NTHMP Maritime Tsunami Hazard Preparedness, Response, Mitigation, and Recovery Guidance

March 2011: MES Co-Chair, Kevin Miller, pointing at sunk boats and recovery efforts in Crescent City Harbor (thinking about creating maritime preparedness, response, mitigation and recovery guidance)

Rick Wilson, California Geological Survey

Coordinated with the state partners in California and with other states through the National Tsunami Hazard Mitigation Program
There are a number of **TSUNAMI HAZARDS** that could directly affect harbors and boaters:

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

- **Eddies/whirlpools** causing boats to lose control

- Sudden **water-level fluctuations** where docks and boats:
  - Hit bottom (grounded) as water level drops
  - Could overtop 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 tens of hours** after first wave arrival, causing problems for inexperienced and unprepared boaters who take their boats offshore

- Recovery delays because of **environmental hazards**
Guidelines and Best Practices for Tsunami Hazard Analysis, Planning, and Preparedness for Maritime Communities

Contents

Purpose of Maritime Planning and Preparedness Guidelines

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Part 1: Guidance for Tsunami Hazard Analysis, Modeling, and Mapping

1.1 Use of Numerical Tsunami Models and Digital Elevation Models/Grids

1.2 Maritime Tsunami Hazard Preparedness Products
   - Product 1: Identification of Areas of Past Damage and Strong Currents
   - Product 2: Mapping Current Velocities and Relationship to Damage
   - Product 3: Identification of Areas of Potentially Large Water Fluctuation
   - Product 4: Identification of Areas of Potential Bores, Seiches, and Amplified Waves
   - Product 5: Identification of Timeframe for Damaging Currents
   - Product 6: Identification of Safe Minimum Offshore Depth

1.3 Basic Guidance on Design of Products

Part 2: Guidance for Tsunami Response, Preparedness, and Education

2.1 General Maritime Guidance
   - Preparedness Strategies
   - Education Strategies

2.2 Harbor/Port Specific Maritime Guidance
   - Alert-Level Tsunami Response Guidance:
     - Scenario-Specific Tsunami Response Playbooks:

Part 3: Guidance for Tsunami Mitigation and Recovery Planning

3.1 Mitigation Planning Strategies

3.2 Recovery Planning Strategies

Resources – Maritime References, Products, and Entities

Keys to Guidance:

1) Consistency in hazard analysis methods used;
2) Consistency in content and “look” of products between states and within NOAA;
3) Consistency with messaging in preparedness products and outreach; and,
4) Consistency in response activities and recommendations
## Guidance for Safe Minimum Offshore Depth for Vessel Movement

Work between NOAA, NTHMP States/Territories/Commonwealths, and U.S. Coast Guard

<table>
<thead>
<tr>
<th>State/Territory</th>
<th>Minimum offshore safe depth</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distant Source (ships in harbor)</td>
<td>Local Source (ships at sea)</td>
</tr>
<tr>
<td>California</td>
<td>30 fathoms</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>Oregon</td>
<td>30 fathoms</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>Washington</td>
<td>30 fathoms</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>Alaska</td>
<td>30 fathoms &amp; vessels should be at least ½ mile from shore</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>Hawaii</td>
<td>50 fathoms</td>
<td>50 fathoms</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>50 fathoms</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>US Virgin Islands</td>
<td>50 fathoms</td>
<td>50 fathoms</td>
</tr>
<tr>
<td>Gulf Coast</td>
<td></td>
<td>100 fathoms</td>
</tr>
<tr>
<td>East Coast</td>
<td></td>
<td>100 fathoms</td>
</tr>
<tr>
<td>American Samoa</td>
<td>50 fathoms</td>
<td>50 fathoms</td>
</tr>
<tr>
<td>Guam</td>
<td>50 fathoms &amp; vessels should be at least ½ mile from shore</td>
<td>100 fathoms</td>
</tr>
<tr>
<td>Commonwealth of Northern Mariana Islands</td>
<td>50 fathoms &amp; vessels should be at least ½ mile from shore</td>
<td>100 fathoms</td>
</tr>
</tbody>
</table>

*Please contact the MMS state representative for further information*
## Determining Appropriate Maritime Planning and Response Guidance

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

*Cost of modeling will vary. States/Territories should calculate these costs before meeting with harbor/port officials.*
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).

<table>
<thead>
<tr>
<th>Location</th>
<th>Event</th>
<th>Peak Amplitude Observed (m)</th>
<th>NTWC Tsunami Alert Level Assigned</th>
<th>Tides During First 5 Hours</th>
<th>Damage Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newport area</td>
<td>1964 M9.2 Alaska</td>
<td>3.5</td>
<td>Warning</td>
<td>High*</td>
<td>Light damage to ships and docks.**</td>
</tr>
<tr>
<td>South Beach</td>
<td>2009 M8.0 Samoa</td>
<td>0.08</td>
<td>Advisory***</td>
<td>High</td>
<td>No damage reported</td>
</tr>
<tr>
<td>South Beach</td>
<td>2010 M8.8 Chile</td>
<td>0.16</td>
<td>Advisory***</td>
<td>Low</td>
<td>No damage reported</td>
</tr>
<tr>
<td>South Beach</td>
<td>2006 M8.3 Kurl</td>
<td>0.17</td>
<td>Advisory***</td>
<td>Low</td>
<td>No damage reported</td>
</tr>
<tr>
<td>South Beach</td>
<td>2013 M9.0 Japan</td>
<td>0.43</td>
<td>Warning***</td>
<td>Low</td>
<td>No damage reported</td>
</tr>
</tbody>
</table>

