# Sea Kayaking From Nanticoke Island

## A Factional Account from 2112

***by Ralph Heimlich***

*Ralph Heimlich III on Nanticoke Island, Md. July 1, 2112.*

*On July 1, 2112, a group of three friends and I set out from Nanticoke Island, off the west coast of Maryland's Eastern Shore. We'd driven down across the causeway and stayed at a pleasant B&B on Nanticoke Island, intent on a few days of kayaking. This trip was a bit of nostalgia, recreating a trip my great-grandfather had done from a campground on Roaring Point, then the mouth of the Nanticoke River, in 2012, 100 years ago.*

*With my coconut and basalt-fiber kayak (the latest technology and not based on petroleum as in my great-grandfather's day), I was also equipped with an antique cedar Greenland paddle handcrafted by my ancestor and still marked with his name (see picture).*

*We left the beach at Nanticoke Island and paddled northwest across the broad, shallow expanse of Fishing Bay, intending to cross the 14-mile expanse with a single stop at Transquaking Island, where we would camp from our kayaks.*

*As we stood on the beach at Nanticoke Island, only tidal flats and sparse flooded marsh separated us to our west across the whole expanse of the Chesapeake Bay from Calvert County beyond small, uninhabited Elliot Island.*

*From Ralph Heimlich III*[i] *"Seakayaking From Nanticoke Island, Maryland,"* ACK *Volume 202, No. 6, October 2112*

I don't know how my great-grandson will be spending his leisure time, but his Chesapeake Bay is likely to be quite different than my Bay, based on the inexorable upward creep of the water level. The Chesapeake Bay shoreline has always changed under the influence of erosion and the rebound from the weight of the last glacier melting to the north of us. But that change is likely to be dwarfed by the rise in water level we are expected to experience in the next 100 years.

Geologists differentiate two kinds of sea level change: absolute change and relative change. Absolute change is the difference in sea depth, on average between two points in time. There are two main reasons why sea level changes, both related to ambient global temperature. First, as the world's seas become hotter, they expand in volume, raising sea level. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3,000 meters and that the ocean has been absorbing more than 80 percent of the heat added to the climate system.

The second reason is that as temperatures rise, glaciers and ice pack at the poles melt, returning as water to the world's oceans and rising sea levels. Mountain glaciers and snow cover have declined on average in both hemispheres. Data show that losses from the ice sheets of Greenland and Antarctica have very likely contributed to global sea-level rise between 1993 and 2003[ii].

Global average absolute sea level rose at an average rate of 1.8 millimeters per year between 1961 and 2003. The rate was faster between 1993 and 2003, about 3.1 mm per year (figure one).

Absolute sea level change is both a symptom of climate change, and a driver of the much more personal changes my great grandson might experience—relative sea level change in local areas. What matters to kayakers is where the beach and shoreline decides to be, not the absolute level of the world's oceans.

Beside absolute sea level change, relative sea level change is influenced by tectonic forces where continental plates are in collision or are subducting (one plate sliding beneath another), rebound of continental plates when glaciers and ice packs melt off, land subsidence due to compaction of sediments or from extraction of oil and natural gas from offshore deposits, and the local "bulging" of water surface from strong, continuous currents. Data from NOAA tide measurements over 50 years show average rates of relative sea level change in the U.S. ranging from -1.41 mm/year in the Pacific Northwest, to 9.85 mm/year at the Mississippi Delta in Louisiana. The sea level measured at Baltimore has been increasing steadily over time, and the rate of change averaged 3.08 mm/year, shown in figure two. Subsidence of the land surface, attributed mainly to adjustments of the Earth's crust in response to the melting of the Laurentide ice sheet and to the compaction of sediments due to freshwater withdrawal from coastal aquifers, contributes to the high rates of relative sea-level rise observed near Baltimore (Gornitz and Lebedeff, 1987; Emery and Aubrey, 1991; Kearney and Stevenson, 1991; Douglas, 1001; Peltier, 2001).

