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The U.S. Tsunami Program: A Brief Overview

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Summary

The National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) manages two tsunami warning centers that monitor, detect, and issue warnings for tsunamis. The NWS operates the Pacific Tsunami Warning Center (PTWC) at Ford Island, Hawaii, and the National Tsunami Warning Center (NTWC) at Palmer, Alaska.

The tsunami warning centers monitor and evaluate data from seismic networks and determine if a tsunami is likely based on the location, magnitude, and depth of an earthquake. The centers monitor relevant water-level data, typically with tide-level gauges, and data from NOAA's network of Deep-Ocean Assessment and Reporting of Tsunamis (DART) detection buoys to confirm that a tsunami has been generated or to cancel any warnings if no tsunami is detected. As of November 18, 2015, 4 of the United States' 39 DART buoys (10%) were not operational. This figure represents an improvement over the course of the year; in March 2015, 9 of the buoys were not operational (23%). The inoperable stations likely would not prevent the issuance of tsunami warnings, which are primarily a function of seismic data from an earthquake or landslide, combined with location information about the event.

On January 7, 2015, the House passed by unanimous consent H.R. 34, the Tsunami Warning, Education, and Research Act of 2015. The bill would amend the Tsunami Warning and Education Act (P.L. 109-424) and authorize appropriations for the National Tsunami Hazard Mitigation Program (NTHMP) through FY2017. Authorization for NTHMP appropriations expired in FY2012. On February 23, 2015, the Senate introduced its version of the bill, S. 533, which would authorize appropriations for six years through FY2021. On October 6, 2015, the Senate passed its legislation as an amendment in the nature of a substitute for H.R. 34 by unanimous consent. Neither bill would make fundamental changes to the NTHMP, but both would broaden the program to include an increased focus on tsunami research and outreach, among other alterations.

The NTHMP assists states in emergency planning and in developing maps of potential coastal inundation for a tsunami of a given intensity. A goal of the program is to ensure adequate advance warning of tsunamis along all U.S. coastal areas and appropriate community response to a tsunami event. The NTHMP formed in 1995 in response to the recognition of a tsunami threat to Oregon, Washington, and Northern California from a large earthquake on the Cascadia subduction zone, which lies off the northwest coast of the United States and is capable of generating earthquakes as large as magnitude 9 or greater. The NTHMP also operates tsunami disaster outreach and education programs that support NOAA's TsunamiReady program.

During FY2015, NOAA reorganized portions of its budget and aligned costs for tsunami activities into two accounts. For FY2015, $12.2 million was allocated under Observations Programs, Projects, and Activities (PPA), and $19.2 million was allocated under Analyze, Forecast, and Support PPA, for a total of $31.4 million. The FY2016 budget request is $6 million less than the FY2015 enacted amount.

Key issues for Congress include maintenance and availability of the DART buoy network. P.L. 109-424 states that "maintaining operational tsunami detection equipment is the highest priority within the program carried out under this Act." The House-passed bill would require that "the Administration's operational tsunami detection equipment is properly maintained," but the Senate-passed version would be more specific and require, "to the degree practicable, [the maintenance of] not less than 80 percent of the [DART] buoy array at operational capacity."

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Introduction: U.S. Tsunami Warning Centers

The United States has two centers that monitor, detect, and issue warnings for tsunamis. The National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) manages both centers. The NWS operates the Pacific Tsunami Warning Center (PTWC) at Ford Island, Hawaii, and the National Tsunami Warning Center (NTWC) at Palmer, Alaska. (Before October 1, 2013, the NTWC was known as the West Coast and Alaska Tsunami Warning Center, or WC/ATWC).[1]

The PTWC monitors for tsunamis and issues warnings for the Hawaiian Islands, the U.S. Pacific territories, and other U.S. and international interests in the Pacific basin outside the NTWC area of responsibility. Following the 2004 Indian Ocean tsunami, the PTWC took on responsibility for monitoring the Indian Ocean, South China Sea, Caribbean Sea, and, temporarily, the U.S. Virgin Islands and Puerto Rico (until June 2007, when responsibility was passed to what was then known as the WC/ATWC).[2] The PTWC was established in 1949 after a strong earthquake and massive landslides off the coast of Southwest Alaska caused a disastrous tsunami that hit the Hawaiian Islands only hours later. The PTWC issued tsunami warnings to Alaska until 1967, when the WC/ATWC was established.

