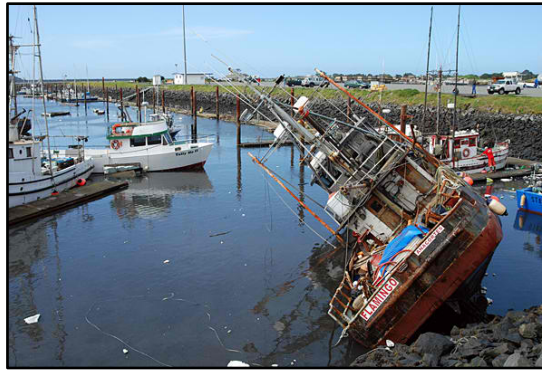
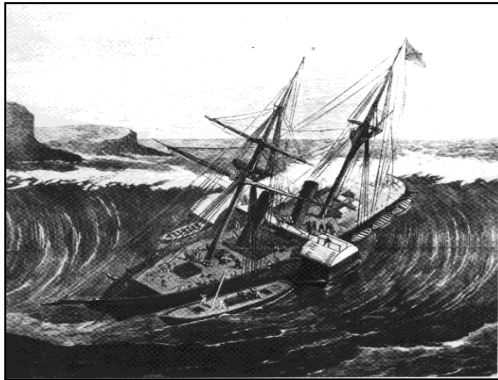
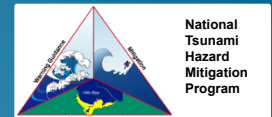


Boat Harbors & Shipping Ports during Tsunamis



**Kevin Miller, CA Governor's Office of Emergency Services
Members of the National Tsunami Hazard Mitigation Program
and Research Partners:**

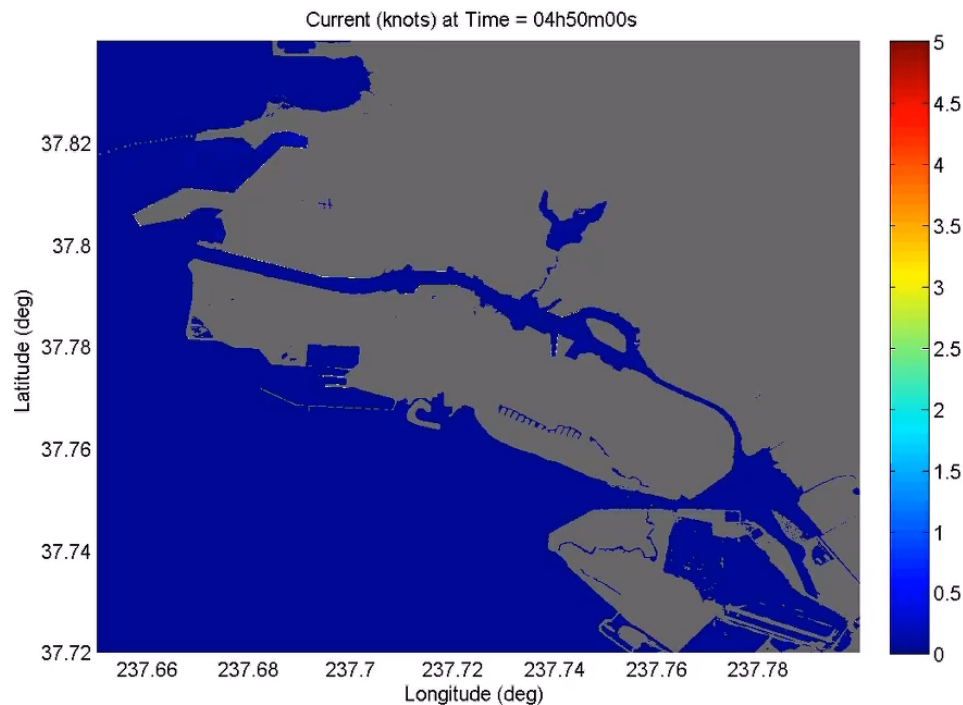


Rick Wilson, California Geological Survey; Amanda Admire, Humboldt State University; Jose Borrero, University of Southern California; Ed Curtis, Federal Emergency Management Agency; Lori Dengler, Humboldt State University; Martin Eskijian, California State Lands Commission; Laurie Johnson, Laurie Johnson Consulting; Patrick Lynett, University of Southern California; Dmitry Nicolsky, University of Alaska, Fairbanks; Cindy Pridmore, California Geological Survey; Jeri Siegel, CA Governor's Office of Emergency Services; Hong Kie Thio, URS Corporation

