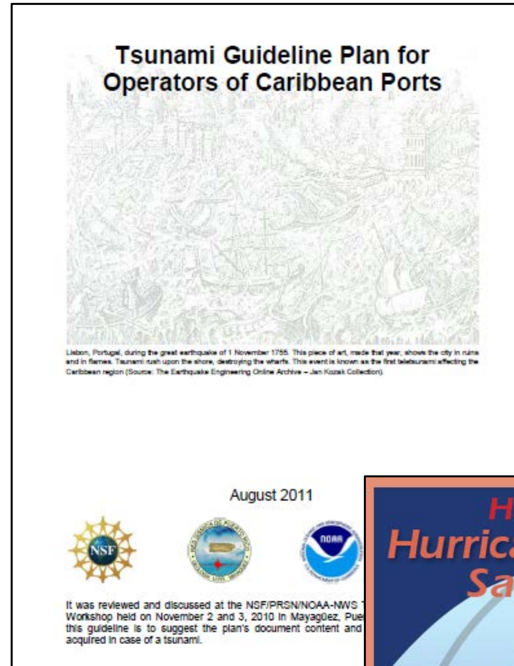
2016 Update on NTHMP Maritime Preparedness and Response

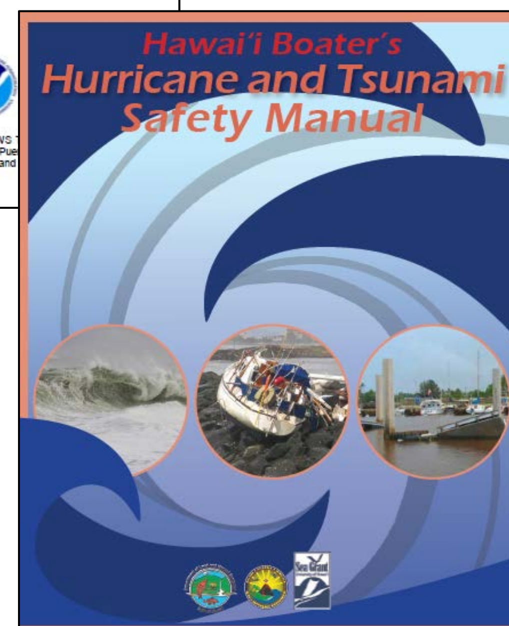
1) Recent need for updating and improving maritime preparedness and response to tsunamis.
2) The NTHMP Strategic Plan measures that address maritime preparedness.
3) The new MMS/NTHMP Maritime Guidance document.
4) The current benchmark workshop and report.
5) An update on what NOAA and the states/territories/commonwealths are working on to address maritime issues.

Pre-Existing Guidance and Information

- Hawaiian and Caribbean guidance

- NOAA recommendation for offshore vessel evacuation = 100 fathoms (600-foot depth)





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

Needs and Lessons Learned from Recent Tsunamis

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

- **Inconsistent response activities, including If/When/Where to reposition vessels**
- **Educate boat owners about tsunami hazards to help them make better decisions**
- **Better collaboration between State/NOAA with maritime officials, including harbormasters, Coast Guard and Navy**
- **Ongoing recovery issues: What can be done to improve tsunami resistance and resiliency in harbors?**
- **Guidance (State and National) for consistent response**

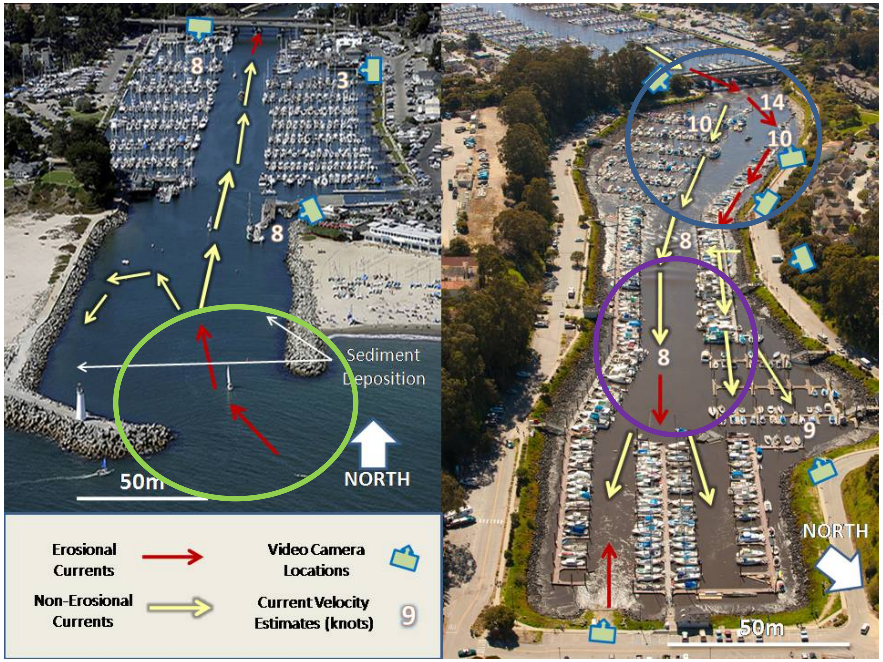
March 2011: Tsunami damage to boats and docks in Brookings Harbor, Oregon

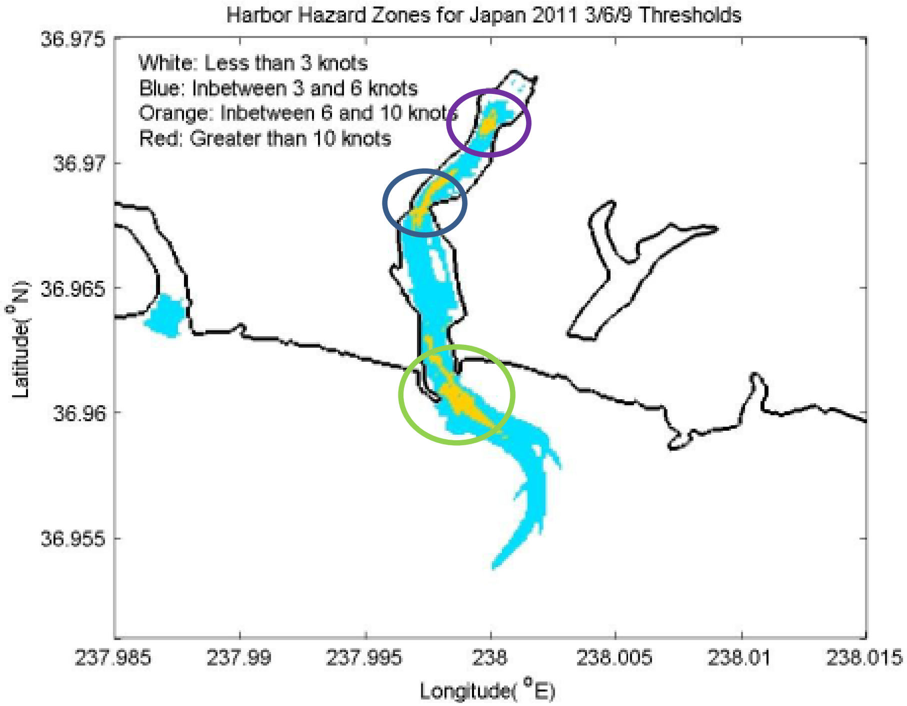
March 2014: Rebuild in "tsunami resistant" Crescent City Harbor