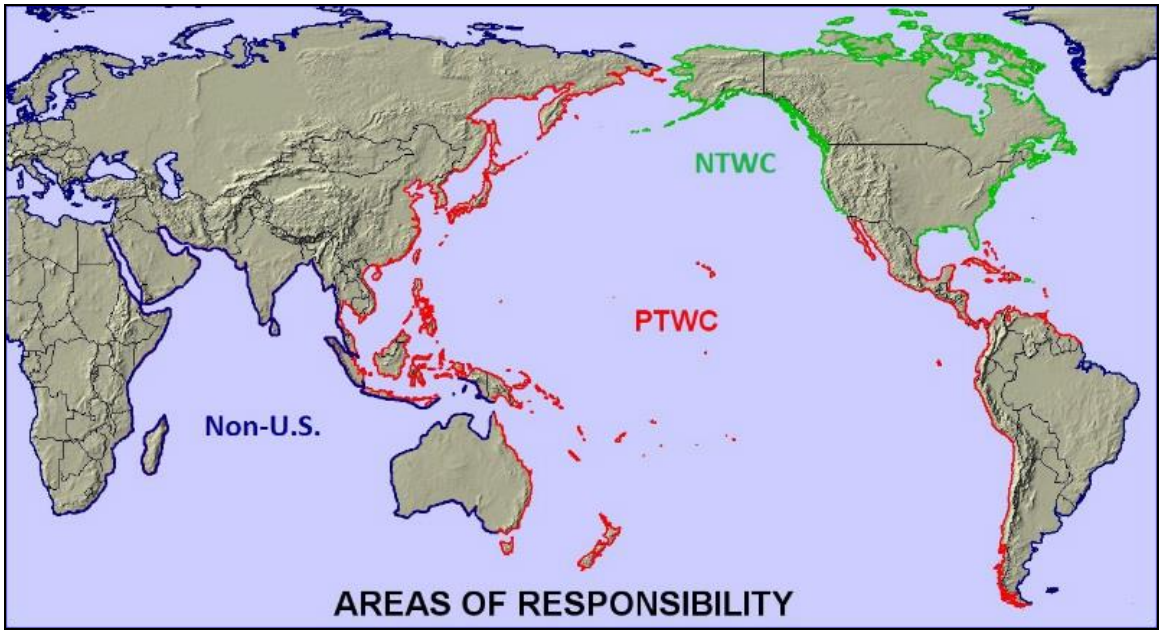
The WC/ATWC (now the NTWC) was established in the aftermath of the magnitude 9.2 Good Friday earthquake that struck Anchorage, Alaska, in 1964 and caused major earthquake and localized tsunami damage.[3] The NTWC is responsible for issuing tsunami warnings to emergency management officials in Alaska, British Columbia (Canada), Washington State, Oregon, and California. In 2005, the NTWC expanded its scope to include the U.S. Atlantic and Gulf of Mexico coasts, as well as the Atlantic coast of Canada. In 2007, the NTWC added Puerto Rico and the U.S. and British Virgin Islands to its scope. **Figure 1** shows the areas of responsibility for the PTWC and the NTWC.

[1] National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), National Tsunami Warning Center (NTWC), "Tsunami Warning Center History," at http://wcatwc.arh.noaa.gov/?page=history.

[2] Ibid. The Pacific Tsunami Warning Center (PTWC) provided interim tsunami warning service from 2005 to 2013 for the Indian Ocean, and it has discontinued that service. Tsunami warning services for the Indian Ocean currently are provided by regional tsunami service providers in Australia, India, and Indonesia. See NOAA, NWS, Pacific Tsunami Warning Center, "PTWC Responsibilities," at http://ptwc.weather.gov/responsibilities.php.

[3] See NOAA, NWS, "TsunamiReady Helps Communities at Risk," at http://www.tsunamiready.noaa.gov/.

Figure 1. Areas of Responsibility for the Pacific Tsunami Warning Center (PTWC) and the National Tsunami Warning Center (NTWC)



Source: National Oceanic and Atmospheric Administration, National Weather Service, National Tsunami Hazard Mitigation Program, at http://nws.weather.gov/nthmp/.

