

# The Multi-Level Approach to Maritime Tsunami Response



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AECOM



FEMA



USGS  
science for a changing world

# 2011 Tohoku Tsunami in California

- 2/3 of state in Warning; 1/3 in Advisory
- Strong currents/debris in harbor
- 27 harbors damaged in California
- Some vessels were taken offshore before tsunami's arrival
- Recovery – took 5 years in some harbors
  - Issues = dock/pile replacement, contamination clean-up, sediment removal, regulatory issues
  - Crescent City = half fishing fleet went elsewhere and did not return



Search "CGS 2011 tsunami in California"

*March 11, 2011 Tohoku Tsunami in California; video at 11AM (about 3 hours after first arrival of tsunami) within Santa Cruz Harbor*

# Lessons Learned from Recent Tsunamis in California

## Maritime Community Issues

- Each harbor/port had unique conditions causing different tsunami currents and damage
- Inconsistent response activities, including If/When/Where to reposition boats
- Need to better educate boat owners about tsunami hazards to help them make better decisions
- Ongoing recovery issues: What can be done to improve tsunami resistance (mitigation) and resilience (recovery) in harbors?



*March 2011:  
Tsunami destruction in Crescent City*



*March 2011:  
Tsunami surge in Santa Cruz Harbor*



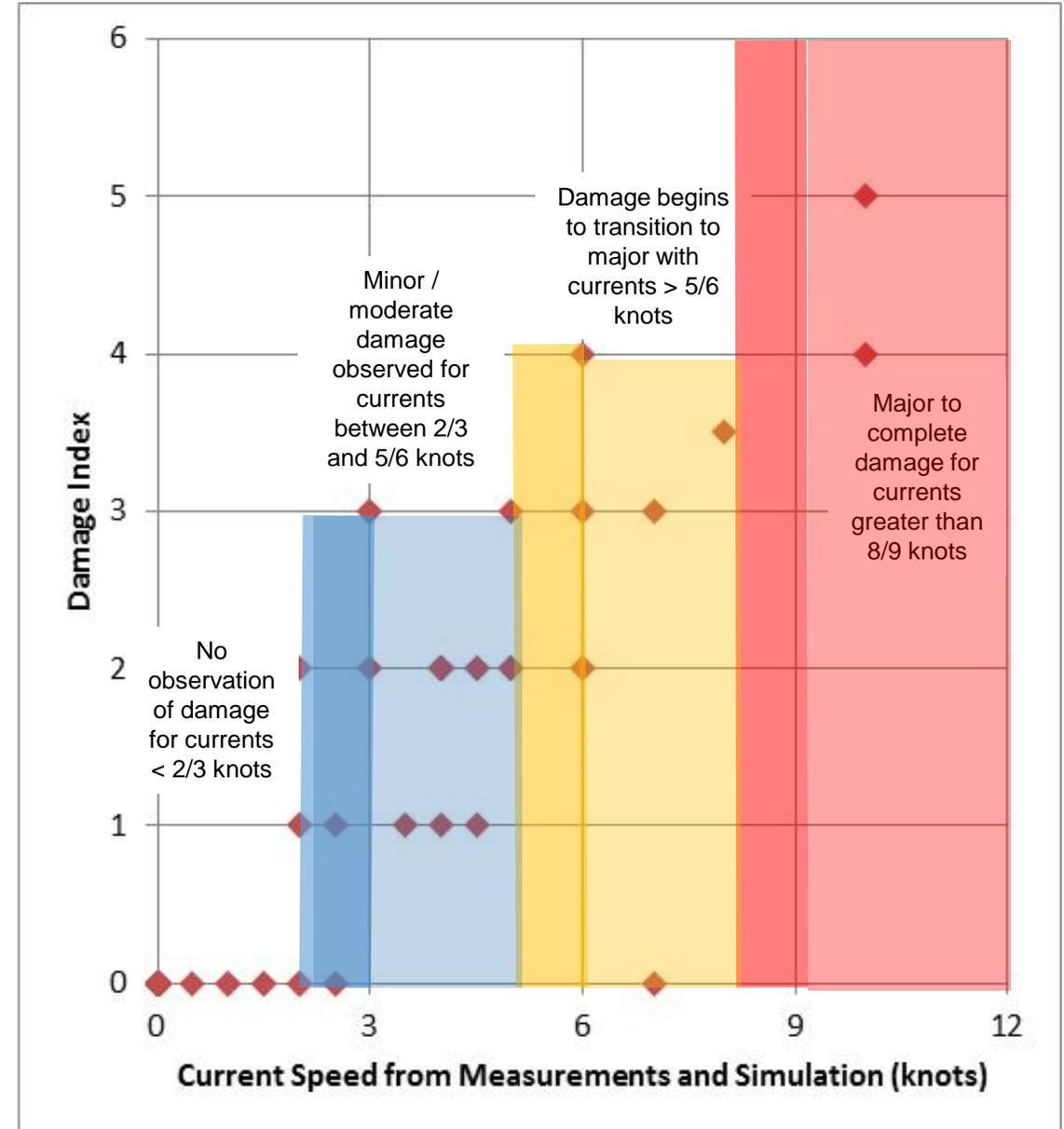
*March 2014:  
Rebuild in "tsunami resistant" Crescent City Harbor*

