Written Statement of

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Good morning Chairwoman Bordallo, Ranking Member Brown, and distinguished Members of the Subcommittee. My name is Larry Mayer and I am a professor and the Director of the Center for Coastal and Ocean Mapping/Joint Hydrographic Center at the University of New Hampshire (CCOM/JHC). The CCOM/JHC is a national center of excellence that works with NOAA and other agencies to develop state-of-the-art techniques for ocean mapping in support of safety of navigation, fisheries, and many other applications.

I thank you for this opportunity to comment on H.R. 2864, *legislation to amend the Hydrographic Services Improvement Act to authorize NOAA to acquire hydrographic data and provide hydrographic services specific to the Arctic.* As Captain Lowell has explained, NOAA's existing mandate includes the Arctic and NOAA has already begun several initiatives to address Arctic mapping issues. Nonetheless, H.R. 2864 is a most welcome amendment in that it highlights the pressing need for enhanced mapping activities in a region that is becoming increasingly critical to our national security, our sovereign rights, and our economic and environmental well-being. And yet, as we begin to recognize the importance and vulnerability of this remarkable region, we must also acknowledge that in the Arctic we lack the most basic of tools to explore for, exploit, and preserve our resources, to understand climate change, and to protect our environment and our security. In scientific terms, what we are missing is the fundamental geospatial framework needed for safe navigation and marine spatial planning – in more understandable terms – what we are missing is a decent map!

The pressing need for enhanced mapping activities comes from the irrefutable evidence that rapid changes are taking place in the Arctic. With these changes have come increased opportunities, increased activities, and increased vulnerabilities to an already fragile environment. My colleagues at this table and numerous reports and documents have presented a clear and unquestionable litany of facts that support these changes and with them the need for enhanced mapping activities. Temperatures in the Arctic have

shown a warming trend since the 1970's, with the average temperature in the Arctic now about 1.8 degrees F warmer than that of the period from 1961 to 1990 (CRS, 2010; 7-5700). Most critically, these warmer temperatures and other factors have led to a rapid decline in multiyear ice that has, in turn, led to greater accessibility to the region and with this a tremendously increased interest in resource exploitation and the potential opening of Arctic sea routes (the Northwest Passage, the Northeast Passage and even direct Trans-Arctic routes).

I will not repeat the details of these facts nor their clear implications in terms of needed infrastructure – rather I would like to take the few minutes I have with you to offer a first-hand account of just how little we know about this region and the rapid changes that are taking place there.

Since 2003, I have had the privilege of being the chief scientist of five Arctic expeditions on board the USCG Icebreaker *HEALY*. These cruises were designed to map the deep seafloor in the regions of the Chukchi Cap and beyond in support of establishing the outer limits of an "extended continental shelf" – a region where the U.S. has sovereign rights over the resources of the seafloor and the subsurface -- well beyond our current 200 nmi Exclusive Economic Zone. The limits of the extended continental shelf are based on a complicated set of formulae that depend on the shape and geology of the seafloor. Included in the information needed to establish the limits of the continental shelf are: 1- the position of the "foot of the slope" a point of maximum change in gradient at the base of the continental slope; 2- the position of the 2500 m depth contour; 3- the thickness of sediment on the margin, and; 4- a line that is 350 nautical miles from the coastal baseline. To define the limits of its extended continental shelf, a coastal state must obtain bathymetric (depth) and seismic (sediment thickness) data, both very difficult to collect in the Arctic. Maps of the deep seafloor in the Arctic have historically been based on very, very sparse data, typically collected as individual depth soundings from drifting ice islands. Based on the existing maps we had in 2003, we believed that in the area of the Chukchi Cap, north of Alaska, the U.S. had the potential for an extended continental shelf with an area slightly more than the size of California (Figure 1).

In 2003, we started to collect new, modern mapping data from the USCG Icebreaker *HEALY* – an icebreaker equipped with a sophisticated mapping system called a multibeam echosounder. This mapping system simultaneously provides many depth measurements over a relatively wide swath of the seafloor (rather than a single depth measurement somewhere under the vessel) that offer remarkable new perspectives of seafloor topography. As soon as we began to map with this new system, we quickly learned that our existing maps were totally inadequate. For example, on our very first cruise we found a giant, 10,000 foot high underwater mountain where none was known -- and in an area often transited by submarines (Figure 2).