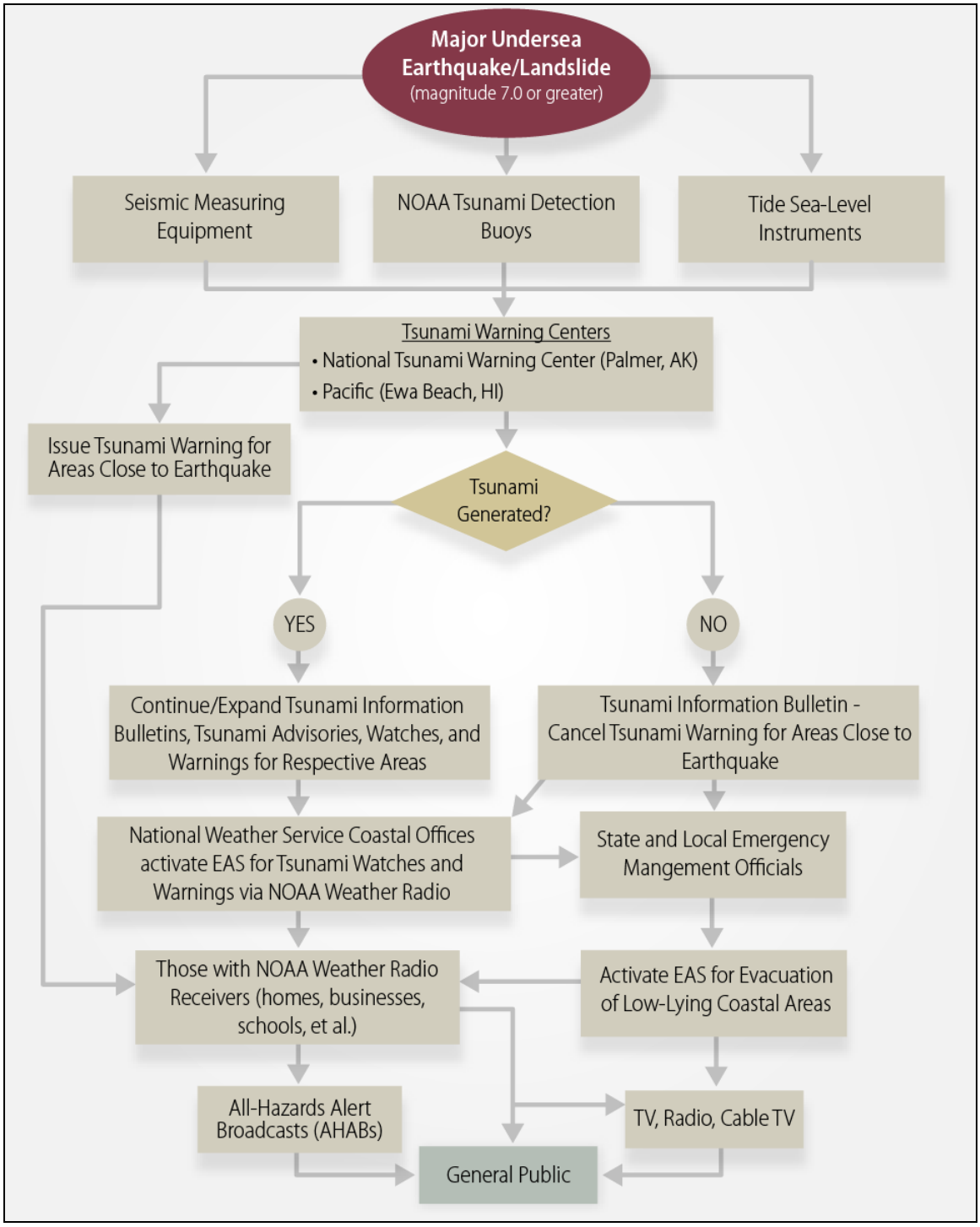
Detecting Tsunamis and Issuing Warnings

The tsunami warning centers monitor and evaluate data from seismic networks and determine if a tsunami is likely based on the location, magnitude, and depth of an earthquake.[4] If a center determines that a tsunami is likely, it transmits a warning message to NOAA's weather forecasting offices and state emergency management centers, as well as to other recipients. The centers monitor coastal water-level data, typically with tide-level gauges, and data from NOAA's network of Deep-Ocean Assessment and Reporting of Tsunamis (DART) detection buoys to confirm that a tsunami has been generated or, if one has not been generated, to cancel any warnings.[5] **Figure 2** shows a generalized decision tree network for the earthquake-detection-through-warning process.

[4] Nearly all tsunamis are triggered by subsea earthquakes, although some may be caused by underwater volcanic eruptions or landslides.

[5] U.S. Government Accountability Office, *U.S. Tsunami Preparedness: NOAA Has Expanded Its Tsunami Programs, but Improved Planning Could Enhance Effectiveness*, GAO-10-490, April 2010, p. 5.

Figure 2. Flow Chart of the Tsunami Warning System



Source: National Oceanic and Atmospheric Administration, *How Does the Tsunami Warning System Work?,* http://www.tsunami.noaa.gov/images/warning-system-smaller.jpg. Modified by CRS.

Note: EAS = Emergency Alert System.

The DART Buoy Network

NOAA first completed a six-buoy DART array in 2001 in the Pacific Ocean. After the 2004 Indian Ocean earthquake and tsunami that killed more than 200,000 people, Congress passed P.L. 109-424, the Tsunami Warning and Education Act, to enhance and modernize the existing Pacific Tsunami Warning System and broaden coverage, reduce false alarms, and increase the accuracy of forecasts and warnings, among other purposes.[6] In part, the 2004 tsunami provided the impetus to expand and upgrade the DART system and to improve the U.S. capability to detect and issue warnings for tsunamis generally. As a result, the DART array was expanded to a total of 39 U.S. DART buoys in March 2008.[7] (See **Figure 3**.) In addition, 8 other countries operate 21 additional DART buoys positioned near faults in the seafloor beneath the Indian and Pacific Oceans, bringing the global total to 60 buoys.[8]

P.L. 109-424 requires that NWS ensure that maintaining operations of tsunami detection equipment is the highest priority within the tsunami forecasting and warning program at NOAA. Further, P.L. 109-424 requires the NOAA administrator to notify Congress[9] within 30 days of (1) impaired regional forecasting capabilities due to equipment or system failures and (2) significant contractor failures or delays in completing work associated with the tsunami forecasting and warning system.[10] As of November 18, 2015, 4 of the 39 U.S. buoys (10%) were not operational. This represents an improvement over the course of the year; in March 2015, 9 of the buoys were not operational (23%).

