It's time to respond. Now What? Lessons Learned in California

Puerto Rico Maritime Community Tsunami Preparedness Workshop

June 27, 2017

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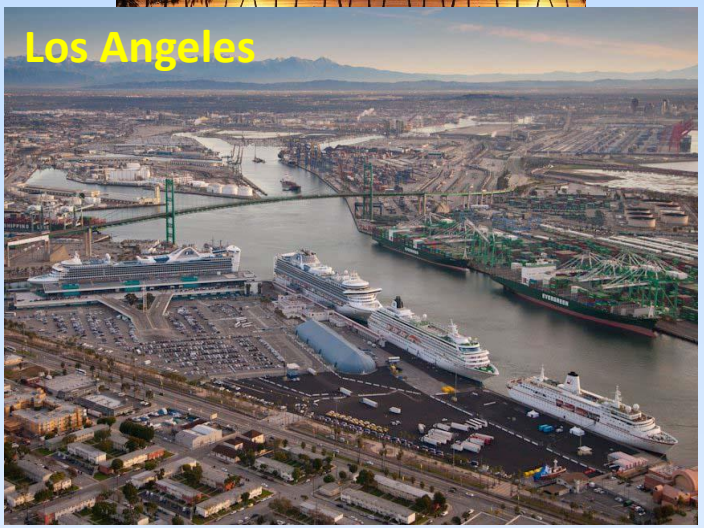
Topics

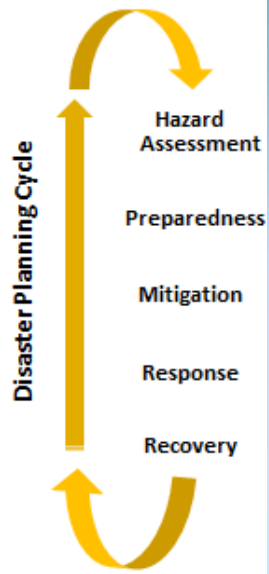
- Tsunami Program Overview
- Alert & Response (Recent Events)
- Tsunami Hazards in California
- Response Tools
  - Evacuation Playbooks
  - Maritime Playbooks
- Exercise/Testing & Public Info

Situational maritime tsunami planning similarities between California & Puerto Rico & Hawaii

- Large difference between number of people evacuated by small VS. large Advisory/Warning event
- Large residential, business, and visitor population exposure in low-lying coastal regions
- Vulnerable ports with large ships, and harbors with both recreational and commercial vessels
- Feb 2016; Aug 2016; Mar 2017 – Invited and met with State of Hawaii and Pacific Tsunami Warning Center and spoke at Hawaiian Resilience Conference.
- May 2017 – Met with National Tsunami Warning Center in Alaska.



State of California
Tsunami Preparedness & Mitigation Program



Hazard Assessment & Understanding
- Inundation modeling & maps
- Evacuation modeling & maps
- Probabilistic modeling & maps

Preparedness
- Evacuation/Maritime Planning & Playbooks
- Training and Exercise Support
- System and Comms Testing
- TsunamiReady® Program Support
- Tsunami Preparedness Week
- Public Education

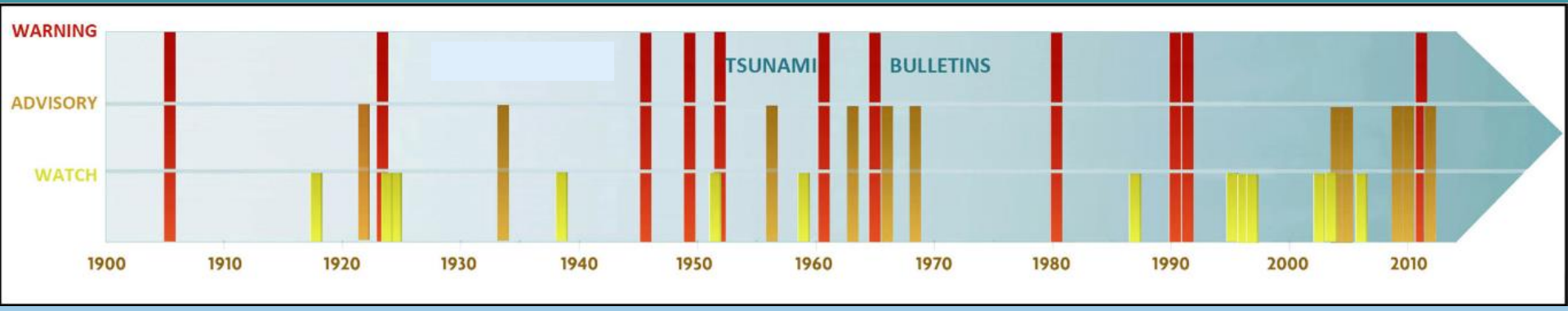
Response
- 24/7 Duty Officer Program
- Real-Time / Post-Tsunami Field Teams

Mitigation & Recovery
- Policy Analysis and Development
- Resiliency and Improvement Reports

Cal OES · CGS California Geological Survey · Humboldt State University 1913 · USC University of Southern California · California Coastal Commission · AECOM · The National Tsunami Hazard Mitigation Program (U.S.) · NOAA · FEMA · USGS science for a changing world

Tsunami Alert & Response

History of Tsunami Alerts in California



Ventura 2010

Santa Cruz 2011

Official NOAA Alert Bulletins

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

There is potential tsunami which may later impact your area

Stay Alert For More Info, May be upgraded to Warning/Advisory

Tsunami INFORMATION

Minor Waves at Most

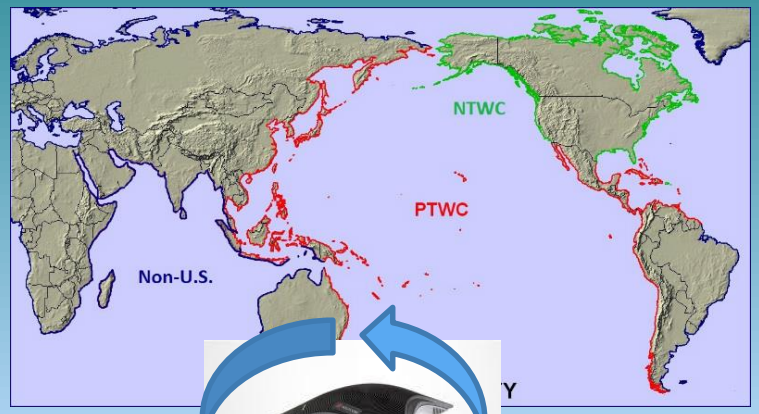
No Action Suggested

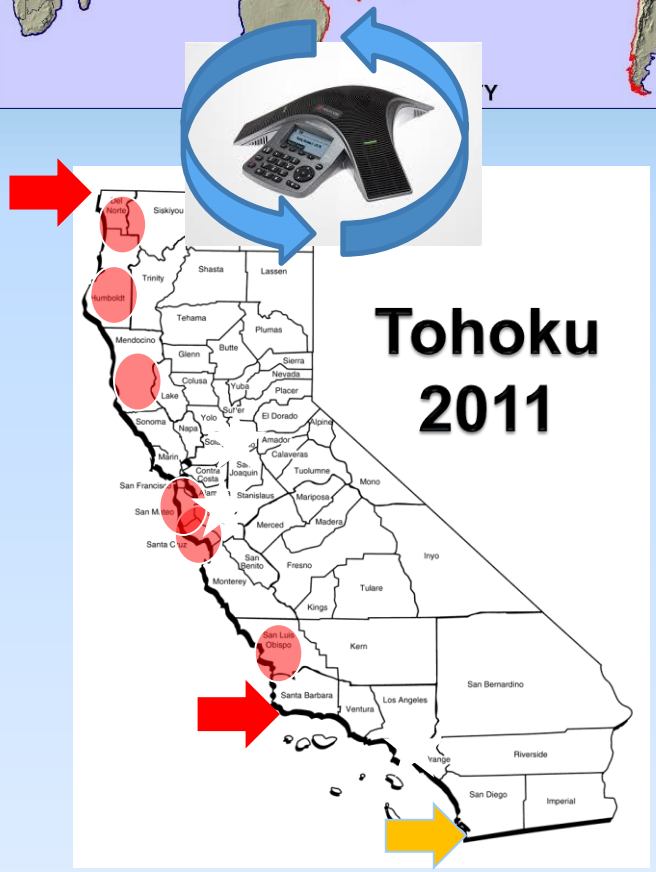
http://wcatwc.arh.noaa.gov/Products/msgdefs.htm

State Response to: WARNING and/or ADVISORY

ACTIONS:

- PARTICIPATE in CALLS WITH NOAA TSUNAMI WARNING CENTER
- ACTIVATE STATE EOC's (SOC/REOC's)
- CONDUCT CALLS WITH EMERGENCY MANAGERS IN 20 COASTAL COUNTIES





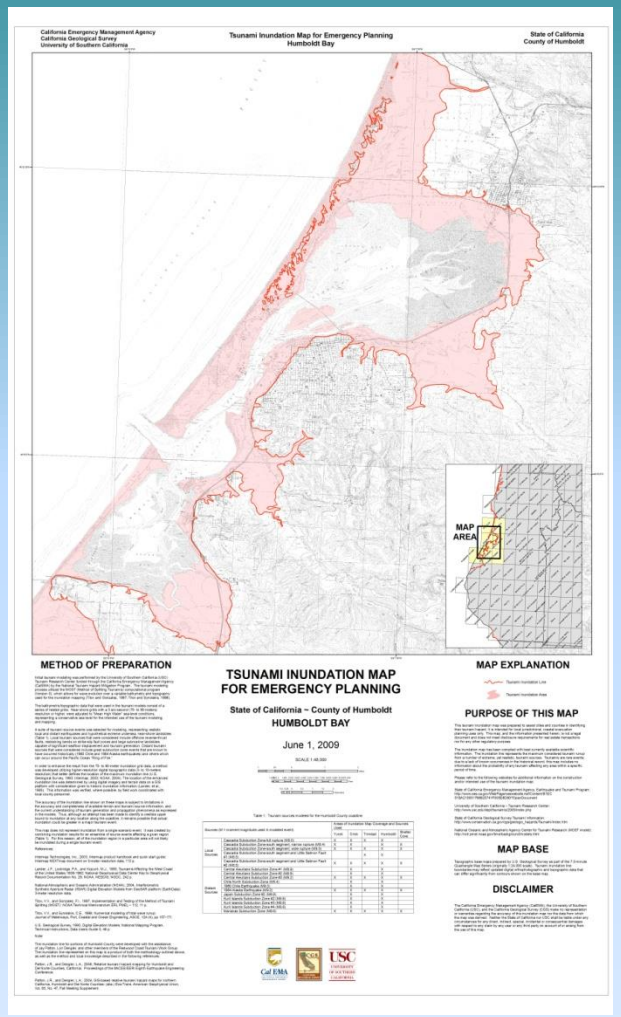
Focus on specific areas or locations of heightened concern based on:

Start of Tsunami

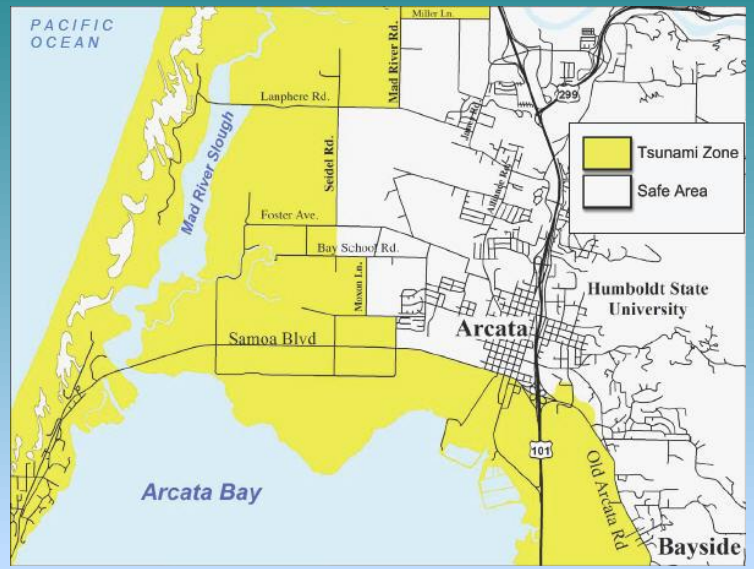
Wave Heights

Tide Conditions

Basic **Evacuation Map / Plan**



Inundation Map



Evacuation Map

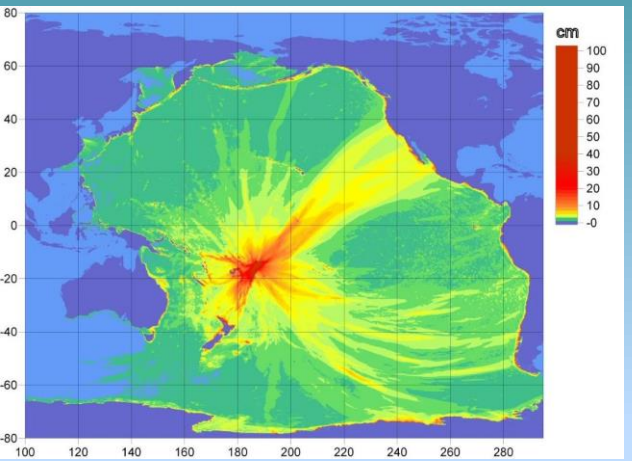
City Evacuation Plan/ConOps

1. **"Evacuate Sector (1) South of Main Street and West of First Street"**
2. **"Evacuate Sector (2) West of PCH between Newport Blvd. and 60th St."**
3. **…**

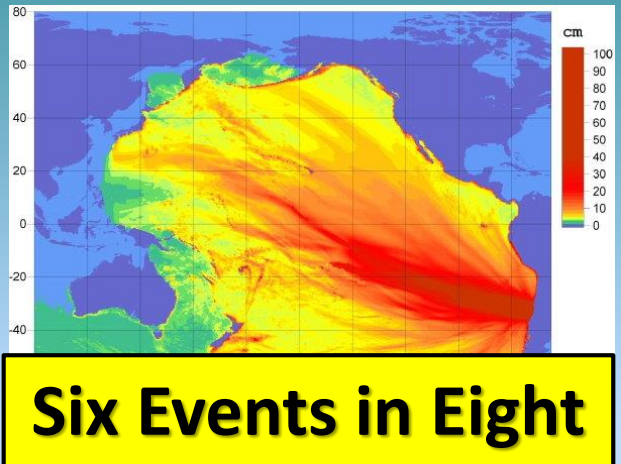
Tsunami Hazard in California

Recent Tsunamis Activating California Emergency Response

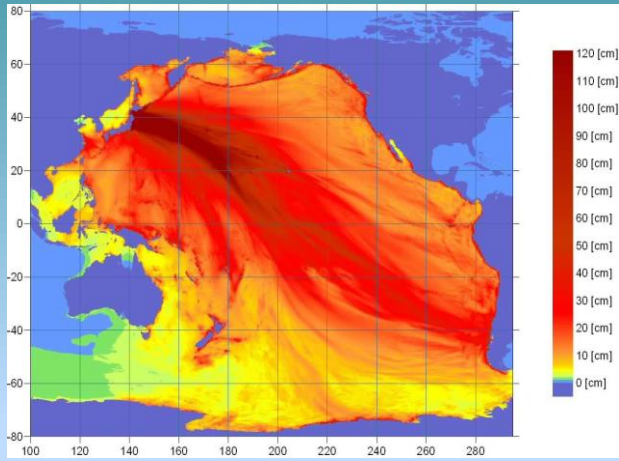
Samoa Sept 2009



Chile Feb 2010

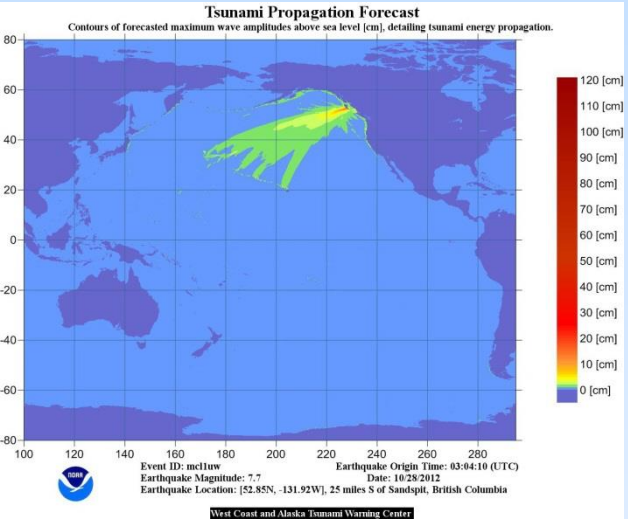


Japan March 2011

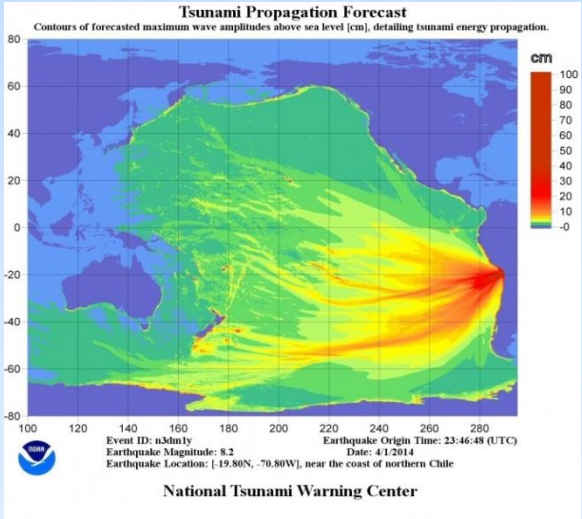


Six Events in Eight Years

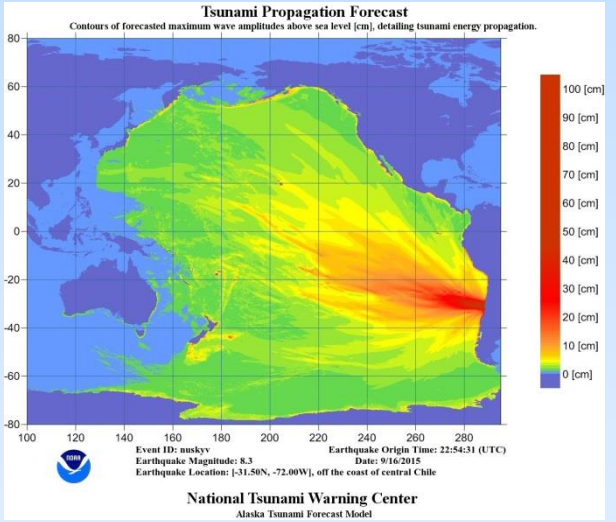
Haida Gwaii Oct 2012



Chile April 2014*

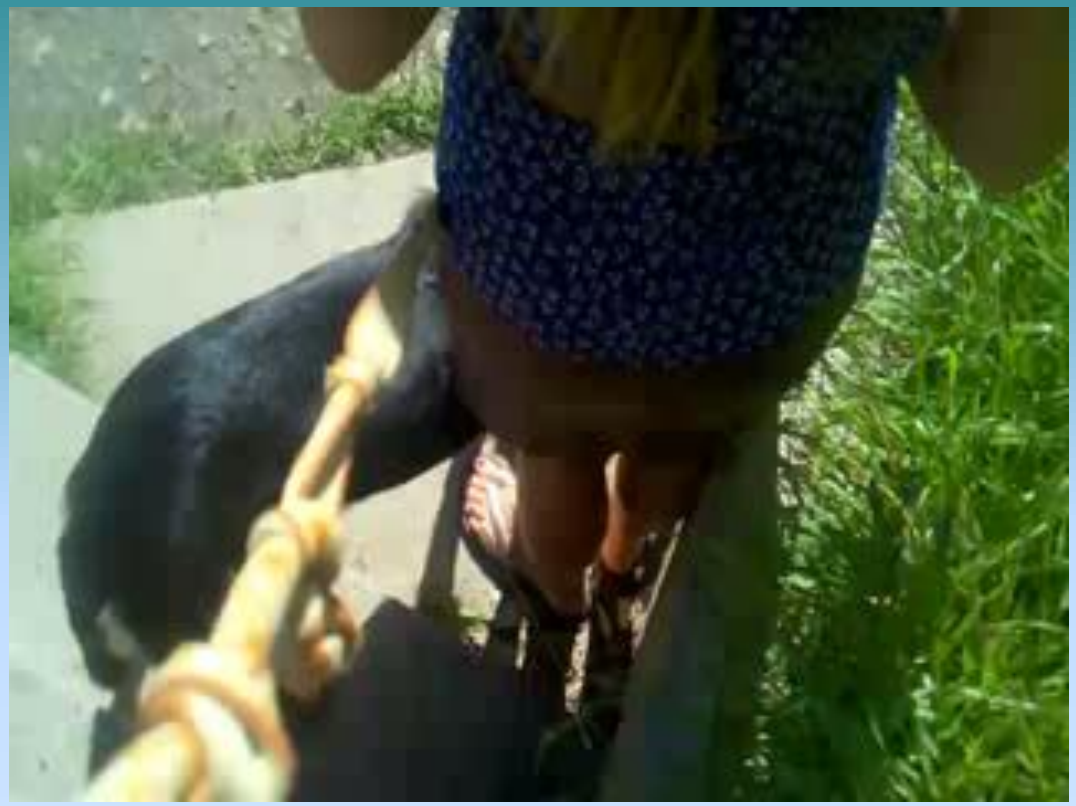


Chile Sept 2015



2011 Tohoku Tsunami in California

- Large tidal fluctuations = 16 feet in Crescent City (largest surges at low tide)
- Strong currents/debris in harbors
- Potential dangerous tsunami conditions lasted for more than 24 hours.
- Impacts: one fatality; two dozen harbors damaged; Official = $50M; Total ~$100M



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

Lessons Learned/Needs: 1) Consistent response statewide; 2) Response plans for minor to moderate event (not just “worst case”); 3) Harbor specific planning tools; and 4) Recommended minimum actions ahead of event