Most importantly, we found that the key features that define the extended continental shelf (in particular the foot of the slope and the 2500 m depth contour) were much different than we had previously believed. Based on these initial findings, we now believe that our sovereign rights over seafloor resources in the Arctic may be much, much more extensive than originally expected (Figure 3). More mapping is needed to verify this and to establish the full extent of our extended continental shelf in the Arctic.

The large uncertainty associated with our understanding of Arctic bathymetry (depths) effects more than our ability to establish limits for the extended continental shelf. Knowledge of seafloor depths is essential to an understanding of how ocean water circulates (through deep and shallow currents). The Arctic is a key component of the global circulation system and this circulation is largely responsible for the distribution of heat on the planet. Thus, without an accurate knowledge of the routes and volumes of water masses, we cannot accurately model the distribution of heat, chemical, or biological constituents in the ocean.

In the course of our mapping, we also found fields of "pockmarks" – gas-escape features on the seafloor – consistent with the Department of Interior's report that 22% of the world's undiscovered recoverable oil and gas resources lie in the Arctic (Figure 4). There is much more mapping needed to establish the distribution of these features, the full extent of our extended continental shelf in the Arctic, and to provide the basic framework for critically needed scientific study, and thus, in part, the importance of H.R. 2864.

The examples I have just presented are from deep water but our lack of knowledge of the shape of the seafloor and coastline is even more critical in the shallow waters that most immediately impact commerce and our indigenous populations. It is in these shallow waters that we will see increased vessel traffic and where safety of navigation is most critically important. We have been working in the Arctic since 2003 and, until 2008, we never encountered another vessel. In the last two years, however, we have seen or heard vessels from China, Korea, Japan, Germany, and Canada. Last year as the *HEALY* came into Barrow, a German sailboat was anchored offshore and we heard it calling on the marine radio for the Barrow harbormaster. We called back and explained that there was no harbormaster in Barrow -- and that there was NO HARBOR in Barrow. We will see more and more of these "adventure" tourists in the years to come. They, as well as any others trying to navigate in this region, are dependent on the charts we produce for safe navigation yet, if we look at the chart of the waters around Barrow, we see that it is based on a handful of depth soundings collected in 1945 and 1951 (Figure 5). Having seen the coastal road in Barrow come and go due to storms over the past few years, I can assure you that these soundings collected more than 60 years ago probably have very little semblance to reality.

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Given the very limited mapping information we have – how can we expect to safely accommodate the increased vessel traffic we are seeing in the Arctic? How can we hope to understand, predict, and mitigate the dramatic coastal changes we are witnessing, as well as support the myriad of other activities that are so rapidly increasing? How can we support native communities and our environmental interests and carry out critical marine spatial planning if we don't even know where the seafloor and coastline are?

And so I strongly support the intent of H.R. 2864 in its call for enhanced mapping activities in the Arctic. The need is great, but so are the challenges. To survey in the Arctic requires vessels that are capable of operating in a harsh environment where ice may be present. Accurate mapping also requires a significant investment in the collection of ancillary data including tides, currents, and accurate land elevations, but virtually none of these exist in the Arctic. Given the logistical challenges and limited weather windows associated with data collection in the Arctic, it is also essential that the data collected serve as many purposes as possible (e.g., safe navigation, fisheries, marine spatial planning, etc.). In this sense, the mapping data required in the Arctic should be a prime example of integrated ocean and coastal mapping and its philosophy of "map once – use many times."

The Arctic is too important to the well-being of the nation to allow us to blindly wander there without an adequate geospatial context. The challenges of acquiring accurate seafloor and coastal mapping data are great, but the consequences of not acquiring such data are even greater. I am confident that, if appropriately equipped and funded, NOAA has the capability and the will to carry out this most critical work.

Once again, I thank you for this opportunity to testify and would be delighted to answer any questions you may have.

Figure 1.