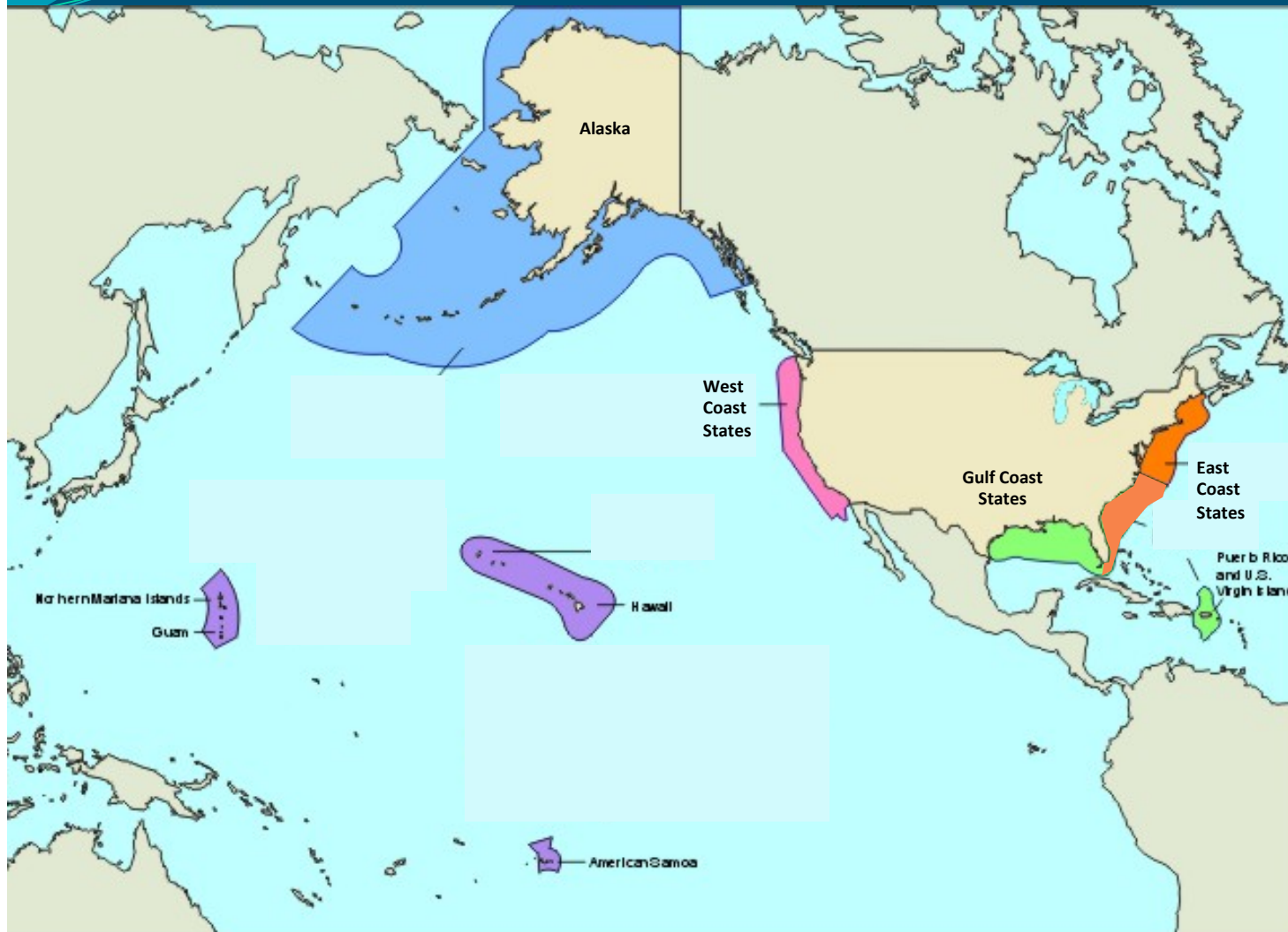
Tsunami Maritime Safety Planning

1. Create in-harbor current hazard maps
2. Create offshore safe depth evacuation zone
3. Provide guidance and outreach
4. Consistent national policy for maritime evacuation

Simulation of currents from USGS SAFRR Alaska Scenario for Alameda Island



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)



National
Tsunami
Hazard
Mitigation
Program



Maritime Community Support Goals



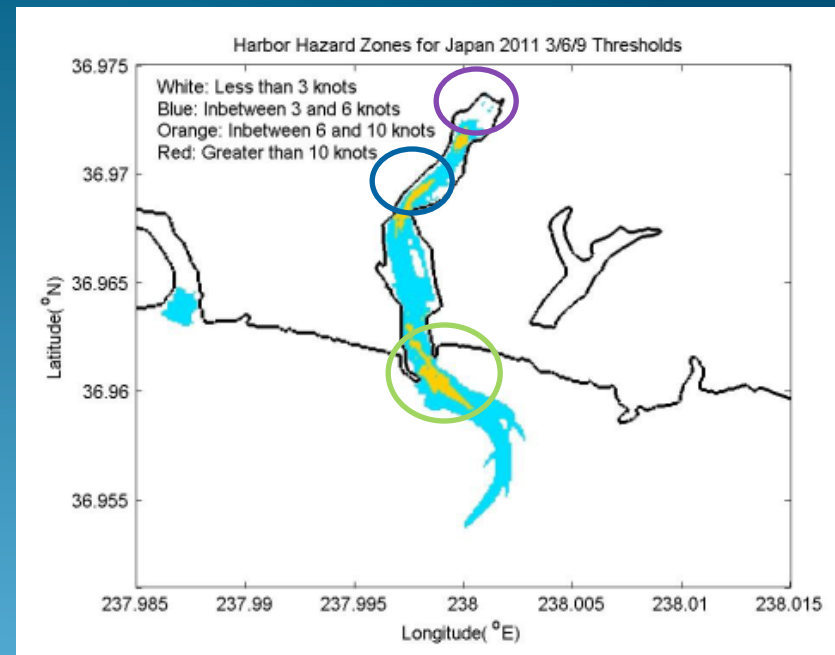
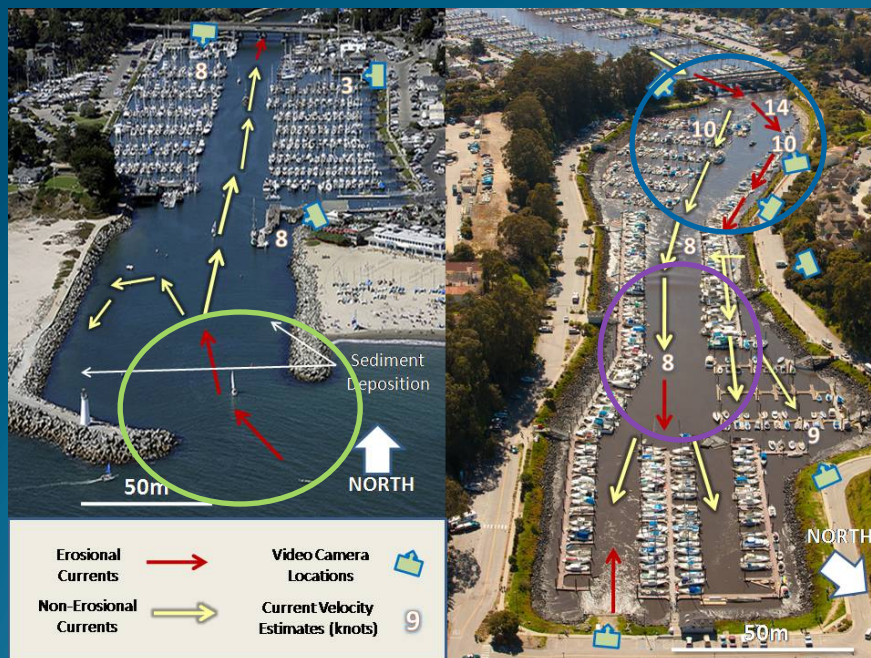
- Promote accurate, consistent decision-making products
- Facilitate emergency harbor response planning activities
- Depict areas in danger and safe from tsunamis
- Create maps through thorough assessment of local risks



Maritime Safety Products

Analysis of 2010 and 2011 tsunamis in pilot study harbors
Crescent City, Santa Cruz, Ventura, Ports of LA/Long Beach,
and San Diego Bay