Needs and Lessons Learned from Recent Tsunamis

March 2011: Post tsunami; Boats sunk; recovery efforts in Crescent City Harbor

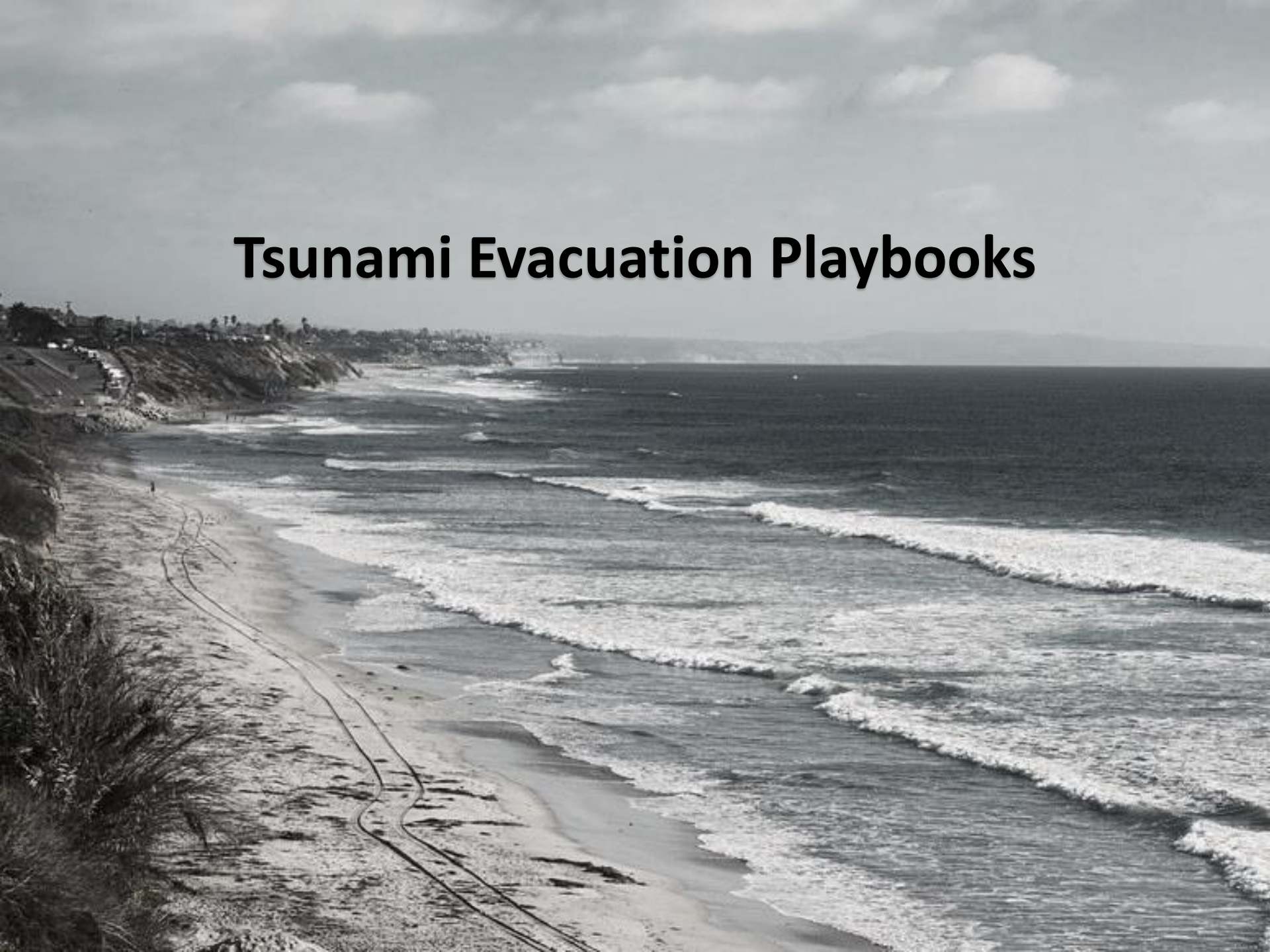
March 2014: Rebuild in "tsunami resistant" Crescent City Harbor

- The only response option was evacuate "everyone or no one"
- Inconsistent response actions taken:
  - under/over evacuation and
  - if/when/where to reposition maritime vessels
- Needed guidance for boaters
- Needed closer collaboration between State, NOAA, communities & maritime officials (including Harbormasters, Coast Guard, Navy)

****Solution****

- **Simple, straightforward and non-public response "Playbooks"**
- **for various size events**
- **designed to support real-time decisions and response options**

Tsunami Evacuation Playbooks



Tsunami Evacuation Playbooks

- Should only be used during distant-source events with greater than 3 to 4 hours of travel time
- Provide secondary tsunami evacuation options other than "all or nothing" approach
- Incorporates storm, tides, and other factors influencing local flooding
- Address "tweener" events: large Advisory (1-3 feet) and minor Warning (3-8 feet)
- Provides real-time recommendations from State, NWS, and TWCs for "minimum" evacuations
- Communities make final decision on evacuations

Elevation-Based Playbook

Phase 1 = beaches/harbors
Phase 2
Phase 3
Maximum Phase

Draft tsunami evacuation "playbook" lines based on elevation for Oakland/Alameda & Honolulu/Waikiki

Evacuation Planning Playbooks

Example of Use of FASTER in California

Working example: Formula for determining playbook evacuation line to use (FA-S-T-E-R):

FA: <u>Forecasted Amplitude (Wave Height)</u> from Warning Center

+

S: <u>Storm</u> surge or existing ocean conditions

+

T: Maximum **<u>tidal</u>** height (first 5-6 hours of tsunami)

+

E: Forecast **<u>error</u>** potential (30%; analysis of 2010-11 events)

+

R: Site amplified **<u>run-up</u>** potential (from existing modeling, unique to each location; applied if inundation expected)

+

(Other non-storm, non-tidal anomalies and wave-setup impact)

_____

= Maximum tsunami run-up height

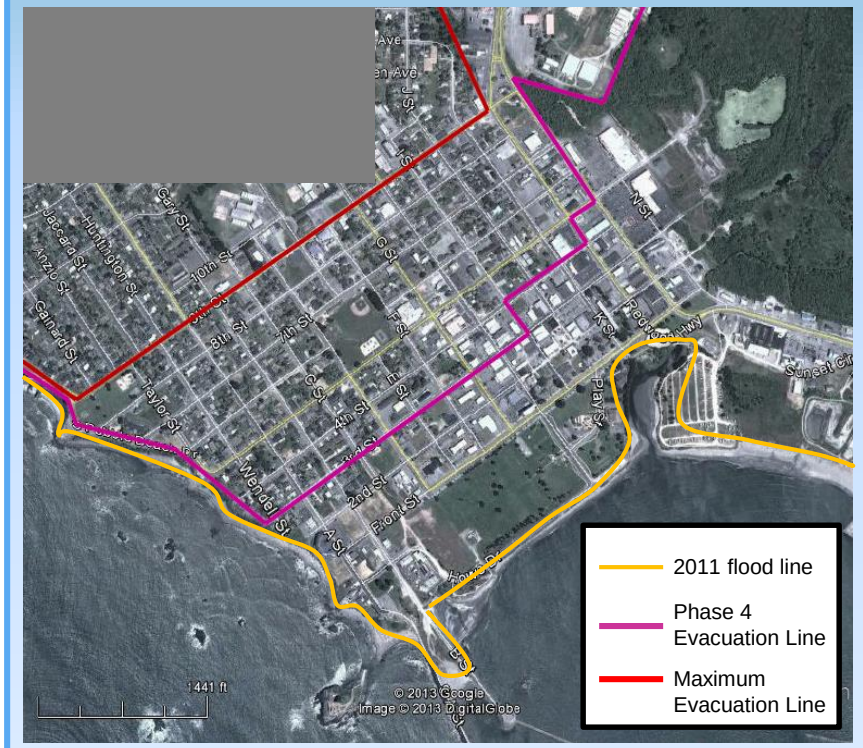
= Playbook elevation line

Working example for March 11, 2011 event at Crescent City:

FA + S + T + E + R = **Height**

2.5m+0m+(-1m)+0.75m+0.5m = **2.75m**

Phase 4 (3.5m) purple line below



Provided on National Tsunami Warning Center website

Location	Country	Lat	Lon	Obs Max Time (UTC) Time at which observed height was recorded	Obs Height Maximum observed tsunami height above tide level at time of measurement	Fcst. Height Maximum forecast tsunami height above tide level at time of measurement	Fcst. Arr Time (PDT) Forecast start time for tsunPMi at this location. TsunPMi can be dangerous for many hours after arrival	TWCTsunami Warning Center that issued this message
Pacifica	United States	37.6 ° N	122.5 ° W	n/a		3.9 feet	3/23/2016 13:42	NTWC
Ocean Beach	United States	37.8 ° N	122.5 ° W	n/a		3.9 feet	3/23/2016 13:43	NTWC
Fort Point	United States	37.8 ° N	122.5 ° W	n/a		3.9 feet	3/23/2016 13:44	NTWC
San Francisco	United States	37.8 ° N	122.5 ° W	n/a		3.3 feet	3/23/2016 13:45	NTWC
Treasure Island Marina	United States	37.8 ° N	122.4 ° W	n/a		3.3 feet	3/23/2016 13:46	NTWC
Oakland Outer Harbor	United States	37.8 ° N	122.3 ° W	n/a		3.0 feet	3/23/2016 13:47	NTWC
Alameda	United States	37.8 ° N	122.3 ° W	n/a		4.3 feet	3/23/2016 13:48	NTWC
Bolinas	United States	37.9 ° N	122.7 ° W	n/a		3.6 feet	3/23/2016 13:49	NTWC
Bolinas Lagoon	United States	37.9 ° N	122.7 ° W	n/a		3.6 feet	3/23/2016 13:50	NTWC
Stinson Beach	United States	37.9 ° N	122.6 ° W	n/a		3.6 feet	3/23/2016 13:48	NTWC
Sausalito	United States	37.9 ° N	122.5 ° W	n/a		3.0 feet	3/23/2016 13:52	NTWC
Richmond	United States	37.9 ° N	122.4 ° W	n/a		3.0 feet	3/23/2016 13:53	NTWC
Point Reyes	United States	38 ° N	123 ° W	n/a		3.3 feet	3/23/2016 13:48	NTWC
Point Reyes Beach	United States	38.1 ° N	123 ° W	n/a		3.3 feet	3/23/2016 13:48	NTWC
Mare Island	United States	38.1 ° N	122.3 ° W	n/a		2.0 feet	3/23/2016 13:58	NTWC
Port Sonoma Marina	United States	38.1 ° N	122.5 ° W	n/a		2.0 feet	3/23/2016 13:59	NTWC
Port Chicago	United States	38.1 ° N	122 ° W	n/a		2.0 feet	3/23/2016 13:58	NTWC
Bodega Bay	United States	38.3 ° N	123 ° W	n/a		3.3 feet	3/23/2016 13:52	NTWC
Russian River Mouth	United States	38.4 ° N	123.1 ° W	n/a		3.3 feet	3/23/2016 13:55	NTWC
Gualala River	United States	38.8 ° N	123.5 ° W	n/a		3.6 feet	3/23/2016 14:01	NTWC

Warning

Advisory

BACKGROUND INFO: FASTER Flood Potential calculated and then immediately reviewed by state/NWS

TSUNAMI FLOOD POTENTIAL USING THE FASTER APPROACH - The following table provides the detailed information related to the FASTER approach calculation that incorporates factors which could influence flooding of dry land: the tsunami FORECAST AMPLITUDE (wave height; used for the Maritime Playbooks), STORM surge, TIDAL conditions, tsunami modeling ERROR, and tsunami RUN-UP potential for each community. 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 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. The "Anticipated tsunami height" information provided in the right-hand columns is used to make the real-time Tsunami Evacuation Playbook Phase recommendation for each community (refer to the RECOMMENDED MINIMUM TSUNAMI EVACUATION PLAYBOOK PLAN table for this information). The fourth column "Forecast Amplitude" is used to determine the approriate MINIMUM Maritime Tsunami Response Plan for each harbor at risk. If you do not have Playbooks in place, use your normal evacuation and response plans for Warning or Advisory level events.