# Tsunami Current Hazard Modeling and Map Creation (led by partners at USC)

- Can we filter this information, create areas where certain levels of damage might be expected?
- Developed relationship between tsunami currents and damage
  - Based on previous observations of damage, and numerical hindcast & direct speed measurements at the damage location

Damage Index:	Damage Type:
0	no damage
1	small buoys moved
2	1-2 docks/small boats damaged, large buoys moved
3	Moderate dock/boat damage, mid-sized vessels off moorings
4	Major dock/boat damage, large vessels off moorings
5	Complete destruction

From Lynett and others (2013)



# History of Maritime Tsunami Response and Mitigation Products

- Received funding from FEMA to develop maritime response/mitigation products (2012)
- Developed Work Group and demonstration projects/products with 5 harbors/ports and US Coast Guard (2013)
- Draft Maritime Response Decision-Support “Playbooks” completed and evaluated by Work Group (2014)
- Because of unique nature of each harbor and port to tsunami currents and damage, completed 33 Playbook documents covering 70+ harbors and ports at risk to tsunamis (2015)
- Initiated work started on draft guidance for NTHMP (2015)

DRAFT 3/22/2017

California Maritime Tsunami Response Playbook  
[Combined, Excerpted version]

City and County of San Francisco  
North and East

2015-SF-01  
2015-SF-02

**DURING AN EMERGENCY, USE THE “QUICK REFERENCE” SHEET ON PAGES 32–33.**  
For the expanded Playbook format, use directions on pages 7–8.

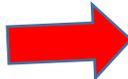


Source: California Maritime Tsunami Response Playbook No. 2015-SF-01  
California Maritime Tsunami Response Playbook No. 2015-SF-02

California Geological Survey  
California Governor’s Office of Emergency Services  
University of Southern California  
Humboldt State University  
National Oceanic and Atmospheric Administration



Funded by the Federal Emergency Management Agency and the National Tsunami Hazard Mitigation Program



**Quick Reference Page for Determining Maritime Tsunami Response Activities for CCSF-North**

**Step 1:** Obtain basic information about the earthquake and tsunami from National Tsunami Warning Center (NTWC), National Weather Service-Monterey office, or San Francisco Department of Emergency Management (SFDEM).  
 Earthquake location: \_\_\_\_\_  
 Earthquake magnitude: \_\_\_\_\_  
 Tsunami Alert level (circle one): WATCH ADVISORY WARNING  
 Closest forecasted tsunami amplitude/wave height: \_\_\_\_\_  
 Forecasted tsunami arrival time: \_\_\_\_\_

**NOTE:** Tsunami Alert Level may change in first couple hours after the earthquake. A WATCH may be upgraded to an ADVISORY or a WARNING.

