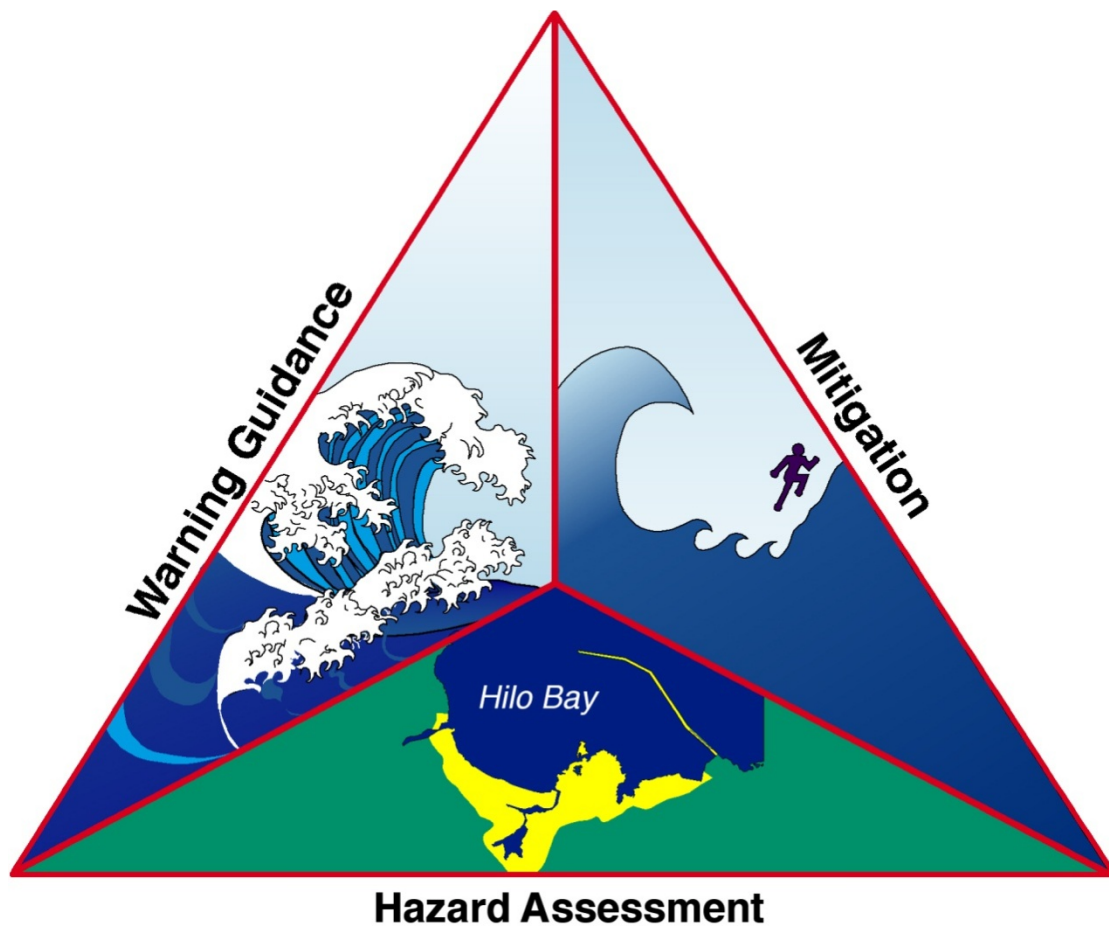


National Tsunami Hazard Mitigation Program
2013 – 2017 Strategic Plan
May 21, 2013



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EXECUTIVE SUMMARY

The National Tsunami Hazard Mitigation Program (NTHMP) is a partnership between Federal and State agencies, and is designed “to improve tsunami preparedness of at-risk areas in the United States and its territories” (Title 33 U.S.C. Ch. 45). Led by the National Oceanic and Atmospheric Administration’s (NOAA) National Weather Service (NWS), the NTHMP includes all 28 U.S. coastal states, territories and commonwealths, the United States Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), and NOAA. This strong and active partnership enables all levels of government to work together toward the common goal of reducing tsunami losses.

The NTHMP was established in 1995 by Congressional action which directed NOAA to form and lead a Federal/State working group aimed at identifying potential hazards and mitigating their risks. This action was based on increased recognition of the Cascadia tsunami threat, the April 1992 earthquake and tsunami on the Cascadia Subduction Zone in northern California, and the loss of life and property in Japan due to the 1993 Hokkaido Nansei-Oki tsunami that devastated the island of Okushiri. These events, together with the historic Alaska tsunamis of 1946 and 1964, brought to light the general lack of tsunami preparedness and hazard assessment for the U.S. coasts and the need for significant improvement in tsunami detection and forecasting. The 2006 Tsunami Warning and Education Act (PL 109-424 – TWEA) refined the NTHMP mission by focusing efforts on mitigation and preparedness activities versus detection and forecasting.

This Strategic Plan describes how, over the next five years (2013 – 2017), the NTHMP will help U.S. coastal communities threatened by tsunamis enhance their preparedness and mitigation efforts. The plan is based on language contained within TWEA; however, modifications to the Strategic Plan may be necessary pending the outcome of TWEA reauthorization. Successful implementation of this Strategic Plan will result in the following outcomes using NTHMP-developed standards:

- ❖ Successful execution of tsunami mapping, modeling, mitigation, planning, and education efforts
- ❖ Tsunami hazard assessment that supports informed decision making in tsunami-threatened communities
- ❖ Tsunami evacuation products and strategies that support effective preparedness and response
- ❖ Creating a community-based culture of tsunami preparedness
- ❖ Establishment of more tsunami resilient communities
- ❖ Effective and reliable warning dissemination to people at risk
- ❖ Understandable and effective Tsunami Warning Center products

The NTHMP Mission is to mitigate the impact of tsunamis through public education, community response planning, and accurate hazard assessment.

The NTHMP Vision is minimal loss of life and property should a tsunami strike any U.S. state or possession, and resilient coastal communities that are prepared for tsunami hazards.

INTRODUCTION

The National Tsunami Hazard Mitigation Program (NTHMP) is the nation's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within the United States and its territories. Tsunami impact can be catastrophic as shown by several recent events including the 2009 Samoa tsunami which killed 34 U.S. citizens in American Samoa. The value of tsunami preparedness was exemplified during the 2011 Japan tsunami where over 95% of the population in inundated areas survived and only 2 deaths occurred outside Japan.