Video and other analyses of observed currents used to validate currents
from numerical models

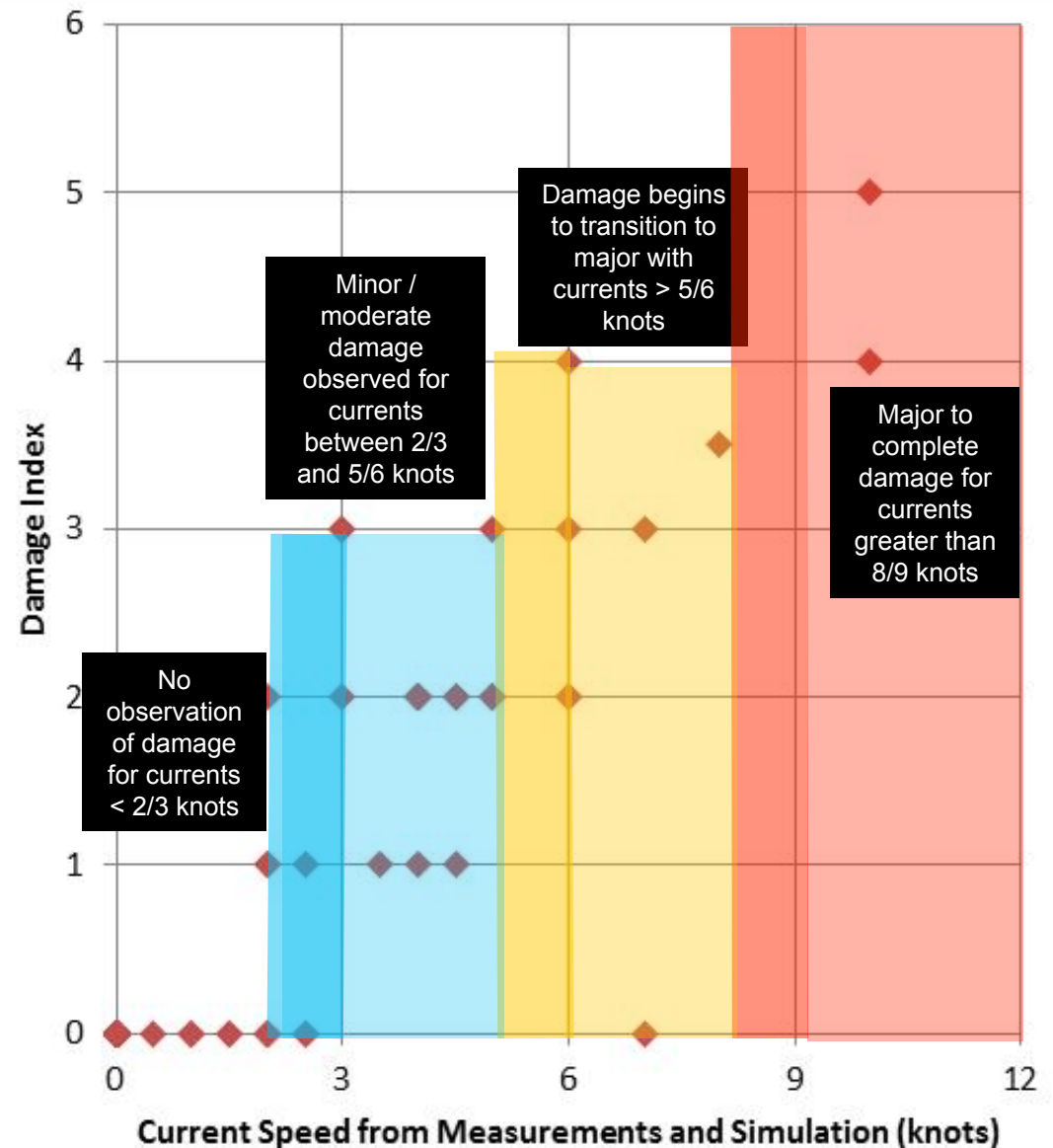


*March 11, 2011 tsunami in Santa Cruz; from Wilson and others, 2012, and
Lynett and others, 2013*

Tsunami Current Hazard Maps

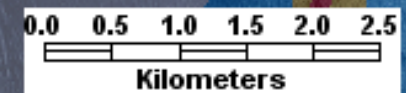
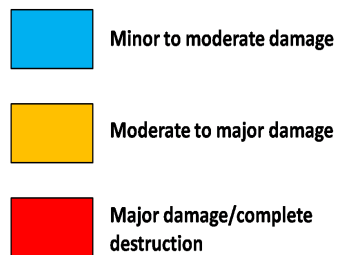
Damage Index:	Damage Type:
0	no damage
1	small buoys moved
2	1-2 docks/small boats damaged, large buoys moved
3	Moderate dock/boat damage, mid-sized vessels off moorings
4	Major dock/boat damage, large vessels off moorings
5	Complete destruction

From Lynett and others (2013)



M9.2 Alaska-Aleutian Scenario 10m resolution

Current Thresholds for Potential Damage



Duration of Damaging Currents

Playbook Plan D (based on M9.4 North Chile Scenario)

Background Information:

Alert level = Warning

Peak Amplitude = 1.2 meters (modeled)

Peak Velocity = 7 knots

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

3-6 knots = 30 hrs; 6-9 knots = 10 hrs; 9 knots = 0 hrs

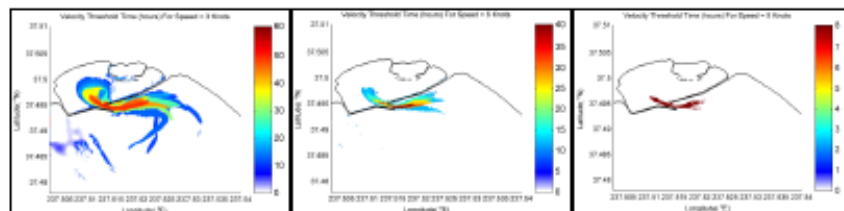
Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 5)
- Inundation of dry land around the bay may 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 100 meters (300 feet) away from these areas.
- Specific areas where vessels should be relocated and docks secured:
 - (completed with maritime community input)

Safe areas for repositioning vessels within Pillar Point Harbor:

..... (completed with maritime community input)

Time thresholds for currents >3 knots.....>6 knots.....>9 knots
(Colors represent HOURS of potential activity)



14

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

Background Information:

Alert level = Warning

Peak Amplitude = 5+ meters (modeled)