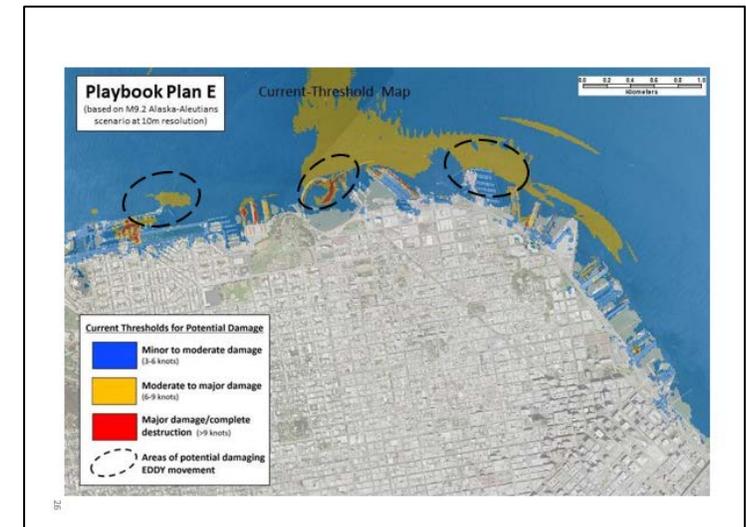
**Step 2 North:** Tsunami evacuation and response depend on the amount of time before tsunami arrival. Four hours is considered the threshold time needed for an officially-conducted evacuation. As a quick reference, the State offers the following guidance:

**If less than four hours before tsunami arrival:**

- ADVISORY - Evacuate beaches, harbor docks, and piers.
- WARNING - Evacuate maximum on-land evacuation zone, or follow guidance provided by SFDEM.

**If more than four hours before tsunami arrival, use the State/NWS recommended Playbook Plan, based on the Forecast Amplitude from Step 1, as “Peak Amplitude” in the table to the right to identify the response plan to use.**

PEAK AMPLITUDE IN BAY (in meters, above existing conditions)	SCENARIO PLAYBOOK PLAN LETTER	PLAYBOOK REFERENCE PAGES
< 0.2	No action	
0.5	A	Pages 9–10
0.7	B	Pages 13–14
1.0	C	Pages 17–18
1.2	D	Pages 21–22
2.5 +	E	Pages 25–26

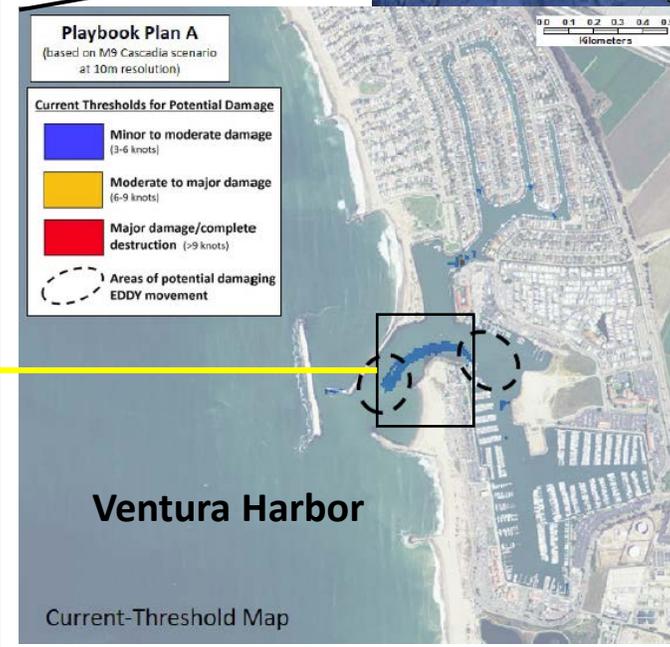


# REAL-TIME USE OF PLAYBOOKS

September 16-17, 2015 Tsunami from Chilean M8.3 EQ

- 15 ports and harbors within 5 county Tsunami Advisory zone
- State recommended minimum Playbook Plan (Plan "A") in real-time
- Many harbors used Maritime Response and Mitigation Playbooks during event, monitoring activity around areas projected to have moderate to high-damaging currents