*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.
Maritime Tsunami Response Playbooks: Background Information and Guidance for Response and Hazard Mitigation Use

By Rick Wilson, Patrick Lynett, Kevin Miller, Amanda Adame, Aykut Ayca, Edward Curtis, Lori Dengler, Michael Hornick, Troy Nicola, and Drew Peterson

2016

California Geological Survey Special Report 241
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Funding by the Federal Emergency Management Agency, the National Tsunami Hazard Mitigation Program, and the National Oceanic and Atmospheric Administration

1) California Geological Survey, California Department of Conservation
   PG 5676, CEG 1881

2) University of Southern California
3) California Governor’s Office of Emergency Services
4) Humboldt State University
5) Federal Emergency Management Agency
6) NOAA, National Weather Service
Tsunami Hazard Products for Mitigation and Recovery Planning - Potential Use in National Guidance

**Maritime Mitigation**

Harbor Improvement Reports and other products that integrate risk reduction methods for coastal hazards (tsunami, SLR, storm, etc.) into Local Hazard Mitigation Plans.

**Maritime Recovery**

Guidance for harbors, communities, and state to produce recovery plans for large local- and distant-source events.
# General Maritime Tsunami Mitigation Measures

## Mitigation Measures for Reducing Impacts in Maritime Communities

<table>
<thead>
<tr>
<th>Real-time response (&quot;soft&quot;) mitigation measures</th>
<th>Permanent (&quot;hard&quot;) mitigation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reposition ships within harbor</td>
<td>Increase size and stability of dock piles</td>
</tr>
<tr>
<td>Move boats and ships out of harbors</td>
<td>Fortify and armor breakwaters</td>
</tr>
<tr>
<td>Remove small boats/assets from water</td>
<td>Replace flotation portions of docks and dock cleats</td>
</tr>
<tr>
<td>Shut down infrastructure before tsunami arrives</td>
<td>Increase flexibility of interconnected docks</td>
</tr>
<tr>
<td>Evacuate public/vehicles from water-front areas</td>
<td>Improve movement along dock/pile connections</td>
</tr>
<tr>
<td>Restrict boats from moving during tsunami</td>
<td>Increase height of piles to prevent overtopping</td>
</tr>
<tr>
<td>Prevent boats from entering harbor during event</td>
<td>Deepen/Dredge channels near high hazard zones</td>
</tr>
<tr>
<td>Secure boat/ship moorings</td>
<td>Move docks/assets away from high hazard zones</td>
</tr>
<tr>
<td>Personal flotation devices/vests for harbor staff</td>
<td>Widen size of harbor entrance to prevent jetting</td>
</tr>
<tr>
<td>Remove hazardous materials away from water</td>
<td>Reduce exposure of petroleum/chemical facilities</td>
</tr>
<tr>
<td>Remove buoyant assets away from water</td>
<td>Strengthen boat/ship moorings</td>
</tr>
<tr>
<td>Stage emergency equipment outside affected area</td>
<td>Construct flood gates</td>
</tr>
<tr>
<td>Activate Mutual Aid System as necessary</td>
<td>Prevent uplift of wharfs by stabilizing platform</td>
</tr>
<tr>
<td>Activate of Incident Command at evacuation sites</td>
<td>Install debris deflection booms to protect docks</td>
</tr>
<tr>
<td>Alert key first responders at local level</td>
<td>Ensure harbor structures are tsunami resistant</td>
</tr>
<tr>
<td>Restrict traffic entering harbor; aid traffic evacuating</td>
<td>Construct breakwaters further away from harbor</td>
</tr>
<tr>
<td>Identify/Assign rescue, survey, and salvage personnel</td>
<td>Install Tsunami Warning Signs</td>
</tr>
<tr>
<td>Identify boat owners/live-aboards; establish phone tree, or other notification process</td>
<td>Identify equipment/assets (patrol/tug/fire boats, cranes, etc.) to assist response activities</td>
</tr>
</tbody>
</table>
Diagram of tsunami vulnerability analysis for harbors, integrated into Harbor Improvement Reports for mitigation planning
(California CTP with FEMA Region IX; 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.

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.

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.
**Tsunami Recovery Issues and Guidance - Maritime and Community**

*(California CTP with FEMA Region IX)*

**Damage to Port of Sendai, Japan, following March 11, 2011 tsunami**

**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 NTHMP and Japan
- Develop “Guidance for Tsunami Recovery” for harbors/communities and states
- Assist communities and harbors in developing local recovery plans

**March 2014: Rebuild in “tsunami resistant” Crescent City Harbor**

*Courtesy of Stover Engineering*
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Part 2: Guidance for Tsunami Preparedness

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   - Outreach & Education Strategies/Examples (ADDED)

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   - Scenario-Specific Tsunami Response Guidance:

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