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HEARING ON
SCIENCE AND RESEARCH AND FORECASTING INNOVATION

SENATE SUBCOMMITTEE ON SCIENCE, OCEANS, FISHERIES, WEATHER
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Chairman Gardner, Ranking Member Baldwin, and Members of the Subcommittee, my name is Erika Washburn. I am the director of the Lake Superior National Estuarine Research Reserve, which is administered by the University of Wisconsin-Madison's Division of Extension. I submit this testimony in my capacity as director of one of two reserves in the Great Lakes and as a member of the National Estuarine Research Reserve Association, which represents 29 designated reserves around the nation.

I appreciate this opportunity to speak about the science associated with climate change from the perspective of a national network of coastal and estuarine places and a federal/state partnership that works directly with coastal communities. For 46 years, the Reserves have delivered science, education, and stewardship to track the health of estuarine and coastal systems and understand how they are changing. I would like to thank Congress for its vision and funding for this important work.

Together, reserves encompass more than 1.4 million acres of locally-owned, special places in 22 states and territories. Since 2011, we've engaged more than 4,000,000 scientists, educators, students, and visitors in research, monitoring, and education. We work in a non-regulatory, non-advocacy framework on issues that coastal communities care about: clean water, safety, informed citizens, abundant fisheries and healthy habitats. Climate change affects all of these.

Of relevance is our unique System-wide Monitoring Program, designed to track environmental change and inform coastal resource management and science. Together, we manage 280 monitoring stations that—every 15 minutes—take readings on water quality, pollution, habitat change, sea level rise and weather. We produce more than 40 million, publically available data points every year. Communities rely on this to plan for extreme weather, manage fisheries, assess storm damage, and more.

Reserves leverage the expertise and resources of our partner, the National Oceanic and Atmospheric Administration (NOAA), which provides the most current and advanced coastal and climate science and data. We collaborate with federal and state agencies, Tribal entities, local governments, school districts, businesses and academic institutions. We address the multi-faceted needs of coastal communities, informing critical decisions that impact the economy, public health, and safety.

I work on the shores of Lake Superior—the world's largest body of freshwater by surface area. Every day, I drive back and forth between Wisconsin and Minnesota over the St. Louis River, home to the largest freshwater port in the world. More than 35 million short tons of cargo pass through here annually, to cities throughout the Great Lakes and beyond. 23 million Americans live within the Great Lakes basin and we contribute more than $3 trillion in GDP with our maritime economy. Our economic health and the resilience of our communities is firmly connected to our coasts. As a social scientist, and anthropologist, I have worked to understand the connections between people and these places.

Today I will focus on three aspects of climate science that are of particular importance to people in coastal communities: changing water levels; changing habitats, and changing water temperatures and chemistry.

Changing Water Levels

My office sits 10 feet from the St Louis River Estuary and a short boat ride to the open waters of Lake Superior. Right now, water levels are 15 inches higher on average than they were between 1918 and 2017. April precipitation topped historic averages by at least 24%. Region-wide, we are projected to reach or exceed record high water levels. NOAA and others warn that, coupled with more frequent and intense storms, this increases our risk for severe coastal flooding like what is happening today in northwest Ohio and southeast Michigan.

Understanding the relationship between lake levels and climate change is complicated, involving regional models, ground and surface water, and ice cover change. Lake levels and flooding have increased because we are experiencing more frequent and intense precipitation events and more rain than snow in winter. Last month the City of Ashland suffered heavy rains which forced five million gallons of untreated sewage into Lake Superior. Last year, Wisconsin's coastal counties experienced multiple severe storms, *one* of which resulted in more than $3.5 million in damages. In 2012, a 500-year storm destroyed infrastructure, roads and businesses in the Twin Ports. Flood damage at our local university approached $24 million, while the Duluth area suffered $100 million in damage. In the past seven years, our region has had 9 Federal disaster declarations related to severe storms and flooding.

The ability to predict and plan for changing water levels is critical for all Great Lakes communities. It affects infrastructure, property values, shipping, dredging, public health, and quality of life. Analysis and modeling from NOAA's Great Lakes Environmental Research Lab is already focused on understanding the connection between global warming and lake levels to project future trends. However, scientists agree that further research is required to prepare communities as they plan for the future.

While we are grateful for past congressional support, continued federal investment in reserves and other monitoring programs is needed. It makes good sense to forecast future changes accurately so that local governments have the information they need to invest in grey and natural infrastructure, reduce flooding, and minimize damage to roads, stormwater systems and businesses. The Lake Superior Reserve and our partners are already hard at work on these critical issues. I am happy to share some examples:

- Duluth residents are piloting natural infrastructure as a strategy to reduce storm damage, thanks to a collaboration between Minnesota Sea Grant and NOAA that developed tools to visualize potential flood impacts and gauge the use of natural infrastructure to mitigate flooding.