Peak Velocity = 9+ knots

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

3-6 knots = 40 hrs; 6-9 knots = 15 hrs; 9 knots = 5 hrs

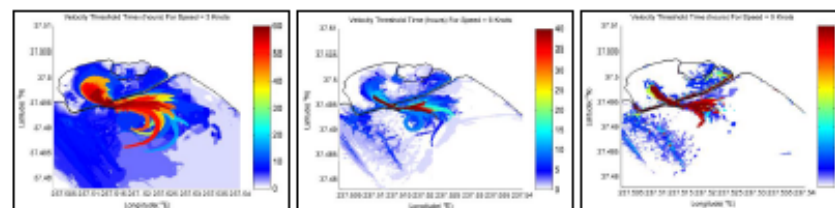
Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 5)
- Inundation of dry land around the bay will 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 100 meters (300 feet) away from these areas.
- Specific areas where vessels should be relocated and docks secured:
 - (completed with maritime community input)

Safe areas for repositioning vessels within Pillar Point Harbor:

..... (completed with maritime community input)

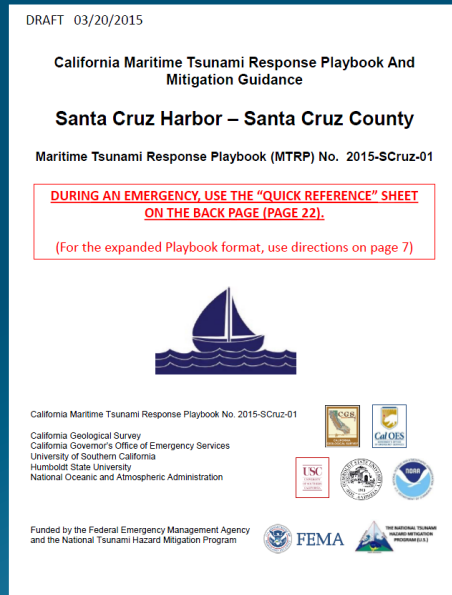
Time thresholds for currents >3 knots.....>6 knots.....>9 knots
(Colors represent HOURS of potential activity)



16

Maritime Response Playbooks

****Draft Maritime Playbook for Santa Cruz Harbor now available****



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 hours after the earthquake; WATCH may be upgraded to ADVISORY or WARNING.**

Earthquake location _____
Earthquake magnitude _____
Tsunami Alert level (circle one) WATCH ADVISORY WARNING
Closest forecasted tsunami amplitude/wave height _____
Forecasted tsunami arrival time _____

Step 2: Tsunami evacuation and response will depend on the amount of time before the tsunami arrival. Four (4) hours is considered the threshold time needed for evacuation. As a quick reference, we offer the following guidance:

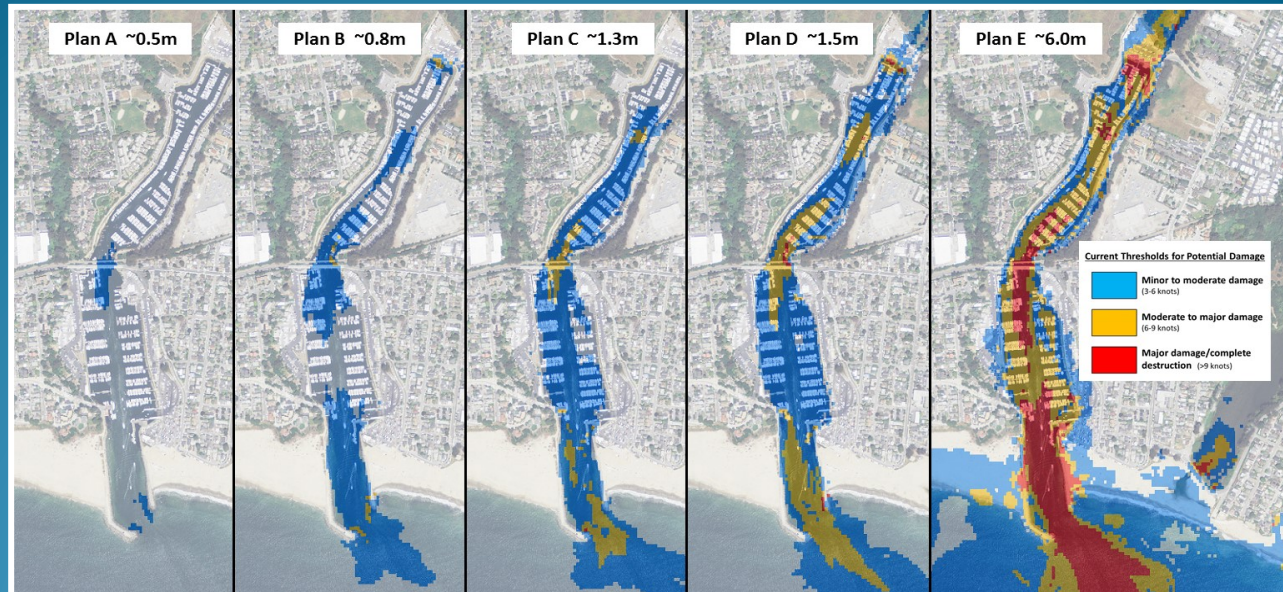
1) **If less than four hours before tsunami arrival, we recommend the following:**

- ADVISORY – evacuate beaches, harbor docks, and piers
- WARNING – evacuate entire maximum on-land evacuation zone, or follow guidance provided by local emergency manager

Reference Pages for Details in Maritime Playbook	Scenario Playbook Plan Letter	Peak Amplitude/wave height (in meters above existing conditions at harbor entrance)
	(No action)	0.2
Page 8-9	A	0.5
Page 10-11	B	0.8
Page 12-13	C	1.3
Page 14-15	D	1.5
Page 16-17	E	6

2) **If greater than four hours before tsunami arrival, and your harbor has fully developed its tsunami response Playbook plans, the harbor can utilize the FORECAST AMPLITUDE from Step 1 on the table on the right to identify the appropriate response plan to use.**

22



Maritime Response Playbooks

APPENDIX

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

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Reference Pages for Details in Maritime Playbook	Scenario Playbook Plan Letter	Peak Amplitude/ wave height (in meters)
	(No action)	0.3
	(No action)	0.4
Page 8-9	A	0.6
		0.9
Page 10-11	B	1.8
Page 12-13	C	2.5
Page 14-15	D	4.0
Page 16-17	E	10+

Each of the over 70 communities in California will get a tsunami forecast value for their location and a recommendation on which associated “phase Playbook” could be followed for the response activities in real time.