Maritime Response and Mitigation Products – FEMA RiskMAP

1. **Create <u>in-harbor hazard maps</u>, based on current vs. damage relationship**
2. **Evaluate and create <u>minimum offshore safety</u> line/zone (30 fathoms=180 feet)**
3. **Provide and make operational statewide planning and response guidance (<u>Playbooks</u>)**
4. **Evaluate mitigation strategies and add to <u>Local Hazard Mitigation Plans</u>**
5. **Integrate into <u>guidelines</u> through National Tsunami Hazard Mitigation Program**

Started with video and other analyses of currents used to validate currents from numerical models





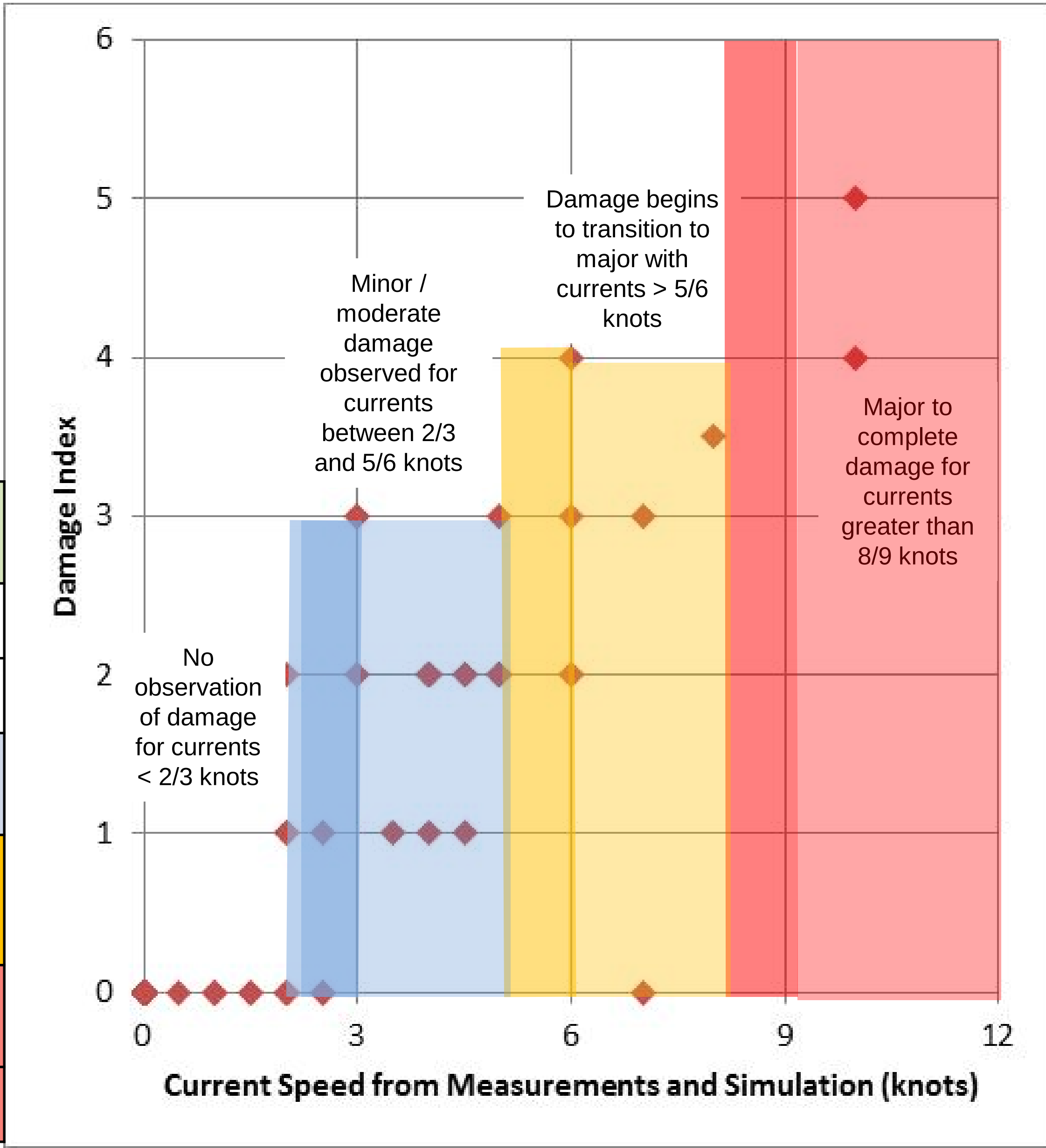
March 11, 2011 tsunami in Santa Cruz; modified from Wilson and others, 2012, and Lynett and others, 2013

Tsunami Current Hazard Maps

- **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

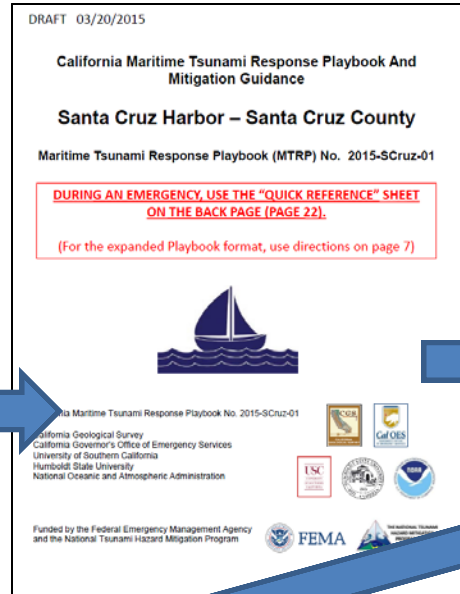
From Lynett and others (2013)



California Maritime Tsunami Response Playbooks
Maps are FEMA RiskMAP Products

Real-time recommendation from State:

Communities/Harbors	Recommended MINIMUM Tsunami Response Playbook Plan, based on tsunami forecast amplitude (wave height)	**Tsunami forecast amplitude** (wave height), in METERS above existing conditions, from National Tsunami Warning Center
Port of Oakland	Response Plan B	0.5
Alameda Marinas	Response Plan A	0.5
East San Francisco	Response Plan B	0.4
North San Francisco	Response Plan B	0.7
Pillar Point Harbor	Response Plan B	0.8
Santa Cruz Harbor	Response Plan B	0.8
Moss Landing Marinas	Response Plan B	0.6
Monterey Harbor	Response Plan A	0.5
Morro Bay Marinas	Response Plan B	0.7
Santa Barbara Harbor	Response Plan A	0.5
Ventura Harbor	Response Plan A	0.5


DRAFT 03/20/2015

California Maritime Tsunami Response Playbook And Mitigation Guidance

Santa Cruz Harbor – Santa Cruz County

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

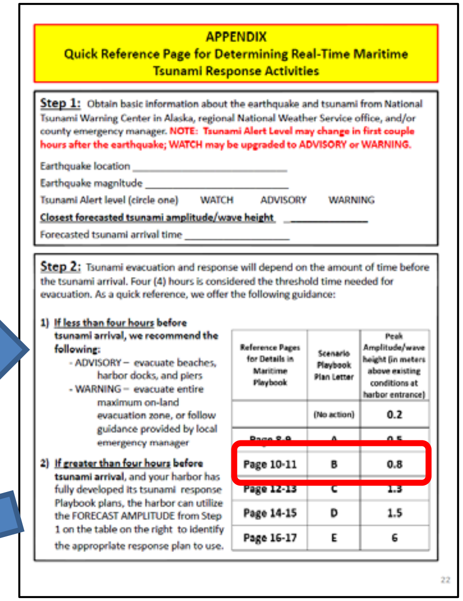
DURING AN EMERGENCY, USE THE "QUICK REFERENCE" SHEET ON THE BACK PAGE (PAGE 22).

