Summary of review comments and response for the *U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves – Update*, Dec. 2015

Summary compiled October 2015

Author Response to Reviewer provided comments:
The document has been briefed to the National Tsunami Hazard Mitigation Program (NTHMP) NOAA, USGS and coastal state and tribal partners. In addition to the reviewer's comments addressed below, some of the comments were stylistic and we accepted those that improved the clarity of the document.

Reviewer number 1.

General Comments	**Action Accepted/Rejected**	**Brief Responder Comments**
Should NGDC be globally changed to NCEI? Check consistency in: tense, m vs meters, and the use of Mw. Figures are all clear and easy to interpret. Tables too are easy to read and interpret. Nice work!	Accepted	NGDC was changed to NCEI and tense, meters, and Mw was reviewed and fixed.
Executive Summary Section:	**Action Accepted/Rejected**	**Brief Responder Comments**
What do the totals refer to?	Accepted	The list of total from four measurements were listed, eg. the total number of reported tsunamis, the number of reported runups, etc.
Specify if damage is in dollars?	Accepted	We examined the difference between … the estimated dollar damage.
A scientific consensus reached at a workshop to develop guidance to the USGS on the input data for the 2014 version of the NSHMs – reference needed	Accepted	Reference was added: Frankel, A.D., 2011, Summary of meeting to evaluate Cascadia turbidite data for the National Seismic Hazard Maps: U.S. Geological Survey Open-File Report 2011–1310, 13 p., accessed February 25, 2012, at *http://pubs.usgs.gov/of/2011/1310*
This update of the original National Tsunami Hazard Assessment has resulted in only a few overall changes to the hazard levels specified earlier (Dunbar and Weaver, 2008) and shown in Table A. – this sentence needs to be after the discussion of new tsunamis, updates to the USGS NSHM.	Accepted	The sentence was moved to follow the discussion of new tsunamis, the USGS NSHM, and the Cascadia workshop.

Section 1. Introduction	Action Accepted/Rejected	Brief Responder Comments
Every year, frequent hazards such as … hurricanes inflict damage.. – hurricanes, etc. - add "relatively frequent"	Accepted	Removed the word "Every" - Frequent hazards such as floods, tornados, landslides…
Had this large population been present in 1700 when the last magnitude 9 Cascadia earthquake struck, there would be been many times this number of deaths – change to "a great number of deaths"	Rejected	There have been 25 deaths throughout history due to tsunamis on the U.S. West coast. Wood (2007) states "Results indicate that the Oregon tsunami-inundation zone contains approximately 22,201 residents (four percent of the total population in the seven coastal counties), 14,857 employees (six percent of the total labor force), and 53,714 day-use visitors on average every day to coastal Oregon State Parks within the tsunami-inundation zone."
Section 2. Known Historical Tsunami Record	**Action Accepted/Rejected**	**Brief Responder Comments**
2.2.2 Feb 27, 2010 Chile. Requested a reference for "Pismo Beach, California, recorded the maximum amplitude of 1.2 m"	Accepted	Added reference: Wilson, et al., 2012, DOI:10.1007/s00024-012-0527-z
2.2.3 March 11, 2011 Japan Tsunami. Requested a reference for "The maximum amplitude on the U.S. west coast was 2.47 m in Crescent City, California, and the current velocity was estimated at 3 to 4.5 m/s."	Rejected	Reference was already listed in for the previous sentence and is also listed in the NCEI historical tsunami database which is the reference database for the entire report. Wilson, et al., 2012, DOI:10.1007/s00024-012-0527-z
2.3.3 Runups Counts. All runups associated with tsunami events flagged as either known meterological events … add "non-seismic (landslide or meteorological)	Rejected	Tsunami events generated by landslides are included in the report statistics.
2.4 Results. Requested a reference for "A 0.68 m runup was observed in New Jersey and associated with the 1929 Grand Banks earthquake"	Rejected	All of the data and statistics in the report are from the NCEI historical tsunami database. Each tsunami event and runup has one or more references.