*Tsunami currents entering Ventura Harbor 9-17-15; video from Dr. Pat Lynett.*



# Recent San Francisco Bay Area and Santa Cruz County Workshops

## Purpose:

- Help community & harbor officials become familiar with
- Practice using tsunami evacuation and maritime playbooks in response to a trans-Pacific tsunami.

## Exercise:

- Walked through the scenario by evaluating Tsunami Information Statements.
- Communities and harbor review the information and determine what response actions they should/will take.
- Discuss what/why decisions were made.

# Maritime Tsunami Response Playbooks

## Real-time recommendation from State and NWS:

### Playbook Plan E

(based on M9.2 Eastern Aleutian-Alaska Scenario)

#### Background Information:

Alert level = Warning

Peak Amplitude = 2.2+ meters

Peak Velocity = 9 knots

Projected duration of strong currents (see location maps below):

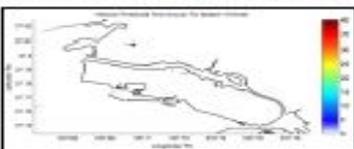
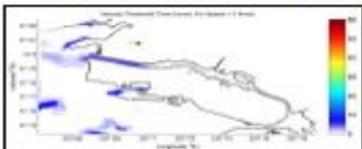
3-6 knots = 20 hrs; 6-9 knots = 10 hrs; >9 knots = 3 hrs

#### Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 5)
- Inundation of dry land could occur in this scenario
- Strong currents and potential scour are expected in areas identified in blue, yellow-red on the map to the right. Consider relocating vessels located within 100 meters (300 feet) of these areas.
- Specific areas where vessels should be relocated from and docks secured: **(completed with maritime community input)**

Safe areas for repositioning vessels within the Oakland/Alameda maritime communities: **(completed with maritime community input)**

Time thresholds for currents >3 knots ..... >6 knots ..... >9 knots  
(Colors below represent HOURS of potential activity for blue, yellow, and red zones on opposite sides of the map)