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

...ia Maritime Tsunami Response Playbook No. 2015-SCruz-01

...alifornia 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


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 ____________

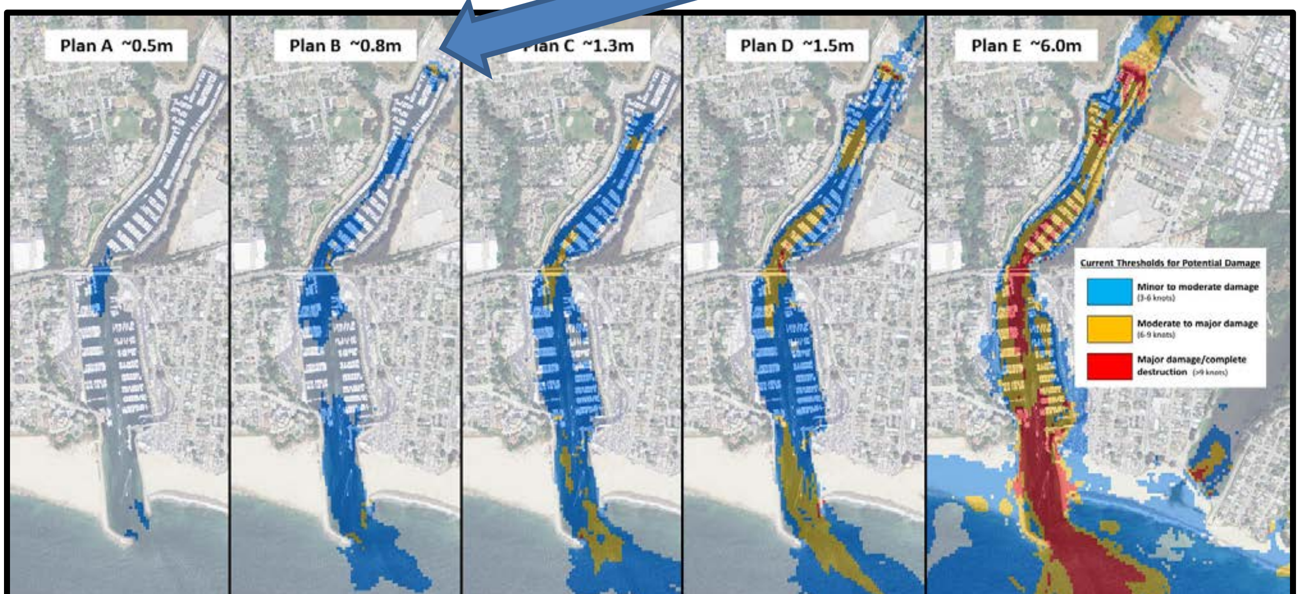
Step 2: Tsunami evacuation and response will depend on the amount of time before the tsunami arrival. Four (4) hours is considered the threshold time needed for evacuation. As a quick reference, we offer the following guidance:

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

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.

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

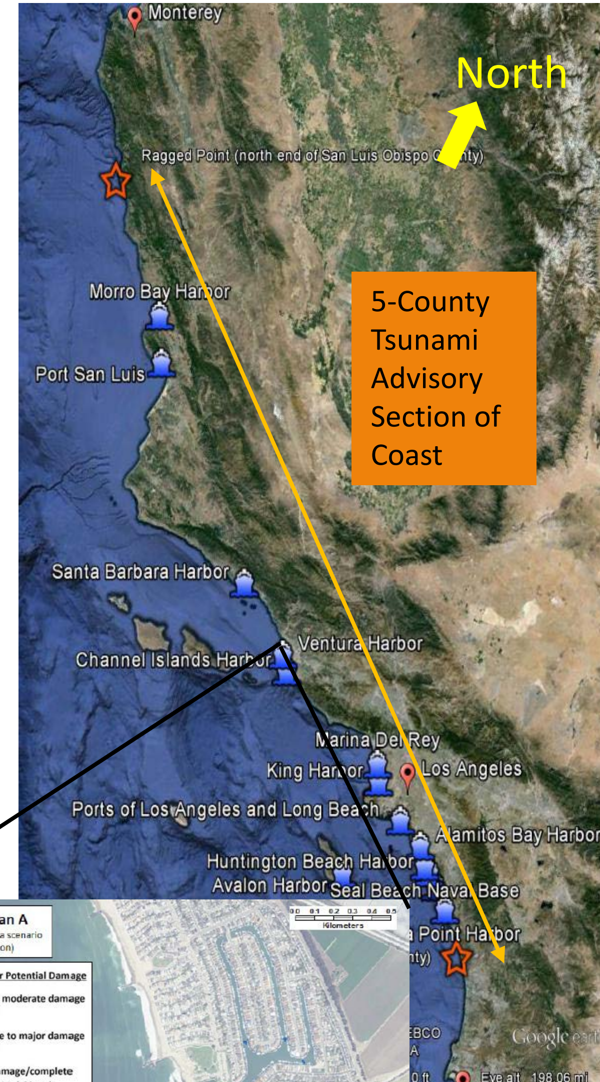
22

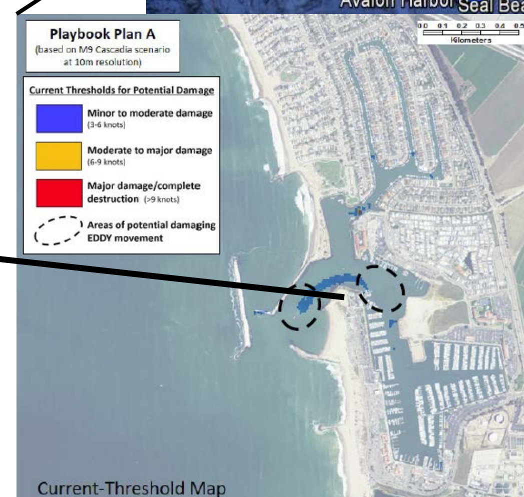


REAL-TIME USE OF PLAYBOOKS

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

- 15 ports and harbors within 5 county Tsunami Advisory zone
- State recommended potential Playbook and actions in real-time
- All harbors in Advisory zone below lowest Playbook Plan (Plan A ~ 0.4-0.6m) because highest forecast wave height 0.3m
- Many harbors surveyed indicated using Maritime Response and Mitigation Playbooks during event
- Harbors monitored and controlled activity around projected areas of moderate-to-high currents





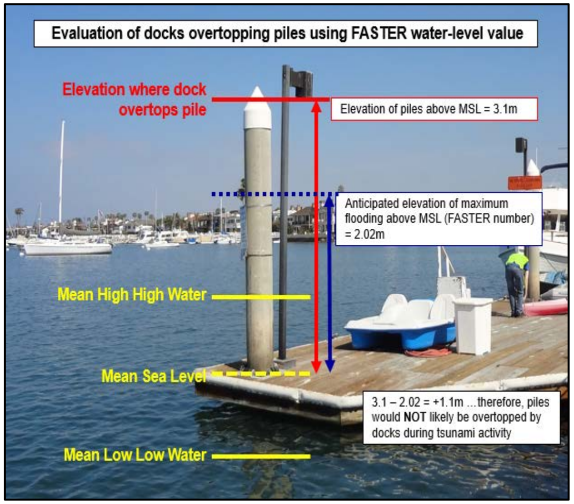
Tsunami currents entering Ventura Harbor 9-17-15; video from Dr. Pat Lynett.