Section 3. New Tsunami Research Results	**Action Accepted/Rejected**	**Brief Responder Comments**
3.4 USGS National Seismic Hazard Maps. Add a reference for "A scientific consensus reached at a workshop	Accepted	Frankel, 2011 reference listed above was added.
Section 4. Discussion	**Action Accepted/Rejected**	**Brief Responder Comments**
4.1 Meteotsunamis. Last sentence in last paragraph change to "Given the nature of the meteotsunami source (atmospheric variations), forecasting of such events will not be routinely accomplished until there is further characterization of setup conditions. "	Rejected	The last sentence was removed completely because this report is not a discussion of the duties of the Tsunami Warning Centers.

Reviewer number 2.

General Comments	Action Accepted/Rejected	Brief Responder Comments
There's a lot of information in the 2008 assessment that would be useful to someone reading this one (who hasn't read the old one). You may want to consider including more notes, including page numbers, referring people back to the original. It would be preferable to combine these two documents and get rid of the 2008 assessment. Some people will only see that one and not know that it's been updated. Maybe that's something to aim for the next.	Rejected	We don't want to remove the 2008 report since we need to show the history of what was considered and assigned and changed in this assessment.
It is sometimes unclear when talking about a single hazard level for a region. There are four hazard levels per region in Table A and three in Table 2.5. Is there a way to roll up these criteria-based hazard levels into one comprehensive hazard level for each region and have these added to the tables? Is there really a need for two different tables? It's unclear why one without the USGS information is necessary.	Accepted	We need input from both the NCEI historical tsunami data and the USGS earthquake probabilities to extend the record back in time since the USGS data includes paleoseismic data from Cascadia. We summarize the results from the two tables in a final table with one hazard level for each region.
Executive Summary Section:	**Action Accepted/Rejected**	**Brief Responder Comments**
Move the paragraph that begins "To determine differences…" to be the fourth paragraph	Accepted	The paragraph that begins "To determine differences…" is the fourth paragraph.
Table A hazard level (Very low to low) based on frequency for Atlantic doesn't agree with hazard level (Very low) in Table 2-5.	Accepted	Based on later suggestions Table A has been collapsed into one hazard level for each region. It is "Very low to low) for the Atlantic coast.
How are you justifying the increase for this region [Northern Mariana Islands and Guam]. The changes for these islands, Guam in particular, just didn't seem that significant.	Rejected	This reflects both the devastating 2009 tsunami and better accounting for the tectonic setting within a major subduction zone. The location of all U.S. Pacific islands in subduction zones warrants a high hazard assessment irrespective of the available (or known) runup data. This is justified by combining the

		historical tsunami and USGS earthquake probabilities.
"As we concluded in 2008, the data in the USGS databases are consistent with our qualitative hazard levels assessments based on the tsunami record, which also takes into account the geologic record in Cascadia" NGDC's tsunami database? Is this the "deposits database"? This could use some clarification since Cascadia doesn't seem to be included in the tsunami record used to make the qualitative assessments.	Rejected	We stated we are using the USGS databases to account for the geologic record in Cascadia, not NGDC's tsunami database.
The source for potential Gulf Coast tsunamis is underwater landslides, but the current record suggests that the large landslides were probably active prior to 7000 years ago. –explain what this means for the current potential.	Accepted	The source for potential Gulf Coast tsunamis is underwater landslides, but the current record suggests that the large landslides were probably active prior to 7000 years ago, possibly posing a lower threat today.
In the last section, we discuss current efforts to move to a probabilistic tsunami hazard assessment and to identify the exposure and vulnerability to tsunamis on the U.S. West Coast. Add "begin incorporating risk.."	Accepted	In the last section, we discuss current efforts to move to a probabilistic tsunami hazard assessment and to begin incorporating risk by identifying the exposure and vulnerability to tsunamis on the U.S. West Coast.
Section 1. Introduction	**Action Accepted/Rejected**	**Brief Responder Comments**
Every year, hazards such as floods, tornadoes, landslides, and hurricanes inflict… - we don't have hurricanes that damage every year.	Accepted	Frequent hazards such as floods, tornados, landslides, and hurricanes inflict damage on local communities, upset economies, and disrupt families.
More than 50 percent of the U.S. population now live in coastal communities.—new report states 39%	Accepted	Nearly 39% percent of the U.S. population now resides in coastal shoreline counties
The results of this national assessment update are essentially the same as in 2008 except for the increase of the hazard level from moderate to high for American Samoa.-- add the Northern Mariana Islands, and Guam.	Accepted	The results of this national assessment update are essentially the same as in 2008 except for the increase of the hazard level from moderate to high for American Samoa, the Northern Mariana Islands, and Guam.
We have not repeated that	Accepted	We did not repeat that analysis