F.A.S.T.E.R.

County	Communities	Set to Receive Forecast Amplitude from NTWC	Forecast Amplitude given and projected (meters)	Storm/ ambient conditions first 5 hours, w/ errors (meters)	Tide conditions first 5 hours, w/ errors (meters)	Error in forecast amplitudes (30% of forecast amplitude; in meters)	Anticipated tsunami height first 5 hours (IN METERS)	Anticipated tsunami height first 5 hours (IN FEET)	Runup potential factor per location (applied if inudation expected)	Runup potential per location	Anticipated tsunami height first 5 hours, if inundation expected (IN METERS)	Anticipated tsunami height first 5 hours, if inundation expected (IN FEET)
Sonoma	Port Sonoma Marina	Yes	0.50	0.00	-0.10	0.15	0.55	1.80	0.00	0.00	0.55	1.80
Marin	Dillons Beach		1.00	0.00	-0.10	0.30	1.20	3.94	0.10	0.12	1.32	4.33
Marin	Pt Reyes tide gauge	Yes	1.00	0.00	-0.10	0.30	1.20	3.94	0.10	0.12	1.32	4.33
Marin	Bolinas Bay tide gauge	Yes	1.10	0.00	-0.10	0.33	1.33	4.36	0.10	0.13	1.46	4.80
Marin	Stinson Beach		1.10	0.00	-0.10	0.33	1.33	4.36	0.10	0.13	1.46	4.80
Marin	Muir Beach		1.10	0.00	-0.10	0.33	1.33	4.36	0.10	0.13	1.46	4.80
Marin	Rodeo Cove		1.10	0.00	-0.10	0.33	1.33	4.36	0.10	0.13	1.46	4.80
Marin	Horseshoe Bay		1.10	0.00	-0.10	0.33	1.33	4.36	0.10	0.13	1.46	4.80
Marin	Sausalito	Yes	0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Marin	Belvadere		0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Marin	Tibiron		0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Marin	Corte Madera		0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Marin	San Rafael		0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Marin	Novato		0.90	0.00	-0.10	0.27	1.07	3.51	0.10	0.11	1.18	3.86
Napa	Mare Island*	Yes	0.60	0.00	-0.10	0.18	0.68	2.23	0.00	0.00	0.68	2.23

MINIMUM Evacuation Playbook Recommendation

RECOMMENDED MINIMUM TSUNAMI EVACUATION PLAYBOOK PLAN - The following table provides recommendations for evacuation planning for each California community. The recommended Evacuation Phase number in Column Three (e.g. Phase 1, Phase 2, etc.) indicates the MINIMUM area to be evacuated by the community according to your emergency response evacuation plan. NOTE: Tsunami evacuation and response activities are the responsibility of the coastal community. This information is provided i…book Program and should only be used if the communities have Playbooks develop…cuation and response plans. We do NOT recommend using this information un…and have the Playbook plans in place. If you do not have Playbooks in place, use yo…s for Warning or Advisory level events.

Emergency Manager INFO

F.A.S.T.E.R. =

RECOMMENDED MINIMUM MARITIME TSUNAMI RESPONSE PLAYBOOK PLAN - The following table provides recommendations for maritime response planning for each California maritime community at risk to tsunamis. 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: Ts…are the responsibility of the coastal community. This information is pro…i Response Playbook Program and should only be used if the harbors …into the tsunami evacuation and response plans. We do NOT recom…ully understand what it means and have the Playbook plans in place. If…your normal evacuation and response plans for Warning or Advisory level…

Emergency Manager INFO

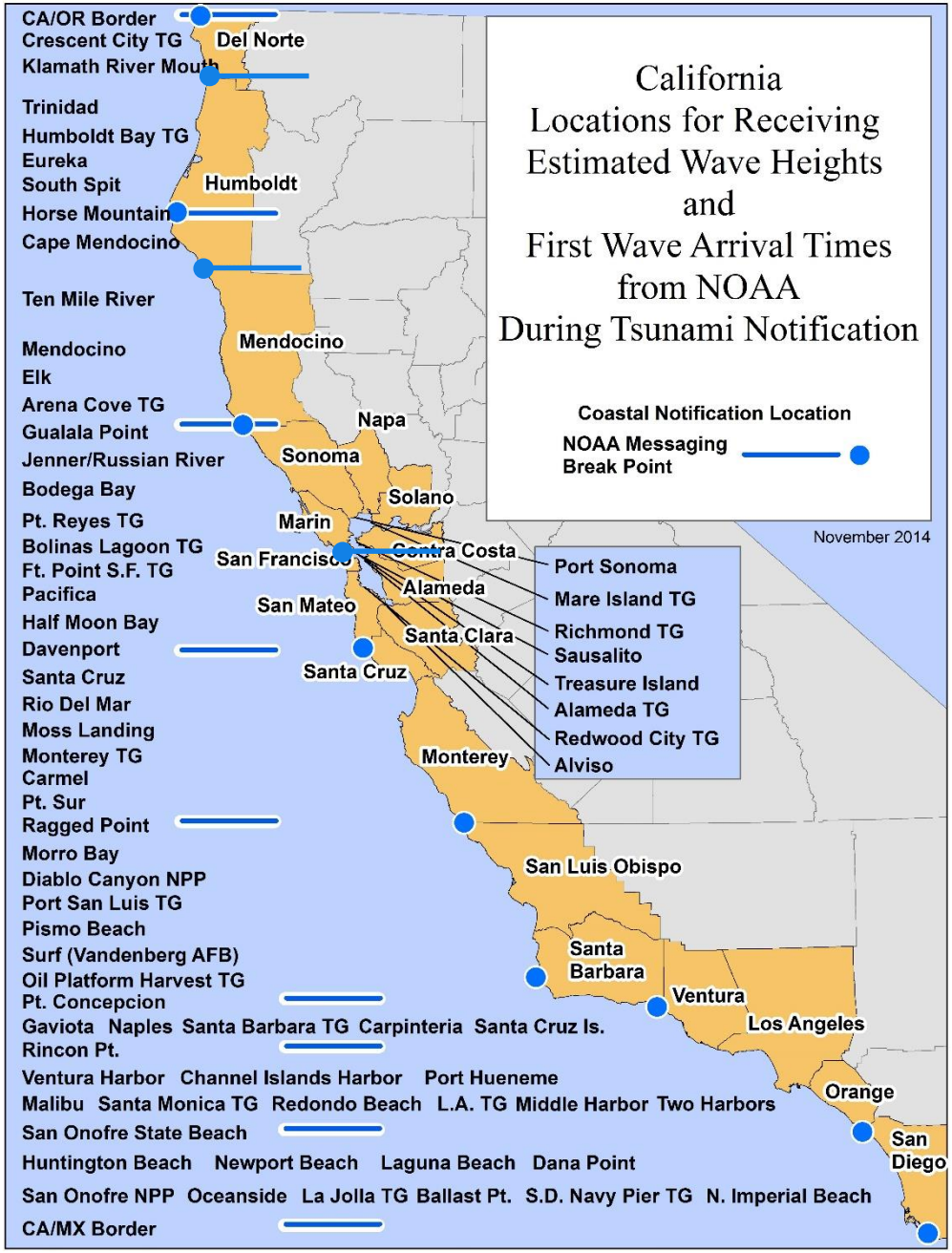
County	Communities	Recommended MINIMUM Tsunami Evacuation Playbook Plan, based on FASTER flood elevation	FASTER flood elevation (in METERS above Mean Sea Level; considers tsunami forecast amplitude, storm and tidal conditions, error and runup)	FASTER flood elevation (in FEET above Mean Sea Level; considers tsunami forecast amplitude, storm and tidal conditions, error and runup)	Maritime Communities Playbook Guidance Plans (Ports, Harbors, and Marinas)	Recommended MINIMUM Maritime Tsunami Response Plan, based on Forecast Tsunami Amplitude	Forecast Tsunami Amplitude from the National Tsunami Warning Center (in METERS above Mean Sea Level; does NOT include existing ocean conditions)	Forecast Tsunami Amplitude from the National Tsunami Warning Center (in FEET above Mean Sea Level; does NOT include existing ocean conditions)
Sonoma	Black Point (SF Bay)	Evacuation Phase 1	0.6	1.8				
Marin	Dillons Beach	Evacuation Phase 2	1.3	4.3				
Marin	Pt Reyes tide gauge	Evacuation Phase 2	1.3	4.3				
Marin	Bolinas Bay tide gauge	Evacuation Phase 2	1.5	4.8				
Marin	Stinson Beach	Evacuation Phase 2	1.5	4.8				
Marin	Muir Beach	Evacuation Phase 2	1.5	4.8				
Marin	Rodeo Cove	Evacuation Phase 2	1.5	4.8				
Marin	Horseshoe Bay	Evacuation Phase 2	1.5	4.8				
Marin	Sausalito	Evacuation Phase 2	1.2	3.9	Richardson Bay maritime	Maritime Response Plan D	0.9	3.0
Marin	Belvadere	Evacuation Phase 2	1.2	3.9				
Marin	Tibiron	Evacuation Phase 2	1.2	3.9				
Marin	Corte Madera	Evacuation Phase 2	1.2	3.9				
Marin	San Rafael	Evacuation Phase 2	1.2	3.9				
Marin	Novato	Evacuation Phase 2	1.2	3.9				
Napa	Mare Island*	Evacuation Phase 1	0.7	2.2				

Delivery Locations for Tsunami Forecast Start Times and Amplitudes (CA)

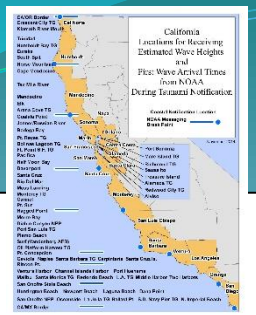
National Tsunami Warning Center will send out forecasts for tsunami start time and maximum tsunami amplitudes (wave heights) for over 60 communities in California for future Advisory and Warning level events.

These locations correspond to tide gauge locations as well as highly populated communities vulnerable to tsunamis. There are several locations within each of the 20 counties in the state.

This information will be projected/ interpolated to all 200+ communities along the coast.



Individual Evacuation Playbook Documents for Each Community



California Tsunami Evacuation Playbook

City of Los Angeles – Los Angeles County

Playbook No. 2015-LA-02

DURING AN EMERGENCY, USE THE "QUICK REFERENCE" SHEET ON THE BACK PAGE (PAGE 18).

(For the expanded playbook analysis, use directions on Page 4)

California Tsunami Evacuation Playbook No. 2015-LA-02

California Geological Survey
California Governor's Office of Emergency Services
National Oceanic and Atmospheric Administration

Funded by the National Tsunami Hazard Mitigation Program

THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM (U.S.)