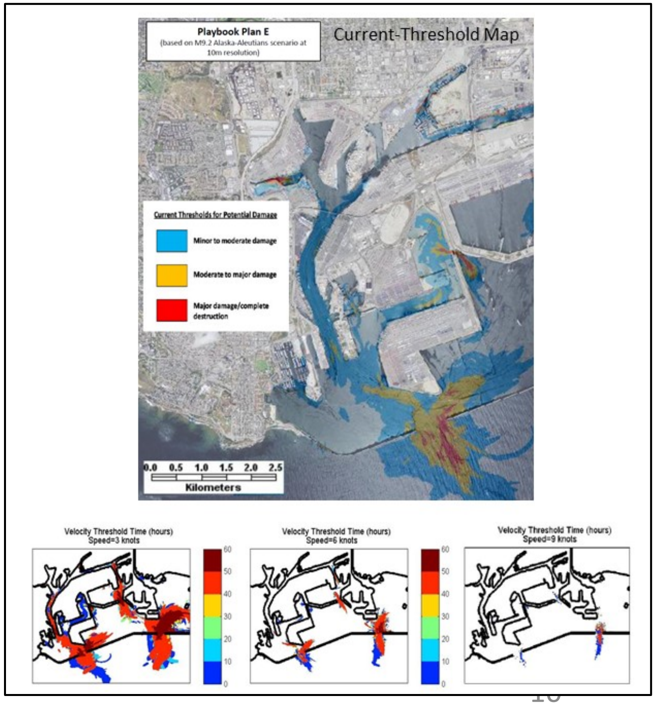
NTHMP 2013-2017 Strategic Plan – Strategies and Milestones

Strategy	Milestone	
Develop new tsunami hazard products to assist the maritime community and meet emergency management and other NTHMP customer requirements.	**Review existing demonstration projects and develop products guidelines** (including offshore safety zones, drawdown, and currents for maritime planning by end of 2013.	MMS
	Benchmark numerical tsunami models for use on maritime products to ensure NTHMP funded models meet NOAA-NTHMP standards by end of 2015.	
	Develop prototype maritime products for one community within each high tsunami hazard state/territory by the end of 2015.	
	Dependent on success of the two above milestones and emergency management and other NTHMP customer requirements, **develop maritime products for 25% of threatened communities** within each high tsunami hazard state/territory by the end of 2017.	
Support tsunami outreach efforts to specific audiences such as coastal residents and businesses, media, maritime community, and tourism	Support the maritime community in **developing educational resources and preparedness efforts** by end of 2017.	MES

Guidelines and Best Practices for Tsunami Hazard Analysis, Planning, and Preparedness for Maritime Communities

Draft December 2015

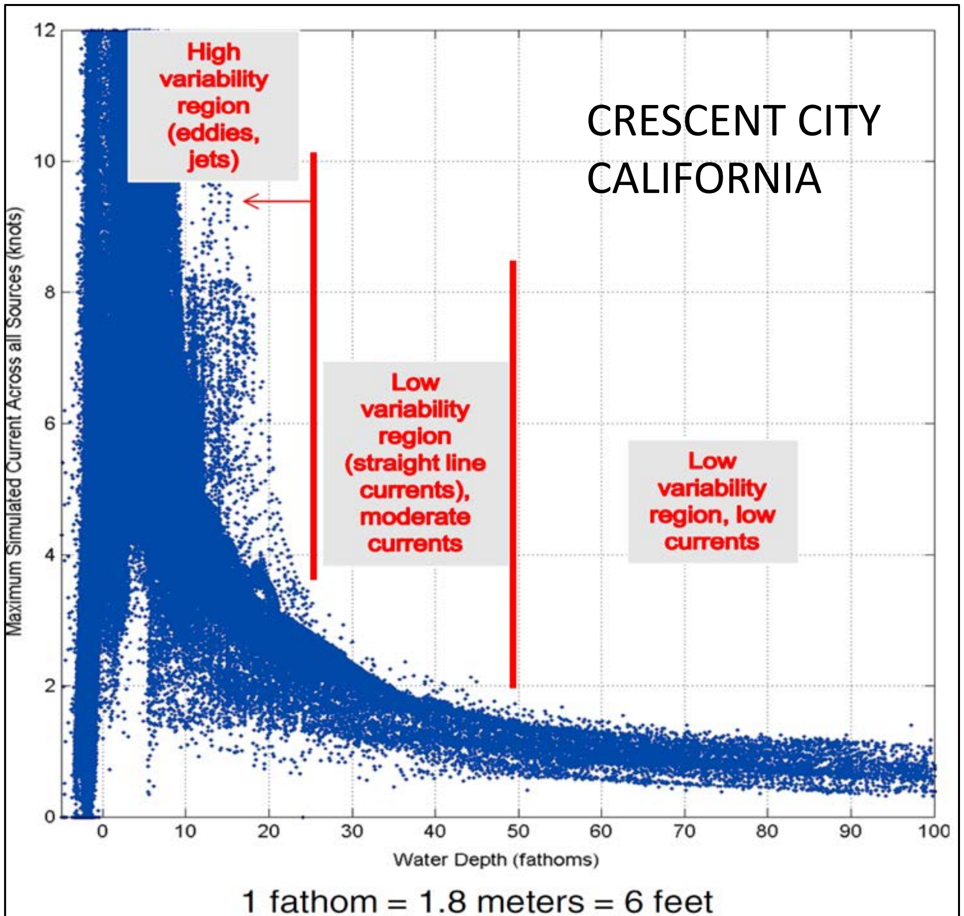


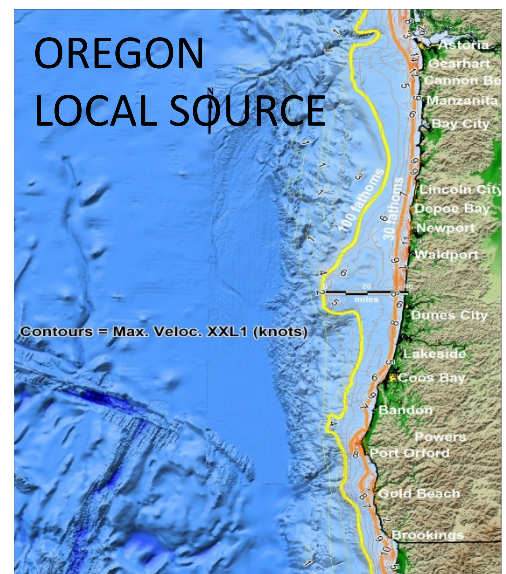


Guidance for Safe Minimum Offshore Depth for Vessel Movement

Evaluation of current speed vs. water depth

to determine minimum safe depth





Guidance for Safe Minimum Offshore Depth for Vessel Movement

Worked between NTHMP States/Territories and U.S. Coast Guard

State/Territory	Distant Source (ships in harbor)*	Local Source (ships at sea)*	Notes
California	30 fathoms	100 fathoms	Evaluated, except for potential safe areas within large bays and ports
Oregon	30 fathoms	100 fathoms	Evaluated
Alaska	30 fathoms	100 fathoms	Evaluated; ships should be at least 1/2 mile from shore
Washington	30 fathoms	100 fathoms	Special conditions exist inside Puget Sound
Hawaii	50 fathoms	50 fathoms	Evaluated; implemented in Coast Guard plan in some locations
Puerto Rico	50 fathoms	50 fathoms	General recommendation
USVI	50 fathoms	50 fathoms	Possibly follow PR
Gulf Coast		100 fathoms	Evaluating ; issues with long, shallow shelf complicate getting far offshore
East Coast		100 fathoms	Evaluating; issues with long, shallow shelf complicate getting far offshore
American Samoa	50 fathoms	50 fathoms	Evaluating, guidance from others
Guam	100 fathoms	100 fathoms	Coordinated with USCG Guam Sector
CNMI	100 fathoms	100 fathoms	Coordinated with USCG Guam Sector

