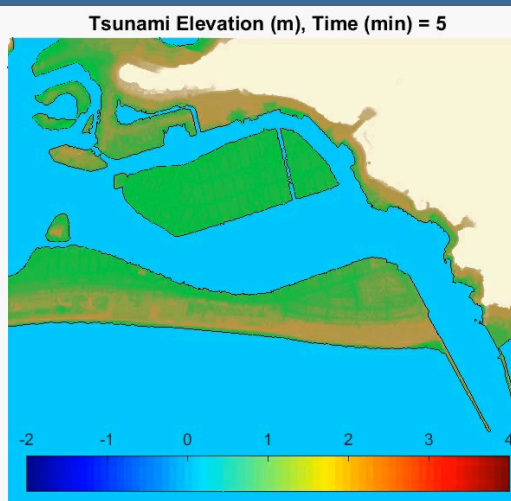
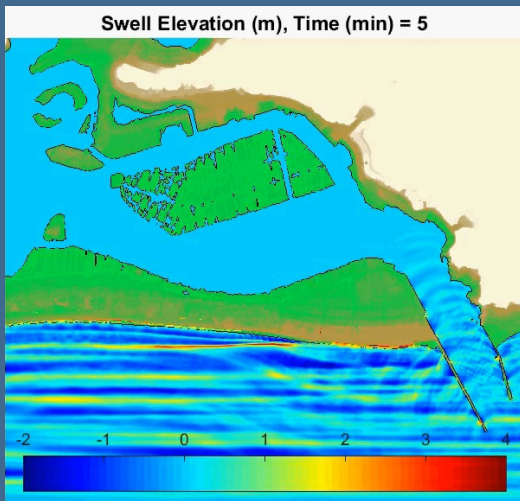
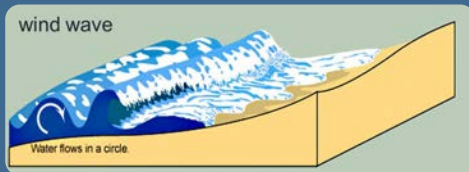
- waves come and go without flooding higher areas



- A tsunami has many surges
- This first surge is almost never the largest
- The danger period can last 24 hours or more
- Tidal levels can affect the impacts of a tsunami

- A regular wave breaks along the coast creating a circular, curling wave
- Waves flow on shore then out in less than a minute
- You can surf a regular wave

Coastal Impacts – Swell vs Tsunami



*Modeling at
Newport Beach
performed by
Pat Lynett, USC*

Can I surf a tsunami?



Some of the rescue swimmers dispatched by the San Francisco Fire Department at Ocean Beach.
San Francisco Fire Department/Twitter

"You have to understand that we usually don't rescue surfers," he added. "It's usually people who go out in the water for the first time. These are all vetted, experienced surfers who went out... That's just how aggressive the waves were."

NO! Tsunami waves are different from regular waves.

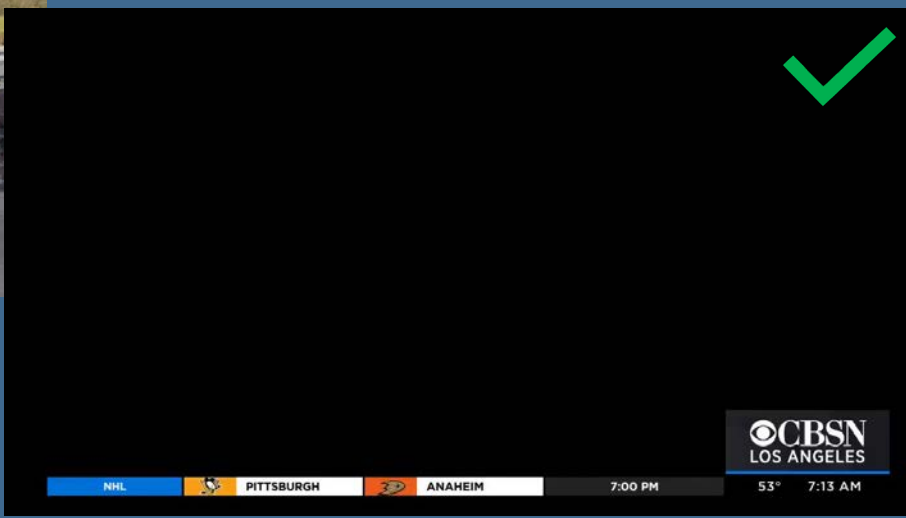
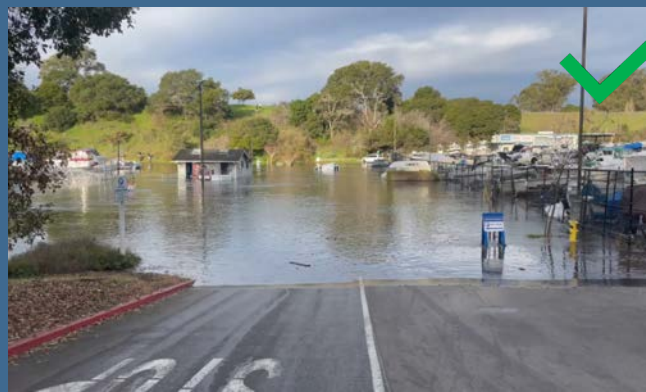
What does a tsunami look like?



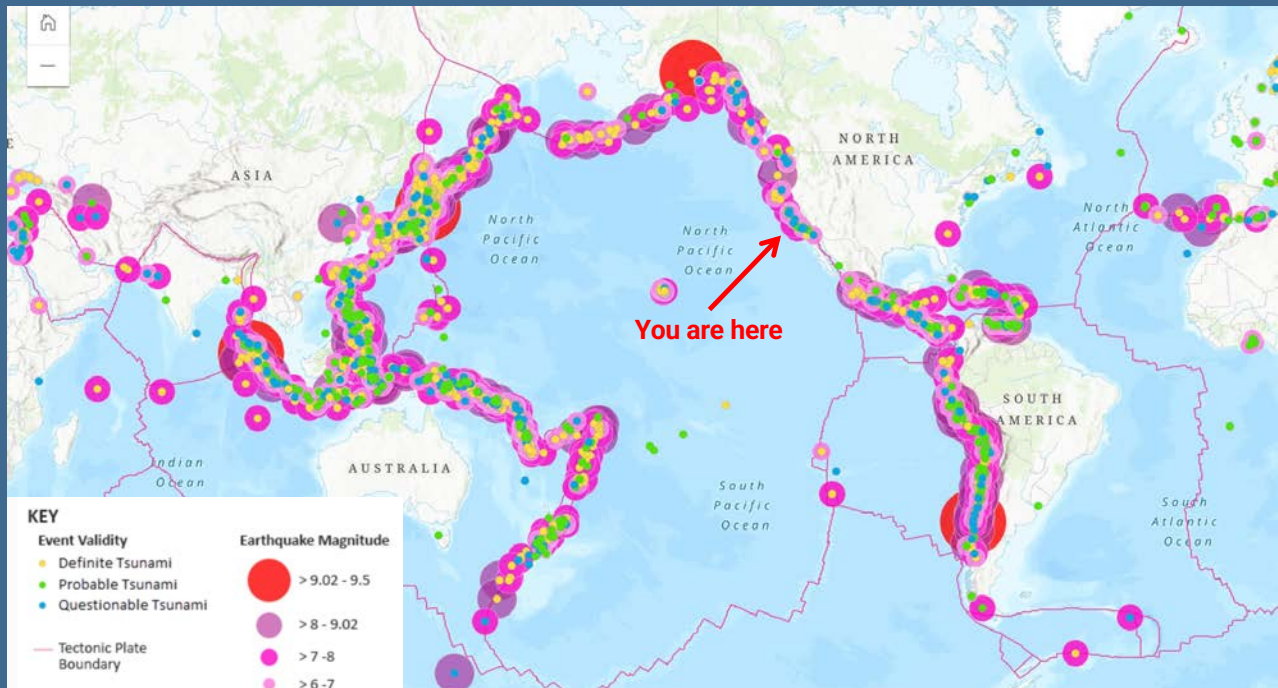
What does a tsunami look like?