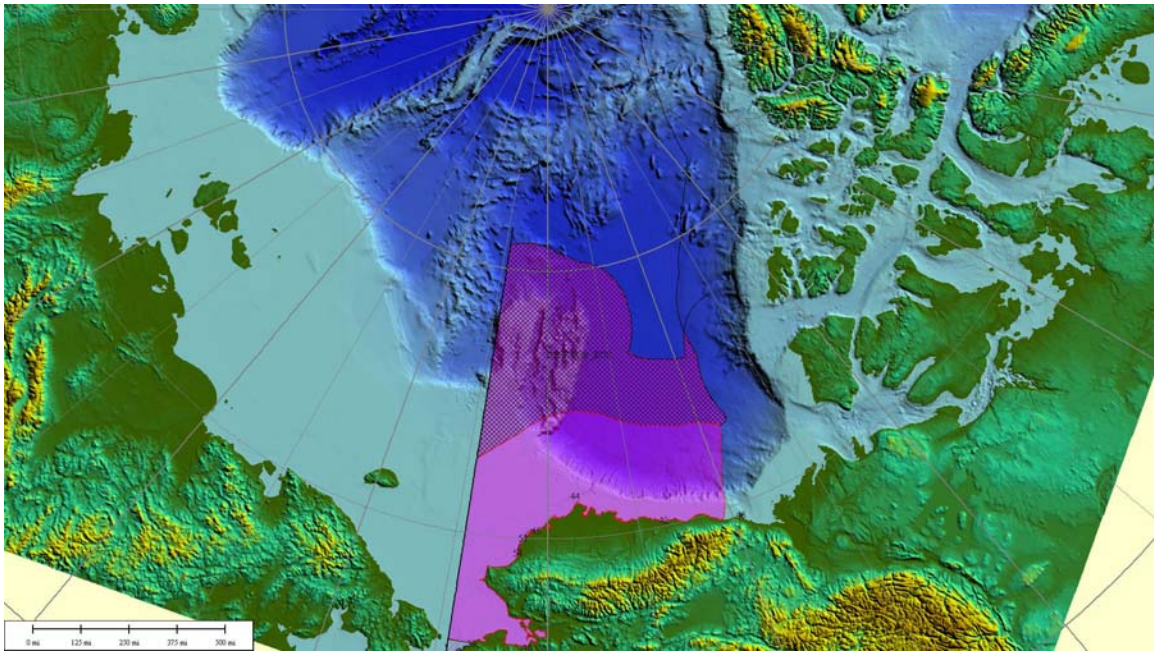

Figure 1. Solid purple is U.S. EEZ around the northern coast of Alaska. Cross-hatched purple area represents an approximation of the extended continental shelf based on the assumed location of the key morphological features required to define the limits of an extended continental shelf (foot of the slope, 2500 m depth isobath, sediment thickness and a line 350 nm from the baseline, as known before U.S. mapping efforts began in 2003. The western boundary of both the EEZ and the potential extended continental shelf is represented by the negotiated U.S./Russian maritime boundary of 1990; boundaries on the eastern side will be the subject of negotiations with Canada.

Figure 2.