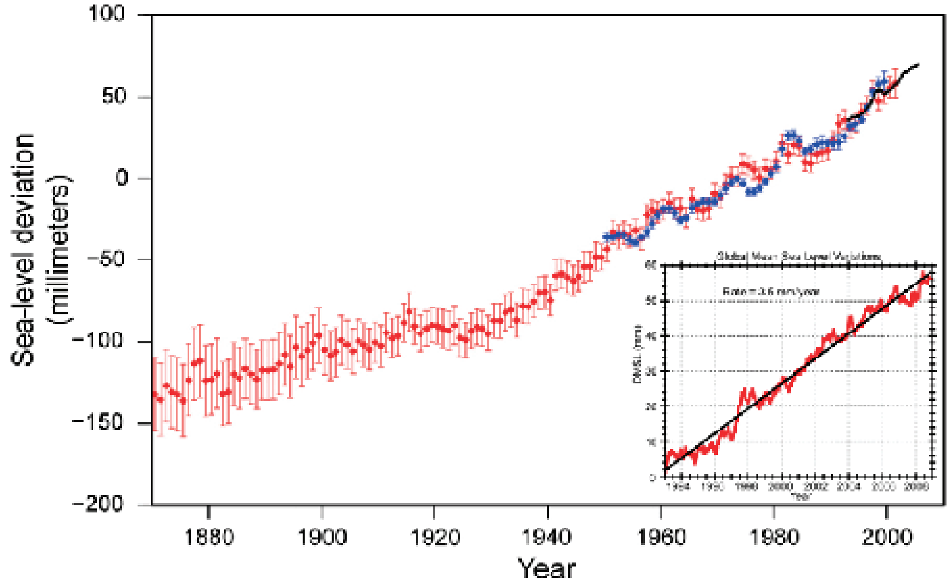
How much more could the level of the Bay rise? At the average rate for the past 105 years of 3.08 mm/year we would see an increase of 1.21 inches in a decade, or over a foot in 100 years. But we've all heard that global temperatures are expected to increase considerably in the future.

Based on a range of possible greenhouse gas emissions scenarios for the next century, the Intergovernmental Panel on Climate Change (IPCC) 2007 assessment estimates the global increase in temperature will likely be between 1.1 and 6.4 degrees Centigrade (2 to 11.5 degrees Fahrenheit).

Estimates of sea-level rise for the same scenarios are 0.18 m to 0.59 m, plus another 0.20 m from accelerated ice discharges from the Greenland and Antarctica ice sheets. That's an absolute increase in sea level of 0.38 to 0.79 meters over 100 years, or 3.8 to 7.9 mm/year.

If the same relationship between absolute and relative sea level change for the Chesapeake Bay area continues, that translates into a rate of relative sea level change of 10 mm/year, or 3.94 inches per decade, or 39.4 inches (1 meter) by the time my great-grandson is paddling.

While the 2007 assessment was based on the understanding of polar ice melting behavior under past (circa 130,000 years ago) warming regimes, new research[iii] on Arctic ice cores reveals that the Antarctic ice sheet may have melted very much faster than previously thought. A new IPCC report on sea level change that came out in September is expected to show greater rises in sea level based in part on these new data. A good layman's version of the story is in *National Geographic Magazine*'s September issue[iv].




***(Note to our readers - to see the charts in color, the October password is Ack#October#13)***

*Figure 1. Annual averages of global mean sea level in millimeters from IPCC (2007). The red curve shows sea-level fields since 1870 (updated from Church and White, 2006). The blue curve displays tide gauge data from Holgate and Woodworth (2004), and the black curve is based on satellite observations from Leuliette et al. (2004). The red and blue curves are deviations from their averages for 1961 to 1990, and the black curve is the deviation from the average of the red curve for the period 1993 to 2001. Vertical error bars show 90 percent confidence intervals for the data points. (Adapted from Climate Change 2007: The Physical Science Basis . Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Figure 5.13. Cambridge University Press.) Source: http://www.ncdc.noaa.gov/indicators/*