- Lake Michigan communities have access to better tools to manage bluff erosion, including a new device that measures bluff movement so residents can protect their property from landslides. Partners include the University of Wisconsin-Madison, Wisconsin Sea Grant, and the University of Michigan.

Many challenges brought about by changing water levels in the Great Lakes are shared by marine communities, and reserves are working with them to meet these head on.

- Florida's Flagler County now has access to improved modeling tools to support adaptation planning and flood management, thanks to our Guana Tolomato Matanzas reserve.

- Communities across the Gulf of Mexico have access to enhanced sea level rise data and storm surge models that they are using to assess the vulnerability of built and natural infrastructure. These tools were supported by our Florida, Mississippi, and Alabama reserves.

- In Texas, the City of Rockport is using a vulnerability assessment conducted by the Mission-Aransas reserve to reduce economic and property losses related to changing water levels.

Changing Habitats

Coastal habitats are rich, vibrant systems that serve as shelter and nursery for valuable fisheries

and thousands of species of birds and wildlife. *But they are changing*. As water levels increase, temperatures warm, water chemistry changes, and storms intensify, habitats are lost or dramatically altered, native species struggle to survive and invasive species take hold. This impacts the survival of the very species that drew people to settle in coastal areas in the first place. In the Ojibwe origin story, their ancestors traveled around Lake Superior until they found a place where wild rice, or manoomin, grew on the water. Today, changing water levels and other factors threaten the future of wild rice—not just in our region where we partner with the Fond Du Lac Band of Lake Superior Chippewa—but across the upper Great Lakes. This threatens Ojibwe heritage and identity; children cannot be properly named without a wild rice ceremony.

Essential to coastal habitat conservation and restoration are advances in our understanding of natural shorelines as a way to mitigate flooding and increase ecological resilience. Reserves work with many partners to understand the biophysical science behind replacing hardened shorelines with natural features and the social and economic impacts of these investments. This requires a social science lens and the ability to pull together builders, contractors, engineers, scientists, managers and local decision makers to translate the science and explore potential solutions. Reserves do this well. Here are two examples.

- Permanent monitoring stations at the Lake Superior and Ohio reserves are providing data decision makers need to protect water quality, species, and habitat, while reducing community flooding. These stations track changes resulting from more intense storms, increased sediment, and nutrient runoff.

- Enhanced recreation and tourism opportunities are improving visitor experiences on Wisconsin Point, a beloved local beach, thanks to an ongoing restoration project supported by NOAA, the City of Superior, and the Lake Superior Reserve.

As a networked system of 29 reserves, we know salt marshes are struggling to keep pace with sea level rise, and communities are contemplating whether to support marsh migration in already crowded coastal watersheds. What will they lose? What will they gain? What are the costs? They must balance questions like these with ones about how best to protect or migrate infrastructure, property, and roads. All 29 reserves are helping communities address these questions with the best science, data, and information.

- Alaska's Kachemak Bay reserve supported a model of regional groundwater flows that is informing decisions to protect habitats for salmon, the state's most important fishery. This is of value to Alaskans because Coho and Chinook salmon depend on freshwater habitats that are changing due to reduced snowpack, altered rain patterns, and wetland drying.

- Florida's Apalachicola reserve provides science to address critical local issues, including the impact of salinity on the bay's oysters, which have suffered a 90% decline in recent years. Reserve monitoring tracks the influence of upstream water diversions, land use change, climate change, hurricanes, and other natural events on local water quality.

- Endangered native birds and fish have returned to the He'eia Estuary as a result of restoration, supported by monitoring and outreach from Hawaii's He'eia reserve. Their work removes invasive mangroves, encourages natural freshwater flows, restores habitat, provides food for communities, and supports management as a traditional Hawaiian ahupua'a.

- The invasive marsh grass Spartina—which was threatening the local oyster industry—was eradicated from Washington's Padilla Bay, as a result of a combined monitoring and restoration initiative. Today, regional resource managers look to the reserve for information and guidance for invasive species removal and control.

Changing water chemistry and temperature

When I came to Lake Superior almost seven years ago, everyone referred to algal blooms as something for the lower Great Lakes, especially Lake Erie. They couldn't happen in Superior; it's the biggest, deepest, coldest, most oligotrophic (nutrient poor) Great Lake! Fast forward to today: there have been three documented algal blooms in the last two years. Why? Research tells us that storms and sediment plumes play a role. These events are expected to intensify. Even more concerning is scientific monitoring and modeling from the University of Minnesota Duluth's Large Lakes Observatory, which shows that Lake Superior is warming faster *than almost any lake on Earth*. And, the research shows, this is clearly climate driven.