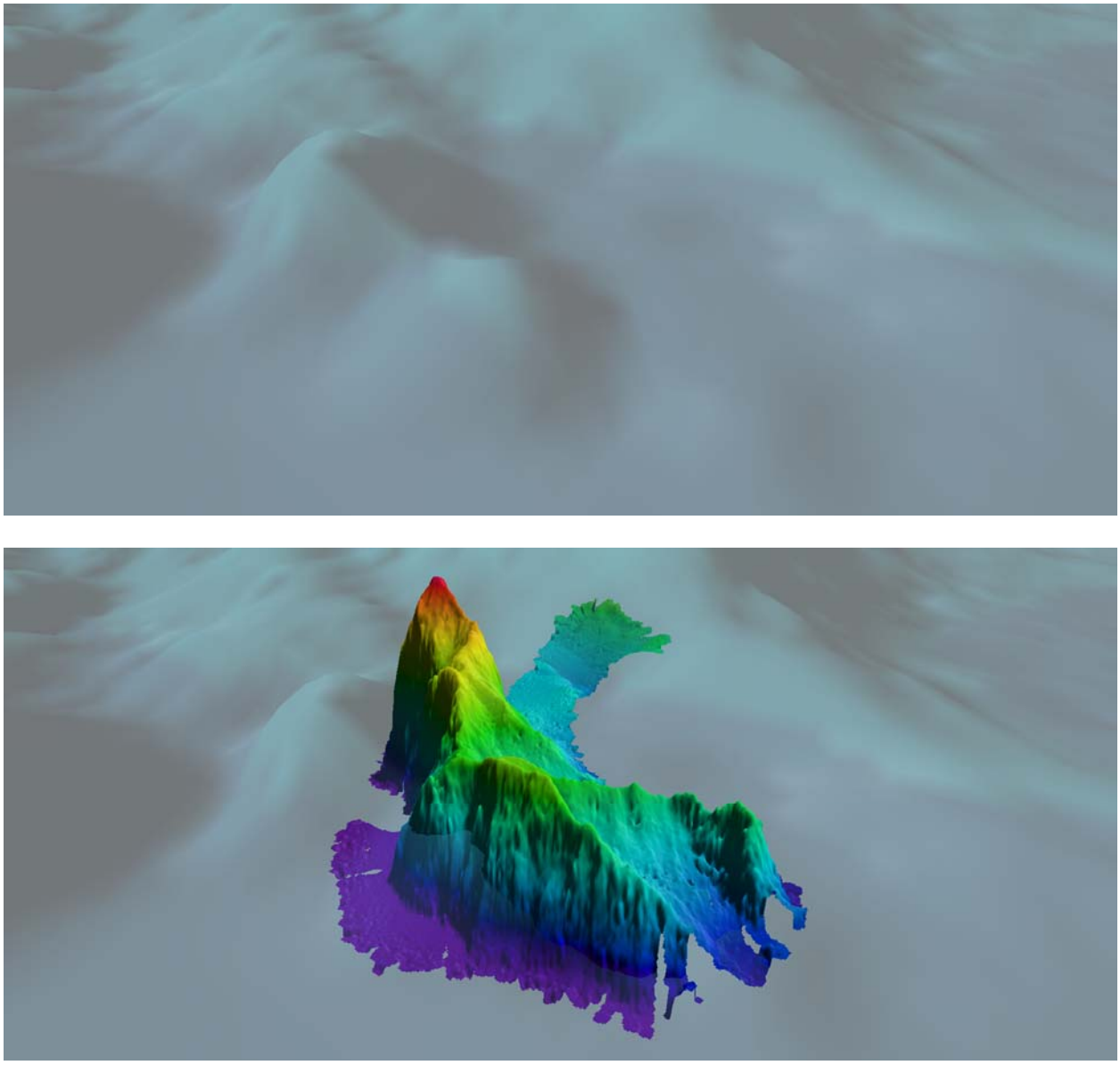

Figure 2. Mapping on the Chukchi Cap revealed a seamount (underwater mountain) that rose more than 10,000 feet above the surrounding seafloor in a region thought to be relatively flat and deep (top figure represents map of the seafloor before U.S. mapping cruises). There are many more unmapped features like this in the Arctic.

Figure 3.