Since 1995, the NTHMP and its members have diligently worked to ensure U.S. communities are prepared to respond to a tsunami emergency. In the early years of the Program, this included development of operational tsunami warning networks as well as preparedness and mitigation activities.

The passage of the Tsunami Warning and Education Act in December 2006 further focused NTHMP activities on mitigation and preparedness efforts and moved operational tsunami warning aspects of the Program to NOAA. Even though the Tsunami Warning and Education Act expired in 2012 and future funding levels are uncertain, the foundation this law has provided NTHMP can continue to help guide the Program's objectives in the coming years. However, without appropriate resources, progress may be slow and some initial gains made begin to trend downward.

In 2008, the NTHMP created a Strategic Plan to guide efforts during 2009-2013. This plan focused efforts and aligned funding to meet a well-defined set of performance measures and milestones. Major advancements to U.S. tsunami preparedness during this time frame include:

- Near complete inundation map coverage for communities along the west coast and in Hawaii and Puerto Rico,
- Development of national guidelines for inundation and evacuation maps,
- Validation of inundation models to meet NOAA standards,
- Development of national tsunami exercises and communication tests,
- Initiation of a national Tsunami Preparedness Week,
- Development of a national Tsunami Education Plan and media tools, and
- Number of TsunamiReady communities more than doubled.

Major projects which were planned but not completed during this time frame include implementation of a web-based repository for NTHMP-developed products. The 2009-2013 Plan is archived at nthmp.tsunami.gov.

This Strategic Plan defines strategies, performance measures, and milestones for the Program in the 2013-2017 time frame. It takes into account recommendations from the 2007 5-Year external review of the NTHMP and the 2010 National Academy of Sciences Tsunami Warning and Preparedness Report (http://www.nap.edu/catalog.php?record_id=12628) as well as lessons learned from the previous Strategic Plan period and recent tsunamis.

The 2007 external review panel issued a consensus statement which summarized the NTHMP as:

“A unique partnership among multiple states and federal agencies that has been developed over the past decade, has set challenging goals, and met many of them. This program has

institutionalized a partnership between federal and state members that is unmatched by other hazard and risk management programs.”

This 2013-2017 Plan acts on suggestions put forth in the external review. Some of these include:

- Establishing performance standards and standardized assessment tools for evaluating its effectiveness,
- Transferring lessons learned in the program to the new 24 members of the Program,
- Establishing an information clearinghouse where local officials can obtain the information they need for community tsunami hazard management,
- Establishing a long-term plan for developing and disseminating tsunami inundation maps, recognizing planners can do much with approximate maps produced from low-resolution data, and
- Producing consistent evacuation maps among all state partners while allowing for necessary state and local variations.

In 2010, the National Academy of Sciences (NAS) released a multi-year study on the tsunami preparedness and warning systems in the U.S. The report provided many recommendations for the NTHMP, such as:

- NOAA and its NTHMP, in collaboration with researchers in social and physical sciences, should complete an initial national assessment of tsunami risk in the near term to guide prioritization of program elements.
- NOAA and its NTHMP partners should institute a periodic assessment of the sources of tsunamis that threaten the United State, focusing mainly on earthquakes, but also on landslides and volcanoes.
- To improve tsunami inundation modeling, the NTHMP should periodically review progress in hydrodynamic modeling.
- NTHMP should reduce unnecessary and costly disparities in inundation modeling approaches among states and territories. NTHMP should conduct modeling efforts consistently across political boundaries and execute efforts through a cooperative partnership among NOAA, USGS, and NTHMP members.
- The NTHMP Mapping and Modeling subcommittee should develop guidelines on evacuation-map production that fosters consistency in format and quality across the United States; and a national, online repository for tsunami evacuation maps.
- NTHMP should periodically inventory the number and type of people in tsunami hazard zones, with special attention to groups whose heightened sensitivity to tsunamis could constrain their ability to prepare for and evacuate from future tsunamis.
- For all communities with close or intermediate proximity (i.e., arrival times ranging from minutes to about an hour) to a potential tsunami source, the NTHMP should conduct evacuation modeling studies to assess the likelihood of successful horizontal evacuations.
- Faced with limited resources, the NTHMP should give priority to systematic, coordinated perception and preparedness studies of communities with near-field tsunami sources, in order to discover whether at-risk individuals are able to recognize natural cues of tsunamis and to take self-protective actions.
- To increase the effectiveness of tsunami education, the NTHMP should:
 - Develop consistent education efforts among its members using evidence-based approaches,

- Tailor tsunami education to local circumstances,
- Create and maintain an on-line repository of education efforts,
- Develop and implement an evaluation program of the effectiveness of education efforts, and
- Leverage hazard-education efforts and expertise of other NOAA entities.
- The NTHMP should actively encourage all members to develop and maintain strong tsunami working groups to help facilitate and coordinate tsunami education, preparedness, and warning dissemination.
- To ensure that managed evacuations for far-field tsunamis are effective and minimize societal and economic interruptions, the NTHMP should develop guidelines on the design of effective exercises for use by emergency-management agencies.
- Social science post-event research audits should be performed after all tsunami “warning events” that hold the potential to document important lessons to be learned.

This Plan first lists the NTHMP customers and partners, followed by an overview of the 5-year outcomes, and then specific strategies organized under four main themes:

- Over-arching outcomes and strategies
- Mapping and modeling outcomes and strategies
- Mitigation and education outcomes and strategies
- Warning coordination outcomes and strategies

An implementation section then addresses how the NTHMP will execute the strategies. Performance measures and milestones are listed in Appendix A.

CUSTOMERS

The NTHMP activities impact, either directly or indirectly, all people of the United States. The following are the primary beneficiaries of NTHMP efforts.

- Coastal residents and visitors
- Business and government organizations
- Elected officials
- State, local and tribal emergency responders
- State, local, and tribal land use planning authorities
- Insurance industry
- Tourism industry
- Educators
- U.S. Coast Guard and maritime industry
- International tsunami warning systems
- News media
- Private weather providers

PARTNERS

NTHMP partners are agencies whose actions help accomplish the mission of the Program. These include:

- Academia
- Emergency management/response associations
- National Earthquake Hazard Reduction agencies (USGS, NIST, NSF, FEMA)
- Regional Seismic Networks
- Building code developers
- Land use planners
- National Weather Service/Warning Forecast Offices
- Regional tsunami and earthquake working groups
- United Nation's Educational, Scientific, and Cultural Organization (UNESCO)
Intergovernmental Oceanographic Commission (IOC) Intergovernmental Coordination Groups (ICGs) for Tsunamis.
- Professional/scientific organizations
- News media

5-YEAR STRATEGY

This Strategic Plan describes NTHMP outcomes and strategies for the next five year period (2013-2017). The NTHMP will execute this plan to support its objective to provide scientifically accurate assessments of the tsunami hazard, mitigate the threat through public outreach, local dissemination, planning and education, and lend guidance to optimize real-time warnings to communities on all U.S. Coastlines.