The maritime community can refer to the playbook guidance document for the specific instructions to follow.

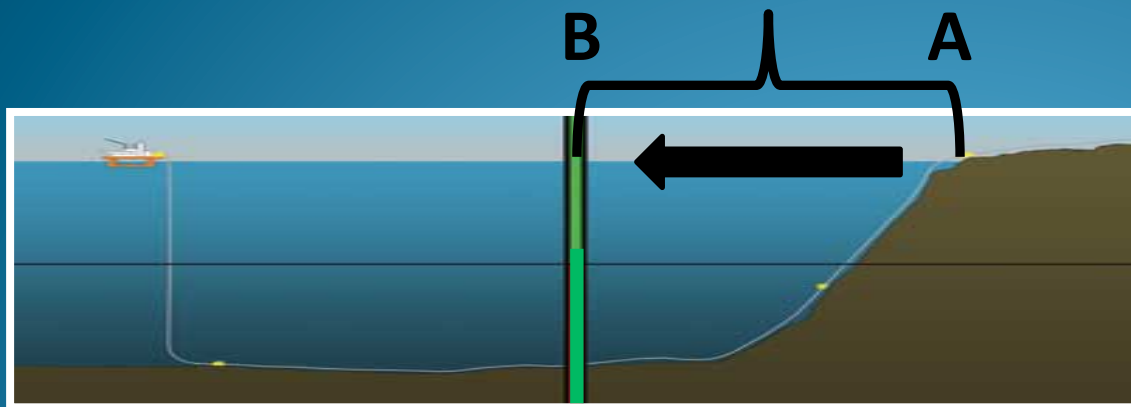
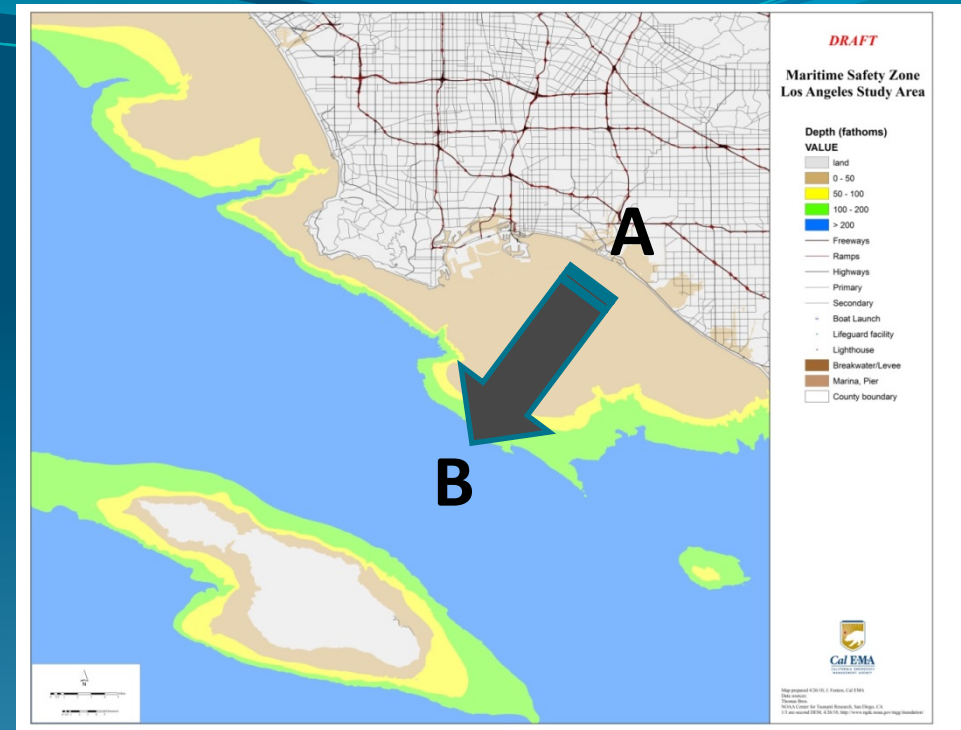
The background is a solid blue color with a gradient. At the top, there are several thin, wavy lines in lighter shades of blue and teal, creating a sense of movement or waves. The text is centered in the middle of the image.

Minimum Offshore Safe Areas for Maritime Evacuation In California and Rest of U.S.

Offshore Safety Zones for Maritime Community

Given a tsunami Warning or Advisory, how long does it take to get from?