What does a tsunami look like?



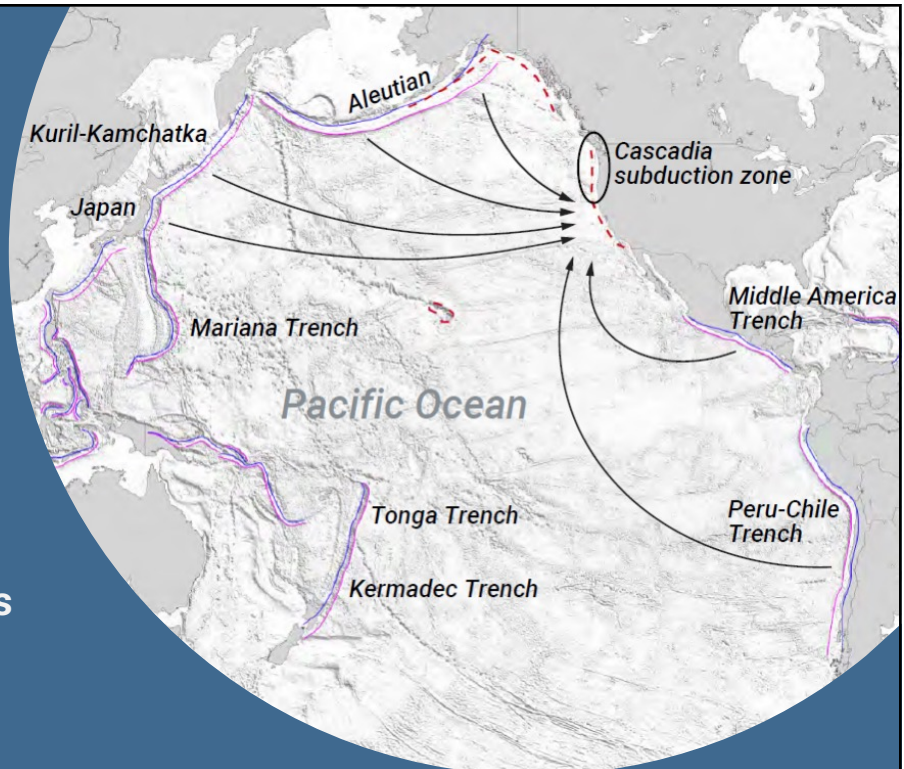
Where do tsunamis occur?



Distant vs Local Tsunamis

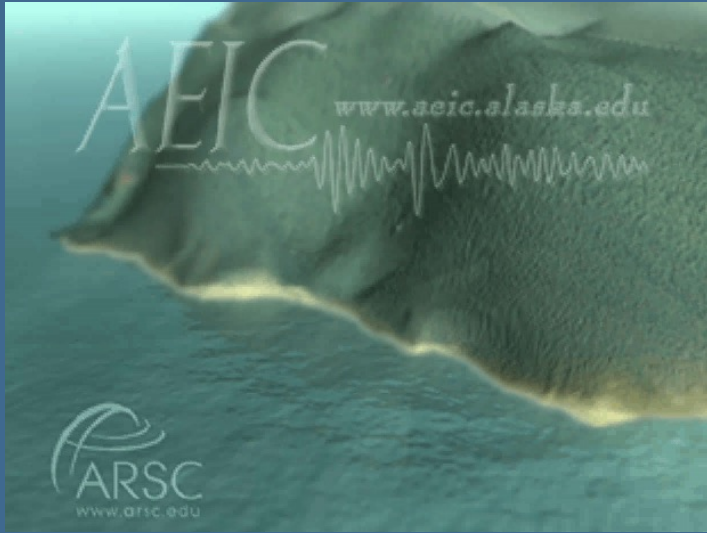
Distant source tsunamis

- Earthquake will not be felt
- Tsunami can arrive in 4-13 hours
- There will be time for official notifications to go out



Local Source Tsunami

Local tsunamis can be generated by the sudden movement of offshore faults or submarine/coastal landslides



California Tsunami Program

3/21/2024

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Awareness, planning, and preparedness can save lives and keep our coastal communities resilient to tsunami hazards.

California Tsunami Program

3/21/2024

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Q&A

To be notified of future events and recordings, join ECA (free!):

EarthquakeCountry.org/join

Please take our survey:

[SurveyMonkey.com/r/CYBYR5T](https://www.surveymonkey.com/r/CYBYR5T)

Questions?