Warming waters complicate everything. They compromise water quality, which impacts tourism and fisheries, accelerate habitat change, increasing the likelihood that native species will be overcome by invasives and—when combined with damaging storms and floods—put public health at risk. Along our marine coasts, warmer temperatures are contributing to ocean acidification, which threatens hard shelled creatures, like lobsters and oysters, around which many local economies have been built.

Some impacts of changing water temperatures are well understood. The really complicated science, however, focuses on the human dimensions of these problems. How to communicate risk? How to connect decisions made up watershed with degraded water quality on the coast? Social scientists such as anthropologists, economists, and communication experts are exploring questions like these in the context of climate projections.

It is critical that Congress continue to invest in science to understand trends in acidification, marsh migration, sea level rise, saltwater intrusion, and harmful algal blooms. By doing this, our

partners in coastal communities will be better prepared to make decisions that mitigate economic loss and reduce risk to public health. Programs across the region are responding to the need to predict and manage harmful algal blooms:

- The Lake Superior reserve is working with the public health community to reduce algal blooms by improving monitoring efforts. This summer we will collect water samples immediately following storm events to better understand bloom formation.

- Milwaukee decision makers will soon have access to enhanced technology for real-time, early-warning detection of blooms, with support from Sea Grant. With support from NOAA and partners, this technology will provide forecasts to inform local governments and public health experts about risks to residents and tourists.

Through our national network, we know that coastal water temperatures, chemistry, and quality are in flux around the country. Communities are dealing with harmful algal blooms and dead zones, pollution from legacy industries and current events, amid the more basic biogeochemistry of wetlands. Here again, reserves are supporting their communities.

- Continuous monitoring from Florida's Rookery Bay reserve demonstrated that estuaries protected by conservation land are more resilient to large storms. During Hurricane Irma, reserve instruments captured the storm surge, extraordinary rainfall, and the subsequent dissolved oxygen crash. Fisheries monitoring showed that fish left the estuary when the oxygen crashed and returned as the oxygen levels return to normal.

- In Alaska, the Kachemak Bay reserve's potentially lifesaving shellfish toxin alerts are provided to state officials, commercial oyster farms, and thousands of recreational and subsistence shellfish harvesters.

Emerging Trends

As a social scientist, I would like to conclude with some observations on what all of this change will mean for people. In recent years, we have seen the warmest temperatures recorded, powerful storms, increased flooding from sea level rise and storm surge, devastating wildfires, and the melting of glaciers and polar sea ice. These accelerating patterns of change are affecting how everyone lives, works, and plays on all U.S. coasts. They affect businesses and industries, public health, and everyone's psychological well-being.

In the Great Lakes, we expect public health will suffer due to more extreme heat, increased water temperatures, degraded water quality, reduced air quality in urban areas, changes to agricultural systems, and the spread of vector borne diseases like Lyme. Not all populations or communities will suffer these impacts equally. At-risk communities are more vulnerable to climate change, and tribal nations are especially so because of their reliance on threatened natural resources for

their cultural, subsistence, and economic needs.

Research to address these challenges is becoming a larger part of the coastal science portfolio because communities demand it. They are calling for us to assess the vulnerabilities of people, alongside environmental concerns so they can better manage risks and increase overall resilience particularly as they relate to vulnerable populations.

At the Lake Superior Reserve, we coordinate a diverse network of experts to explore the human side of climate change. We are at the forefront of work examining the mental health impacts of solastalgia, or the grief and anxiety that comes from the loss of ecosystems, species, landscapes, and identity due to environmental change. This work involves natural and social scientists, public health and medical experts, social workers, and those serving on the front lines of tragedy. We are joined by our colleagues in Tribal communities who bring the strength of Traditional Ecological Knowledge and an understanding of the impacts of lost heritage, identity, and place. Sadly, their difficult work is helping us see parallels with what Lake Superior residents are all beginning to experience as the region changes in front of our eyes.

The Lake Superior reserve, the 28 sister reserves that make up our national system, and all of our many partners will continue to support the baseline monitoring and interdisciplinary research that coastal communities need to understand how climate change is influencing their lives and the places in which they live. We could not have accomplished what we have so far without strong federal and state investments in coastal science programs embedded in local communities, or without the Research Reserve's System-wide Monitoring Program that continually assesses changing water levels, water quality and habitats. Thank you, again, to Congress for your investments in all our programs. It is critical that these continue if we are to ensure that future science is focused on issues of vital importance to our coastal communities, neighbors, families and friends.

Thank you for your time and consideration.