Page 2: Purpose and use of Tsunami Playbooks

Page 3: Tsunami Alert Bulletins and FASTER info

Page 4: Expanded real-time response page

Page 5: Tsunami evacuation/response "Decision Tree"

Page 6: Tsunami elevation-based Playbook info

Page 7: Tsunami scenario-based Playbook info

Pages 8-15: Tsunami elevation-based evacuation Playbook plans and maps

Page 16-17: Notable historical tsunamis and state tsunami program modeling results

Page 18: APPENDIX – Quick Reference Page for real-time response activities

Secondary Evacuation Plans - Tsunami Evacuation Playbooks

Evacuation maps based on elevation using streets and landmarks (CGS Special Report 236)

Event-specific, real-time recommendation from State and NOAA/WFOs:

Background Information:
Alert level = Warning
FASTER tsunami value = between 1.0m (3.3 ft) and 1.5m (5.0ft)

Specific Instructions:

- Follow general guidance for Warning-level tsunamis (Page 3)
- Evacuate areas are shown in red, including beaches, piers, and harbor docks and boats. Strong currents and potential scour may be expected in harbors.
- A digital file showing evacuation maps and response instructions is available for use.
- Specific evacuation and response instructions..... (completed with community input)

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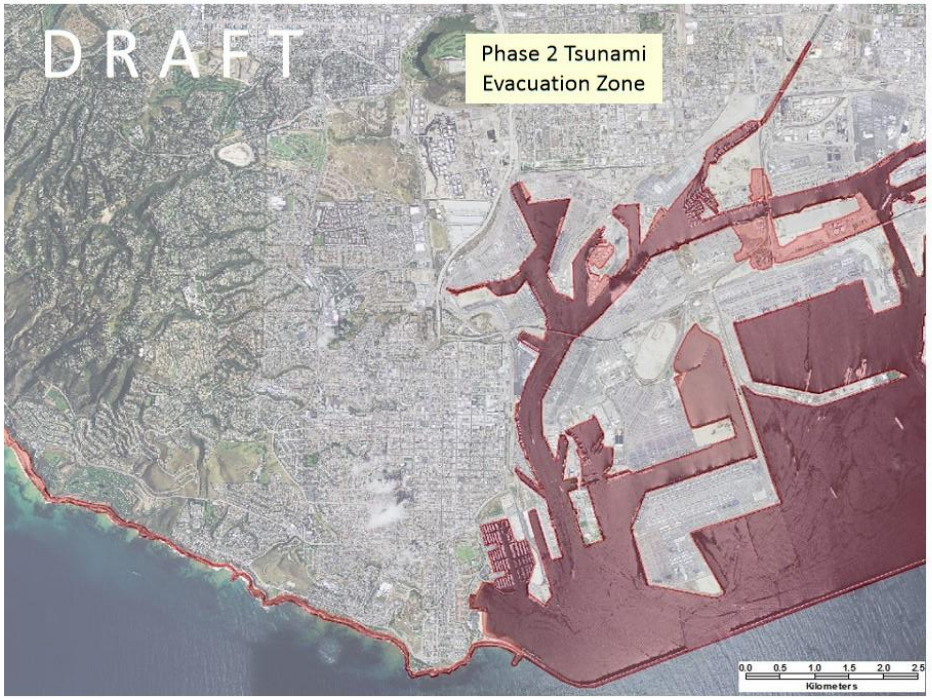

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California Geological Survey
California Governor's Office of Emergency Services
National Oceanic and Atmospheric Administration

Funded by the National Tsunami Hazard Mitigation Program

THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM (U.S.)

and your community has fully developed its tsunami playbooks plans, communities can utilize the tsunami elevation-based evacuation playbook "phase" plan recommended by the state and/or NOAA. Use the table on the right to identify the page numbers for the appropriate phase plan.

Pages 12-13	Phase 3 Evacuation
Pages 14-15	Maximum Evacuation Phase

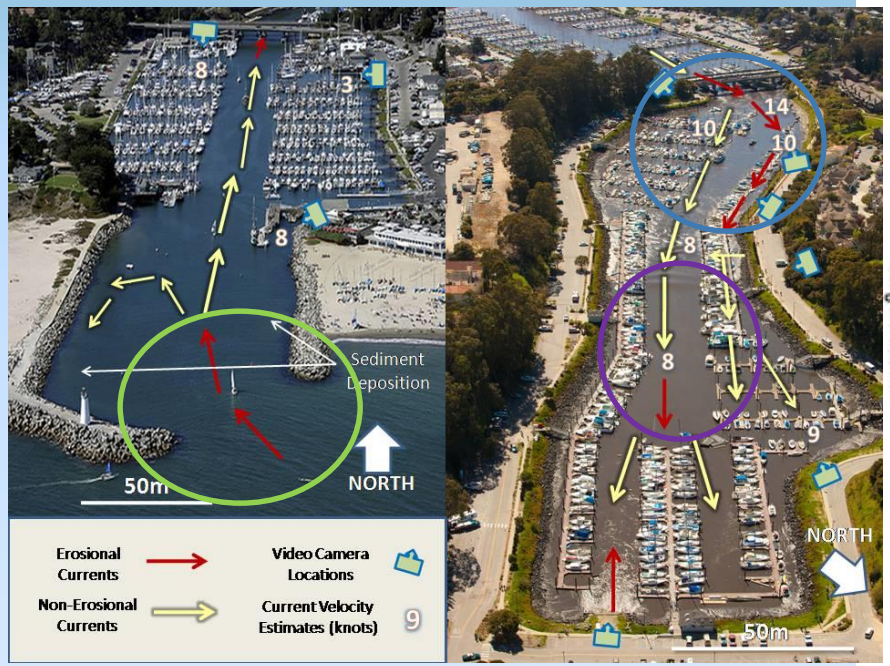
18

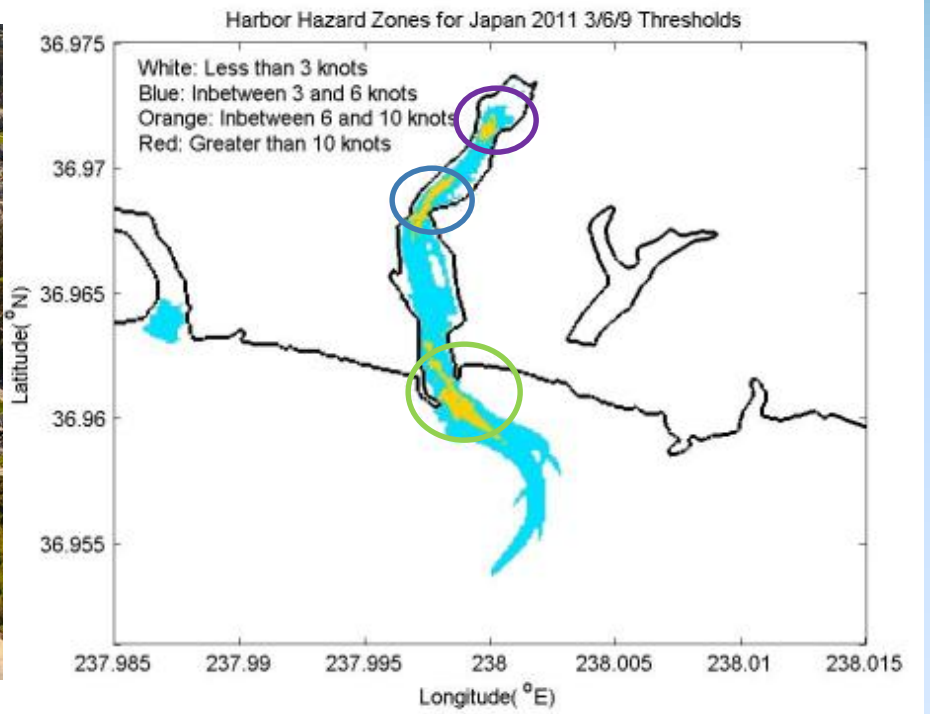
Maritime Response Playbooks

Maritime Safety Products – Playbook Approach

1. **Create in-harbor hazard maps, based on current vs. damage**
2. **Create minimum offshore safety line/zone (30 fathoms=180 feet)**
3. **Provide statewide planning and response guidance (Playbooks)**

For work in California, it started with analysis of video and other observations of currents used to validate currents from numerical models





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

Tsunami Hazards/Issues for Harbors, Ports, and Boaters

Strong and unpredictable currents, especially where there are narrow entrances, narrow openings, and other narrow or shallow parts of harbor

Eddies/whirlpools circular currents causing boats to lose control

Sudden **water-level fluctuations** where docks and boats hit bottom as water level drops

Overtopping piles as water level rises

Dangerous conditions offshore – what is **safe-offshore depth** for vessels?

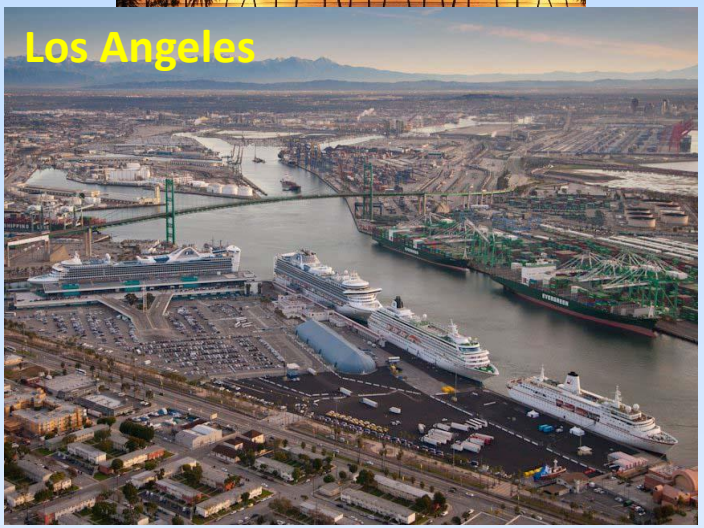
Tsunami bores and amplified waves resulting in swamping of boats and damage to docks

Drag on deep draught boats causing damaging forces to the docks they are moored to

Collision with other boats, docks, and debris in the water

Scour and sedimentation can affect harbor protection measures and shipping channels, respectively

Dangerous tsunami conditions can last many hours after first wave arrival, causing problems for inexperienced and unprepared boaters who take their boats offshore