info@earthquakecountry.org

California Tsunami Program

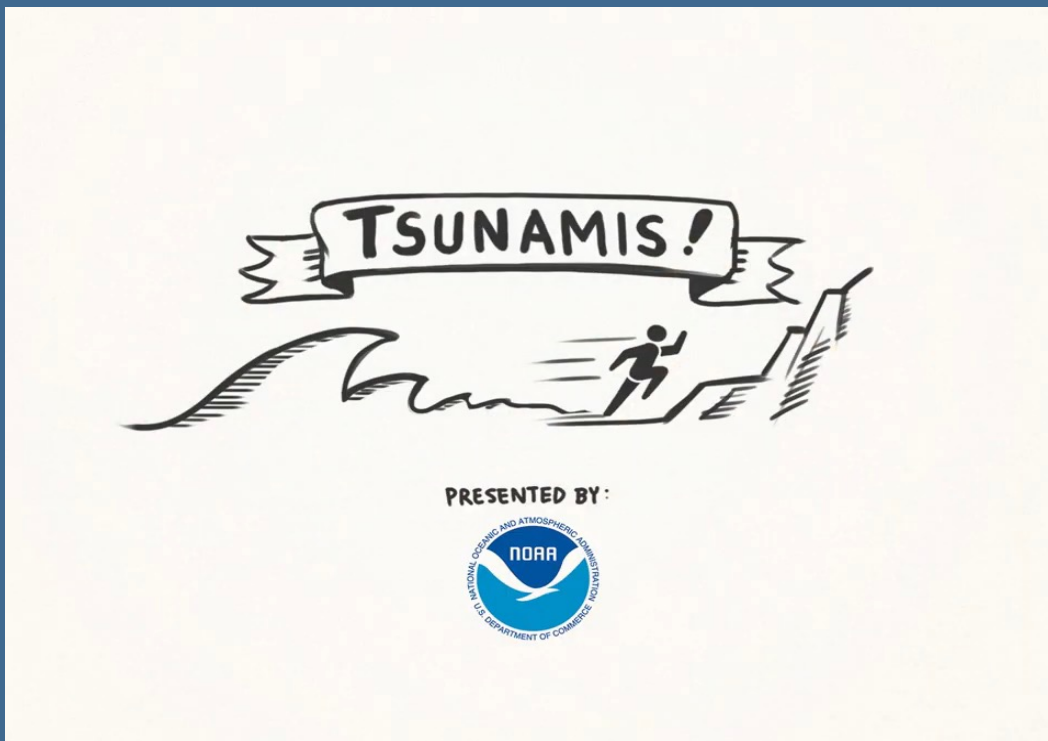


Governor's Office of Emergency Services

And

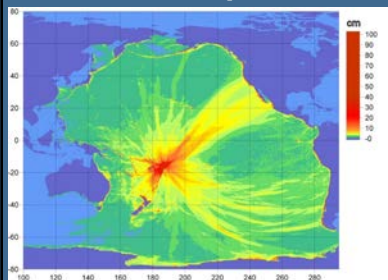
California Geological Survey



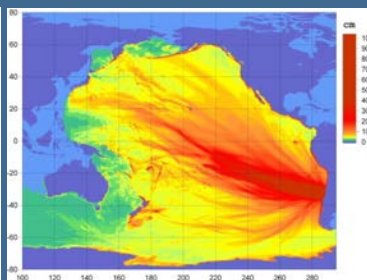


Notable Tsunamis in the Last ~15 - Years

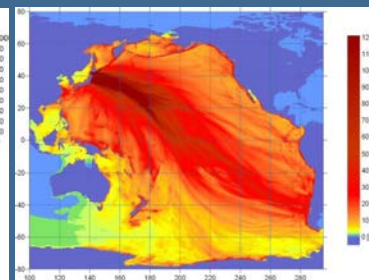
Samoa - Sept 2009



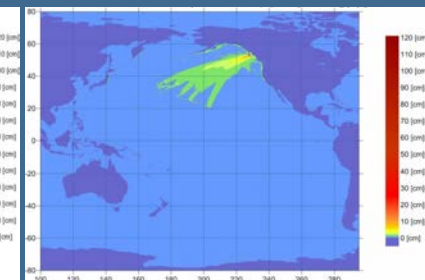
Chile - Feb 2010



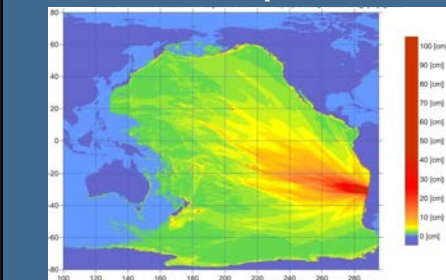
Japan - March 2011



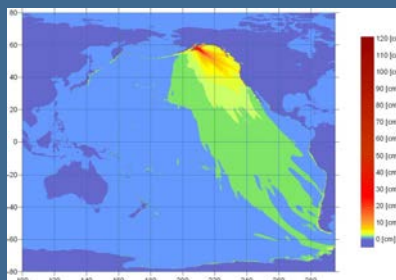
BC Canada - Oct 2012



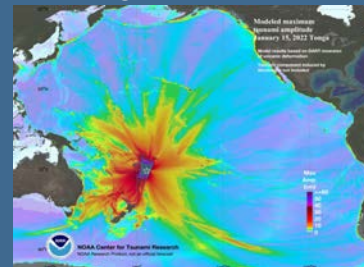
Chile - Sept 2015



Alaska - Jan 2018



Tonga - Jan 2022



2011 Tohoku Tsunami - Santa Cruz Harbor



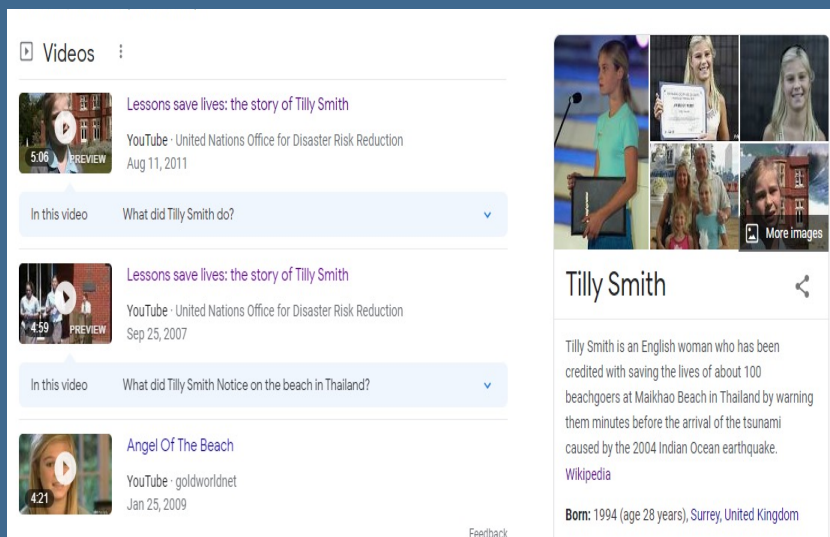
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Santa Cruz Harbor - 2011



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Why Do I Need to Know About Tsunamis?



<https://www.youtube.com/watch?v=E0yrONL1Q3g>

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Tsunami Hazard

Tsunami's Can Cause Damage On Land:

- ✓ Flooding/Water Surge
- ✓ Erosion
- ✓ Floating Debris
- ✓ Hazardous Materials/Hazardous Chemicals
- ✓ Utility Outages – Power, Water, Sewer



May 22, 1960, M9.5 Chile EQ
Damage in Hilo, Hawaii

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How Do I Know if a Tsunami is Coming?