- Point “A” - Feet on the dock to
- Point “B” - Safe Offshore Depth

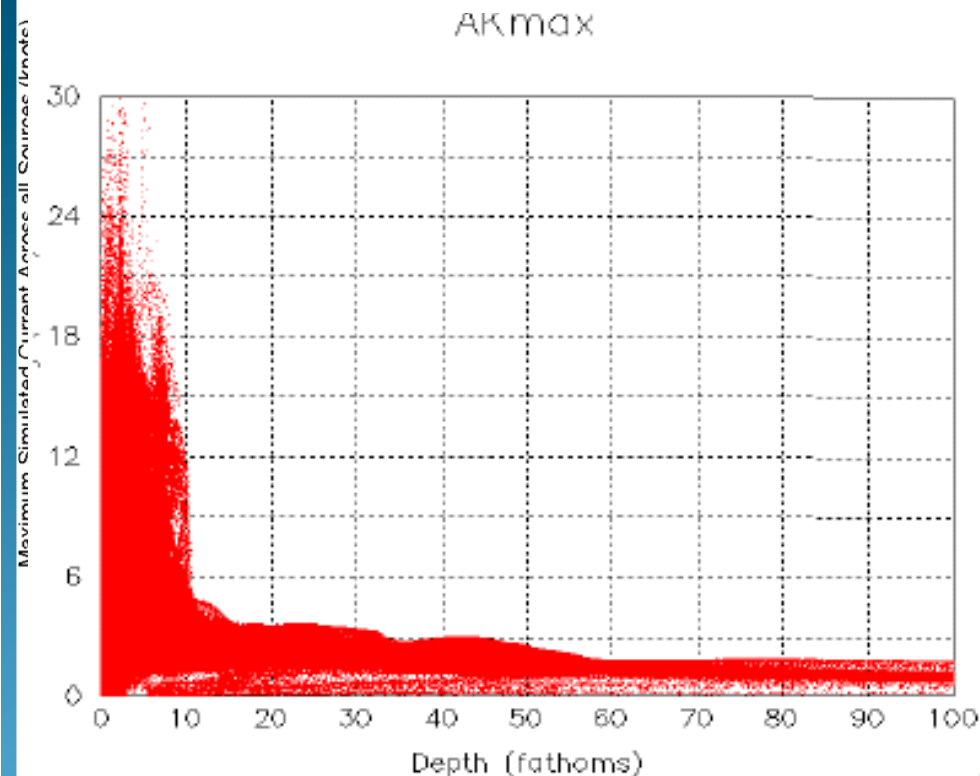


180 FEET

**Working with NOAA
and NTHMP
partners a “Rule of
thumb” for safety
has been 100
fathoms (600 feet)**

Safe Depth for Offshore Evacuation

- Ran simulations for range of different distant and local sources at five locations (from Lynett and others, 2013)
- Plot the max current vs. depth for each source as scatter plot
- Determined current variability at all depths
- Currents above 3 knots (1.5 m/sec) are considered the threshold for potentially causing damage
- Depth where low variable, straight-line 2-3 knot currents occur beyond 25 fathoms
- State Steering Committee accepts 30 fathoms (180 feet) as MINIMUM safe depth for offshore evacuation



1 fathom = 1.8 meters = 6 feet

Recommendation Results for Minimum Offshore Depth U.S. States and Territories (to date)

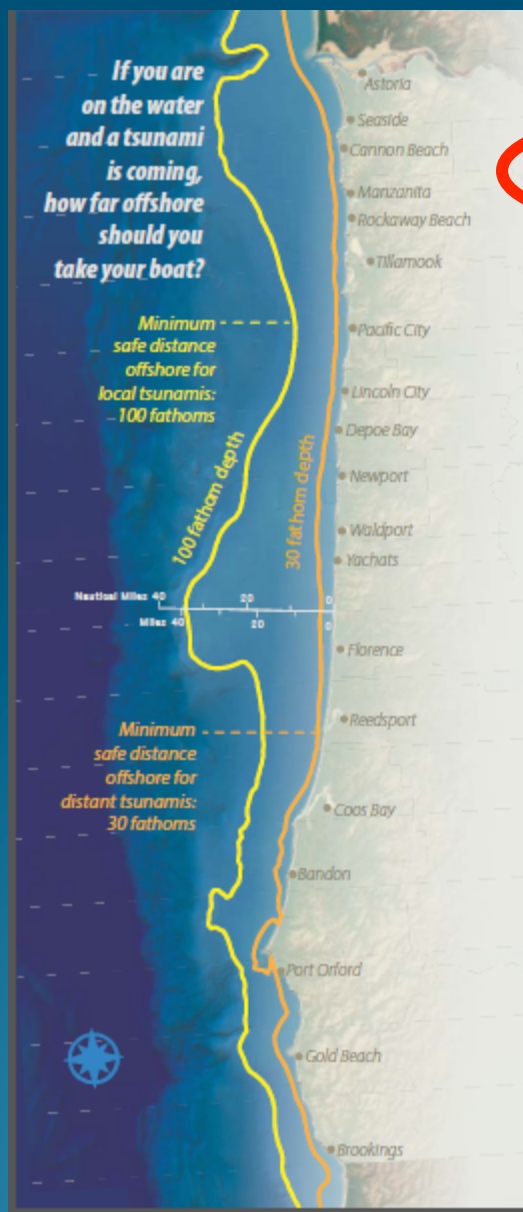
State/Territory	Distant Source (ships in harbor)	Local Source (ships at sea)	Notes
California	30 fathoms	100 fathoms	Evaluated; following Oregon recommendation for local source
Oregon	30 fathoms	100 fathoms	Evaluated
Hawaii	50 fathoms		Evaluated; implemented in Coast Guard plan in some locations
Alaska			Still evaluating
Washington			Still evaluating; forming state harbor advisory group
Caribbean	50 fathoms	50 fathoms	General recommendation
Gulf Coast			Still evaluating
East Coast			Still evaluating
American Samoa			Evaluating, guidance from others
Guam			Evaluating, guidance from others
CNMI			Evaluating, guidance from others

OREGON

If you are on the water and a tsunami is coming, how far offshore should you take your boat?

Minimum safe distance offshore for local tsunamis: 100 fathoms

Minimum safe distance offshore for distant tsunamis: 30 fathoms



WHAT TO DO WHEN A TSUNAMI STRIKES

What to do depends on what type of tsunami occurred and where you are

Distant Tsunamis

You generally have at least 15 minutes after the initial earthquake to take action.

If you are on the water

- Check with the US Coast Guard (USCG) before taking any action. If advised that offshore evacuation is an option and this option looks practical for your vessel, proceed to a staging area **greater than 30 fathoms (180 ft)**. If conditions do not permit, dock your boat and get out of the tsunami evacuation zone.

If you are on land or tied up at the dock

- Your choices are to a) evacuate out to sea beyond 30 fathoms, b) leave your vessel and evacuate out of the distant tsunami inundation zone, or c) go upriver. **DO YOUR HOMEWORK** before the event to understand how practical these options are for the largest distant tsunamis that might strike your area. Check with local authorities and www.oregontsunami.org for information.
- Check with local authorities before taking any action. Most distant tsunamis are small enough that it is safer to keep your boat docked. Congestion in the waterway or among those trying to pull boats out with trailers can create serious problems. Sea and weather conditions may be more dangerous than the tsunami! Get yourself out of the tsunami evacuation zone.

After the tsunami

- If in an offshore staging area**, check with the USCG for guidance before leaving the staging area; conserve fuel by drifting until you know what actions you need to take.
- If in an onshore assembly area**, check with local authorities for guidance before returning to the inundation zone.

BROADCASTS DURING A TSUNAMI EVENT

USCG will issue Urgent Marine Information Broadcasts on CH 16, and additional information will be available from NOAA Weather Radio.



Local Tsunamis

You have only ~10 minutes to take action, so have a plan ahead of time that includes a quick way to release commercial fishing gear so your boat is not dragged down by currents; have least 3 days of food, fuel, and water.