analysis here because there have been no significant changes to those databases that would affect the assessment.—clarify by adding "USGS" and "update"		here because there have been no significant changes to the USGS databases that would affect this assessment update.
Section 2. Known Historical Tsunami Record	**Action Accepted/Rejected**	**Brief Responder Comments**
"It's confusing that you use database singular in some places and plural in others. I think it would help to clarify this in some way. Maybe refer to it just as a single database that includes information about tsunami sources and tsunami runups.	Accepted	Changed the sentence to: The database includes two related tables: global observations of tsunami sources and tsunami runup records (locations where tsunami waves were observed by eyewitnesses, field…
The earlier assessment benefited from improvements to the database. We made a few minor adjustments to the database used here.--confusing	Accepted	The earlier assessment benefited from improvements to the two tables that resulted in correcting a number of errors and erroneous characterizations. In the continuing process of improving the database tables, we made a few minor adjustments to the data used here.
The inundation details are described in articles found in the NGDC's tsunami deposits reference database, but they are not included in the historical database discussed in this section.--confusing	Accepted	Deleted the sentence because the USGS earthquake hazard assessments do contain the paleotsunami studies and are used in the tsunami hazard assessment.
Section 2.1 Validity of data	**Action Accepted/Rejected**	**Brief Responder Comments**
Add a footnote to define seiche	Accepted	Added (seiches (standing wave oscillating in a partially or fully enclosed body of water)
2.3 NGDC Database Searches	**Action Accepted/Rejected**	**Brief Responder Comments**
The first report was a Hawaiian chant composed in the 16th century describing a huge wave that struck the west coast of Molokai and killed the inhabitants. – was this unconfirmed?	Accepted	Added: The first report was a Hawaiian chant composed in the 16th century describing a huge wave that struck the west coast of Molokai and killed the inhabitants (unconfirmed).
2.3.2 Earliest Historical Accounts in the Atlantic	**Action Accepted/Rejected**	**Brief Responder Comments**
(The first confirmed report of a tsunami on the Canadian Atlantic Coast was the 1755 Lisbon tsunami.) - add	Accepted	The first confirmed tsunami report for the North American Atlantic coast is from the 1755 Lisbon earthquake where it was observed on the Canadian east