The inoperable stations likely would not prevent the issuance of tsunami warnings, which are primarily a function of seismic data from an earthquake or landslide, combined with location information about the event. However, lacking stations could mean the warnings encompass a larger area than would be the case if all stations were operating, and it could lengthen the time a warning remains in effect.

[6] P.L. 109-424 was signed into law on December 20, 2006.

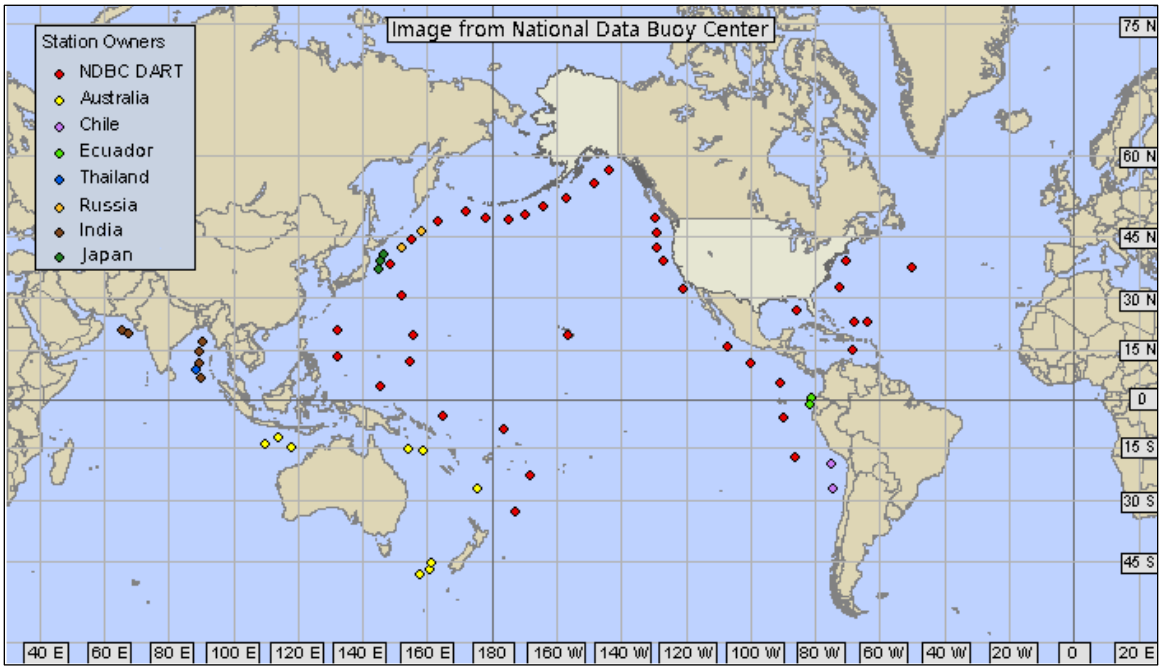
[7] According to NOAA, 32 of the Deep-Ocean Assessment and Reporting of Tsunami (DART) buoys are deployed in the Pacific Ocean and the rest are deployed in the Atlantic Ocean and the Caribbean. NOAA, National Data Buoy Center, "Deep-ocean Assessment and Reporting of Tsunamis (DART) Description," at http://www.ndbc.noaa.gov/dart/dart.shtml.

[8] Personal communication from Mackenzie Tepel, Congressional Affairs Specialist, Office of Legislative and Intergovernmental Affairs, NOAA, January 16, 2015.

[9] Specifically, P.L. 109-424 requires the NOAA administrator to notify the Committee on Commerce, Science, and Transportation in the Senate and the Committee on Science (now Science, Space, and Technology) in the House.

[10] The statute does not define what is considered impairment of the forecasting abilities or specify a threshold for significant contractor failures or delays. However, the committee report accompanying the bill states that the NWS is required to notify Congress when the tsunami forecasting capabilities are impaired for more than three months; U.S. Congress, House Science, *United States Tsunami Warning and Education Act*, report to accompany H.R. 1674, 109th Cong., 2nd sess., 2006, H.Rept. 109-698, p. 10. The NWS uses an 80% operational threshold as its internal guideline; telephone conversation with Laura Furgione, Deputy Director, NWS, March 15, 2011.