NTHMP Outcomes

- ❖ Successful execution of NTHMP tsunami mapping, modeling, mitigation, planning and education efforts
- ❖ Tsunami hazard assessment that supports informed decision making in tsunami-threatened communities
- ❖ Tsunami evacuation products and strategies that support effective preparedness and response
- ❖ Creating a community-based culture of tsunami preparedness and response
- ❖ Establishment of more tsunami resilient communities
- ❖ Effective and reliable warning dissemination to people at risk
- ❖ Understandable and effective Tsunami Warning Center products

This Plan defines ambitious strategies that will strengthen the Program and meet the outcomes stated above. These strategies address many of the recommendations provided in the 2007 external review and 2010 NAS Report. The strategies are followed by performance measures and milestones which will provide goals to define success (Appendix A).

Important drivers and issues that face the NTHMP are considered. These items include state-of-knowledge constraints, funding uncertainty, and the need to balance the immediate requirement for community readiness over long-term research requirements including hazard and risk assessments. The NTHMP Coordinating Committee (CC) must provide prioritization of performance measures and milestones annually as funding levels may not be sufficient to achieve all stated goals. Language contained in the Tsunami Warning and Education Act of 2006 is used as guidance for this document. Modifications to the Strategic Plan may be necessary pending the outcome of the Act's reauthorization.

OVER-ARCHING OUTCOME and STRATEGIES

The effective execution of this Strategic Plan requires the NTHMP CC to be responsible for the overall implementation of the plan. Most strategies will be executed through the NTHMP subcommittees; however, there are five strategies identified in this section which will either support the NTHMP in its entirety or require joint efforts of multiple subcommittees. The NTHMP Chair or designee will take the lead and actions necessary to complete the strategies, measures, and milestones related to the outcome listed below.

Outcome: Successful Execution of NTHMP Tsunami Mapping, Modeling, Mitigation, Planning and Education Efforts

The Tsunami Warning and Education Act authorized the NTHMP CC to recommend how funds within the NTHMP (under Section 5) are appropriated, recommend improvements to the National Weather Service's TsunamiReady Program, and ensure all components of the program are integrated with on-going hazard warning and risk management activities, emergency response plans, and mitigation programs in affected areas. The NTHMP Chair or designee is responsible for the overall achievement of this outcome, which will predominantly be achieved through the NTHMP subcommittees. The strategies below are directly tied to this outcome and benefit the overall NTHMP.

Strategies:

- Establish an accessible web-based repository for NTHMP-related products commensurate with current and expected budget limitations.
 - The NTHMP has a wealth of products and information that can be used to develop and improve tsunami hazard management. An accessible web-based repository for these and related products is necessary to ensure the products are easily available. This repository will contain all products funded by the NTHMP including but not limited to: inundation maps and models, non-proprietary digital elevation models, evacuation maps, K-12 curriculum and lesson plans, mitigation and preparedness materials, and peer-reviewed documents. Such a tool enhances digital collaboration and enables communities to leverage existing products and reduce costs.
- Strengthen subcommittees to execute this Strategic Plan.
 - The NTHMP's three subcommittees: Mapping and Modeling, Mitigation and Education, and Warning Coordination, are tasked to achieve the activities outlined in this Strategic Plan. The CC will ensure funds are provided to the extent available for subcommittee activities necessary to accomplish the measures and milestones in Appendix A. Subcommittees will meet periodically to address these and any other assigned actions.
 - Ensure that the NTHMP Rules of Procedure and the subcommittee Terms of Reference are kept up-to-date and provide the proper framework for accomplishing NTHMP performance measures and milestones.
- Conduct periodic external review of the NTHMP.
 - The NTHMP supports external 5-Year Reviews of the Program. Three external programmatic reviews, in 2001, 2007, and 2010 (NAS), were conducted to determine

program strengths and address weaknesses. A fourth review is set as a milestone for this performance period.

- Support a research effort to develop U.S. tsunami risk assessment methodologies.
 - The NAS report suggests a national tsunami risk assessment be conducted as well as related studies including tsunami source quantification, inundation model studies, and vulnerability analyses. A complete study as laid out by the NAS is presently beyond the funding capabilities of the NTHMP, though the NTHMP is in an excellent position to advocate for this type of research.
 - The NTHMP will support the FEMA tsunami HAZUS module development by providing expertise as requested.
- Support and implement post-tsunami event protocol for U.S. states and territories.
 - In 2012, the NTHMP Coordinating Committee voted to support a set of ten post-tsunami event protocols. Effective and efficient post-tsunami science surveys require the coordination and collaboration of multiple actors, both from the government and non-government sectors, working in a disaster zone. The ultimate goal of the surveys is to collect ephemeral data that may be of immediate use to response personnel, and that will also contribute to efforts to better understand, prepare, and mitigate for future tsunamis elsewhere. The NTHMP and its partners will develop plans to initiate post-tsunami field team protocols.

MAPPING and MODELING OUTCOMES and STRATEGIES

Mapping and modeling outcomes concern efforts to define areas with potential tsunami hazard for emergency preparedness and other uses. The NTHMP has provided states funding to develop these products. Specifically, maps that provide emergency management agencies the necessary input to create evacuation maps and plans. With funding provided by the NTHMP, plans are in place to create inundation maps for most highly threatened communities (as defined by the states) along the U.S. west coast, Hawaii, and Puerto Rico by the end of 2013. All new maps will meet NTHMP-developed guidelines (http://nthmp.tsunami.gov/modeling_guidelines.html), and the underlying models will meet NOAA modeling standards (Synolakis, et al., 2007; NOAA/NTHMP, 2012a). Many communities with lower threat levels, or where little bathymetric and elevation data exists, still require hazard area definition.

A recurring theme from the 2007 NTHMP external review was that maps made with lower resolution input data provide emergency management with valuable input to create first-order evacuation maps even if it is not as accurate as those made with high resolution data. Methods have been devised by the Mapping and Modeling Subcommittee (MMS) to provide inundation zone estimates where either the threat is low enough that the coast does not warrant high-resolution maps, or insufficient bathymetric/elevation data exists to create high quality maps. These methods must be implemented so that all coastal communities are provided inundation guidance.