		coast. – sentence added
2.4 Results	**Action Accepted/Rejected**	**Brief Responder Comments**
Add this sentence to the fourth paragraph: We have summarized the results in Table 2-1 and on the maps in Figures 2-2 and 2-3.	Accepted	Sentence added to the beginning of the third paragraph.
Add sentence to end of third paragraph: Both states incurred damage from these tsunamis, and one death was reported in California during the 2011 event.	Accepted	Sentence added to the beginning of the end of the third paragraph.
2.4.1. Local vs Distant Tsunami Sources	**Action Accepted/Rejected**	**Brief Responder Comments**
Several edits to the paragraph describing Table 2-2 were suggested.	Accepted	Most of the changes were made.
The last paragraph before section 2.5 should be moved to the bulleted section about the May 1964 tsunami	Accepted	The sentences were added to the May 1964 bullet.
2.5 Discussion	**Action Accepted/Rejected**	**Brief Responder Comments**
Talke and Jay (2013) point out that the only exceptions to the neglect today of the pre-1900 tidal data are the marigrams used by Lander et al. (1993) to reconstruct past tsunamis – confusing	Accepted	Edited sentence: Talke and Jay (2013) point out that the pre-1900 tidal marigrams are generally not used today, but were used by Lander et al. (1993) to reconstruct past tsunamis.
For Hawaii and the lower 48 States, the first arrival of distant tsunamis from subduction zones in the Pacific is at least four hours. – Delete this sentence from the 6th paragraph	Accepted	Sentence was deleted
2.6 Qualitative Hazard Assessment	**Action Accepted/Rejected**	**Brief Responder Comments**
Many comments related to number of runups and frequency	Partially Accepted	This section was expanded and re-written to examine frequency of runup heights.
2.6 Considerations of the USGS Earthquake Hazards Databases	**Action Accepted/Rejected**	**Brief Responder Comments**
The third paragraph had two sentences summarizing the USGS earthquake probabilities and there was a typo for the level for the Gulf coast.	Accepted	One of the sentences was removed and the level for the Gulf coast was corrected.
Section 3. New Tsunami Research Results	**Action Accepted/Rejected**	**Brief Responder Comments**
3.2 U.S. Gulf Coast		

The likeliest source for a U.S. Gulf Coast tsunami is an underwater landslide, but the current record suggests that the large landslides were probably active prior to 7,000 years ago. needs clarification.	Accepted	The likeliest source for potential Gulf Coast tsunamis are underwater landslides, but the current record suggests that the large landslides were probably active prior to 7000 years ago during a period of rapid sea level change.
Section 4. Discussion		
4.2 Landslide forecasting and possible tsunami generation		
That likelihood will grow as more forecast offices adopt the capability covering ever larger portions of the country. – sentence needs to be rewritten	Accepted	The likelihood to provide forecasts will grow as more forecast offices adopt the capability resulting in coverage over larger portions of the country.
Section 5. References	**Action Accepted/Rejected**	**Brief Responder Comments**
Replace Crossett (2004) with newer reference	Accepted	Replaced Crossett (2004) with Crossett (2013)

Reviewer number 3.

General Comments	Action Accepted/ Rejected	Brief Responder Comments
The report is generally well written, not overly long, and reviews the pertinent data and new research that applies to tsunami hazard assessment.		
One of the main conclusions of the report states that the 2010 Chile and 2011 Japan tsunamis did not change the results of the original assessment. In other words, runups for these events fell within the range of runups in the NGDC historical database. This seems reasonable however, it raises a question: Had there been a large earthquake generated tsunami along the Cascadia coast after 2008, would the impacts have resulted in a change in the tsunami hazard assessment? A casual look at the data tables suggests that such an event, if it resulted in hundreds of deaths or more and tens of runups >3 m, might result in a higher hazard assessment for the Cascadia coast. A similar result might happen in Alaska if a major event had happened there. I think the authors should discuss the sensitivity of the updated hazard assessment to a hypothetical case where a large Cascadia or Aleutian tsunami causes substantial fatalities and loss of life.		If there had been a large Cascadia tsunami that was included in the NGDC historical tsunami database, it would result in the change in one extra tsunami runup value in Table 2-1 for each state that observed the tsunami (most likely Washington, Oregon, California and perhaps Hawaii). This one point would not have much impact on the frequency and distribution calculations in Tables 2-6 and 2-7. The number of deaths and dollar damage would definitely change for the states that were affected by the tsunami.
The organization of the report is disjointed and distracted me. Rather than include references with each section, list them all at the very end in a References section for the entire report. Section 2 has a "Discussion" section. Could the report be condensed by including this discussion in the discussion of Section 4? There may be other ways to reorganize the report to make it easier to read and possibly decrease its length. I suggest following the simple standard of Introduction, Methodology/Data, Analysis, Results, Discussion, Conclusions, References.	Partially Accepted	All references were moved to one section at the end of the report – Section 5. The other sections were left the same to make it easier to compare to the first assessment.