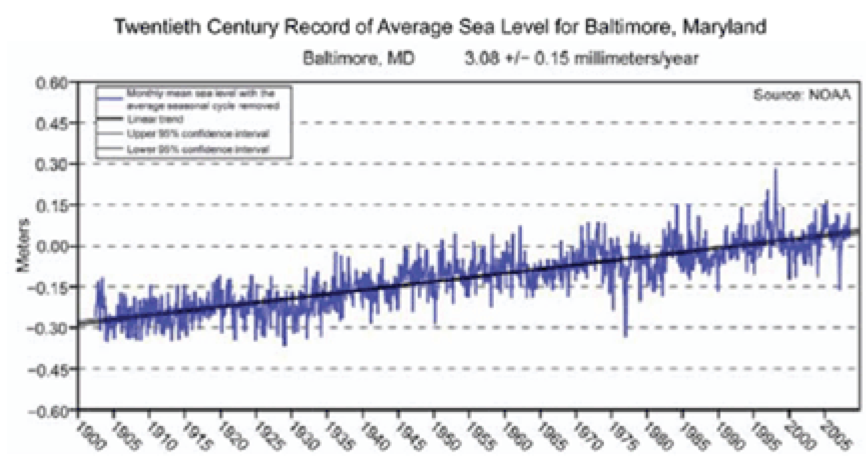



*Figure 2. The monthly computed average sea-level record (black line) from 1900 to 2006 from the Baltimore, Maryland tide gauge. The blue line is the observed data. The zero line is the latest 19-year National Tidal Datum Epoch mean value.*

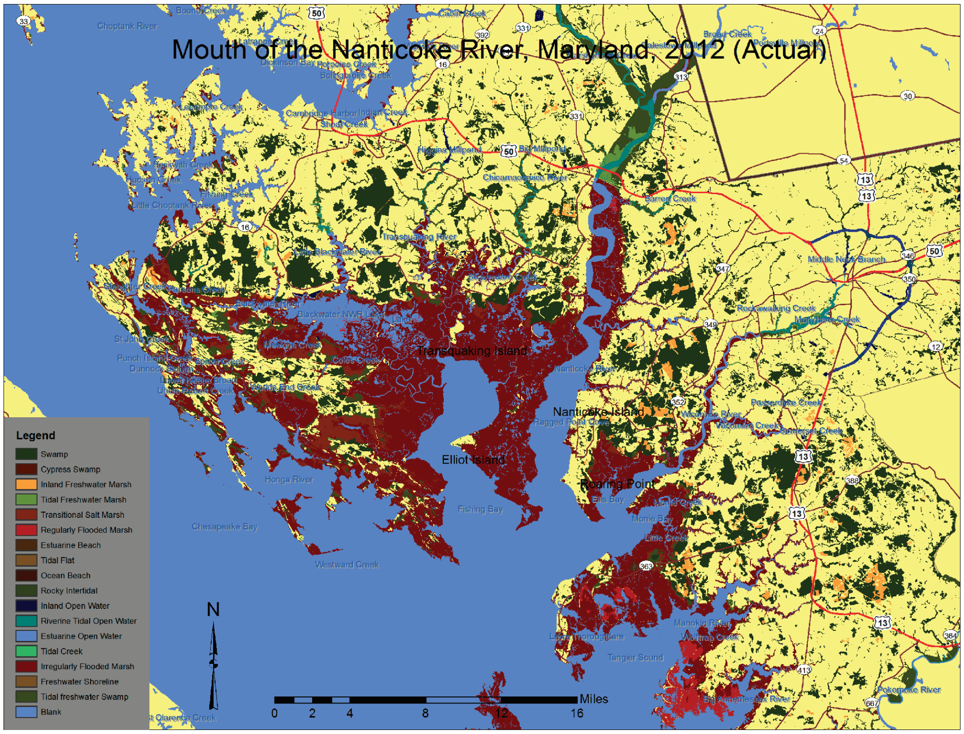



*Figure 3. Current situation at the mouth of the Nanticoke River including tidal and non-tidal wetlands and upland. Map created by Ralph Heimlich using data from Maryland DNR at http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SLAMM.*