Figure 3. Locations of Deep-Ocean Assessment and Reporting of Tsunamis (DART) Buoys



Source: National Oceanic and Atmospheric Administration, National Data Buoy Center (NDBC), at http://www.ndbc.noaa.gov/dart.shtml.

Note: The United States owns and operates 39 of the world's 60 DART buoys.

The National Tsunami Hazard Mitigation Program

According to NOAA, the National Tsunami Hazard Mitigation Program (NTHMP) was formed in response to the recognition of a tsunami threat to Oregon, Washington State, and Northern California from a large earthquake on the Cascadia subduction zone, which lies off the northwest coast of the United States and is capable of generating earthquakes as large as magnitude 9 or greater.[11]

Among other activities, the NTHMP assists states in emergency planning and in developing maps of potential coastal inundation for a tsunami of a given intensity. The NTHMP also operates tsunami disaster outreach and education programs in support of NOAA's TsunamiReady[12] program.[13] NOAA's primary goals for the NTHMP are as follows:

1. raise awareness of the affected population;
2. develop integrated tsunami maps and recognize models that can be used to develop improved warning guidance and evacuation maps;

[11] Ibid.

[12] TsunamiReady is a NOAA/NWS program designed to help cities, towns, counties, universities, and other large sites in coastal areas reduce the potential for disastrous tsunami-caused damage. See http://www.tsunamiready.noaa.gov/.

[13] NOAA, *National Tsunami Hazard Mitigation Program*: *2013-2017 Strategic Plan*, May 21, 2013, p. 4, at http://nws.weather.gov/nthmp/documents/NTHMPStrategicPlan.pdf. See also NOAA, NWS, "TsunamiReady Helps Communities at Risk," at http://www.tsunamiready.noaa.gov/.

3. improve tsunami warning systems; and
4. incorporate tsunami planning into state and federal multi-hazard programs.[14]

The Tsunami Warning and Education Act, P.L. 109-424, further focused the NTHMP and charged NOAA with addressing the nation's priorities in tsunami detection, warning, and mitigation. As authorized by P.L. 109-424, the NTHMP assumed responsibility for planning and executing NOAA's tsunami activities, namely detection, warning, forecasts, communication, outreach and education, and research.[15] The program coordinates activities among NOAA organizational entities and outside partners.

Issues for Congress

Maintenance and availability of the DART buoy network have been key issues for Congress. In its report accompanying the FY2015 Commerce, Justice, Science, and Related Agencies appropriations bill, the House Appropriations Committee admonished NOAA for failing to maintain its network to its own 80% availability standard, despite receiving full funding in FY2014.[16] In P.L. 109-424, Congress stated that "maintaining operational tsunami detection equipment is the highest priority within the program carried out under this Act." This requirement also was included in a Senate bill (S. 2181) that would have reauthorized the tsunami program in the 113th Congress.

In the 114th Congress, bills introduced in the House (H.R. 34) and Senate (S. 533) address DART buoy maintenance and availability as well as other issues regarding the NTHMP. The House passed H.R. 34, the Tsunami Warning, Education, and Research Act of 2015, on January 7, 2015, by unanimous consent. The Senate passed its version of the legislation, as an amendment in the nature of a substitute for H.R. 34, on October 6, 2015, by unanimous consent. The following section provides a brief comparison of the bills.

Reauthorization of the National Tsunami Hazard Mitigation Program: Legislation in the 114th Congress

Both versions of the legislation would amend the Tsunami Warning and Education Act and authorize appropriations for the NTHMP through FY2017 (H.R. 34) or through FY2021 (S. 533). Authorization for the program's appropriations in P.L. 109-424 expired in FY2012. Both bills apparently would not make fundamental changes to the NTHMP but would broaden the program to include an additional focus on tsunami research and outreach, among other alterations.

The following summarizes the changes the House- and Senate-passed bills would make to P.L. 109-424 on a section-by-section basis and notes significant differences between the two versions. Except where noted, the discussion refers to specific sections of the proposed legislation and not to sections of current law.

[14] NOAA, NWS, "About the National Tsunami Hazard Mitigation Program (NTHMP)," http://nws.weather.gov/nthmp/about_program.html.

[15] Ibid.

[16] U.S. Congress, House Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies, *Commerce, Justice, Science, and Related Agencies Appropriations Bill, 2015*, 113th Cong., 2nd sess., May 15, 2014, 113-448 (Washington: GPO, 2014), p. 27.

Section 1: Short Title

Both bills would add the term *research* to the title of the act.

Section 2: Definitions

P.L. 109-424 defined *NOAA* and the *NOAA administrator*. Both bills would omit the section on definitions.

Section 3: Purposes

Both bills would streamline and update the language in several subsections and add a new subsection (4) that focuses on research as part of the program: "to improve research efforts related to improving tsunami detection, forecasting, warnings, notification, mitigation, resiliency, response, outreach, and recovery."