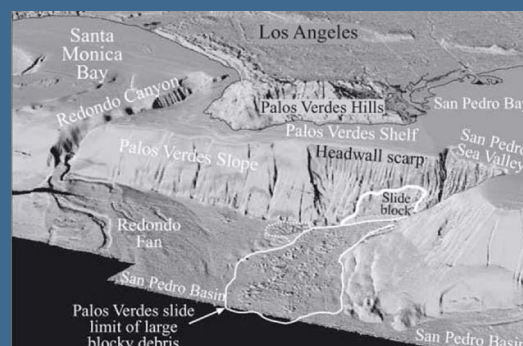


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Local Tsunami Threat

Natural Warning Signs

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



EQ triggered Submarine Landslide

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

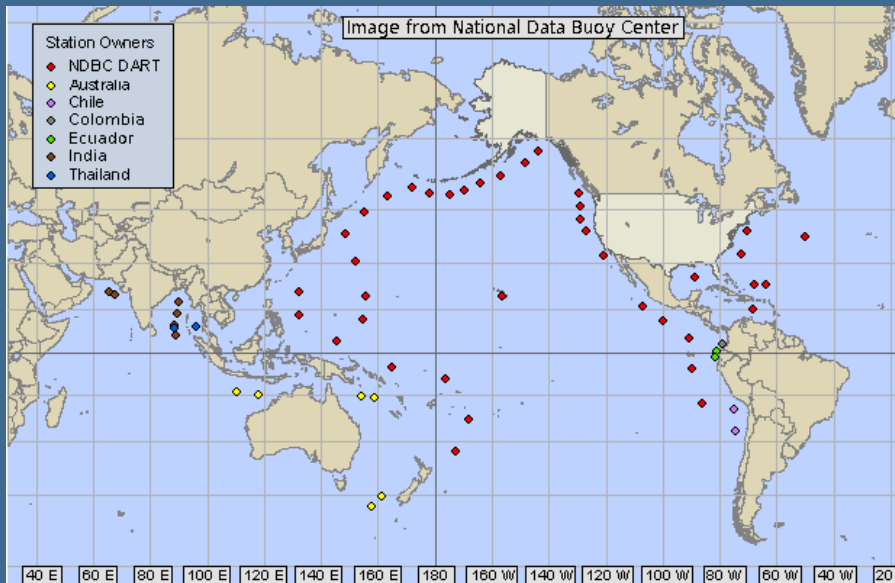
You May Only Have **Minutes** before a Tsunami Arrives.

40

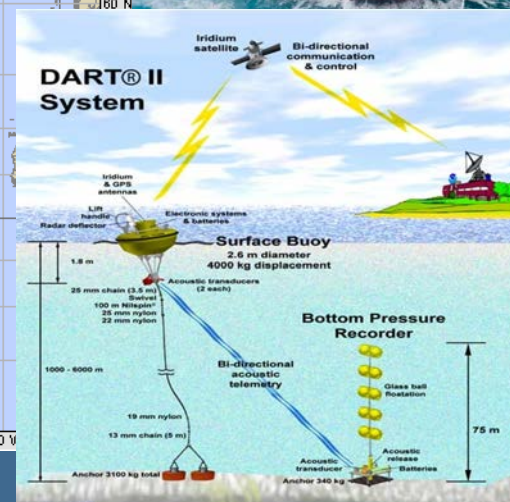
Earthquakes Near the Ocean



Tsunami Warning System



DART System



Tsunami Alert Bulletins

- Tsunami Information Statement
 - Issued within 5 Minutes
- Earthquake 4.0M+ (Near Coast)
 - Tsunami Information Statement Issued
 - No Tsunami Impacts



Tsunami.gov

BULLETIN
Public Tsunami Message Number 4
NWS National Tsunami Warning Center Palmer AK
216 AM AKST Tue Jan 23 2018

UPDATES

* Updated observations

...THE TSUNAMI WARNING REMAINS IN EFFECT...

...THE TSUNAMI WATCH REMAINS IN EFFECT...

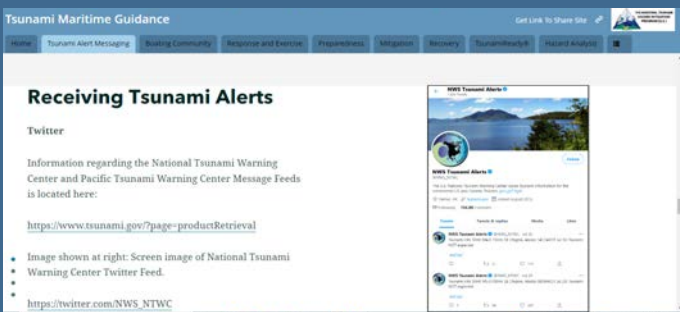
Tsunami Warning in Effect for;

- * BRITISH COLUMBIA, The Juan de Fuca Strait coast, the outer west coast of Vancouver Island, the central coast and northeast Vancouver Island, and the north coast and Haida Gwaii
- * SOUTHEAST ALASKA, The inner and outer coast from the BC/Alaska Border to Cape Fairweather, Alaska (80 miles SE of Yakutat)
- * SOUTH ALASKA AND THE ALASKA PENINSULA, Pacific coasts from Cape Fairweather, Alaska (80 miles SE of Yakutat) to Unimak Pass, Alaska (80 miles NE of Unalaska)
- * ALEUTIAN ISLANDS, Unimak Pass, Alaska (80 miles NE of Unalaska) to Attu, Alaska including the Pribilof Islands

Tsunami Watch in Effect for;

- * CALIFORNIA, The coast from The Cal./Mexico Border to The Oregon/Cal. Border including San Francisco Bay
- * OREGON, The coast from The Oregon/Cal. Border to The

Tsunami Alert Tools



Twitter Notifications

Register to receive Alerts and Emergency Information from Officials in your County:





<https://calalerts.org/signup.html>



NOAA Weather Radio



Tsunami Alert Notifications

Alert Name	Actions	Potential Hazards
 WARNING	Get to high ground or inland IMMEDIATELY Follow tsunami evacuation signage	DANGER! TSUNAMI IMMINENT! Flooding/powerful currents Wave heights > 3 ft. or unknown
 ADVISORY	Stay out of the water and away from the shore	STRONG CURRENTS AND DANGEROUS WAVES in or very near coastal water Wave heights of 1 - 3 ft.
 WATCH	Be prepared to take action Stay tuned to local radio/TV/ NOAA "alert" weather radios	TSUNAMI IS POSSIBLE Alert level may change once more information is known
 INFORMATION STATEMENT	No action needed	NO TSUNAMI IMPACT EXPECTED Alert level may change once more information is known

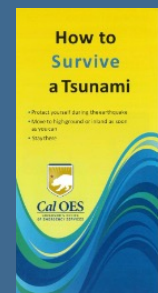
THREAT Message: Intended to alert international partners only. Not applicable to U.S. coasts