If you are on the water

- At less than 100 fathoms (600 ft):** (1) Stop commercial fishing operations immediately, (2) free the vessel from any bottom attachment (cut lines if necessary), and (3) if you can beach or dock your boat and evacuate on foot within 10 minutes of a natural warning, then this is your best chance. If that is not possible, head to greater than 100 fathoms, keeping in mind the following:
 - Proceed as perpendicular to shore as possible.
 - Sail directly into wind waves, keeping in mind that wind waves opposed by tsunami currents will be greatly amplified.
 - Maintain as much separation as possible from other vessels.
 - Synchronize movements with other vessels to avoid collisions.
- At greater than 100 fathoms:** If you are in deep water but not quite 100 fathoms, head to deeper water. If you are already at greater than 100 fathoms, then you are relatively safe from tsunamis, but deeper water is safer from tsunami currents and the amplification of wind waves by those currents.

If you are on land or tied up at dock

- Evacuate out of the tsunami evacuation zone.** You don't have time to save your boat and could die if you try to do so.

After the tsunami

- If in an offshore staging area**, check with the USCG for guidance before leaving the staging area; conserve fuel by drifting until you know what actions you need to take.
- If in an onshore assembly area**, check with local authorities for guidance before returning to the inundation zone.
- Do not return to local ports** until you have firm guidance from USCG and local authorities.
 - Local ports will sustain heavy damage from a local tsunami and may not be safe for days, weeks or months.
 - If at sea, check to see if you can reach an undamaged port with your current fuel supply and watch for floating debris or survivors that may have been washed out on debris.
 - If at sea, consider checking with USCG about your role in response and recovery.

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 take your boat offshore. Secure your boat to the dock and leave the dock area before the tsunami arrives.



Boat attempting to leave Crescent City Harbor during the March 11, 2011 tsunami

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/

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

NOAA tsunami website: www.tsunami.gov

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

Sign up for NWS alerts and updates by email:
www.weather.gov/emailupdates/index.php

Redwood Coast Tsunami Work Group/ Humboldt State University:
www.humboldt.edu/rctwg/

California Harbor Master and Port Captain Association:
www.harbormaster.org/

Marine Recreation Association:
marina.org

CA Boating Safety Officers Association:
cbsoa.org

TSUNAMIS!

What
BOATERS
should know



The March 11, 2011 tsunami in Santa Cruz Harbor



Crescent City Harbor after the March 11, 2011 tsunami

Prepared by:



Funded by:



CARIBBEAN

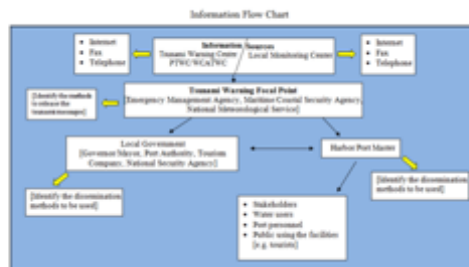
Preparedness Materials Maritime Community

Tsunami Protocol Template for the Caribbean Port and Harbor Operators

UPRM Puerto Rico Seismic Network, NOAA NW Caribbean Tsunami
Warning Program, National Science Foundation

INTRODUCTION

Tsunami (~~tsu~~-NAH-~~tsa~~) is a Japanese word meaning harbor wave. A tsunami is a series of waves with a long wavelength and period (time between crests) generated by a large, impulsive displacement of sea water. Time between crests of the wave can vary from a few minutes to over an hour, but generally are in the range of 15 to 25 minutes. Tsunamis are often incorrectly called tidal waves; they have no relation to the daily ocean tides, although depending on the stage of the tide, the tsunami will reach a higher or lower elevation. Tsunamis are generated by any large, impulsive displacement of the sea level. The most common cause of a tsunami is sea floor uplift associated with an earthquake. Tsunamis are also triggered by landslides into or under the water surface, and can be generated by volcanic activity and meteorite impacts.



available at: <http://www.srh.noaa.gov/srh/ctwp/>
and <http://prsn.uprm.edu>

WHAT TO DO?

TSUNAMI SAFETY FOR BOATERS

1. Since tsunami waves cannot be seen in the open ocean, do not return to port if you are at sea and a tsunami warning has been issued. Port facilities may become damaged and hazardous with debris. Listen to mariner radio reports when it is safe to return to port.
2. Tsunamis can cause rapid changes in water level and unpredictable dangerous currents that are magnified in ports and harbors. Damaging wave activity can continue for many hours following initial tsunami impact. Contact the harbor authority or listen to mariner radio reports. Make sure that conditions in the harbor are safe for navigation and mooring.
3. Boats are safer from tsunami damage while in the deep ocean (>200 fathoms, 1200 ft, 400 m) rather than moored in a harbor. But, do not risk your life and attempt to motor your boat into deep water if it is too close to wave arrival time. Anticipate slowdowns caused by traffic gridlock and hundreds of other boaters heading out to sea.
4. For a locally-generated tsunami, there will be no time to motor a boat into deep water because waves can come ashore within minutes. Leave your boat at the pier and physically move to higher ground.
5. For a tele-tsunami generated far away, there will be more time (one or more hours) to deploy a boat. Listen for official tsunami wave arrival time estimates and plan accordingly.
6. Most large harbors and ports are under the control of a harbor authority and/or a vessel traffic system. These authorities direct operations during periods of increased readiness, including the forced movement of vessels if deemed necessary. Keep in contact with authorities when tsunami warnings are issued.

Centro Internacional de Información sobre Tsunami
737 Bishop St., Manka Tower Suite 2200
Honolulu, Hawaii 96813-3213 USA
Tel: <1> (808) 532-6422 Fax: <1> (808) 532-5576
Correo electrónico (e-mail): lit.tsunami@jhu.edu
Página electrónica: <http://tsunamiwave.info>
Traducción al español: María E. Font, UPR Sea Grant
Red Sísmica de Puerto Rico en Mayagüez
Tel: <1> (787) 833-8433
Correo electrónico (e-mail): staff@midas.uprm.edu
Página electrónica: <http://redsisimica.uprm.edu>