Lessons learned from recent tsunami events will help guide tsunami hazard product development such as updating existing maps, development of new products for the land-use and maritime planning communities, and support for the FEMA-developed HAZUS tsunami module.

NTHMP will accomplish mapping and modeling activities necessary to meet requirements for NTHMP planning and response purposes through the MMS. These activities may include tsunami hazard assessments and products for improved evacuation planning, maritime planning, land-use planning, and building code development. To meet recommendations made by both the 2007 external review and 2010 NAS Report, new MMS projects will be conducted on a uniform basis for all coastlines, though may be initiated through state trials. The MMS will review new tsunami hazard assessment projects and recommend to the CC the most accurate, consistent, and cost-effective development approach (for example, contracting the project out, utilizing NOAA capabilities, conducting the project through MMS state programs, or with a sub-group of MMS members, etc.). Any approach which utilizes multiple models or modeling groups must go through a model validation process, conform with the project guidelines in model use, and be subject to funding limits set by the MES and the NOAA NTHMP Chairperson. While the outputs may vary due to state/territory laws, the techniques used will be consistent for all coastlines. This process will be used for any new projects started with the 2013 grants for which NTHMP funding is utilized.

Outcome: Tsunami Hazard Assessment that Supports Informed Decision Making in Tsunami-Threatened Communities

Identification of tsunami hazards faced by coastal communities is an important role of the MMS. Tsunami flow depths, currents, and inundation levels are used by various user communities including

emergency management, maritime, engineering, and land-use/vertical evacuation planning. Tsunami inundation maps provide information necessary to create evacuation maps. Where potential maximum sources and coastal bathymetry/elevation are known, evacuation maps can be created by modeling expected inundation using one of many numerical techniques. To accurately represent actual inundation through a model, high resolution bathymetric and elevation data are necessary. Where either the source or bathymetric /elevation data are not well known, other techniques as defined by MMS guidance can be used to estimate maximum inundation. The Program will work toward ensuring that all U.S. coastal regions are provided an estimate of their inundation potential; using either high resolution mapping estimates or lower resolution estimates if necessary. All end-products must be output in a consistent manner across jurisdictional boundaries.

Consistency among tsunami models was tested in 2012 when the MMS completed tsunami model verification through benchmarking (NOAA/NTHMP, 2012a). This process ensures that all models funded by NTHMP to create inundation maps meet NOAA standards defined in NOAA Technical Memorandum OAR PMEL-135 (Synolakis, et al., 2007). All models being funded by NTHMP in 2012 to compute inundation zones as well as several others successfully completed the verification tests.

Strategies:

- Continue to ensure all models utilized in mapping efforts funded by NTHMP meet the NOAA standards for inundation models as defined in NOAA-NTHMP (2012a).
 - The Tsunami Warning and Education Act required that NTHMP inundation models meet a standard of accuracy defined by NOAA. To ensure that NTHMP-funded numerical models used in inundation studies are scientifically acceptable, this standard will be extended beyond the life of the 2008-2012 NTHMP Strategic Plan.
 - The NAS report recommended *“To improve tsunami inundation modeling, the NTHMP should periodically review progress in hydrodynamic modeling.”* Periodically updating the standards will help assure that NTHMP modeling efforts remain state-of-the-art.
 - Add current benchmarks to NOAA-NTHMP modeling standards for use in future maritime products.
- Ensure all NTHMP-funded inundation studies adhere to the NTHMP inundation modeling and map guidelines, except where they conflict with state/territorial-mandated laws or policies.
 - A recommendation from the 2007 NTHMP review was for the different inundation modeling efforts supported by the NTHMP to follow the same basic guidelines when creating inundation maps. Further, the NAS report recommended *“NTHMP should reduce unnecessary and costly disparities in inundation modeling approaches among states and territories. NTHMP should conduct modeling efforts consistently across political boundaries and execute efforts through a cooperative partnership among NOAA, USGS, and NTHMP members.”* MMS developed inundation map guidelines for NTHMP-funded models in 2010. Adherence to the guidelines, which include resolution, sources, and output formats, will help meet the recommendations to ensure consistency throughout NTHMP inundation mapping efforts.
- Support an update to the 2008 National Tsunami Hazards Assessment.
 - NOAA and USGS completed a National Tsunami Hazards Assessment (Dunbar and Weaver, 2008). Since then many tsunamis have impacted the U.S. and its possessions. Based on the new data and recent scientific advances the Assessment should be updated with NTHMP support.

- Develop inundation maps for all communities with high tsunami hazard as defined by state tsunami programs.
 - Based on the 2008 National Tsunami Hazards Assessment (Dunbar and Weaver, 2008), U.S. regions are characterized by tsunami hazard ranked from very low to very high. Inundation maps should be developed for all threatened communities in regions with tsunami hazard ranked high or very high that have not already been completed (Alaska, Hawaii, U.S. west coast, Puerto Rico, U.S. Virgin Islands, CNMI, American Samoa, and Guam).
 - Update previously developed inundation maps as necessary based on new tsunami source information, improved digital-elevation models, and/or improved modeling technology. Consistency of new inundation technology across political boundaries will be maintained through coordination among NTHMP partners.
- Develop expected inundation limits for communities which are not provided with high-resolution inundation maps.
 - Many communities do not have either well known potential tsunami sources or DEMs. The new techniques developed under the previous Plan to provide appropriate guidance will be implemented.
- Ensure models used for NTHMP-funded work is shared.
 - To improve coordination between the different mapping efforts funded by the NTHMP, source code used to compute expected runup should be shared.
- Develop new tsunami hazard products to assist the maritime community and meet Emergency Management and other NTHMP customer requirements.
 - Recent advances in numerical tsunami hazard analysis could improve overall evacuation planning efforts for communities. These advances include evaluation of the time needed to evacuate and secondary earthquake hazards that might inhibit safe evacuation.
 - Recent tsunamis have shown that the maritime community requires additional information and guidance about tsunami hazards and post-tsunami recovery (Wilson et al, 2012a and b). Tsunami hazard products which include tsunami current forecasts, offshore safe zones, duration of danger forecasts, tidal interactions, and sediment/erosion impacts would be helpful for both maritime emergency response as well as infrastructure planning. The MMS will review the work being done in a number of states as demonstration projects for the MES and create standards for maritime products.
 - Develop and implement any other new hazard assessment tools and products recommended by the MES to carry out planning and response activities as dictated by evolving needs (for example, event playbooks, revised hazard zones based on probabilistic approaches, vertical evacuation, etc.).