Section 4: Tsunami Forecasting and Warning Program

Both bills are broadly similar throughout Section 4, with some important distinctions. Both bills would streamline and update the language in several subsections. In subsection (b), the Senate-passed version would require that 80% of the DART buoys be maintained at operational capacity. It also would include a requirement for a cooperative effort among NOAA, the U.S. Geological Survey, and the National Science Foundation under which the agencies' directors would "provide rapid and reliable seismic information ... from international and domestic seismic networks." The House-passed bill does not include those provisions.

Both bills would rename subsection (c) the Tsunami Warning System (previously System Areas). This subsection would require the system to be capable of forecasting tsunamis in the Pacific, Arctic, and Atlantic Oceans, including the Caribbean Sea and Gulf of Mexico. Subsection (c) also would require a system that supports other international forecasting and warning efforts.

Subsection 4(d) in both bills explicitly names the NTWC (formerly the WC/ATWC), and includes a requirement that, to the extent practicable, the tsunami warning centers use a range of models to predict tsunami arrival times and flooding estimates. The House-passed bill would add four new subsections, 4(d)(3) through 4(d)(6), that would require a fail-safe warning capability, meaning the two tsunami centers would perform back-up duties for each other. The subsections also would require the tsunami warning centers to coordinate with the NWS; the NTHMP to develop uniform operational procedures for both centers; and NOAA to ensure that resources, including supercomputing resources, are made available to fulfill the obligations of the legislation.

The Senate-passed bill adds language focusing on using data to calculate new inundation estimates, including estimates for ports and harbors at risk of tsunami inundation, as well as ensuring coordination and data sharing with the Coast Guard.

Both bills would require coordination with the NWS. The House-passed bill, however, would direct the NWS to coordinate with the tsunami warning centers, whereas the Senate-passed bill would require that the NOAA administrator coordinate with the NWS, as well as any other program office considered appropriate. It is unclear whether the different emphasis on who is required to coordinate with whom would affect the degree of coordination that would ensue. Further, the Senate-passed bill calls for the increased coordination effort to ensure that regional and local forecast offices would implement mass communication tools, both those in effect and tools yet to be developed, so that tsunami warnings would be delivered in a timely and effective fashion.

Both bills in subsection (e) would omit requirements in P.L. 109-424 for a report to Congress regarding integration of the tsunami warning system with other U.S. observational systems and for a report to Congress on how technology developed under the tsunami research program is being transferred to operations.

The House-passed bill further would omit subsections 4(g) through 4(k) in Section 4 of P.L. 109-424. The Senate-passed bill would omit subsection 4(g), and subsections 4(i) through 4(k) of P.L. 109-424, but it would retain subsection 4(h), which requires congressional notification in case of impaired forecasting capabilities due to equipment or system failures. Under subsection 4(h), the Senate-passed bill also would require congressional notification within 90 days of a significant tsunami warning, including brief information and analysis of the accuracy of the tsunami model used, the monitoring equipment that detected the tsunami, and the effectiveness of the warnings issued. The House-passed version does not include this congressional reporting requirement.

Section 5: National Tsunami Hazard Mitigation Program

Both bills are broadly similar in Section 5. In subsection (a), they both would require consultation with the Federal Emergency Management Administration and other agencies that NOAA deems relevant in conducting a community-based tsunami hazard mitigation program to improve tsunami preparedness and resilience in at-risk areas of the nation. Current law does not specify that NOAA consult with any particular agency.

The bills would omit subsection (b) of current law, which established a coordinating committee for the NTHMP,[17] and would include expanded and modified requirements for program components as the new subsection (b). For example, the new subsection 5(b)(1) would require the NTHMP to provide technical and financial assistance to coastal states, territories, tribes, and local governments to develop and implement activities under Section 5. Both bills would require similar activities, under 5(b)(4), to support the development of regional tsunami hazard and risk assessments. The Senate-passed bill also would require evaluations and technical assistance for "vertical evacuation structure planning for communities where models indicate limited or no ability for timely evacuation." In other words, where members of the community would not have time to move inland before the tsunami struck, they could occupy the "vertical evacuation structures" to climb above the tsunami wave crest as the wave passed below.

Section 5 of both bills would add a new subsection (c) of authorized activities that the program may include, such as multidisciplinary vulnerability research, education, and training; risk management training for local officials and community organizations; development of applications for existing or emerging technologies; risk management, risk assessment, resilience data and information services; and risk notification systems.

Section 5 also would include a new subsection 5(d) in the House-passed bill (5(e) in the Senate-passed version) that would allow states to designate at-risk areas based on knowledge of local conditions in addition to those designated by the federal program.