* And a minimum of ½ mile from shore or fringing reef

Determining Appropriate Maritime Planning and Response Guidance

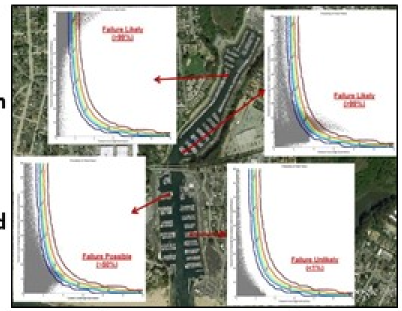
	2-Level Response Guidance	Multiple-Level Response Guidance
Type of maritime community	Small open-coast harbors or harbors within rivers or bays which have not experienced significant tsunami damage in the past	Harbors and ports which have had damage in past events, especially during both Advisory and Warning level events
Basis for response planning	Response for either Advisory level events or Warning level events	Response specific to multiple scenarios between the Advisory and Warning level range
Scenario modeling required	Minimal modeling required, velocity and flow depth for one or two maximum considered distant source scenario	More comprehensive modeling is required for a variety of distant tsunami sources with the near-shore forecast peak wave amplitude range of 0.3m to 1.5m
Relative cost*	Minor cost for modeling single maximum scenario	Moderate cost for modeling multiple scenarios
Relative accuracy	Moderate accuracy for capturing tsunami conditions	Higher accuracy by selecting response plan with more specific information about severity and location of damaging currents
Decision making and response	Simplified approach with only two choices predetermined by the tsunami alert level	Advanced approach with a number of response choices based on forecast peak wave amplitude from the Warning Center
Real-time decision making assistance from state/NWS	Assistance to select the response level is not required	Assistance to select the response level is recommended; MINIMUM scenario plan may be recommended by state or NWS IDSS

Demonstration component diagram of tsunami vulnerability analysis for harbors, integrated into Harbor Improvement Reports for mitigation planning

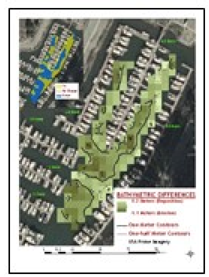
(examples from Santa Cruz Harbor)

Numerical Current Velocity Modeling of design event (50-year equivalent) as input. Flood elevation and inundation modeling will also be used. Severe storms, extreme tides, and sea-level rise will also be evaluated in similarly.

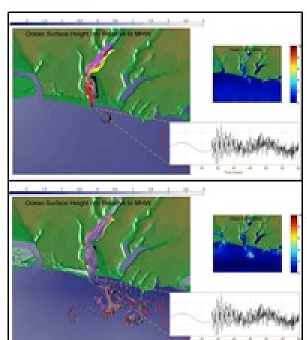
Damage Potential Analysis – Current velocity and direction is compared to damage potential curves for various harbor structures and infrastructures.



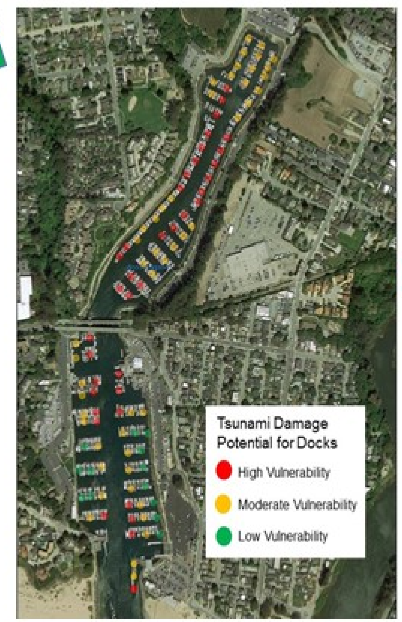
Sediment Movement Analysis – Current velocity data is used to determine where sediment erosion and accumulation will occur.



Debris Movement Analysis – Current velocity data is used to determine where debris (damaged docks, loose vessels, etc.) will move during and accumulate after event.



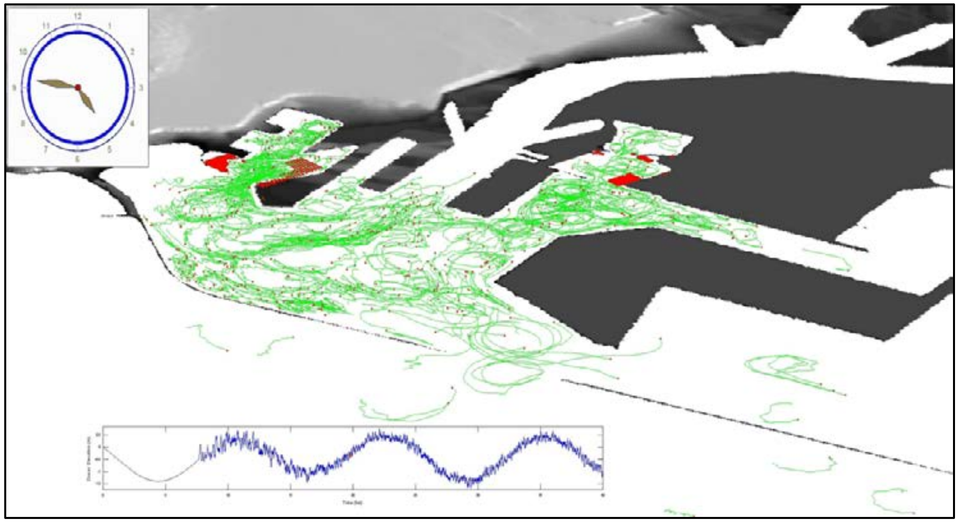
Vulnerability Analysis – Combines damage potential analysis with sediment and debris analyses to determine the vulnerability of harbor structures and infrastructure. Detailed analysis of sub-dock units will be included.



Mitigation Recommendations – The vulnerability of potential harbor pollutions sources will be evaluated and harbor mitigation/improvements recommended. These may included dock or infrastructure replacement or repositioning, increased dredging, and increased protection measures.