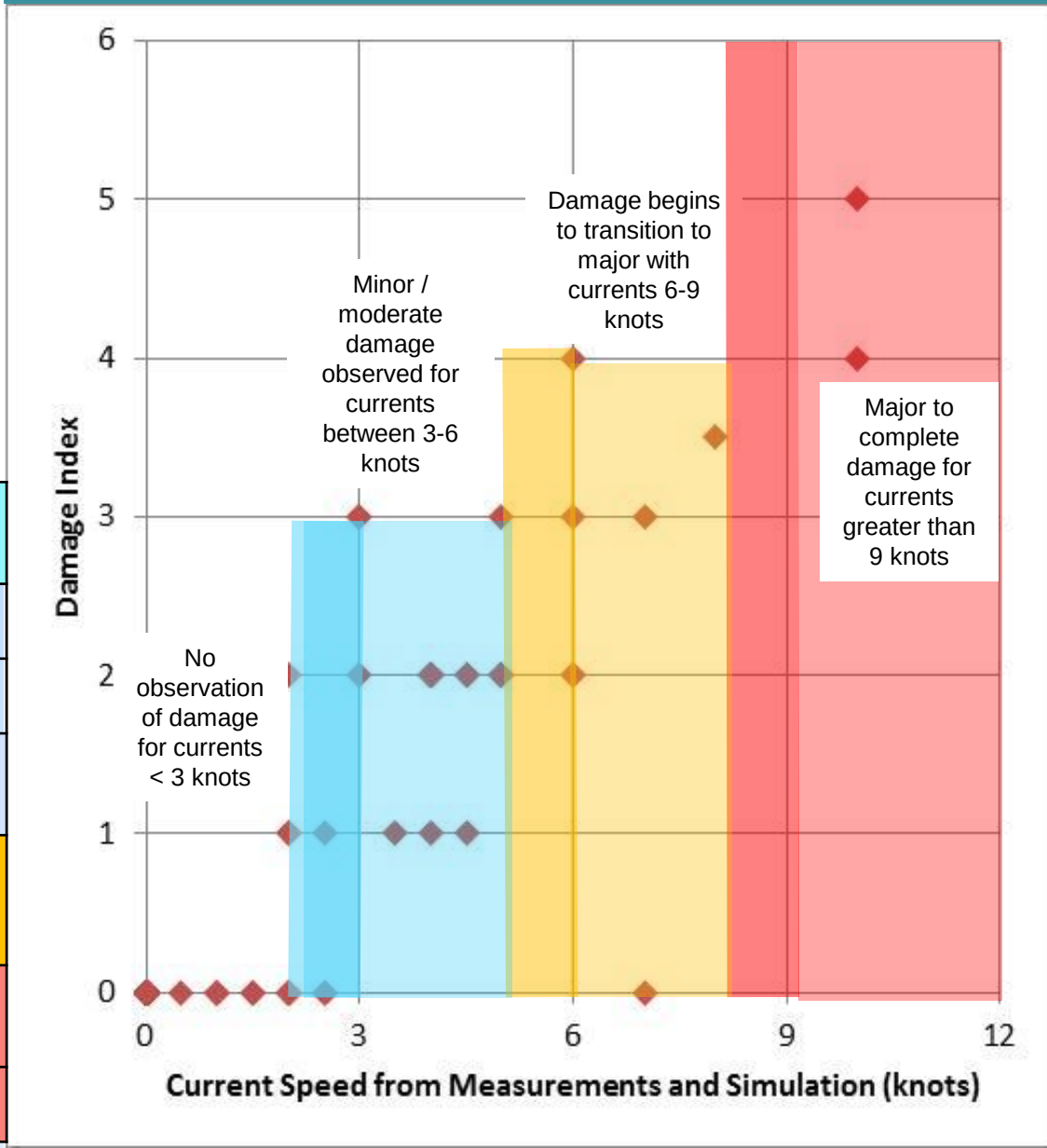


Tsunami Current Hazard Maps

- **Can we filter velocity 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**

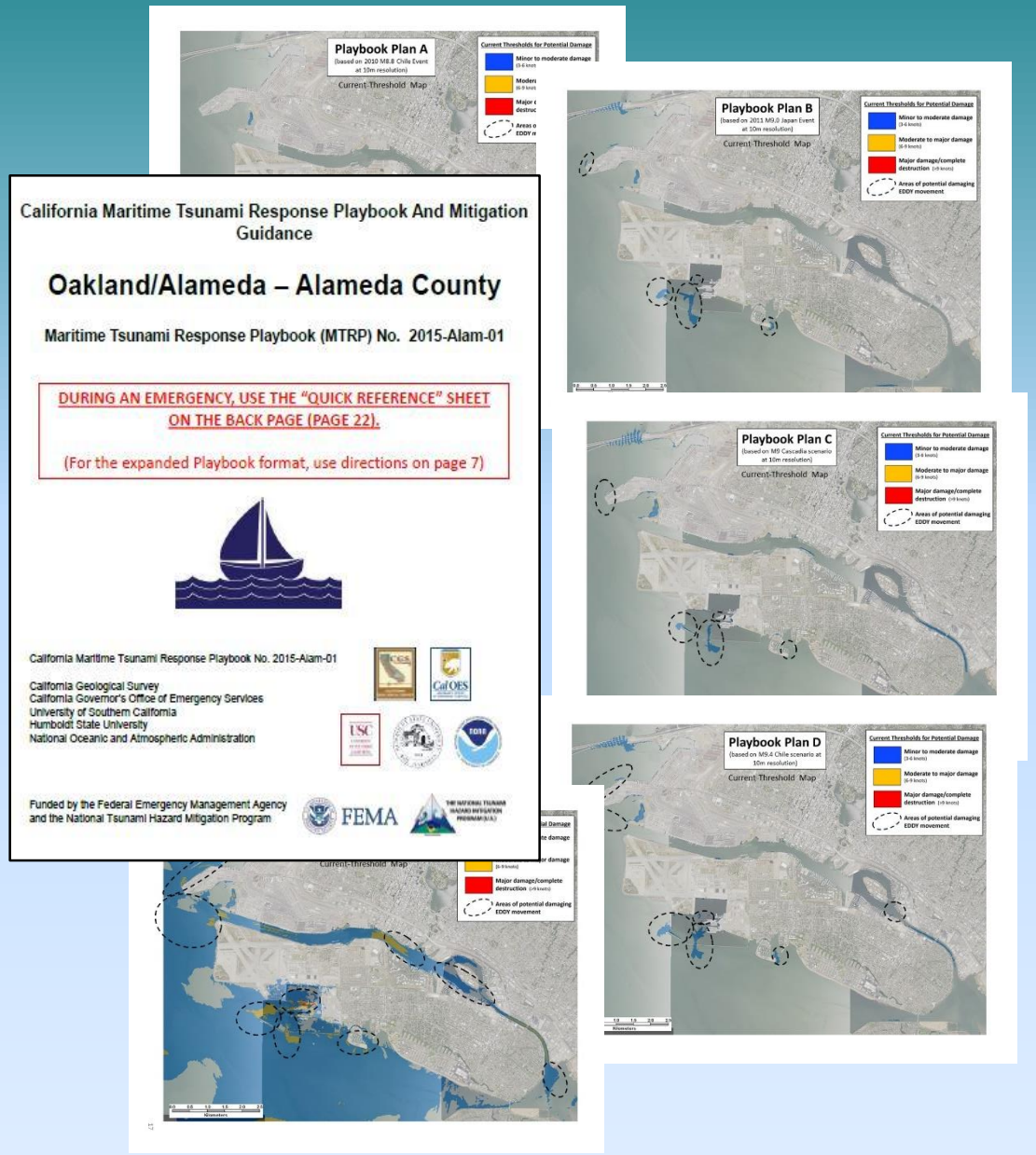
Damage Index:	Damage Type:
0	no damage
1	small buoys moved
2	1-2 docks/small boats damaged, large buoys moved
3	Moderate dock/boat damage, mid-sized vessels off moorings
4	Major dock/boat damage, large vessels off moorings
5	Complete destruction

From Lynett and others (USC Tsunami Research Center 2013)



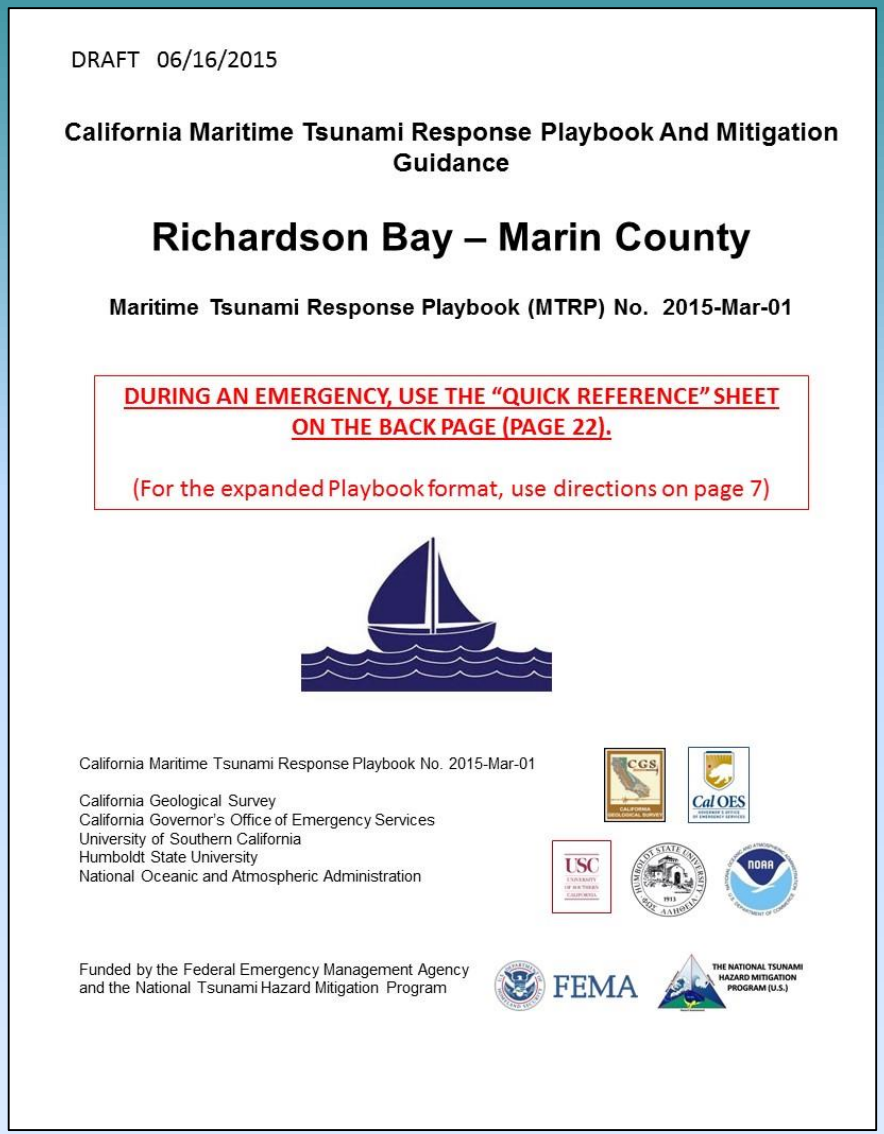
Maritime Tsunami Response Playbooks

1. Identifies areas within harbor where strong currents and damage occurs, as well as where safe areas exist
2. Provides multiple response options based on tsunamis of different sizes
3. Real-time MINIMUM response recommendation for events from a distant source
4. Helps with consistent response activities



Individual Maritime Response Playbook Documents

Completed - Covering 70+ Harbors/Ports in California



DRAFT 06/16/2015

California Maritime Tsunami Response Playbook And Mitigation Guidance

Richardson Bay – Marin County

Maritime Tsunami Response Playbook (MTRP) No. 2015-Mar-01

DURING AN EMERGENCY, USE THE "QUICK REFERENCE" SHEET ON THE BACK PAGE (PAGE 22).

(For the expanded Playbook format, use directions on page 7)

California Maritime Tsunami Response Playbook No. 2015-Mar-01

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

FEMA

THE NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM (U.S.)