In addition, Section 5 in both bills would require a report on accreditation of the TsunamiReady program within 180 days of enactment. The report would indicate which authorities and activities

[17] Subsection 11(b) of the House-passed bill would establish the coordinating committee, similar to the one established by P.L. 109-424 (discussed in more detail below in "Section 11: Outreach Responsibilities"). The Senate-passed bill would establish a coordinating committee under subsection 5(d).

would be needed to have the TsunamiReady program accredited by the Emergency Management Accreditation Program.[18]

Section 6: Tsunami Research Program

Both bills would modify the research program authorized under P.L. 109-424 in several ways. It would task NOAA with supporting and maintaining the research program in consultation with other federal agencies, state and territorial governments, academic institutions, the coordinating committee (established in Section 11 of the House-passed bill and Section 5 of the Senate-passed bill), and the scientific advisory committee established in Section 8 (see "Section 8: Tsunami Science and Technology Advisory Panel").

Section 6 also would broaden the responsibilities of the research program. For example, the section specifies that the program shall consider other research to mitigate the impacts of a tsunami, including the improvement of near-field[19] tsunami detection and forecasting abilities, which may include use of the Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoys and NOAA supercomputers. In addition, Section 6 would add a new subsection to require development of the technical basis for validation of tsunami maps, numerical tsunami models, digital elevation models, and forecasts.

In the House-passed bill, Section 6 also would allow NOAA to launch a pilot project to examine a specific area, the Cascadia region along the northwest coast of the United States, and develop near-field tsunami forecasting capability for that region. The Senate-passed bill does not contain a similar provision. The Cascadia subduction zone lies offshore of Washington State, Oregon, and Northern California, and it has the potential to generate major earthquakes of similar magnitudes to the magnitude 9 Great Sendai Earthquake that struck Japan on March 11, 2011, and generated a devastating tsunami that killed thousands of Japanese citizens. Forensic evidence has shown that one of the world's largest earthquakes occurred along the Cascadia subduction zone in the year 1700, generated a large tsunami that struck the northwest coast of the United States, and traveled across the Pacific and damaged coastal villages in Japan.[20]

Section 7: Global Tsunami Warning and Mitigation Network

Both bills would update the language of this section and require that NOAA coordinate with the U.S. State Department to provide technical assistance and training to the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization and other international entities.

Section 8: Tsunami Science and Technology Advisory Panel

Both bills would establish a new advisory panel in Section 8 by requiring the NOAA administrator to "designate an existing working group within the Science Advisory Board of the Administration to serve as the Tsunami Science and Technology Advisory Panel." The panel

[18] The Emergency Management Accreditation Program (EMAP) is a voluntary standards, assessment, and accreditation process for disaster preparedness programs in the United States. See http://www.emaponline.org/.

[19] Generally, when the source of the tsunami is close to the area of interest. NOAA refers to a far-field, or teletsunami, when the tsunami source is greater than 1,000 kilometers away from the area of interest. See NTHMP, "Tsunami Terminology," at http://nthmp-history.pmel.noaa.gov/terms.html.

[20] U.S. Geological Survey, Earthquakes Hazards Program, *Historic Earthquakes-The M9 Cascadia Megathrust Earthquake of January 26, 1700*, http://earthquake.usgs.gov/earthquakes/states/events/1700_01_26.php.

would advise NOAA on tsunami science, technology, and regional preparedness. The panel would meet at least once every four years to review the tsunami-related activities of the federal government and would submit its review findings to NOAA, along with any recommendations. The NOAA administrator, in turn, would submit the panel's report to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science, Space, and Technology.

Section 9: Report on Implementation of Tsunami Warning and Education Act

Both bills would require that NOAA submit to Congress a report on progress in implementing the Tsunami Warning and Education Act with a detailed description of progress in implementing three sections of the proposed legislation:

- Section 4(d)(6), available resources—requirement that NOAA ensure that resources are available to fulfill the obligations in the House-passed bill;
- Section 5(b)(6), dissemination of guidelines and standards for community planning; education; and training products, programs, and tools, including standards for mapping products, inundation models, and effective emergency exercises; and
- Section 6(b)(4), development of the technical basis for validation of tsunami maps, numerical tsunami models, and forecasts.

Section 9 also would require that the report to Congress include a description of the ways in which tsunami warnings and warning products issued by the program can be standardized and streamlined with warnings for other natural hazards, specifically hurricanes, coastal storms, and other coastal flooding events.

The Senate-passed bill also would require an additional report on national efforts that "support and facilitate rapid emergency response following a domestic near-shore tsunami event to better understand domestic effects of earthquake derived tsunami on people, infrastructure, and communities in the United States."[21] The House-passed version does not contain a similar provision.