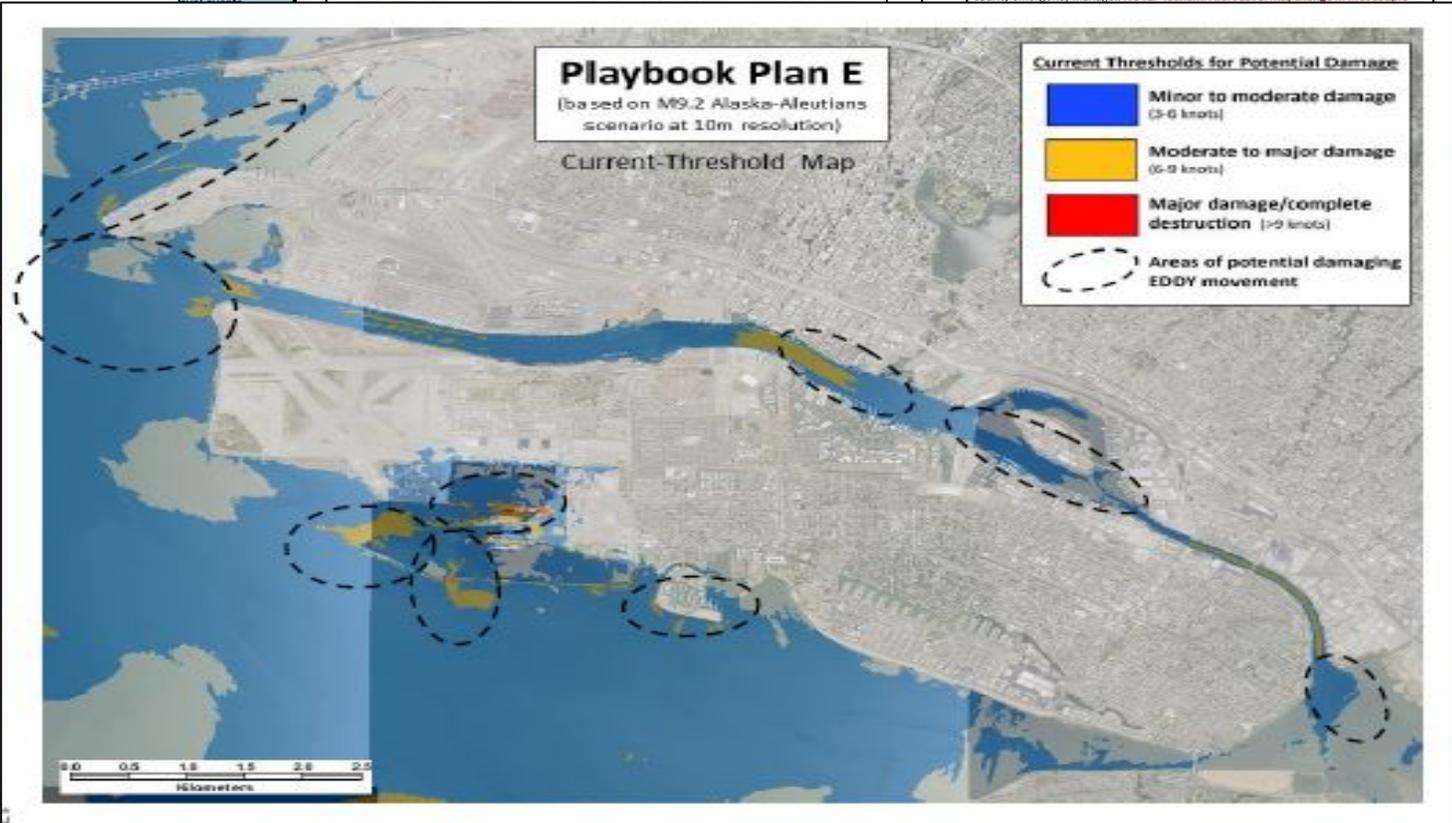


California Maritime Tsunami Response Playbook And Mitigation Guidance

Oakland/Alameda – Alameda County

APPENDIX  
Quick Reference Page for Determining Real-Time Maritime Tsunami Response Activities

Step 1: Obtain basic information about the earthquake and tsunami from National Tsunami Warning Center in Alaska, regional National Weather Service office, and/or county emergency manager. NOTE: Tsunami Alert Level may change in first couple





## First State-County conference call held at : 11:15AM

- State Operations Center will send out **automated notification** via about call at about 11:00AM.
  - To our established contact **distribution list** (20 counties + harbors +)
- CalOES Tsunami Duty Officer/Regions will lead the call.
  - **Background context** about the earthquake and tsunami will be provided, as well as discussion about the tsunami alert status.
  - Extra information provided by the National Tsunami Warning Center will be shared, including possibly **first arrival times**.
  - Duty Officer will ask **California Geological Survey SME** to provide any additional information,
    - ❖ including specifics about the earthquake rupture,
    - ❖ similar historical tsunamis, and
    - ❖ expected tidal conditions in the first 6 hours of tsunami activity.
  - Duty Officer will ask if the **National Weather Service SME** can provide additional coastal conditions, such as storm activity.
- County EM's will have an opportunity to **ask questions/provide details**.