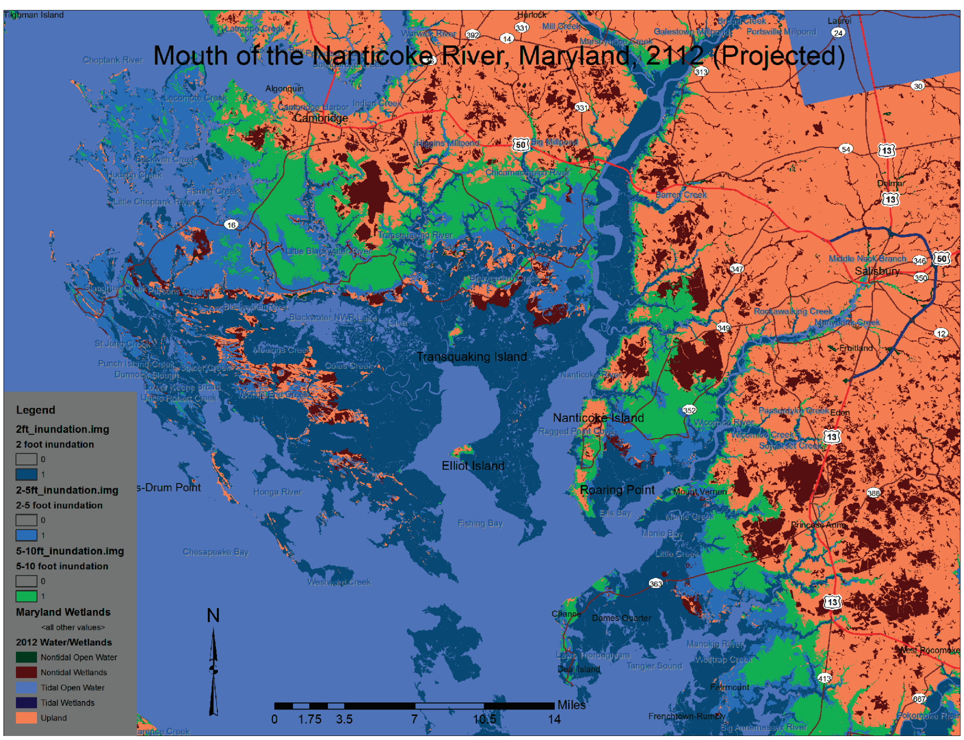



*Figure 4. Areas of expected inundation at the mouth of the Nanticoke River in 2112, based on sea level rise in the Chesapeake Bay. Map created by Ralph Heimlich based on data from Maryland DNR at: http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SLR.*

Maryland's government[v] recently reviewed the science and concluded that the Bay should prepare for sea level rise of 2.1 feet by 2050 and 3.7 feet or more by 2100. The 3.7 foot estimate is the midpoint of a 2.1 to 5.7 foot range. In addition to the uncertainty of future greenhouse gas emissions and their effect on ice melting, the scientists also took slowing of the Gulf Stream, documented since 2004, into account.

Maryland planners[vi] used available data to create GIS datasets showing vulnerability to sea level rise in ranges of inundation of 0-2 feet, 2-5 feet, and 5-10 feet by 2100. In the Roaring Point area mapped below, these elevations are mapped using LIDAR (Light Detection and Ranging) data, which has very little vertical measurement error.

Figure three shows the current situation at the mouth of the Nanticoke River, and figure four shows the areas at the mouth of the Nanticoke River that would be under water assuming inundation of up to two feet (darker blue), up to five feet (medium blue), or up to ten feet (lighter blue) - futures in which my great-grandson may be living. A similar kind of analysis could be done and maps examined for many areas up and down the Eastern seaboard, and around the world. Your depths may vary.

Just knowing the potential depth of inundation doesn't tell you all you need to know about future land (or water) use. A simulation model (the Sea Level Affecting Marshes Model or SLAMM[vii]) uses elevation, accumulation of sediments, wetland accretion and erosion rates, and sea level rise to predicatively model long-term wetland and shoreline change.

Maryland ran SLAMM using a sea level rise rate of 3.4 feet by year 2100 to visualize changes to coastal marshes and shorelines in their current state, 2050 and 2100 year scenarios. Much of what had been tidal wetlands in Dorchester County in 2012 becomes estuarine open water or tidal flats by 2112.

The Blackwater River through the Blackwater National Wildlife Refuge becomes estuarine open water, and upland west of Cambridge and south of the refuge becomes regularly flooded tidal marsh. The winding channel through marshes along the Nanticoke River widens to estuarine open water, and the creeks separating the peninsula on which Roaring Point rests widen and connect through to Ellis Bay, creating Nanticoke Island.

All of this assumes that no action is taken to change the increases in CO2 and other greenhouse gases on which the temperature increase estimates, and the corresponding sea level increase estimates, are based. Judging from the response of the people and government of the United States, and the continuing gridlock in international climate talks, that seems like the most indisputable projection of them all.