MITIGATION and EDUCATION OUTCOMES and STRATEGIES

The NTHMP MES was established to help improve tsunami mitigation, preparedness, response and recovery effectiveness by providing NTHMP partners a means to integrate and share their experiences with existing state and federal partners and apply tsunami risk reduction activities. Some of these activities include but are not limited to:

- Promoting community education networks and programs to ensure readiness including development of comprehensive coastal risk and vulnerability assessment training, implementation of technical training and public education programs;
- The integration of tsunami activities into ongoing all-hazard warning and risk management activities, response plans, and mitigation programs; and
- Promoting adoption of tsunami warning and mitigation measures by federal, state, tribal, and local governments and nongovernmental entities.

Mitigation and Education refer to the activities through which the agencies and people in the potentially impacted zone plan and prepare to take the appropriate actions to save lives and minimize property loss, especially from near-shore tsunamis when traditional warning systems are less effective. Since its creation, the NTHMP has funded state and multi-state projects to improve tsunami preparedness and mitigation efforts. In the wake of the 2004 Indian Ocean Tsunami and the following assessments of the US Tsunami Program, much emphasis has been placed on the importance of educating the public, preparing for evacuation and emergency response, and modifying land use planning and development approval practices to reduce risk. Since 2004 the coastlines of the United States and its Territories have been impacted by the 2009 American Samoa Tsunami, the 2010 Chile Tsunami, and the 2011 Tohoku Japan Tsunami. Every effort the MES makes to plan and prepare communities for tsunamis can significantly increase public safety and save lives.

NTHMP will accomplish Mitigation and Education Outcomes and Strategies through the Mitigation and Education Subcommittee (MES). This subcommittee will take the lead and actions necessary, except where noted in Appendix A, to complete the strategies, measures and milestones related to the outcomes listed below.

Outcome: Tsunami evacuation products and strategies that support effective preparedness and response

The primary strategy for saving lives during a tsunami is to evacuate people from the hazard zone. Tsunami evacuation products are prepared and distributed before an event to increase preparedness and provide the base information required for implementing emergency response plans and evacuation protocols put into play when a tsunami notification is issued. Ideally evacuation maps should include the area at risk, the evacuation routes, the safety zones, assembly areas, and evacuation sites. Consideration can also be given for vertical evacuation if appropriate to the local topography and community. Uniformity in these maps will aid in their clearer interpretation as people travel between different states, territories, and commonwealths. Nevertheless it is important to note that the evacuation maps need to be tailored for population differences, vulnerable populations, and high risk or special facilities located in the hazard zone.

Strategies:

- Implement guidelines for consistency of tsunami evacuation maps based on guidelines developed by the MES in 2011.
 - Ensure all NTHMP-funded maps follow the adopted guidelines and are publicly available through the NTHMP web site. The guidelines for the evacuation maps include scale, colors, symbols, and critical infrastructure to be included as well as the text.
 - Evacuation maps will be based on either high-resolution inundation maps or estimates based on alternative means of determining hazard zones.
- Establish guidelines for evacuation modeling procedures so all at-risk communities can leverage the correct information for evacuating their population.

Outcome: Creating a Community-based Culture of Tsunami Preparedness and Response

The Tsunami Warning and Education Act mandated that the NTHMP shall “improve and increase education and outreach”. This is a challenging mandate, possibly the NTHMP’s most important, considering there are over 500 coastal counties within the ten NTHMP regions. The NAS report added some more specific recommendations to improve the effectiveness of NTHMP-funded educational efforts, which include consistency and evaluation. To reach this objective, the following strategies will be pursued.

Strategies:

- Facilitate educational events.
 - Complete the NTHMP Education Plan started during the last Strategic Plan period to ensure consistent education and tailor near-field/far-field public messaging by NTHMP members and other key stakeholders.
 - By following the NTHMP education plan, ensure consistency among the partner-run tsunami educational programs.
- Continue integrating tsunamis into K-12 education.
 - Guidelines for K-12 on Tsunami preparedness and education should be developed in all tsunami prone jurisdictions.
 - Implement guidelines established above into an Educational curriculum for the entire US. Previously developed guidelines and curriculum such as the Alaska Tsunami Education Program and Washington State’s Earthquake and Tsunami Education Program should be leveraged to save development costs.
- Support tsunami outreach efforts to specific audiences such as coastal residents and businesses, media, maritime community, and tourism.
 - Before, during and after a tsunami the media is a critical sector to reach the public. Media kits provide the tools to deliver an effective message. The number of state media toolkits continues to increase, and MES will support efforts for all MES members to have access to a media toolkit. . The national media toolkit will continue to be maintained and updated.
 - The cooperation of the coastal businesses and tourism is intrinsic to proper tsunami response. Tsunami outreach products need to be developed that meet the special needs of these groups within their corresponding states and jurisdictions. Tsunami education

- products will be developed for the tourist (cruises, hotels, and vacation rental homes) and business communities.
 - Evaluations will be conducted to determine the effectiveness of tsunami education products and the level of preparedness.
 - Promote and share innovative outreach efforts and events to help inform the local public and reach broad audiences (e.g., fairs, mall kiosks, and community workshops).
 - Develop and distribute outreach materials as needed while attempting to utilize existing materials developed within the NTHMP and other credible sources (e.g., posters, brochures, etc.). Adapt and update outreach materials to reflect lessons learned, updated scientific knowledge, and enhanced public safety recommendations.
 - Provide tsunami warning interpretive and evacuation signs as a proven outreach/education tool.
 - Support the maritime community in developing educational resources and preparedness efforts.
- Continue the annual national Tsunami Preparedness week.
 - Tsunami Preparedness week enables the NTHMP and NOAA a time frame to focus preparedness activities such as communication tests and exercises.
- Support the establishment and maintenance of state, local, and regional Tsunami Working Groups
 - As recommended in the NAS report, MES supports strong tsunami working groups to help facilitate and coordinate tsunami education, preparedness, and warning dissemination.
 - NTHMP state/territory/commonwealth partners lead the effort within their jurisdictions to prepare state, county, and community tsunami response. Working groups which coordinate between the different levels of government help information flow and planning throughout the jurisdiction. NTHMP will support these groups' organization and execution.