Table of Contents	**Action Accepted/ Rejected**	**Brief Responder Comments**
Add a Conclusions section?	Rejected	Discussion section describes future work.
Executive Summary Section:	**Action**	**Brief Responder Comments**
"To determine differences between the 2006 results (Dunbar and Weaver, 2008) and those in this report, we examined the paragraph.." -- move to before the summary graph "Since the first …" Shouldn't the years 2006 and 2008 be the same	Accepted	Paragraph was moved and years are both 2008.
"The destructive 2009 American Samoa tsunami accounted for the change of deaths in American Samoa and did the bulk of the damage there as well." -- this is unclear	Accepted	Sentence was changed to: The destructive 2009 Samoa tsunami accounted for the change of deaths and damage in American Samoa.
Since the first assessment, there were no changes to the Atlantic Coast and Gulf coast totals. – totals of what?	Accepted	Changed to "..Atlantic coast and Gulf coast observations."
Several edits to paragraphs 8 and 9 including adding the following sentence to paragraph 8 ". In particular, a greater number of thinner, so-called mud turbidites occur along the southern Cascadia margin (Goldfinger et al., 2012)."	Accepted	The changes were made the sentence was added.
Why is Table A included since it is so similar to Table 2-5.	Rejected	Table A summarizes all the analysis of the historical tsunami record and USGS earthquake probabilities in one table and should be readily available to the reader.
Section 1. Introduction	**Action**	**Brief Responder Comments**
Had this large population been present in 1700 when the last magnitude 9 Cascadia earthquake struck, there would have been many times the number of deaths from the tsunami impact to the Pacific Northwest.—clarify the numbers of deaths in this sentence in the second paragraph	Accepted	Sentence was changed to: "…there would have been many times the total number of historical deaths from the tsunami impact to the Pacific Northwest."
Section 2. Known Historical Tsunami Record	**Action**	**Brief Responder Comments**
Rewrite the first two paragraphs to define the scope, structure and contents of the NGDC tsunami database.	Accepted	Paragraphs were rewritten to define the two tables (source events and wave observations) in the historical tsunami database, ongoing quality-control and possible deficits.
2.2 Significant Tsunamis Affecting the U.S. since 2006	**Action**	**Brief Responder Comments**
Add the phrase "During this period…" to the second sentence in the first paragraph	Accepted	Phrase was added.

2.2.2 February 27, 2010 Chile Tsunami	**Action**	**Brief Responder Comments**
Add current data to California observations.	Accepted	Updated – "Eyewitnesses reported the maximum runup of 1.2 m at Pismo Beach, California, and strong currents of 4–8 m/s in some harbors…"
2.3 NGDC Database Searches		
2.3.2 Earliest Historical Accounts in the Pacific	**Action**	**Brief Responder Comments**
Question about the statement that there is no written record of the 1700 Cascadia tsunami for the U.S. coast, since it was described by Native legends and Japanese written records.	Rejected	The sentence remains. Although the tsunami was described in Japanese written records, there are no "written" records for the U.S.
2.3.3 Runup Counts	**Action**	**Brief Responder Comments**
So, the criteria for selecting the bin was to take the highest runup measured? Explain.	Rejected	**The following sentence in the second paragraph defines the selection—"** For each individual tsunami event, we binned the events based on the maximum-recorded runup height in each state and territory."
2.4 Results	**Action**	**Brief Responder Comments**
What is a "small" tsunami listed in the third paragraph?	Accepted	Changed phrase to: "small tsunamis (<1.0 m).
Is the Caribbean's vulnerability due to the Puerto Rico Trench or other sources? Haiti's earthquake was not on the subduction zone.	No action needed	Yes the Caribbean's vulnerability is due to the Puerto Rico trench,for example the 1918 and 1946 tsunamigenic earthquakes are subduction zone events.
2.5 Discussion	**Action**	**Brief Responder Comments**
You could list the four points here, briefly, then expand on the points in paragraphs that follow. Hard to keep track of the points as is.	Rejected	The paragraph with the First point now begins a paragraph and the Second, Third and Fourth points all begin new paragraphs.
And what about Alaska? Russian accounts are spotty. – requires more discussion	Accepted	Updated sentences: The main gaps in our knowledge of historical tsunamis are along the Pacific Northwest and Alaskan coasts where the observational record spans only about 150 years. In Alaska, with many local tsunami sources, this gap is less critical to our assessment than in the Pacific Northwest where a magnitude 9 earthquake and tsunami occurred in 1700, but there is no written record of the local tsunami impact.
2.6 Qualitative Hazard Assessment	**Action**	**Brief Responder Comments**
Section 3. New Tsunami Research Results	**Action**	**Brief Responder Comments**