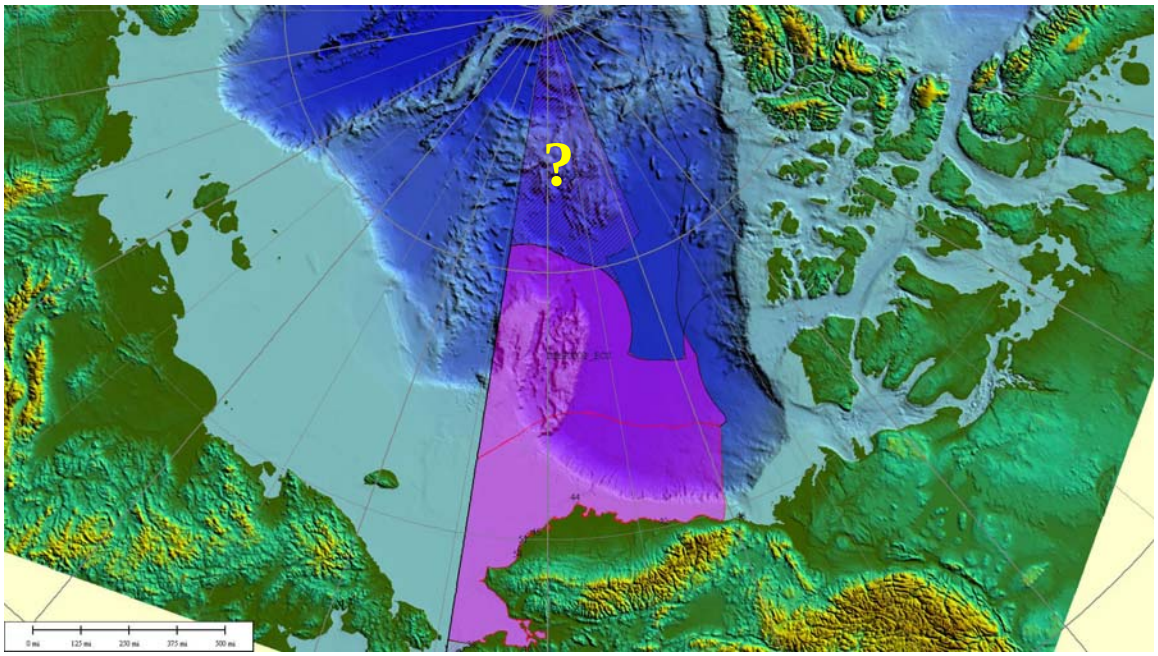

Figure 3. Recent mapping has revealed that the key features used to define the extended continental shelf are different than had been previously thought. If supported by further mapping, these differences may allow the extended continental shelf to extend much farther north. Again, final boundaries will be the subject of negotiations with neighboring states.

Figure 4.

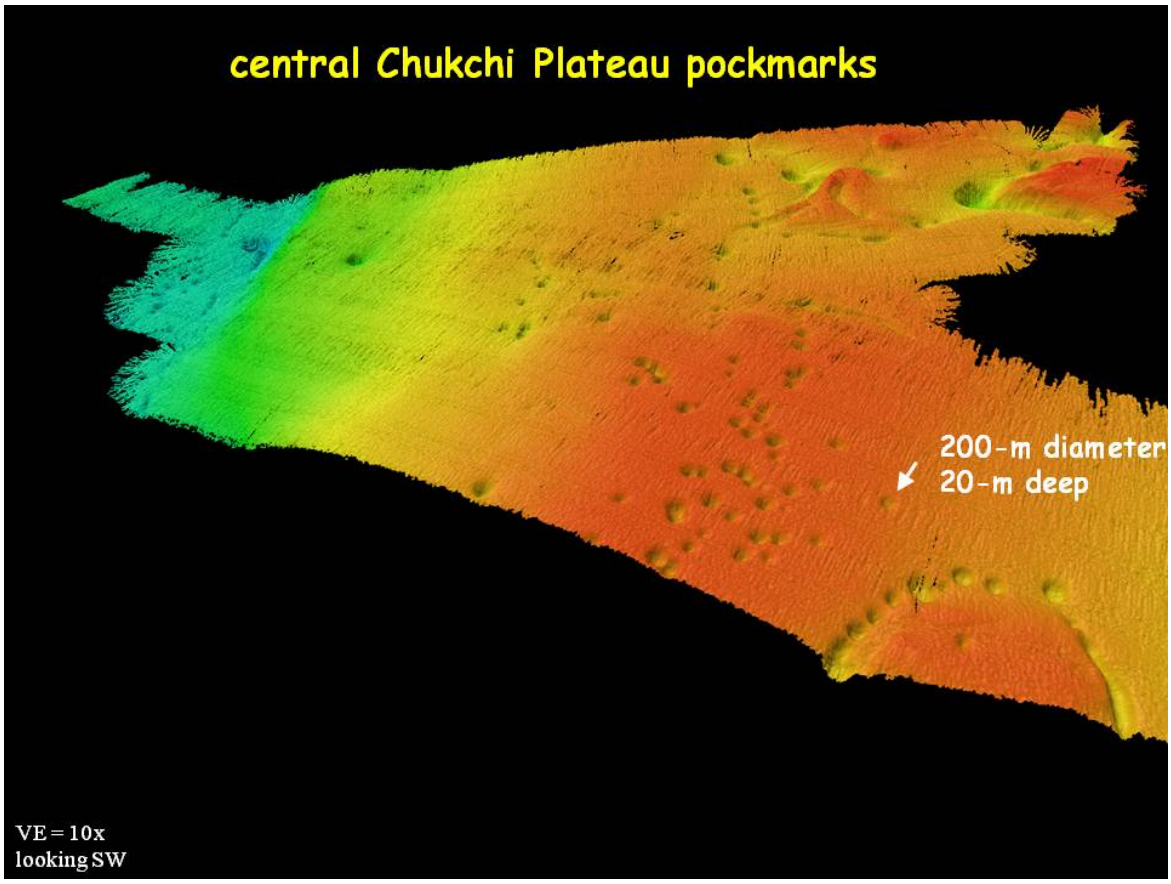

Figure 4. "Pockmarks," believed to be gas-escape features, imaged with a seafloor mapping system on the Chukchi Cap.

Figure 5.

Figure 5. The total database of seafloor depth measurements for the area off Barrow Alaska. These data were collected in 1945 and 1951 and have not been updated since