Outcome: Establishment of more Tsunami Resilient Communities

Resilience is the capacity to cope with unanticipated danger after they have become manifest, learning to bounce back (Wildavsky, 1991). The Tsunami Warning and Education Act directs the NTHMP to seek ways to make communities more tsunami resilient through the use of inundation maps and other mitigation practices. Tsunami resilient communities are not only prepared to respond to tsunamis, but also protect existing development from tsunami losses, take special precautions in locating and designing infrastructure, and have plans in place to recover if a tsunami should strike.

Strategies:

- Provide funding through the NTHMP grant program to help enable communities achieve TsunamiReady recognition.
 - NOAA's TsunamiReady Program is designed to help cities, towns, counties, universities and other large sites in coastal areas reduce the potential for disastrous tsunami-related consequences. TsunamiReady helps community leaders and emergency managers strengthen their local operations. No community is tsunami proof, but TsunamiReady can help reduce loss through preparedness measures. The TsunamiReady program recognizes

communities that meet specific criteria. Over 100 communities have been recognized in the US as TsunamiReady. The NTHMP will help support NOAA to increase the number of communities to become TsunamiReady.

- Maintain the strong coordination between NOAA Weather Forecast Offices and State/Territorial NTHMP partners by implementing TsunamiReady assistance through formation of regional TsunamiReady Advisory Boards
- Expand the use of the TsunamiReady Supporter aspect of the TsunamiReady program to recognize well-prepared smaller communities and private sector partners that do not have the infrastructure or mandate to meet the full TsunamiReady requirements.
- Incorporate the TsunamiReady program into the NTHMP Educational Plan being developed.
- Support reviews of the TsunamiReady program.
 - The NTHMP recognizes that this critical program will need periodic review and improvement to continue to enhance local community preparedness efforts. To that end, the NTHMP will support review of the program and assist in implementation of an improvement plan completed during the last Strategic Plan period.
- Promote the integration of the tsunami hazard and risk into building codes and land use policy and planning efforts.
 - In 2011, Appendix M was added to the International Building Code (IBC) which provides tsunami building standards. Most local building codes are based on the IBC which is prepared by the International Conference of Building Officials (ICBO). Updates to Appendix M continue. NTHMP supports further involvement with the ICBO will help ensure tsunamis are considered long term.
 - Although the 1972 Coastal Zone Management Act and the FEMA National Flood Insurance Program are particularly important for land use planning in coastal areas, there are no federal requirements for statewide or local land use planning for tsunamis. Land use planning for tsunamis, regulation and permitting take place at the state and local level. NTHMP partners will seek ways to incorporate tsunami loss-prevention measures to help make communities less vulnerable in the future.
- Promote development of tsunami emergency response procedures including collaboration among federal, state, local, and non-governmental agencies.
 - Enhance collaboration and actively seek out partnerships leveraging existing resources to further build tsunami resilient communities.
 - In the wake of a tsunami, emergency management personnel must be ready to respond. These response efforts will be coordinated between national, regional, and local governments. Response procedures must be developed and then tested for their appropriateness.
 - Response procedures will include rapid and safe evacuation of people at risk, establishment of evacuation routes, assembly areas, evacuation areas, dissemination of current information, and attention for vulnerable populations and visitors. The response procedures need to address the hazards it faces, whether it is both a local earthquake and tsunami and/or a regional and distant tsunami. Clear procedures will be developed for evacuation, holding, and returning to the at-risk areas once the danger has passed. NTHMP will support state-level review of local response plans for accuracy and effectiveness.

- In preparing and responding to disasters, it is indispensable that the characteristics of the population at risk be identified. A clear understanding of the population composition and distribution in the areas at risk provide responders with the capacity to attend, manage, and channel aid more effectively. Decision support tools will help emergency officials and a wide range of decision makers to better visualize the potential impacts of a particular event.
- The NTHMP will promote an annual national table top exercise as well as other scenario-based exercises. Exercises reveal flaws and weaknesses in current systems. They also provide important feedback as to whether evacuation measures, emergency response, and mobilization procedures are appropriate. The exercises will also be used to promote community evacuation drills and educating the public.

WARNING COORDINATION OUTCOMES and STRATEGIES

Warning Coordination outcomes relate to the content and delivery of the operational Tsunami Warning System's (TWS) products. The NTHMP is a guidance body to the NOAA-operated U.S. TWS and provides recommendations on the format and content of Tsunami Warning Center (TWC) domestic messages. The NTHMP also takes an active role in assuring the local delivery of TWC products. The NTHMP supports community warning point reception and dissemination equipment and provides for coordination of TWS exercises and tests.

NTHMP will accomplish warning coordination goals through the Warning Coordination Subcommittee (WCS).

Outcome: Understandable and effective Tsunami Warning Center Products

Tsunami warnings, watches, and advisories are relatively rare products for any given U.S. location. U.S. west coast locations have experienced four warnings in the last 45 years (1986, 1994, 2005, 2011) while the state of Hawaii has experienced four warnings in the same time period (1986, 1994, 2010, 2011). Advisories and watches historically have been slightly more common. U.S. East, Gulf of Mexico, and Puerto Rico/Virgin Islands coasts have never been put in tsunami warning, watch, or advisory status since service started for these regions in 2005. Since these products are received so rarely, they must be clear and concise in content. Graphical products must support textual content and provide straight-forward information.

Strategies:

- Provide guidance to refine TWC products.
 - Guidance for text products will be provided to the TWCs through the WCS. TWCs will implement minor changes proposed by the WCS after necessary coordination. Major changes will be made using the NWS Service Change procedures (<http://www.nws.noaa.gov/directives/> NWSI 10-1805).
 - Guidance for TWC graphical products will include web site graphics and forecast model results.

Outcome: Effective and Reliable Warning Dissemination to people at risk.

One of the biggest challenges facing the TWS is tsunami message delivery to those at risk. TWCs utilize standard NWS message dissemination routes such as NOAA Weather Radio, NOAA Weather Wire, Emergency Managers Weather Information Network, NWS web-based services, and others. Products issued over these routes provide local emergency management guidance when making decisions regarding evacuation. It is critical for proper operation of the TWS that local emergency management have reliable TWC product reception and the capability to distribute the message to those at risk.

Strategies:

- Encourage authorities to receive and respond to Tsunami Warning Center products.