WEAK53 PAAQ  
TSUAK1

Tsunami Information Statement Number 1  
NWS National Tsunami Warning Center Palmer AK  
1015 AM PDT WED Mar 29 2017

...THIS IS A TSUNAMI INFORMATION STATEMENT FOR ALASKA, BRITISH COLUMBIA,  
WASHINGTON, OREGON AND CALIFORNIA...

### EVALUATION

- \* Earthquakes of this size are known to generate tsunamis potentially dangerous to coasts outside the source region.
- \* The U.S. National Tsunami Warning Center is analyzing the event to determine the level of danger.
- \* More information will be issued as it becomes available.
- \* This earthquake has the potential to generate a destructive tsunami in the source region.

### PRELIMINARY EARTHQUAKE PARAMETERS

\* The following parameters are based on a rapid preliminary assessment and changes may occur.

- \* Magnitude 8.2
- \* Origin Time 0900 AKDT March 29, 2017  
1010 PDT March 29, 2017  
1800 UTC March 29, 2017
- \* Coordinates 45.0 North 150.0 West
- \* Depth 6 miles
- \* Location near southern Kuril Islands

### ADDITIONAL INFORMATION AND NEXT UPDATE

- \* Refer to the internet site [ntwc.arh.noaa.gov](http://ntwc.arh.noaa.gov) for additional information.
- \* Pacific coastal regions outside California, Oregon, Washington, British Columbia and Alaska should refer to the Pacific Tsunami Warning Center messages at [ptwc.weather.gov](http://ptwc.weather.gov).
- \* The next message will be issued in 30 minutes to keep you informed of the progress of this event.

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Provided by CalOES and  
NWS at: 11:45 AM



# TSUNAMI PLAYBOOKS for SantaCruz County

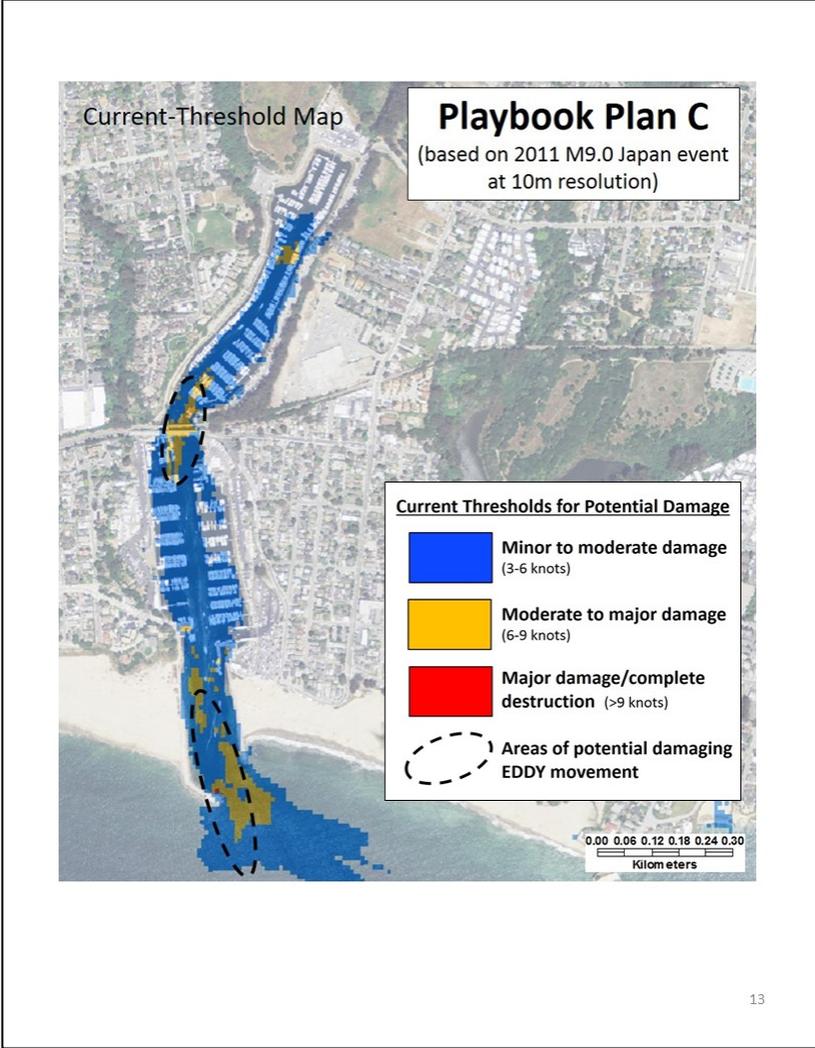
**RECOMMENDED MINIMUM TSUNAMI EVACUATION AND MARITIME RESPONSE PLAYBOOK PLANS** - The following tables provide recommendations for evacuation and maritime response planning for each California community and harbor, respectively. The recommended Evacuation Phase number in Column Two (e.g. Phase 1, Phase 2, etc.) indicates the MINIMUM area to be evacuated by the community according to your emergency response evacuation plan. The recommended Maritime Response Plan letter in the middle column (e.g. Plan A, Plan B, etc.) indicates the MINIMUM Playbook Response plan which should be used by ports, harbors, and marinas covered by that particular response plan.