Page 2: Purpose and Use of Maritime Response Tsunami Playbook and Mitigation Guidance

Page 3: Mitigation Planning

Page 4-5: Tsunami Hazards, Tsunami Alert Levels, and General Response Recommendations

Page 6: Forecast Amplitude and FASTER Reference Information; Current-Damage Relationship

Page 7: Expanded Response Reference Page

Pages 8-17: Maritime Tsunami Response Playbook Scenario Plans and Maps

Page 18-19: Notable historical tsunamis and state tsunami program modeling results

Page 20-21: Offshore and On-shore Evacuation Plans

Page 22: APPENDIX – Quick Reference Page for real-time response activities

Maritime Tsunami Response Playbooks

Maps are FEMA RiskMAP Products

Playbook Plan E

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

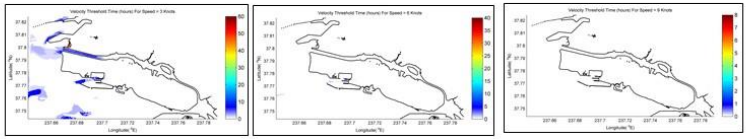
Background Information:
Alert level = Warning
Peak Amplitude = 2.2+ meters
Peak Velocity = 9 knots
Projected duration of strong currents (see location maps below):
3-6 knots = 20 hrs; 6-9 knots = 10 hrs; >9 knots = 3 hrs

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 page)



16

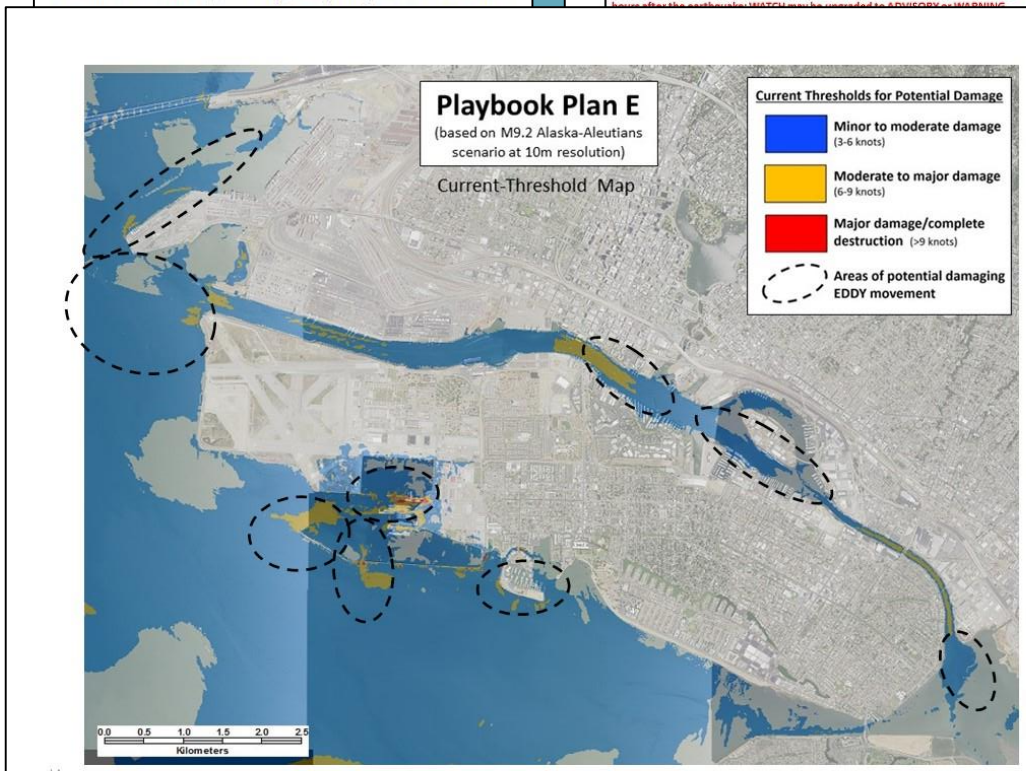
California Maritime Tsunami Response Playbook And Mitigation Guidance

Oakland/Alameda – Alameda County

Maritime Tsunami Response Playbook (MTRP) No. 2015-Alam-01

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**



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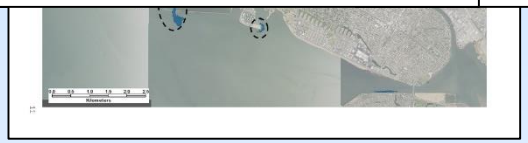
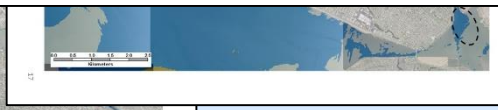
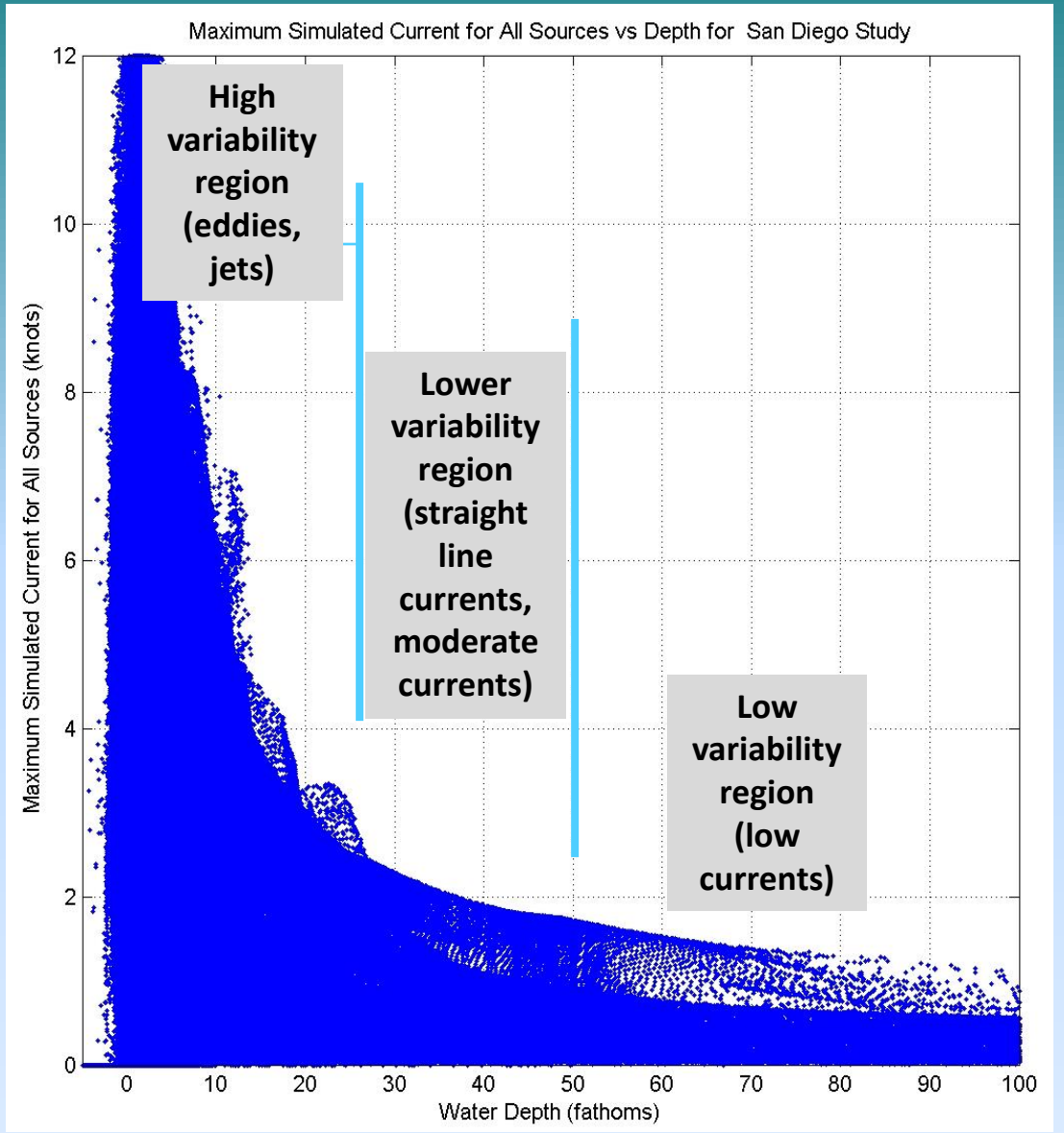




Offshore Safe Tsunami Depths for Navigation

- **Ran simulations for a range for different sources and areas**
- **Created a maximum current map for each source**
- **Determine current variability at all depths**
- **Set an acceptable current & depth threshold**



1 fathom = 1.8 meters = 6 feet

Offshore Safe Depths for Tsunamis

- **Previous "Rule of thumb" for safety was 100 fathoms (600 feet)**
- **New recommendation 30 fathoms (180 feet)**
- **General statewide guidance for Advisory and Warning events, not to evacuate offshore**

PLAN FOR OFFSHORE EVACUATION OF BOATS

NOTE: The safety of the boating public should outweigh the benefit of saving boats and harbor property during a tsunami.

- For most harbors in California, it is safer to keep boats docked during a tsunami because most tsunamis are relatively small.
- On the rare occasion when a large, damaging tsunami and associated strong currents are expected and there are no safe areas within the harbor, the boat owner may be considering taking their boat offshore.
- There are a number of factors that should be considered prior to recommending boats evacuate offshore prior to the arrival of the tsunamis, including:
  - (1) the SIZE of the tsunami;
  - (2) is there sufficient TIME to get to the 30 fathom depth (180 feet), which has been evaluated as safe depth for boats during distant source tsunamis (map below);
  - (3) the PREPAREDNESS of the boat and its captain to stay at sea over 24 hours;
  - (4) the WEATHER at sea could be as dangerous as the tsunami itself; and,
  - (5) if significant damage occurs within the harbor, boaters should have enough fuel and supplies to travel to a non-damaged harbor.

Note for trailer boat owners: Expect congested boat ramps and remember that you have to get your boat to the trailer, out of the water, and out of the tsunami zone before the tsunami arrives.

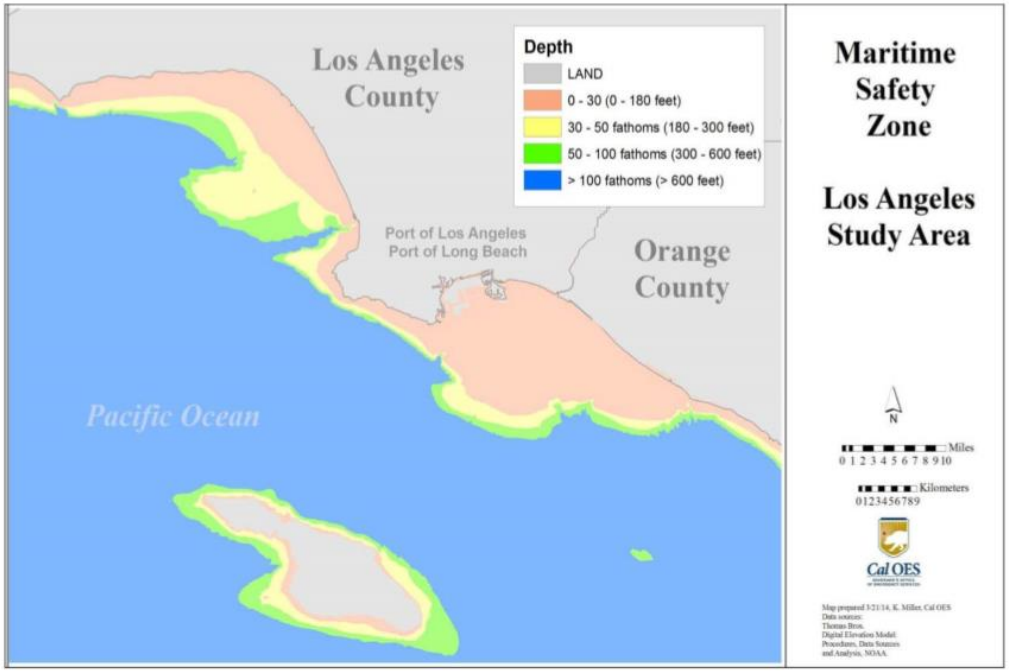
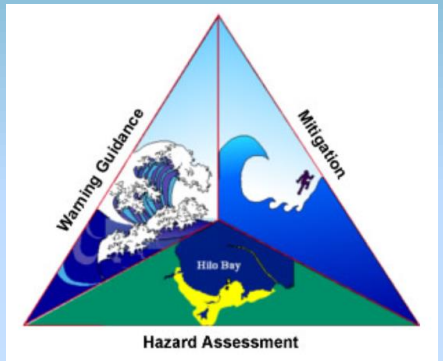


TABLE 1: Specific regional guidance for minimum offshore safe depths for maritime vessel evacuation prior to the arrival of tsunami.