- The WCS will provide the coordination mechanism for system-wide communication tests. Monthly or quarterly communication tests will be conducted by the TWCs to ensure message receipt by primary recipients. Annual end-to-end tests will be conducted using the live tsunami warning Emergency Alert System (EAS) code and over NOAA Weather Radio (NWR) when approved by the state.
- NTHMP will encourage all coastal states and territories to participate in the annual end-to-end testing of the Tsunami Warning System.
- Expanding on the three post-warning effectiveness surveys developed and conducted in 2011, the NTHMP will update the process considering lessons learned and new message procedures (e.g., broadcast text messages).
- Improve local warning dissemination capabilities to people at risk.
 - Based on the inventory of local dissemination capabilities determined in the 2011 MES-conducted emergency management survey, the WCS will take actions to improve dissemination capabilities at threatened communities nation-wide. This strategy is also a critical part of a community's TsunamiReady criteria.
- Improve community warning point reception capabilities.
 - Before communities can disseminate tsunami information to people at risk, they first must be able to reliably receive tsunami information from the TWCs. As above, based on the inventory of local reception capabilities determined in the 2011 MES-conducted emergency management survey, the WCS will take actions to improve warning reception capabilities at threatened communities nation-wide. This strategy is also a critical part of a community's TsunamiReady criteria.

IMPLEMENTATION

Outcomes and strategies of the plan naturally fall into one of four categories: over-arching outcomes and strategies which impact the entire program; inundation mapping outcomes and strategies which relate to the NTHMP's modeling effort; mitigation and education outcomes and strategies which relate to planning, public education and preparedness activities; and warning guidance outcomes and strategies which relate to warning products and dissemination. Structurally, these categories mesh well with the NTHMP's subcommittee structure. The over-arching outcomes and strategies will be executed by the NTHMP Chair or designee while the other three categories will be executed by the appropriate subcommittee. The CC must ensure that the subcommittees' Terms of Reference are such that they are able to complete to assigned measures and milestones.

Implementing the strategies and achieving the performance measures will require significant time from the NTHMP Chair or designee and the subcommittee Chairs. Subcommittee Chairs must be in a position in which the responsibilities of executing the plan align with their existing responsibilities, have the extra time necessary, and have sufficient financial support from their respective agency or from the NTHMP to accomplish the tasks.

Subcommittees will need to compile, track, and complete actions and performance measures generated directly and indirectly through this plan. Action item and performance measure status will be provided to the CC annually.

Grants and Contracts provided through the NTHMP must complete and support strategies and measures within this plan. Each subcommittee will track the success of Grantee and Contractor completion of funded tasks in relation to their respective subcommittee performance metrics. Subcommittees will provide an annual report to the CC on the status of their respective performance metrics.

The CC must provide prioritization of performance measures and milestones annually if funding levels are not be sufficient to achieve all stated goals. Prioritization should take into account the NTHMP core mission and Program authorization documents.

ACKNOWLEDGEMENTS

The developers of this plan would like to acknowledge the following parties and individuals for their support:

The National Tsunami Hazard Mitigation Coordination Committee for their support and guidance to develop this Strategic Plan.

The 2007 5-Year Review Panel whose recommendations helped guide the development of this document.

The National Academy of Sciences Review Panel which provided many helpful recommendations for the NTHMP.

The Government Accountability Office who critically reviewed the previous Strategic Plan and provided many suggestions.

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ACRONYMS

CC:	Coordinating Committee of the NTHMP
DEM:	Digital Elevation Model
EAS:	Emergency Alert System
FEMA:	Federal Emergency Management Agency
GIS:	Geographic Information System
IBC:	International Building Code
ICBO:	International Conference of Building Officials
ICG:	Intergovernmental Coordination Groups
IOC:	Intergovernmental Oceanographic Commission
MES:	Mitigation and Education Subcommittee
MMS:	Mapping and Modeling Subcommittee
NAS:	National Academy of Sciences
NIST:	National Institutes of Standards and Technology
NOAA:	National Oceanic and Atmospheric Administration
NSF:	National Science Foundation
NTHMP:	National Tsunami Hazard Mitigation Program
NTHMP Regions:	Gulf Coast States, Eastern States, Pacific Islands, Hawaii, Alaska, Oregon, Washington, California, Puerto Rico, and U.S. Virgin Islands
NWR:	NOAA Weather Radio
NWS:	National Weather Service
OAR:	Office of Atmospheric Research
PMEL:	Pacific Marine Environmental Laboratory
TWC:	Tsunami Warning Center
TWS:	Tsunami Warning System
UNESCO:	United Nation's Educational, Scientific, and Cultural Organization
USGS:	United States Geological Survey
WCS:	Warning Coordination Subcommittee

Appendix A – Performance Measure Chart

Outcome	Strategy	Measure	Milestone	Execution
Successful execution of NTHMP tsunami mapping, modeling, mitigation, and education efforts.	Establish an accessible web-based repository for NTHMP-related products commensurate with current and expected budget limitations.	Percentage of NTHMP- related products available through web-based repository from 0% in 2013 to 90% by 2017.	Develop plan to implement repository by end of 2013. Web-based repository operational by end of 2015.	NTHMP Chair
	Strengthen NTHMP subcommittees to execute this Strategic Plan	90% of action items from subcommittee meetings will be completed within one year of being assigned.	Conduct at least one in-person meeting per year for each subcommittee.	NTHMP Chair/All subcommittees
			Update NTHMP Rules of Procedure and subcommittee Terms of Reference by end of 2013 and bi-annually thereafter.	
	Conduct periodic external review of the NTHMP.		Conduct external review of program in 2017.	NTHMP Chair
	Support a research effort to develop U.S. tsunami risk assessment methodologies.		Provide expertise to the FEMA HAZUS tsunami module development as requested.	NTHMP Chair/All subcommittees
	Support and implement post-tsunami event protocol for U.S. states and territories.		Develop plans for implementing post-tsunami protocols for field teams.	MES/MMS
Tsunami hazard assessment that supports	Continue to ensure all models funded by NTHMP meet the NOAA	Only models which have proven to meet the standards will be	MMS, in coordination with PMEL and TWCs, update inundation modeling standards to	MMS