Tsunami Recovery Issues and Guidance (Maritime and Community)

Model of potential debris movement in Port of Los Angeles during large Alaska tsunami



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

Direct Impacts (Damage):

- Vessels, docks, and harbor infrastructure damage
- Permanent land change in large local source EQ
- Debris in water and on land
- Sedimentation and scour
- Contaminants in water and sediment
- Environmentally protected areas/species

Indirect Impacts (Time):

- Residential reconstruction and/or relocation
- Commercial fishing and shipping disruption
- Business disruption
- Regulatory redundancy and delays
- Limited funding for recovery
- Limited resources for recovery
- Loss of business and workforce over time

- **Continue work with recovery/land-use planning specialist and colleagues in Japan**
- **Develop "Guidance for Tsunami Recovery" for harbors/communities and states**
- **Assist communities and harbors in developing local recovery plans**
- **Add information to NTHMP guidance**

*****Draft recovery guidance available in 2016; Final guidance - pending CTP funding*****

NTHMP Tsunami Current Model Benchmark Workshop

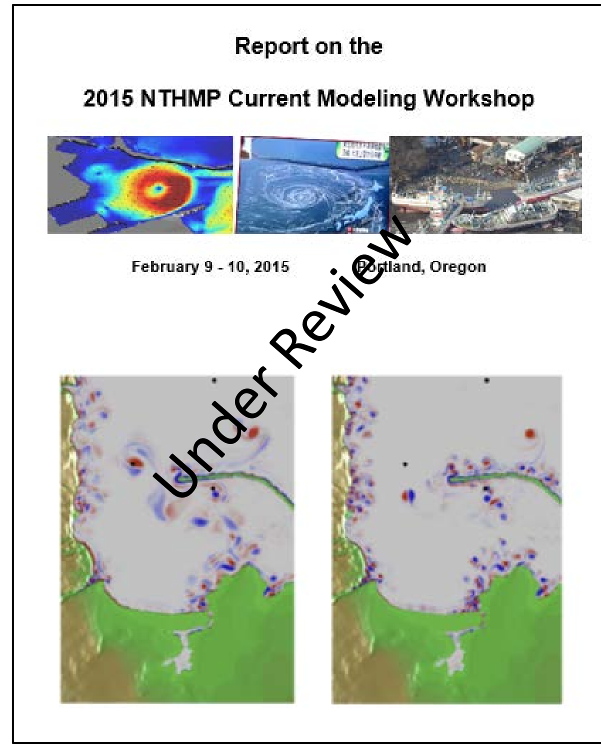
WORKSHOP: Held February 9-10, 2015 with 14 NTHMP and international models participating; five benchmarks were provided with two mandatory benchmarks to run

PURPOSE:

1. **Satisfy the requirement of the FY2013-2017 NTHMP Strategic Plan for the Mapping and Modeling Subcommittee.**
2. **Verify the accuracy/adequacy of current models for use by NOAA and NTHMP partners to help produce accurate and consistent maritime and other hazard reduction products.**

PRELIMINARY FINDINGS AND POSSIBLE OUTCOMES:

1. Models similar in their ability to identify areas of high currents, especially where jetting occur.
2. A few models consistently captured velocities with a greater degree of accuracy than others, especially where eddy formation and migration occurred in data sets.
3. The deficiencies of the models in the areas where eddies form and are expected to migrate might be addressed by:
   - A. **Running ensemble of models** and combining the results to capture the maximum current velocities;
   - B. **Binning modeled current velocities** into numerical categories related to damage potential, to reduce the reliance on absolute accuracy of the velocities; and/or,
   - C. **Identifying and encircling the areas where eddies** are expected to be generated and migrate.



Maritime Guidance for Distant Source Tsunami Events

Ports of Newport and Toledo Lincoln County, Oregon

Oregon Maritime Tsunami Response Guidance (MTRG) No. 2015-OR-01

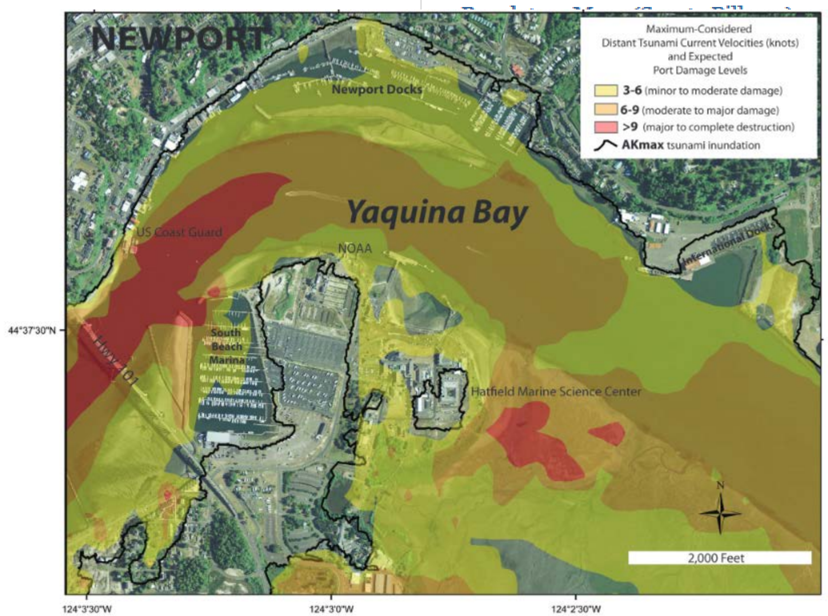
Maritime response guidance in this document is based on anticipated effects of a **maximum-considered distant tsunami event**, scenario **AKmax** of the Oregon Department of Geology and Mineral Industries (see www.oregontsunami.org for more information on this scenario). Smaller distant source tsunamis will occur more commonly and are likely to cause significantly less damage than this maximum considered scenario. Check with local authorities for more specific guidance that may be appropriate for smaller distant tsunami events.

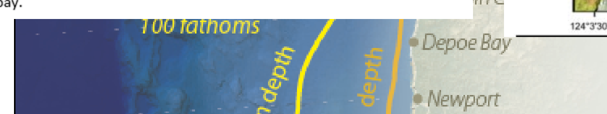
NOTABLE HISTORICAL TSUNAMIS IN NEWPORT AREA

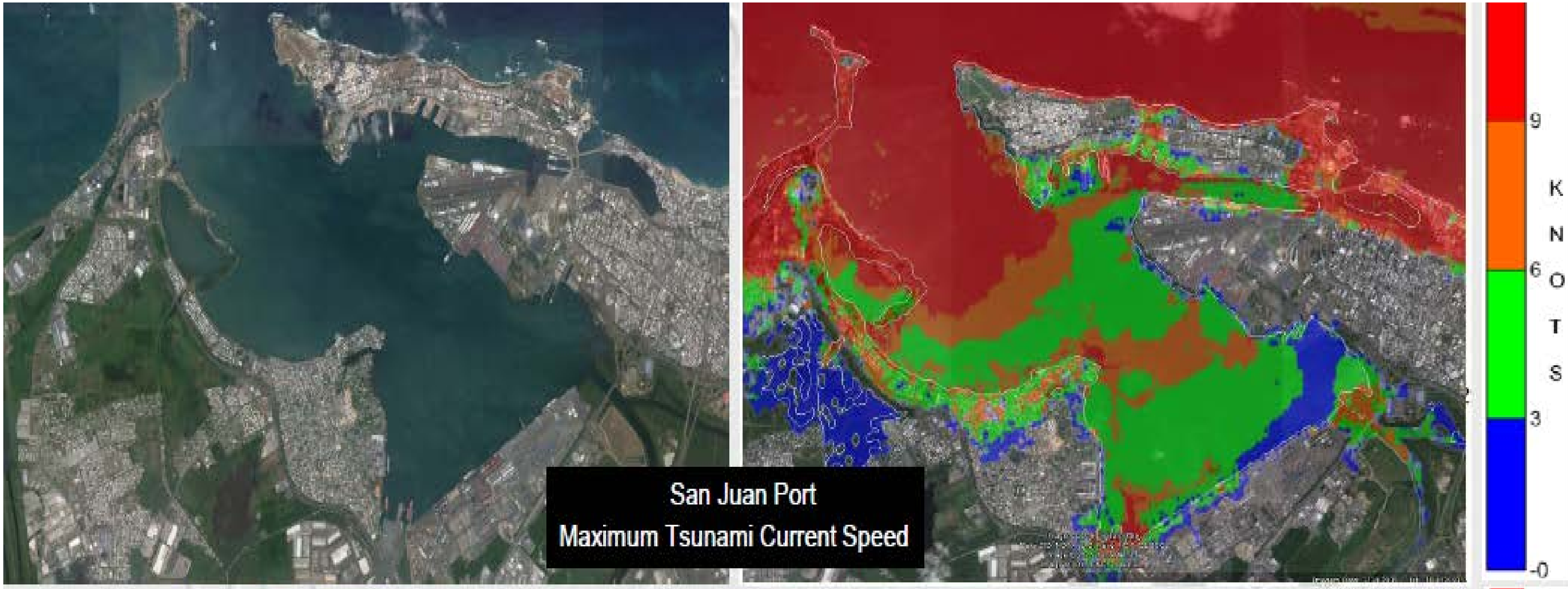
The table provides basic information about historical tsunami events; very minor tsunamis are not shown. The largest, most damaging distant-source tsunamis in Newport area have come from large earthquakes in the Alaska-Aleutian Islands region. The peak amplitude and damage information may help provide port authorities background for comparing future Advisory and Warning level tsunamis in the area. For example, the 2011 Japan tsunami may provide a threshold for no damage occurring below a forecast amplitude (wave height) of 0.43 m (1.4 ft).