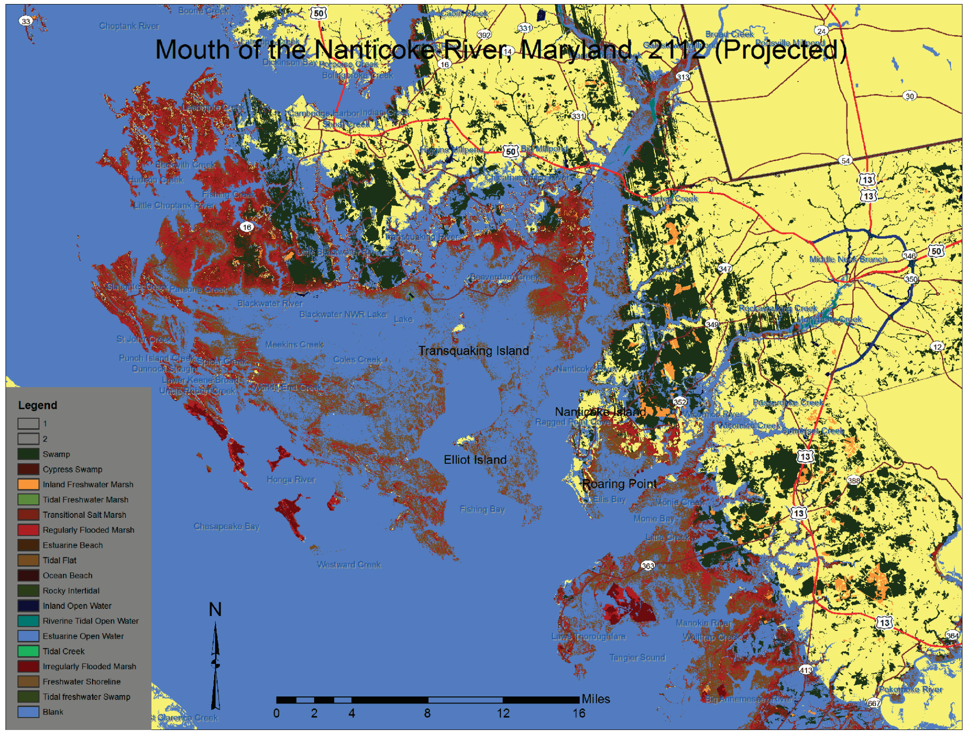



*Figure 5. Projected 2112 land uses based on SLAMM modeling of 3.4 foot sea level rise. Map by Ralph Heimlich based on data from MD DNR at http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SLAMM*

## Notes:

**i.** Ralph Heimlich III is the yet-to-be-born great grandson of Ralph Heimlich, a frequent contributor to *ACK*

ii. See Wayman, Erin. "Shrinking polar ice caused one-fifth of sea level rise." *ScienceNews*, November 29, 2012 online at http://www.sciencenews.org/view/generic/id/346733/description/Shrinking_polar_ice_caused_one-fifth_of_sea_level_rise.

iii. Mahoney, J., 2013. "Cold, Hard Facts: Ancient ice suggests that scientists may be dangerously underestimating future sea levels," *Popular Science*, 282(6): June, p. 31-32. Online at http://www.popsci.com/science/article/2013-05/cold-hard-facts.

iv. Folger, Tim. 2013. "Rising Seas" *National Geographic* 224(3) September pp. 30-59, especially fold out map at page 42. Also online at http://ngm.nationalgeographic.com/2013/09/rising-seas/folger-text

v. *Sea Grant Maryland. 2013.* "Scientists Unvail New Projections for Sea Level Rise in Maryland: State should consider longevity of structures built near water, report says," online at http://www.mdsg.umd.edu/news/scientists-unveil-new-projections-sea-level-rise-maryland

vi. See data documentation at http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SLR.

vii. See explanation at http://www.dnr.state.md.us/ccp/habitats_slr.asp and data documentation at http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SLAMM. To learn more about SLAMM please refer to Warren Pinnacle Consulting, Inc. http://www.warrenpinnacle.com/prof/SLAMM/SLAMM_Model_Overview.html

*OMEN - The picture that leads this article is a prediction of what the area will look like in 100 years. It is (will be) "taken" from what is now dry land and then will be the new shoreline of "Nanticoke Island."*