informed decision making in tsunami-threatened communities.	standards for inundation models as defined in NOAA-NTHMP (2012a).	used in NTHMP-funded inundation studies.	include new advancements in modeling technology by end of 2014.	
			Add current benchmarks to modeling standards by end of 2014.	
			Develop archive location for numerical model benchmark data by 2014.	
	Ensure all NTHMP-funded inundation models adhere to the NTHMP inundation map guidelines, except where they conflict with state/territorial-mandated laws or policies.	NTHMP-funded maps meet established guidelines.	All NTHMP-funded inundation model results publicly available via internet using GIS technologies (e.g., GoogleEarth)	MMS
		Update inundation map guidelines by the end of 2014.		
	Support an update to the 2008 National Tsunami Hazards Assessment		Provide expertise as requested to help NOAA/USGS update the National Tsunami Hazards Assessment.	MMS
	Develop inundation maps for all communities with high tsunami hazard as defined by state tsunami programs	Complete inundation maps for all threatened communities in Washington, Oregon, California, Hawaii, Puerto Rico, and the U.S. Virgin Islands by 2013.	Test in a high-hazard-rated selected community the importance of updating previously computed inundation maps based on new tsunami source information, improved digital-elevation models, and/or improved modeling technology by the end of 2014.	MMS
		Complete inundation maps for 50% of highly-threatened communities in Alaska and the U.S. Pacific Island Territories by 2017		

	Develop expected inundation limits for communities which are not provided with high-resolution inundation maps.		Determine the potential inundation zones for non-mapped coastal regions using the established guidelines by the end of 2014.	MMS
	Ensure models used for NTHMP-funded work is shared.		All inundation model code used for NTHMP-funded work shall be freely available to all NTHMP partners upon request by 2013.	MMS
	Develop new tsunami hazard products to assist the maritime community and meet Emergency Management <u>and other NTHMP customer</u> requirements.		<p>Review existing demonstration projects and develop product guidelines (including offshore safety zones, drawdown, and currents) for maritime planning by the end of 2013.</p> <p>Benchmark numerical tsunami models for use on maritime products to ensure NTHMP funded models meet NOAA-NTHMP standards by end of 2015.</p> <p>Develop prototype maritime products for one community within each high tsunami hazard state/ territory by the end of 2015.</p> <p>Dependent on success of the two above milestones and Emergency Management <u>and other NTHMP customer</u>.requirements, develop maritime products for 25% of threatened communities within each high tsunami hazard state/ territory by the end of</p>	MMS

			2017.	
			Produce guidelines/standards and prototypes for new products specified by Emergency Management <u>and other NTHMP customer requirements.</u> for planning and response purposes within grant performance period.	
Tsunami evacuation products and strategies that support effective preparedness and response	Implement guidelines for tsunami evacuation maps based on guidelines developed by the MES in 2011.	100% of NTHMP-funded evacuation maps available on-line.	All NTHMP-funded maps follow the approved 2011 guidelines by end of 2013.	MES
	Establish guidelines for evacuation modeling procedures so all at-risk communities can leverage the correct information for evacuating their population.		Coordinate with experts to discuss proper strategies for evacuation studies of the inundation area (including horizontal evacuation) and produce guidelines for evacuation studies by end of 2014.	
Creating a community-based culture of tsunami preparedness and response.	Facilitate educational events		Finalize the NTHMP Education Plan and Strategy and make available on-line by the end of 2014.	MES
	Continue integrating tsunami education into K-12 curriculum	50% of high-hazard state/territories will have K-12 educational guidelines or curricula by end of 2017.	.	MES

	Support tsunami outreach efforts to specific audiences such as coastal residents and businesses, media, maritime community, and tourism.	50% of high-hazard state/territories will have a media guidebook by end of 2017.	Annually update the national tsunami media toolkit.	MES
			Conduct evaluations to determine the effectiveness of tsunami education products and programs in 10 selected communities by 2014.	
		Ensure educational events are conducted at all at-risk communities over the period of this plan. (Events can include workshops, town-hall meetings, and outreach in schools).	Continue creation of updated outreach materials, such as brochures, posters, interpretive signs, etc.	
			Maintain, update, and continue distribution of tsunami education products for the tourist community (e.g., hotels, cruises, and vacation rental homes) annually.	
			Support the maritime community in developing educational resources and preparedness efforts by end of 2017.	
	Continue the annual national Tsunami Preparedness week.		Annually, declare a national Tsunami Preparedness Week.	NTHMP Chair
	Support the establishment and maintenance of state, local, and regional Tsunami	50% of high-tsunami-hazard states/territories will have a regional or local		MES

	Working Groups	tsunami workgroup by the end of 2017.		
Establishment of more Tsunami resilient communities	Provide funding through NTHMP grant program to provide communities resources necessary to obtain TsunamiReady recognition.	Increase the number of communities that have attained TsunamiReady recognition by 40 by the end of 2017.	Expand TsunamiReady Supporter program to acknowledge preparedness by small communities not able to meet the full TsunamiReady requirements.	MES
			Create regional TsunamiReady Advisory Groups that include NOAA Weather Forecast Office and state/territory representation.	
	Support reviews of the Tsunami Ready program.		Provide guidance annually to NOAA on proposed changes to TsunamiReady program.	MES
	Promote the integration of the tsunami hazard and risk into building codes and land use policy and planning efforts.		Work with FEMA to inform communities of new building codes available for voluntary adoptions and new tools available to establish their risk to include in future mitigation planning by end of 2017	MES
	Promote development of tsunami emergency response procedures including collaboration among federal, state, local, and non-governmental agencies.		Conduct state-level reviews of all local response plans for accuracy and effectiveness by the end of 2014.	MES
			Conduct an annual tsunami exercise and test tsunami response plans.	WCS

			Develop a decision support tool to address the characteristics of the population at risk by the end of 2015.	MES
Understandable and effective Tsunami Warning Center Products	Provide guidance to refine TWC products		Conduct an annual review of TWC products at the annual WCS meeting and update products accordingly.	WCS
			Include new graphical products in TWC web site based on annual review suggestions.	
Effective and reliable Warning dissemination to people at risk.	Encourage authorities to receive and respond to Tsunami Warning Center products.	Continue primary recipient response to monthly TWC communication tests at a greater than 90% response rate.	Conduct an annual EAS/NWR end-to-end communications test of the U.S. Tsunami Warning System	WCS
			Update the post-event review process with lessons learned from the three warning effectiveness surveys in 2011 by the end of 2013.	
			Conduct post-event reviews and compile report within six months of a U.S. tsunami warning.	
	Improve local warning dissemination capabilities to people at risk.	Annually increase local warning dissemination capabilities by 10%, based on the baseline established in 2011.		
	Improve community warning point reception capabilities.	Annually increase local warning reception capabilities by 10%, based on the		

		baseline established by 2011.		
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