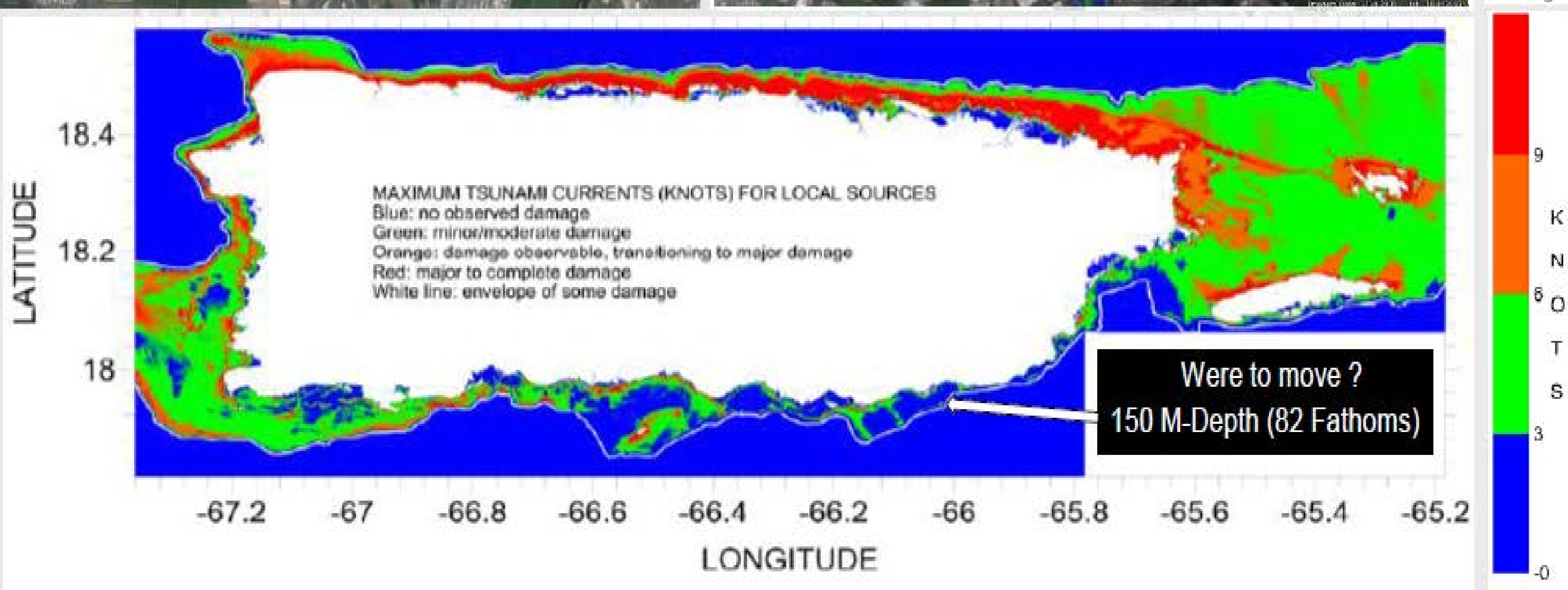
		Peak Amplitude Observed		NTWC Tsunami Alert Level Assigned	Tides During First 5 Hours	Damage Summary
Location	Event	(m)	(ft)			
Newport area	1964 M9.2 Alaska	3.5	11.5	Warning	High*	light damage to ships and docks**
South Beach	2009 M8.0 Samoa	0.08	0.3	Advisory***	High	no damage reported
South Beach	2010 M8.8 Chile	0.16	0.5	Advisory***	Low	no damage reported
South Beach	2006 M8.3 Kuril	0.17	0.6	—	Low	no damage reported
South Beach	2011 M9.0 Japan	0.43	1.4	Warning***	Low	no damage reported

*Alaska 1964 arrival on PNW coast was at mean high water flood tide.
**1964 observation by ship captain Terry Thompson communicated February 19, 2015 to George Priest.
***Alert assigned by forecast OUTSIDE of bay.






San Juan Port
Maximum Tsunami Current Speed
9
6
3
-0
K N O T S


MAXIMUM TSUNAMI CURRENTS (KNOTS) FOR LOCAL SOURCES
Blue: no observed damage
Green: minor/moderate damage
Orange: damage observable, transitioning to major damage
Red: major to complete damage
White line: envelope of some damage
Were to move ?
150 M-Depth (82 Fathoms)
LATITUDE
18.4
18.2
18
LONGITUDE
-67.2
-67
-66.8
-66.6
-66.4
-66.2
-66
-65.8
-65.6
-65.4
-65.2
9
6
3
-0
K N O T S