State/Territory	Distant Source (ships in harbor)*	Local Source (ships at sea)*	Notes on this Update
California	30 fathoms	100 fathoms	Evaluated; evaluating potential safe areas within large bays and ports
Oregon	30 fathoms	100 fathoms	Evaluated; also evaluating Columbia River
Alaska	30 fathoms	100 fathoms	Evaluated; ships should be at least 1/2 mile from shore for all scenarios
Washington	30 fathoms	100 fathoms	Evaluated; evaluating special conditions exist inside Puget Sound
Hawaii	50 fathoms	50 fathoms	Evaluated; implemented in Coast Guard response plans at some locations
American Samoa	50 fathoms	50 fathoms	Evaluating, guidance from others
Puerto Rico	50 fathoms	100 fathoms	Evaluated
USVI	50 fathoms	100 fathoms	Evaluating; possibly follow PR
Guam	50 fathoms	100 fathoms	Coordinated with USCG Guam Sector
CNMI	50 fathoms	100 fathoms	Coordinated with USCG Guam Sector
Gulf Coast States		100 fathoms	Evaluating; issues with long, shallow shelf complicate getting beyond safe depth
East Coast States		100 fathoms	Evaluating; issues with long, shallow shelf complicate getting beyond safe depth

* Ships also recommended to be a minimum of ½ mile from shore or fringing reef

National Tsunami Hazard Mitigation Program



Minimum Offshore Safe Depths for tsunami vessel evacuation by region

Public Safety and Operational Benefits

REAL-TIME USE OF PLAYBOOKS

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

- **15 ports and harbors within 5 county Tsunami Advisory**
- **All harbors in Advisory zone below lowest Playbook Plan (Plan A) because highest forecast wave height was 0.3m**
- **Harbormasters indicated using Maritime Response Playbooks during event and found them useful**
- **Harbors monitored and controlled activity around projected areas of moderate-to-high currents**

Tsunami currents and eddies from post-processed video by Dr. Pat Lynett.

Benefits of Playbook Approach in California Collaborations with USGS

- Paper on statewide benefits of Playbook approach using M9 Chile scenario, as example, compared to maximum evacuation
  - **$123M savings in business closure/evacuation costs**
  - **$14M savings in public evacuation costs**
  - **Evacuation reductions shown in table = 45% of total residents, 29% of the total employees**

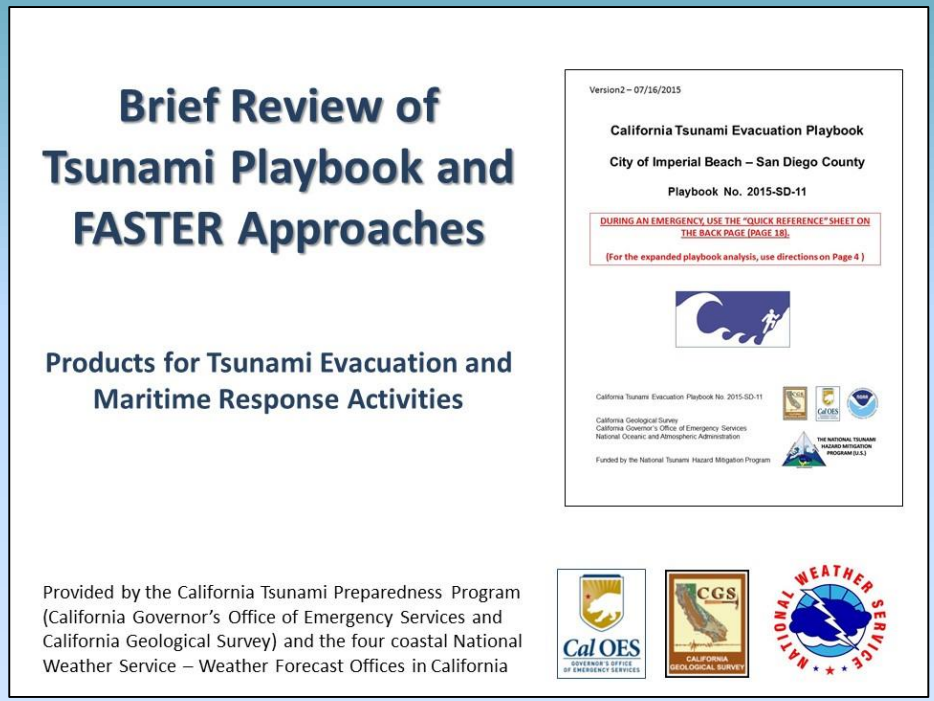
Evacuation reductions using Playbook approach during M9 Chile scenario (Wood et al. in press) (yellow=counties with Playbooks)

County	Residents in Hazard Zones			Employees in Hazard Zones		
	Scenario	In Maximum Zone but Not in Scenario	Total in Maximum Zone	Scenario	In Maximum Zone but Not in Scenario	Total in Maximum Zone
Del Norte	1594	2529	4123	1438	1184	2622
Humboldt	1513	6593	8105	161	10648	10809
Mendocino	234	0	234	383	0	383
Sonoma	86	2	88	7	5	12
Marin	6745	8750	15495	3137	9901	13038
Napa	0	27	27	0	0	0
Solano	0	231	231	0	76	76
Contra Costa	633	0	633	418	0	418
Alameda	2495	62245	64741	720	67190	67910
Santa Clara	0	1	1	0	30	30
San Francisco	2974	14033	17008	1106	20920	22026
San Mateo	4624	1260	5885	1802	618	2420
Santa Cruz	638	12410	13049	640	8547	9187
Monterey	1041	1033	2074	2954	3331	6285
San Luis Obispo	655	4804	5458	585	3401	3986
Santa Barbara	2260	2	2262	3545	3	3548
Ventura	8443	8838	17281	1594	2835	4429
Los Angeles	25214	27559	52773	17375	22596	39971
Orange	58155	17723	75878	15975	5328	21303
San Diego	26619	10606	37225	11929	2658	14587
TOTALS	143,925	178,646	322,570	63,769	159,271	223,040

Training, Testing & Exercise

Duty Officer Training Review Video

- 10-minute video reviewing overall tsunami Playbook approach
- Describes the FASTER flood height number and how it is calculated
- Discusses how the Playbook recommendations are made and distributed to communities
- Reviews time sequence of real-time activities from tsunami generation to arrival



Tsunami Preparedness Week - EXERCISES
March 27-31, 2017

Tsunami Warning Communications Test (3 County OA's)

- Weds, 3/23/16 (**11:00** PDT)
- NOAA Press Release (via Western Region HQ)

Required Monthly Test (RMT) (17 County OA's)

- Weds. 3/23/16 **(10:15** PDT)
- NOAA Press Release (via Western Region HQ)

Air Ops On-Board Audio Testing

Playbook Communications Drill (20 County OA's)

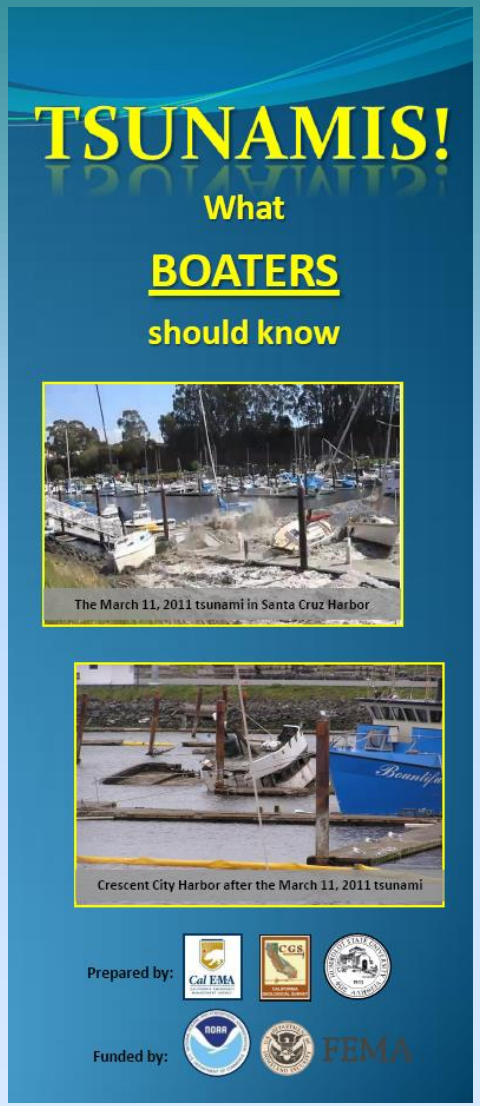
- **Weds. 3/23/16 (14:00 PDT)**
- **State to County Conference Call**

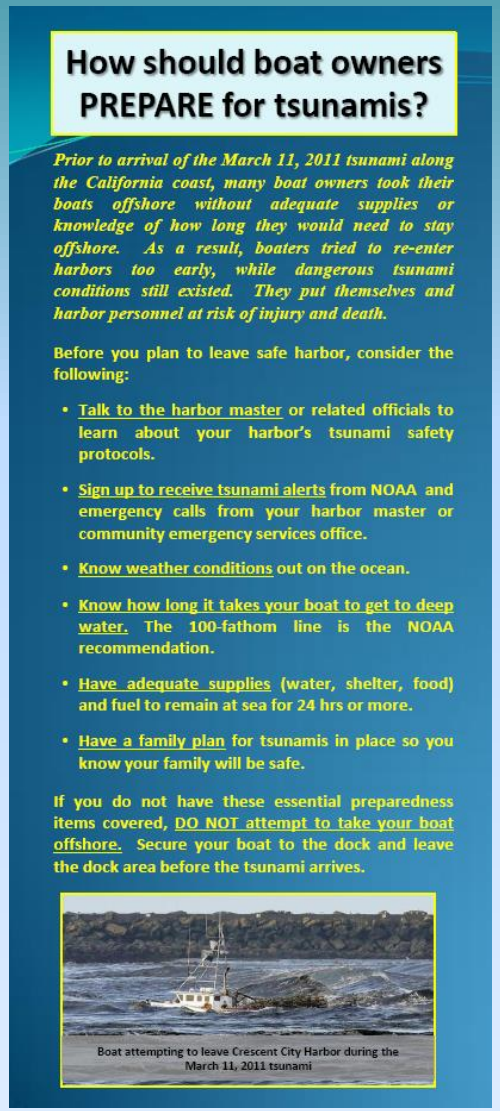
Local Exercises:
Tabletops, Informational, Functional

- PacifEX16 = Cascadia Rising NOAA-sponsored Exercise (NTWC)

Public Education & Outreach

- **AUDIENCE (different size ships and levels of experience):**
  - Recreational
  - Commercial/Fishing
  - Large transport/cruise ships/military
- **SAFETY INFORMATION**
  - Talk to Harbor Master
  - Sign up to get tsunami alerts
  - Know weather conditions
  - Know how long it takes you to get to safe depth
  - Have adequate supplies
  - Have a family plan
  - Are you prepared to be out for lengthy periods of time???





Key Points

1. Playbooks only intended for response use during **distant** source tsunamis more that 4 hours away
2. Evacuation Playbooks are important resource for planning evacuation from **different size** events
3. Maritime Playbooks are an important resource (where **strong currents** are/are not) for mitigation planning
4. Our **general recommendation** is **not to evacuate** vessels further offshore, especially for locally generated tsunamis

Thank You!

Kevin.Miller@CalOES.ca.gov

www.TsunamiZone.ca.gov

www.tsunami.ca.gov