**THE NATIONAL TSUNAMI WARNING CENTER ISSUES OFFICIAL TSUNAMI ALERTS.
CHECK TSUNAMI.GOV OR WEATHER.GOV WEBSITES FOR TSUNAMI ALERT DETAILS.**

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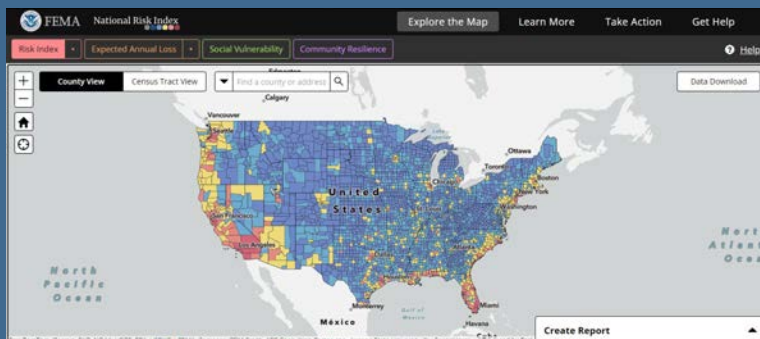
What Should I Do?

- Be Informed
- Be Prepared
- Get Involved



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Are You in the Tsunami Zone?



<https://hazards.fema.gov/nri/map>

[Tsunamizone.org](https://tsunamizone.org)

Announcing Updated and New Tsunami Products

MARCH 2021

New Tsunami Maps for California

In March we released a total of seven new tsunami maps covering the counties of Los Angeles, Monterey, San Mateo, Alameda, Mendocino, Humboldt, and Del Norte. We have maps for other counties, too (they're just not updated yet).

MARCH 11, 2021

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A scientific perspective of the event, including details of what happened in Japan and subsequently in California.

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

WELCOME TO THE TSUNAMIZONE IN CALIFORNIA!

Thank you to everyone who participated in California's 2023 Tsunami Preparedness Week (March 25 – 31)! If you missed it, we encourage you to plan and register #TsunamiPrep activities (at work, school, and home) on any other day of the year!

There are many ways to participate – you can organize or join a group tsunami walk, attend an in-person lecture or an online webinar, find out if you are in a **tsunami hazard zone**, update your "Go Bag," or many other options.

View or add to a list of events open to the public

406,292 Participants and counting!

Click the map for details about each area

Over 820,000 participants registered

Be Prepared



Evacuation Kit List

- Water
- Snacks
- Flashlight
- Portable Radio
- Emergency Blanket
- Cash
- ID Copy
- Insurance Info.
- Prescription Meds
- Contacts / glasses
- First Aid Kit
- Charging Cables
- Battery Pack
- Shirt
- Pants
- Underwear
- Socks
- Shoes
- Jacket
- Toothpaste
- Toothbrush
- Soap
- Pens
- Chalk
- Toilet Tissue
- Facial Tissue
- Pet Supplies
- Games / Toys
- Diapers / Formula
- Personal Items:

Are You in The Zone?

[TsunamiZone.org](https://tsunamizone.org)



Family Emergency Plan

Your family may not be together when disaster strikes, so plan what you will do in different situations and give everyone your plan. Preparedness allows you to manage life's challenges.

When the family splits up:

Name:	Address:	Phone:
Relationship:	Emergency Contact:	Relationship:
Address:	Address:	Address:
Phone:	Phone:	Phone:
Emergency Contact:	Emergency Contact:	Emergency Contact:
Relationship:	Relationship:	Relationship:



Get Involved Practice – Do a Drill



Move Inland or to higher ground

Follow Evacuation Route Signs

Listen to instructions from local officials

Be prepared to stay where you are for hours – possibly 2 days



Evacuation Communication

Look for signs and maps showing you which way to walk to exit the tsunami hazard area.

Official Tsunami Warning
Warnings are issued due to the imminent or expected threat of a tsunami typically called when forecasted tsunami amplitudes are equal to or greater than 1m (3ft). If you receive a tsunami warning:

1. MOVE to higher ground or inland beyond the Tsunami Hazard Zone.
2. SEEK further information from local radio, social media, or television stations.
3. FOLLOW directions from emergency personnel. DO NOT CALL 911.

Get connected
City of Hermosa Beach
www.hermosabeach.gov
Twitter: @HermosaBchCity
Facebook: CityofHermosaBeach
Register for South Bay Alerts (It's free).
Text "ALERTSB" to 626777





2024 California Tsunami Preparedness Week

Over 700,000 Registrations Worldwide

Earthquake Country Alliance **2024 California Tsunami Preparedness Webinar**

Tsunami Preparedness: Are You in the Zone? Learn about tsunami hazards in California – what they are, tsunami maps and alerts, and what to do before, during, and after a tsunami occurs.

Mar. 21, 2024 | 1pm – 2pm PT

Register Now
EarthquakeCountry.org/2024ctp

Register to join live: recording will be available soon

Join Us #TsunamiPrep Week
 March 23 - 31, 2024
 Register: TsunamiZone.org

220,647 Participants and counting!

Click the map for details about each area

Join Us

Register your #TsunamiPrep Activities!

Register: TsunamiZone.org

TsunamiZone.org
Tsunami.ca.gov
Tsunami.gov

Be Tsunami smart whenever you're at the coast

California Tsunami Program

5/24/2023



Contacts

Yvette LaDuke
Earthquake and Tsunami Program Manager
California Governor's Office of Emergency Services

Yvette.laduke@caloes.ca.gov

or

Todd Becker
Tsunami Program Specialist
California Governor's Office of Emergency Services

Todd.Becker@caloes.ca.gov

or

Nick Graehl, Geologist
California Geological Survey

Nicholas.Graehl@conservation.ca.gov



**WORLD
TSUNAMI
AWARENESS
DAY**
5 NOVEMBER



Q&A

To be notified of future events and recordings, join ECA (free!):

[EarthquakeCountry.org/join](https://www.earthquakecountry.org/join)

Please take our survey:

[SurveyMonkey.com/r/CYBYR5T](https://www.surveymonkey.com/r/CYBYR5T)

Questions?