**NOTE:** Tsunami evacuation and response activities are the responsibility of the coastal community. This information is provided in support of the Tsunami Evacuation and Maritime Response Playbook Programs and should only be used if the communities/harbors have Playbooks developed and integrated into the tsunami evacuation and response plans. We do NOT recommend using this information unless you fully understand what it means and have the Playbook plans in place. If you do not have Playbooks in place, use your normal evacuation and response plans for Warning or Advisory level events.

Coastal Location	Recommended Minimum Tsunami Evacuation Playbook	FASTER flood elevation (in feet)	FASTER flood elevation (in meters)
Davenport	Phase 3	7.66 ft	2.33 m
Natural Bridges	Phase 3	7.91 ft	2.41 m
Santa Cruz	Phase 3	7.91 ft	2.41 m
Capitola	Phase 3	7.91 ft	2.41 m
Seacliff/Soquel	Phase 3	6.91 ft	2.11 m
Aptos	Phase 3	6.91 ft	2.11 m
Rio Del Mar	Phase 3	6.91 ft	2.11 m
La Selva Beach	Phase 3	6.91 ft	2.11 m
Pajaro Dunes	Phase 3	7.54 ft	2.30 m
Maritime Location	Recommended Minimum Maritime Tsunami Playbook	Amplitude (in feet)	Amplitude (in meters)
Santa Cruz Harbor	Plan C	4.30 ft	1.31 m

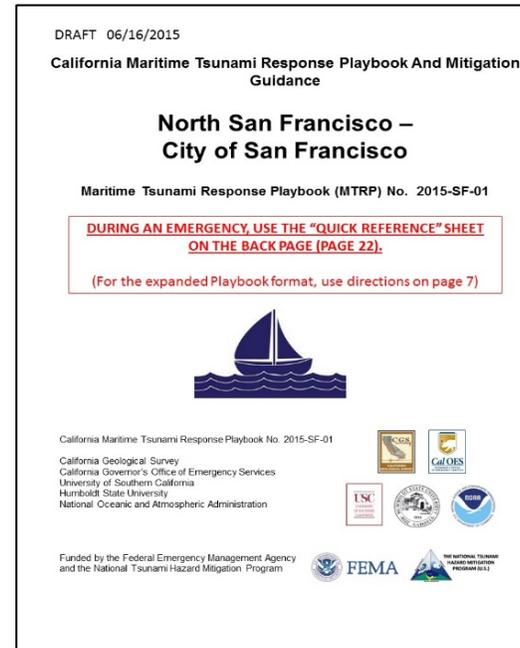
NOTE: This Information has been reviewed by the State of California and NOAA National Weather Service.