3.1 Atlantic Basin		
Landslide tsunamis – do they require a seismic source?	No action needed	No
Global compilation of landslide dates	No action needed	[Cannot be used as a proxy for deriving the distribution of landslides on the Atlantic margin.] This is a direct quote and we are not commenting on any of these points.
3.2 U.S. Gulf Coast		
Mobility analysis suggests that constitutive parameters	No action needed	Mobility analysis [of debris flow] This is a direct quote and we are not commenting on any of these points.

Reviewer number 4.

General Comments	Action Accepted/ Rejected	Brief Responder Comments

Executive Summary Section:	Action	Brief Responder Comments
The location of all U.S. Pacific islands in subduction zones warrants a high hazard assessment irrespective of the available (or known) runup data -- Location in subduction zones warrants a high hazard assessment in Table A irregardless of other data. This criteria should be stated when Table A is discussed.	Accepted	"First, Guam, the Northern Mariana Islands, and American Samoa have been moved into the high hazard level based on the observations of the 2009 tsunami and the tectonic setting of all three territories." – was added to section 2.6.4 *Qualitative tsunami hazard assessment based on NCEI Global Historical Tsunami Database*
Please define meteotsunamis in paragraph 12	Accepted	Added (atmospherically-caused tsunamis)
Section 2. Known Historical Tsunami Record	**Action**	**Brief Responder Comments**
2.1 Validity of Tsunami Data		
Provide examples of validity 2 and 3	Accepted	Added actual examples of validities 1, 2, 3, and 4.
2.2.2 February 27, 2010 Chile Tsunami	**Action**	**Brief Responder Comments**
It would be helpful, if possible, to maintain use of the word, runup, used in the tables…	Accepted	Definitions and figures were added to explain runup and tide gauge amplitude and explain that we will be using the maximum wave height that is available whether it is a tide gauge or field survey runup report.
2.4 Results	**Action**	**Brief Responder Comments**
Known historical sources of tsunamis recorded on the U.S. Atlantic and Gulf coasts are few, consisting of: -- Provide citations for these sources if possible, especially for the explosion in 1964	Rejected	Every tsunami source and runup has one or more source documents associated with the record. The reference citation is listed with each record and available online through database searches.
2.6 Qualitative Hazard Assessment	**Action**	**Brief Responder Comments**
General comment was overall point is that you could do much more analysis on these tables than has been done.	Accepted	We added two new sections where we determined the time interval for all tsunamis observed per state and from that total events, >1m events, and >3m events per year. We determined runup height and frequency criteria for assigning hazard levels of very low, low … very high. For example, "Very High" hazard level was defined

		as all states that had observed >50 tsunami events, and >3m runups with a frequency per year of ≥0.02
4.2 Landslide forecasting and possible tsunami generation	**Action**	**Brief Responder Comments**
It seems imperative that the database guarantee that those charged with public safety are able to rely on the database to help understand the possibilities.--clarify	Accepted	It seems imperative that the tsunami runups from inland water landslides be included in the tsunami database.