info@earthquakecountry.org

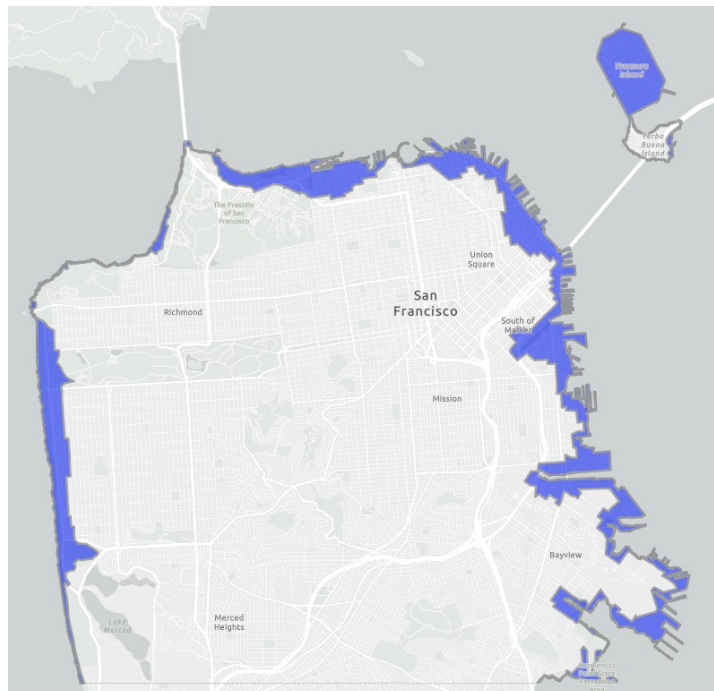
Tsunami Signage Project March 2024

City and County of San Francisco
Department of Emergency Management
Division of Emergency Services

For Official Use Only (FOUO)

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Tsunami Level 4



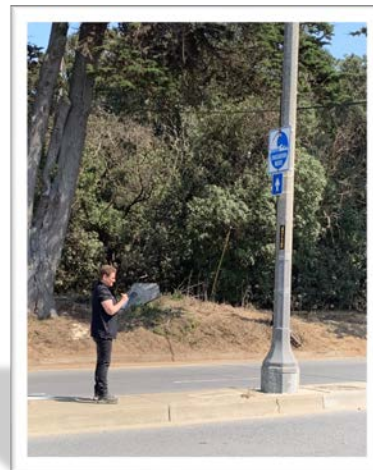
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CCSF Tsunami Signage Process

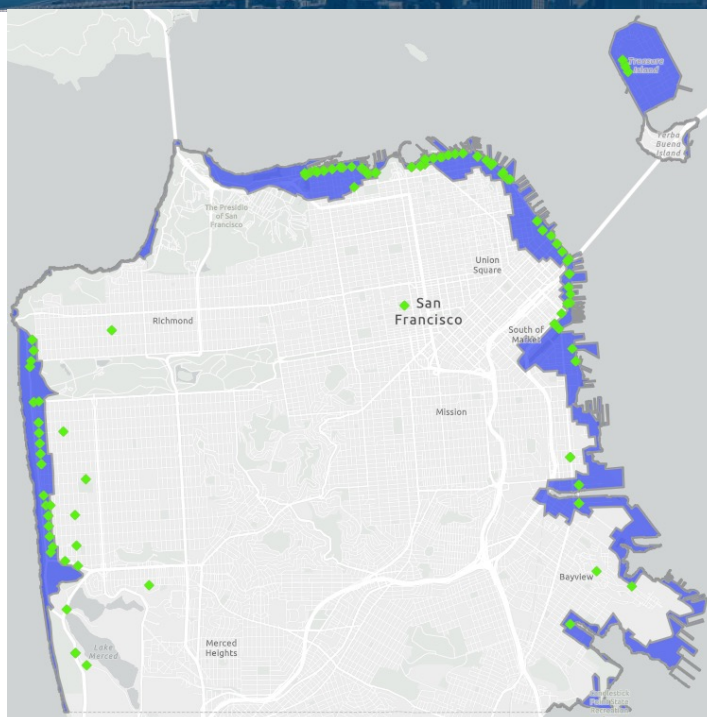


- Conducted extensive fieldwork validating existing tsunami signage
- Further analysis of San Francisco's updated tsunami hazard zones (THZ)
- Plan: install additional wayfinding signage to increase public safety when faced with tsunami threats.



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CCSF Current Tsunami Signage



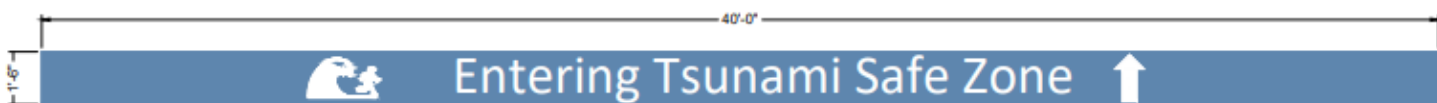
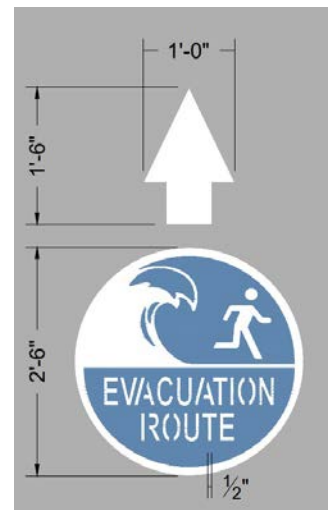
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Proposing: Incorporating the Blue Line / Blue Circle Project



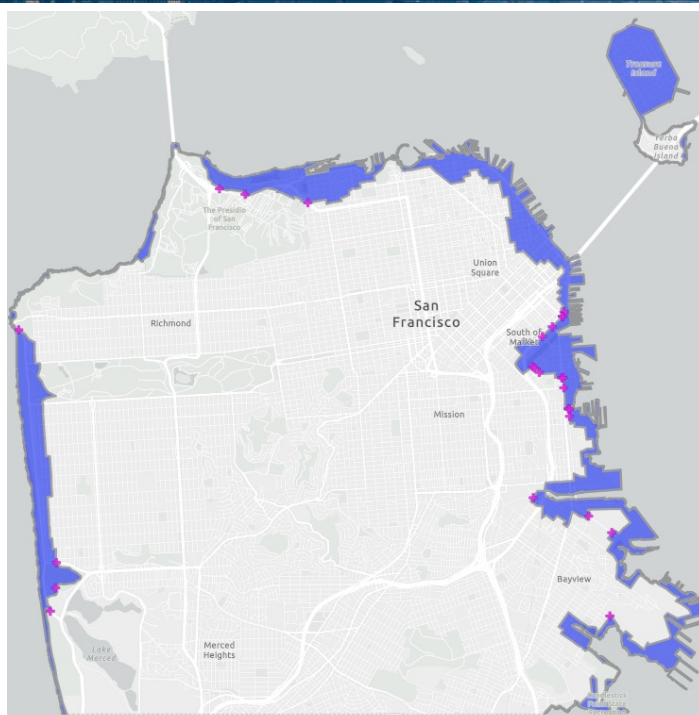
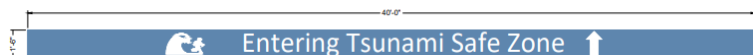
- The CCSF design would emphasize universal understanding
- Colors would be Light blue with white, to ensure drivers and pedestrians view them as other than exclusive traffic signs.
- Material has high reflectivity in darkness and antiskid properties
- CCSF would be incorporating Tsunami symbols & language within the single blue line.