# Evacuation and Maritime Playbooks for Exercise Scenario



# Maritime Tsunami Response Playbooks Benefits

1. Identifies areas where strong currents and damage occurs, as well as where safe areas may exist
2. Provides multiple response options based on tsunamis of different sizes (Advisory/minor Warning events)
3. Real-time MINIMUM response recommendation for events from a distant source
4. Helps with consistent response activities
5. Projected time of dangerous currents, and sediment/debris movement models also available



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tsunami

# CALIFORNIA

## How should boat owners PREPARE for tsunamis?

*Prior to arrival of the March 11, 2011 tsunami along the California coast, many boat owners took their boats offshore without adequate supplies or knowledge of how long they would need to stay offshore. As a result, boaters tried to re-enter harbors too early, while dangerous tsunami conditions still existed. They put themselves and harbor personnel at risk of injury and death.*

Before you plan to leave safe harbor, consider the following:

- **Talk to the harbor master** or related officials to learn about your harbor's tsunami safety protocols.
- **Sign up to receive tsunami alerts** from NOAA and emergency calls from your harbor master or community emergency services office.
- **Know weather conditions** out on the ocean.
- **Know how long it takes your boat to get to deep water.** The 100-fathom line is the NOAA recommendation.
- **Have adequate supplies** (water, shelter, food) and fuel to remain at sea for 24 hrs or more.
- **Have a family plan** for tsunamis in place so you know your family will be safe.

If you do not have these essential preparedness items covered, **DO NOT attempt to bring your boat offshore.** Secure your boat to the dock and leave the dock area before the tsunami arrives.



## Other resources for tsunami information in California

Information about tsunamis can come from a variety of sources, but the following sources are the most reliable:

- Harbor masters and port captains
- Local Coast Guard contact
- State and local emergency managers
- Local National Weather Service – Weather Forecast Offices

State of California Tsunami Program  
(California Geological Survey website):  
[www.tsunami.ca.gov/](http://www.tsunami.ca.gov/)

California Emergency Management Agency Earthquake and Tsunami Program:  
[www.calema.ca.gov/PlanningandPreparedness/Pages/Tsunami-Preparedness.aspx](http://www.calema.ca.gov/PlanningandPreparedness/Pages/Tsunami-Preparedness.aspx)

NOAA tsunami website: [www.tsunami.gov](http://www.tsunami.gov)

NOAA – National Weather Service (NWS)  
Weather Forecast Offices:  
Eureka – [www.weather.gov/eka/](http://www.weather.gov/eka/)  
San Francisco Bay/Monterey – [www.weather.gov/mtr/](http://www.weather.gov/mtr/)  
Los Angeles/Oxnard – [www.weather.gov/lox/](http://www.weather.gov/lox/)  
San Diego – [www.weather.gov/sdx/](http://www.weather.gov/sdx/)

Sign up for NWS alerts and updates by email:  
[www.weather.gov/emailupdates/index.php](http://www.weather.gov/emailupdates/index.php)

Redwood Coast Tsunami Work Group/ Humboldt State University:  
[www.humboldt.edu/rctwg/](http://www.humboldt.edu/rctwg/)

California Harbor Master and Port Captain Association:  
[www.harbormaster.org/](http://www.harbormaster.org/)

Marine Recreation Association:  
[marina.org](http://marina.org)

CA Boating Safety Officers Association:  
[cbsoa.org](http://cbsoa.org)

# TSUNAMIS!

What  
**BOATERS**  
should know



富嶽三十六景 神奈川沖  
浪表

**Thank You!**

[TsunamiZone.ca.gov](http://TsunamiZone.ca.gov)

[tsunami.ca.gov](http://tsunami.ca.gov)

[myHazards.CalOES.ca.gov](http://myHazards.CalOES.ca.gov)