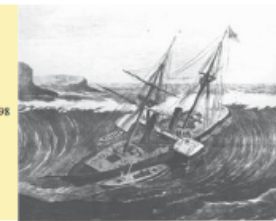
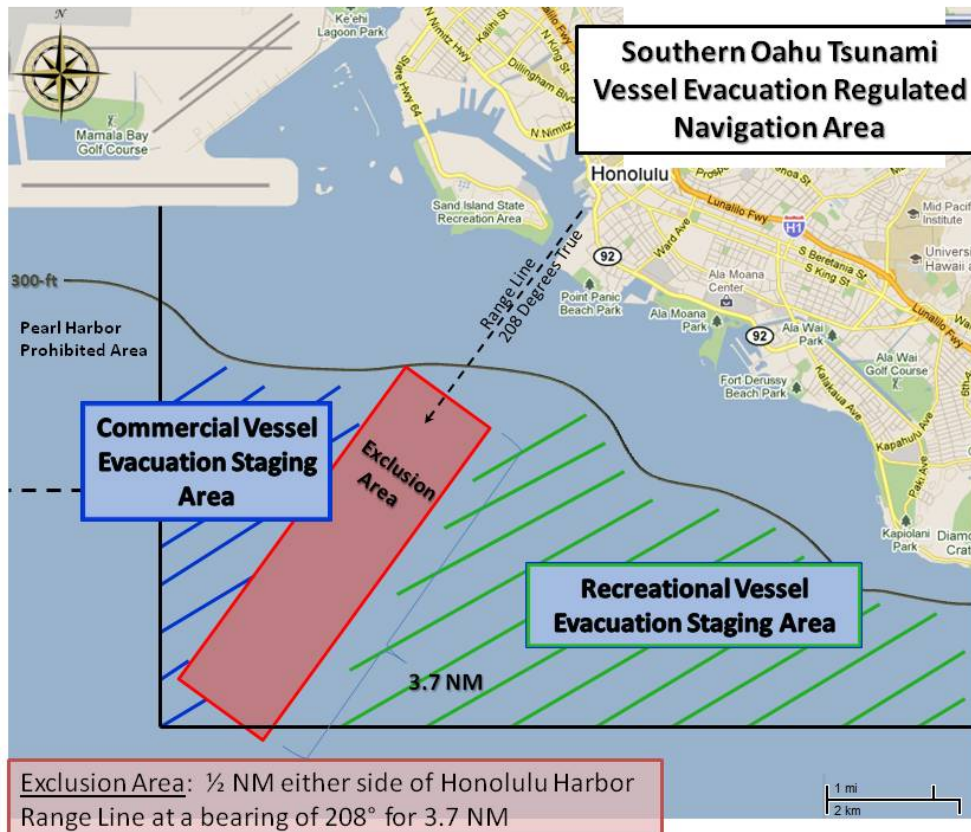


Foto: Tsunami en St. Thomas, V.I., tomada de: Harper's Weekly, 23 Jan. 1868, p. 49. Private collection



HAWAII

Outreach



USCG Planning

Hawai'i Boater's Hurricane and Tsunami Safety Manual



Tsunami Recovery Issues and Guidance



Direct Impacts (Damage):

- Vessels, docks, and infrastructure damage
- Debris in water and on land
- Sedimentation and scour

Indirect Impacts (Time):

- Residential reconstruction and/or relocation
- Commercial fishing and shipping disruption
- Business disruption

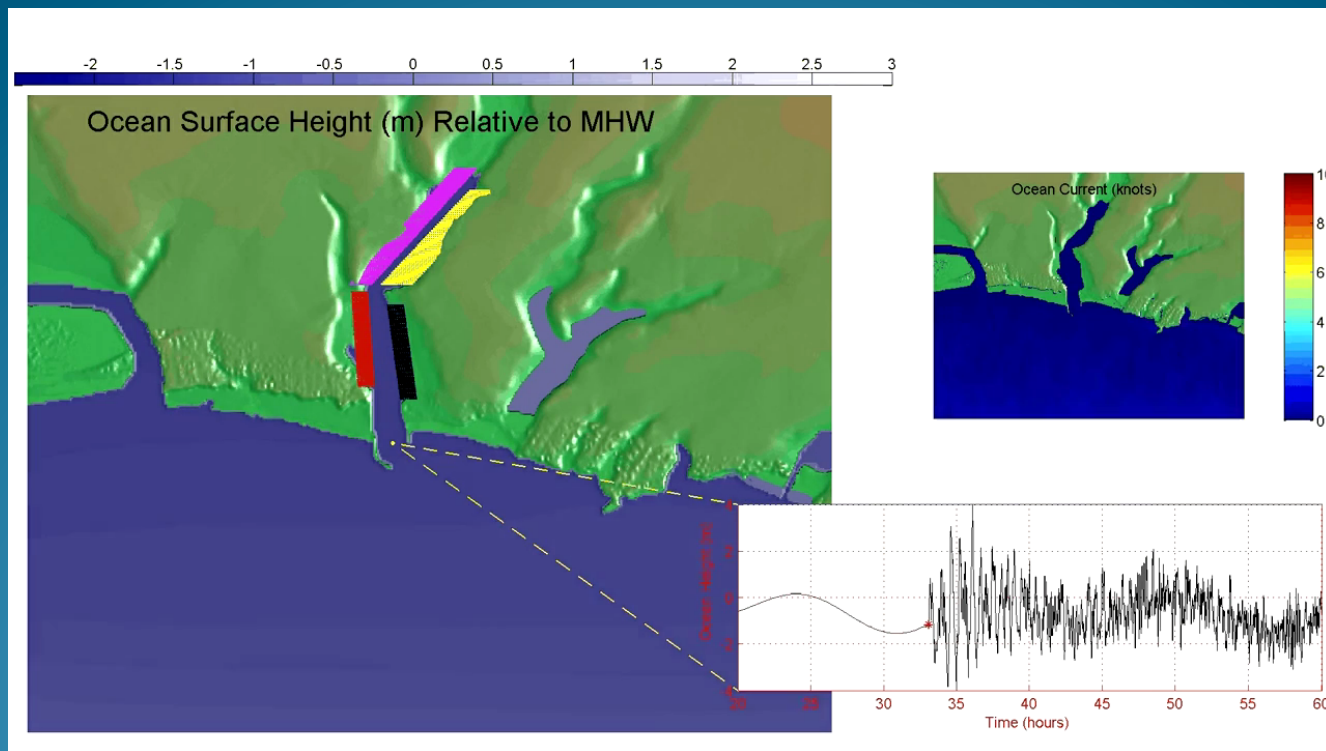
“Guidance for Tsunami Recovery” for harbors/communities

- Evaluate impacts on recovery from SAFRR scenario
- Test/Use/Integrate new HAZUS Tsunami Module (when completed)
- Develop state-level recovery plan

Conclusion: Maritime Mitigation Planning, Guidance, and Implementation

To assist with:

- 1) Traffic control in and out of harbors
- 2) Minimum offshore evacuation safe depth
- 3) Port re-opening and Recovery issues
- 4) Consistent national policy for maritime evacuation



Kevin Miller
Kevin.Miller@CalOES.ca.gov



www.TsunamiZone.org
www.tsunami.ca.gov