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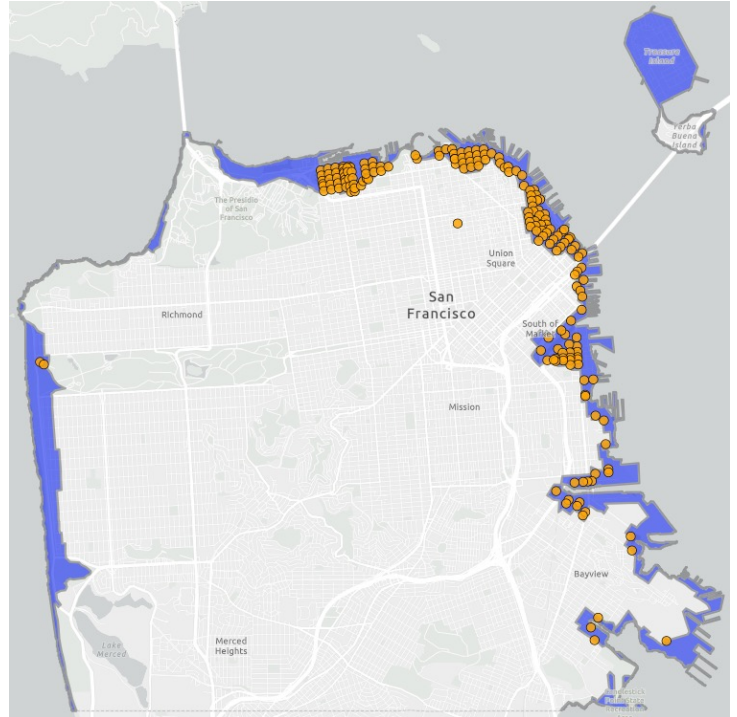
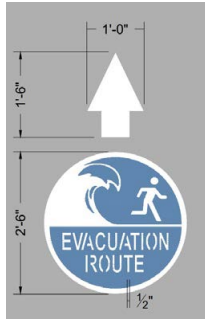
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Proposing CCSF Tsunami Blue Line Signage



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Proposing CCSF Tsunami Blue Circle Signage

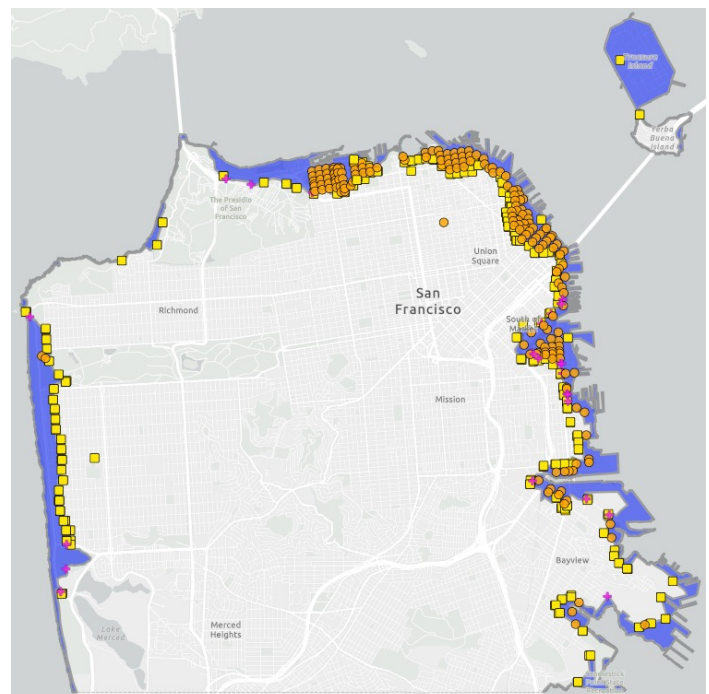


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Proposing CCSF Total Tsunami Signage- Hybrid Approach

Utilizing a Hybrid Approach:

- Traditional metal signs on metal posts
- Preformed Thermoplastic decals

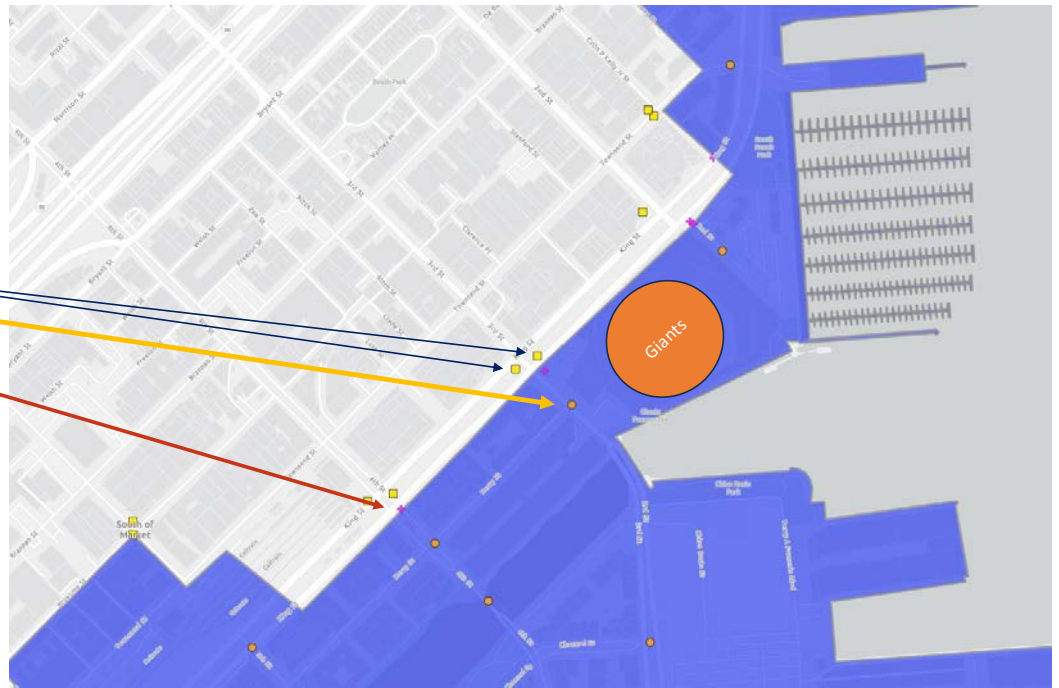


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Proposing CCSF Hybrid Approach – A Closer View

New Tsunami Signs

- METAL Sign
- CIRCULAR
- LINE



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Proposing CCSF New Signage Installation - Proposing Phased Approach 2024-2025