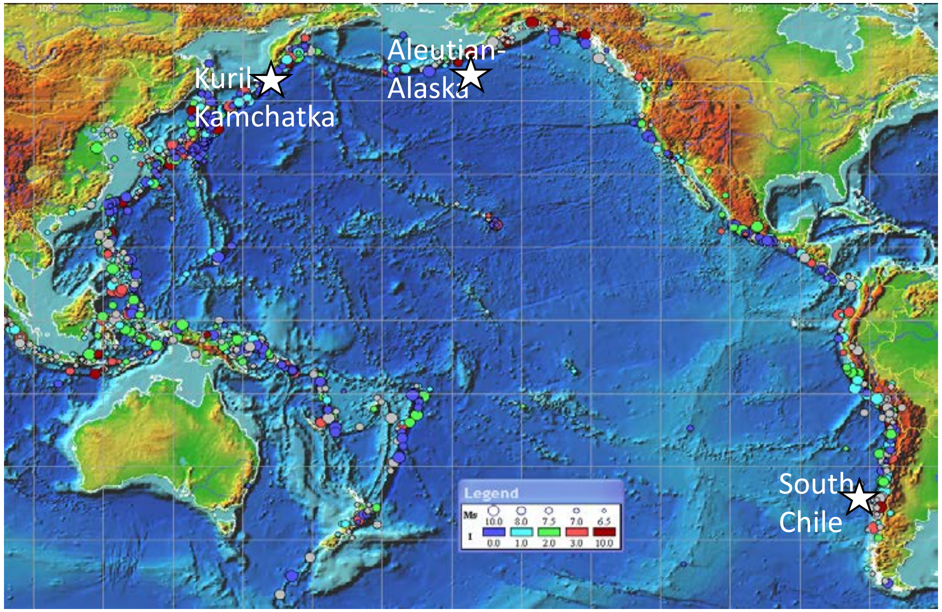
Hawaii Maritime Hazard Mapping Project

US Coast Guard 14th District

- Hawaii, American Samoa, and the Mariana Islands

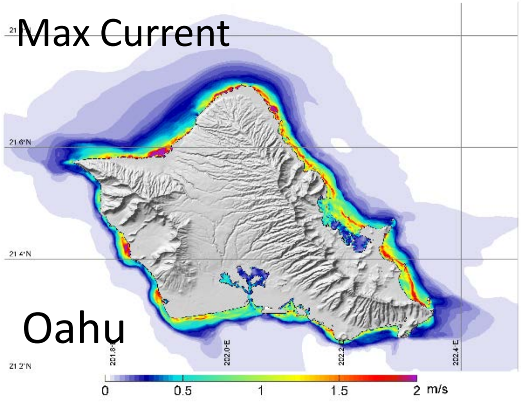
US Coast Guard Advisory Group

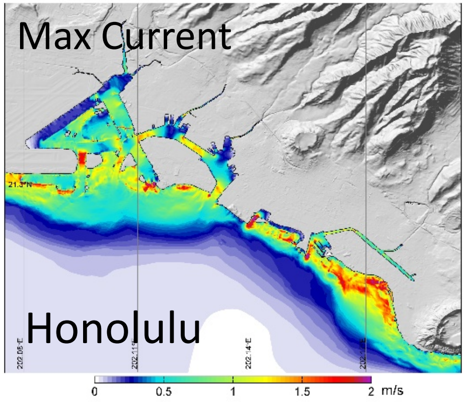
- In-harbor hazard maps of current speed, surge elevation, and drawdown
- Offshore current speed for definition of safe zones, and
- Attenuation time *for forecast near-shore wave amplitude from PTWC*

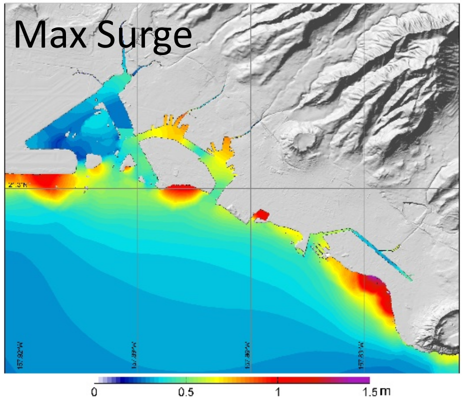


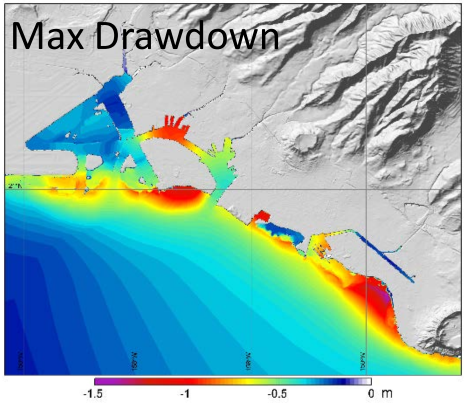
Primary project task

- Development of pre-computed tsunami scenarios from three potential sources
- Potential decision support tool – Playbook-type database system

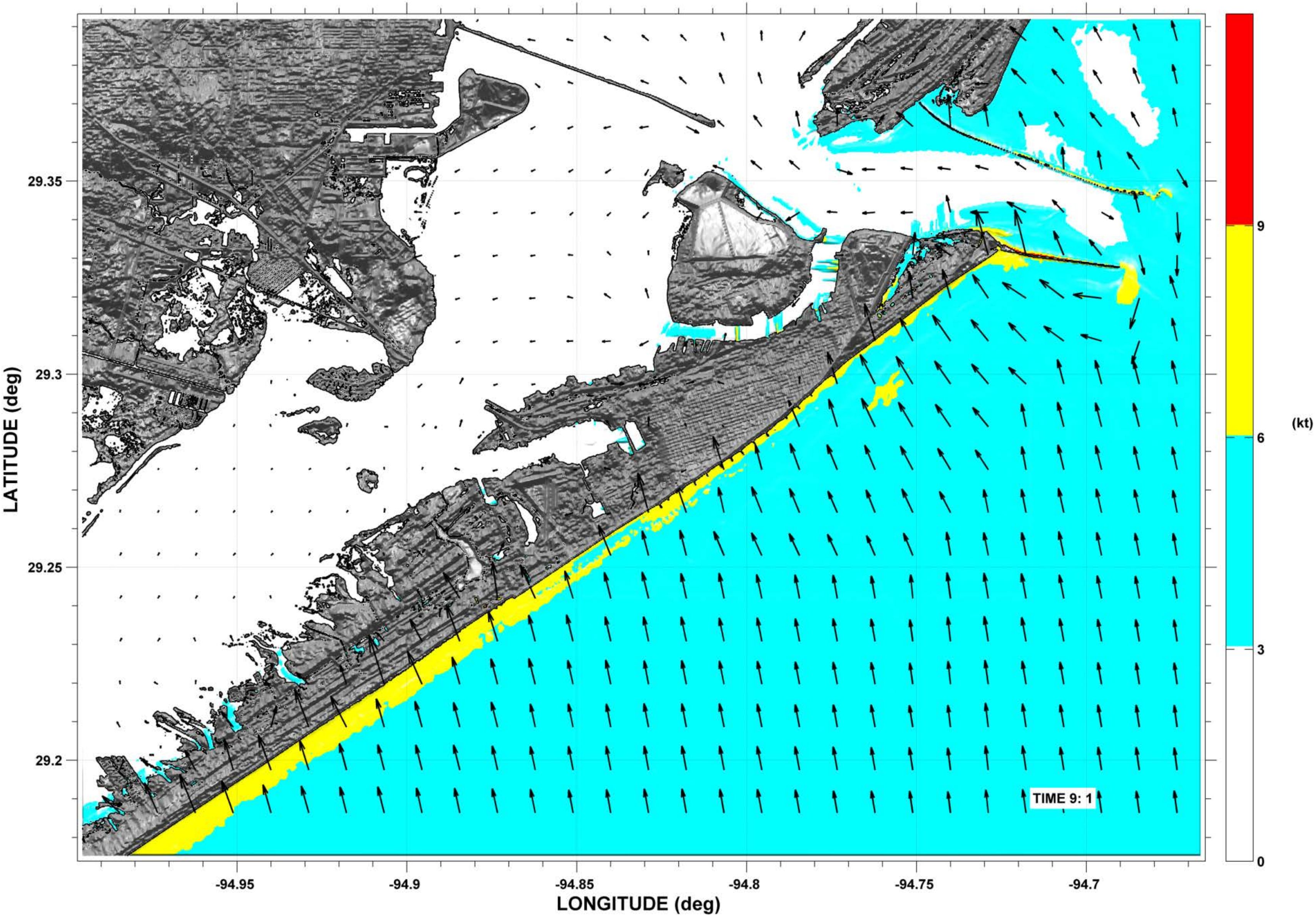








Galveston, TX
Maximum Wave Speed - Mississippi



Galveston, TX
Maximum Wave Speed by WC scenarios