Section 10: Authorization of Appropriations

The House-passed bill would authorize appropriations for the tsunami activities for three years—FY2015 through FY2017—in the amount of $27 million each year. As in current law, the bill specifies that no less than 27% of the amount appropriated would be for the NTHMP under Section 5 of the bill and that no less than 8% of the appropriated amount should be for the Tsunami Research Program under Section 6 of current law. The Senate-passed bill contains the same formula for allocation of the appropriations but would authorize the program for six years, from FY2016 to FY2021.

Section 11: Outreach Responsibilities

Both bills would require NOAA to coordinate with state and local emergency managers to develop and carry out formal outreach activities with the goals of improving tsunami education and awareness and fostering the development of resilient communities.

[21] The bill would require that the report include those activities in place on the day before the date of the legislation's enactment.

Section 11 in the House-passed bill would reauthorize the NOAA administrator to convene a coordinating committee, originally established under Section 5(b) of P.L. 109-424, that would assist with the administration of the NTHMP.[22] Section 11 would require the committee to have representatives from each of the states at risk from tsunamis in addition to other representatives that the NOAA administrator deems appropriate. The coordinating committee would contribute to the program as follows:

- provide feedback on how funds should be prioritized to carry out the NTHMP as established by Section 5 of P.L. 109-424 and modified by the House-passed bill;
- ensure that the areas encompassed by the tsunami warning system in the Pacific Ocean, Arctic Ocean, and Atlantic Ocean, Caribbean Sea, and Gulf of Mexico have the opportunity to participate in the program;
- provide recommendations to the NOAA administrator on how to improve and advance the TsunamiReady program; and
- ensure that all components of the NTHMP are integrated with state-based hazard warning, risk management, and resilience activities.

Funding for the Tsunami Program

For FY2015, the Senate Appropriations Committee instructed NOAA to maintain funding at the FY2014 level for the NTHMP.[23] The committee report rejected a proposal from NOAA to terminate funding for tsunami preparedness within the program. The House Appropriations Committee instructed NOAA to allocate $27 million for the NOAA Tsunami Program.[24] The House report noted that the funding amount fully supports planned maintenance for the DART buoy network (discussed above) and that the committee expects NOAA to maintain availability at no fewer than 80% of the stations. (Currently, about 90% of the stations are operational, as noted above.) In addition, the House report included instructions to include $6 million above NOAA's request for FY2015 to restore Administration-proposed reductions to NTHMP grant funds.

During FY2015, NOAA reorganized portions of its budget and aligned costs for the tsunami activities into two accounts: DART buoys are funded out of Observations Programs, Projects, and Activities (PPA), and all other tsunami activities are funded out of Analyze, Forecast, and Support PPA.[25] For tsunami activities in FY2015, NOAA allocated $12.2 million under Observations PPA and $19.2 million under Analyze, Forecast, and Support PPA, for a total of $31.4 million.[26] The FY2016 budget request was $6 million less than the FY2015 enacted amount (representing a $6 million reduction in the NTHMP grant funds, similar to the Administration's FY2015 request).

Funding for the NOAA tsunami program historically has supported three main categories of activities: (1) *warning*, such as the activities of the tsunami warning centers and DART network; (2) *mitigation*, such as the activities of the NTHMP; and (3) *research*, including activities

[22] The Senate-passed bill would reauthorize the coordinating committee in Section 5 of the legislation.

[23] U.S. Congress, Senate Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies, *Departments of Commerce and Justice, and Science, and Related Agencies Appropriations Bill, 2015*, 113th Cong., 2nd sess., June 5, 2014, 113-81 (Washington: GPO, 2014), pp. 43-44.

[24] Ibid., p. 27.

[25] Personal Communication, Matthew Borgia, Congressional Liaison for Weather, Office of Legislative and Intergovernmental Affairs, NOAA, November 16, 2015. Per its FY2016 Budget Justification, NOAA restructured portions of its budget as part of a broader effort to align budget to function.

[26] Ibid.

conducted by the Pacific Marine Environmental Laboratory and the National Buoy Data Center.[27] In the NOAA budget, these activities have been cross-cutting among different activities under the NWS line item. The Government Accountability Office (GAO), which analyzed funding data for the three general categories in 2010, noted that total funding for all these activities ranged from $5 million to $10 million annually between FY1997 and FY2004 but increased after the 2004 Indian Ocean tsunami from approximately $27 million in FY2005 to $42 million in FY2009. According to GAO, the proportion of funding allocated to warning activities increased from about 40% of the total in FY2004 to approximately 70% of the funding in FY2009.[28] The proportion allocated to mitigation decreased from approximately 50% of the total in FY2004 to about 30% in FY2009, whereas the proportion for research remained steady between about 6% and 10%.[29]

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[27] U.S. Government Accountability Office, *U.S. Tsunami Preparedness: NOAA Has Expanded Its Tsunami Programs, but Improved Planning Could Enhance Effectiveness*, GAO-10-490, April 28, 2010, p. 7.

[28] Ibid., p. 8.

[29] The percentages do not sum to 100 due to rounding.