Phase 1: Traditional signage– entering & leaving

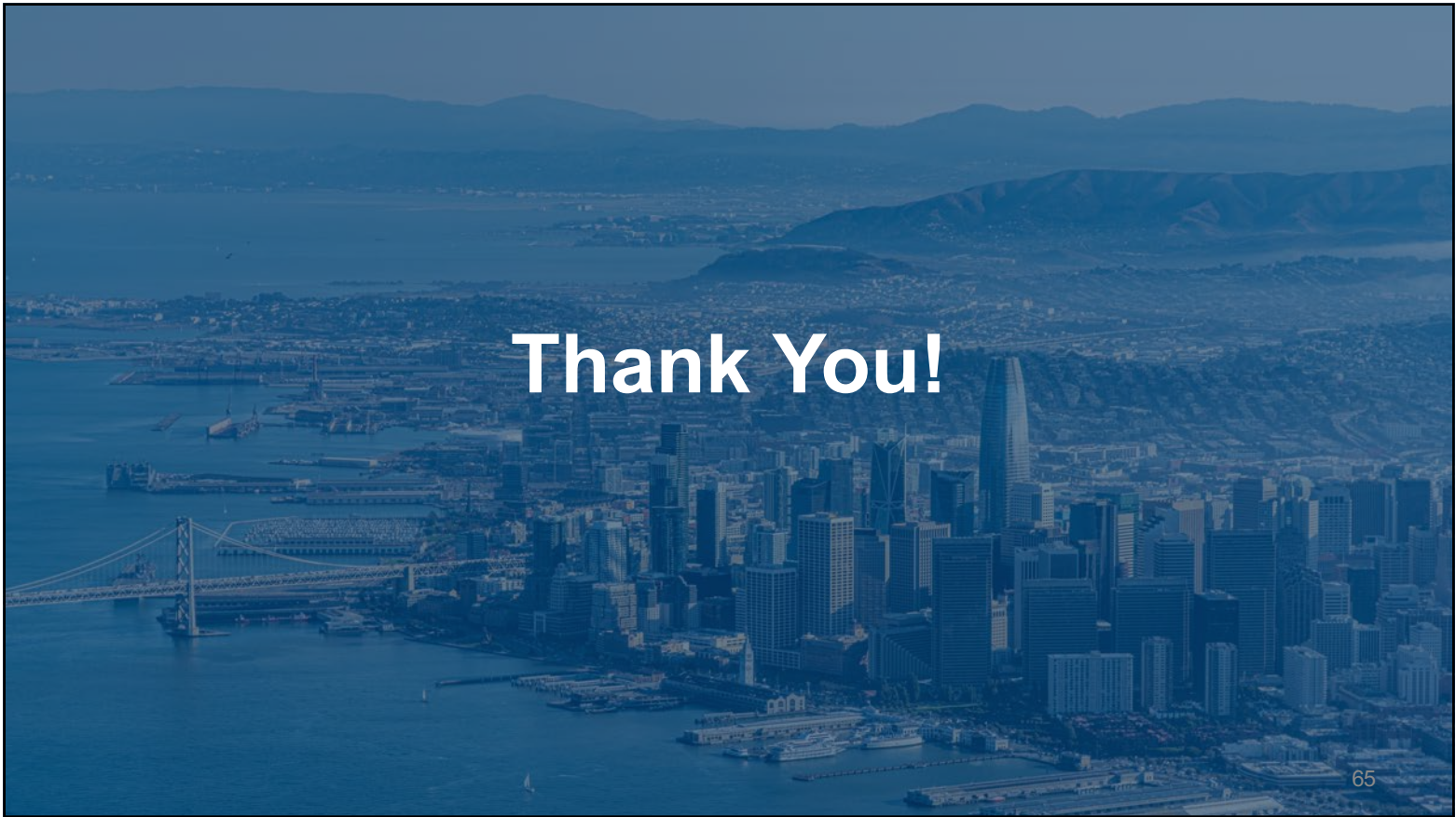
Phase 2: New signs, repairs and replacements

Phase 3: Blue Line/Circle Project

Phase 4: Kiosks

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Q&A

To be notified of future events and recordings, join ECA (free!):
[EarthquakeCountry.org/join](https://www.earthquakecountry.org/join)

Please take our survey:
[SurveyMonkey.com/r/CYBYR5T](https://www.surveymonkey.com/r/CYBYR5T)

Questions?
info@earthquakecountry.org

California Tsunami Preparedness Week

- March 23-31, 2024
- Activities coordinated locally across the state
- Register your activities, similar to ShakeOut participation.
- Hold a "Tsunami Walk"
- Become a TsunamiReady Community
- Many ways to participate!

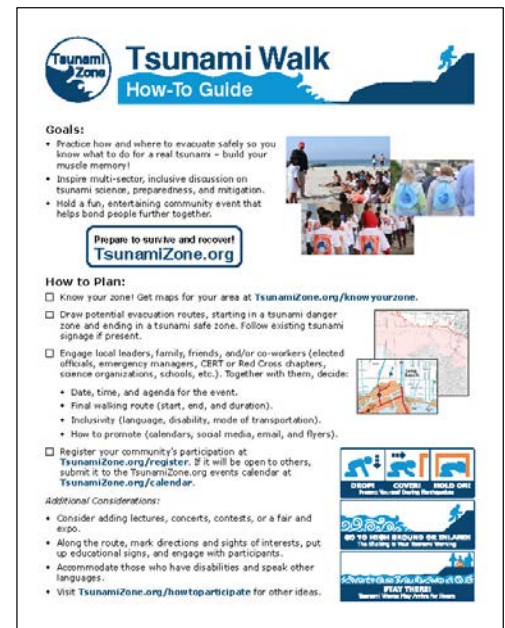


TsunamiZone.org/california

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California Tsunami Preparedness Week

- Attend a publicly organized tsunami walk drill
- **Organize your own tsunami walk drill**
- Participate in a boat evacuation drill
- Attend a Public Lecture
- Put together a preparedness kit
- Make a family plan
- Establish an out of town contact
- Participate in a work-related tsunami exercise
- Attend a commemorative event
- Re-tweet Tsunami Preparedness Info
- Participate in a school evacuation drill
- Watch a tsunami preparedness video
- Attend an open house at museum/government office
- Print out a map of your evacuation zone



TsunamiZone.org/california

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**Register your Tsunami Activities during
Tsunami Preparedness Week
(or any day of the year)**

[TsunamiZone.org/register](https://tsunamizone.org/register)

**If you are having an event open to the
public and/or news media, submit it
here:**

[TsunamiZone.org/calendar](https://tsunamizone.org/calendar)



TsunamiZone.org

**What is something that you:
learned
will do
will use
will tell others**

Please take our survey:
SurveyMonkey.com/r/CYBYR5T

Connect with ECA & TsunamiZone

- EarthquakeCountry.org
Terremotos.org
info@earthquakecountry.org



- TsunamiZone.org
info@TsunamiZone.org



Please take our survey:
[SurveyMonkey.com/r/CYBYR5T](https://www.surveymonkey.com/r/CYBYR5T)